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1 Introduction

1.1 Purpose and Organization of the Planning Study Report

This is the Planning Study Report for the San Francisquito Creek, San Francisco Bay to Searsville Dam Flood Protection Project (Project). The purpose of this report is to document the Project objectives, flooding and erosion problems, the development and evaluation of solutions to these problems, and provide a staff-recommended alternative to solve these problems. This report includes the following:

- Project Origins, Objectives, and Location (Chapter 1)
- Study Background (Chapter 2)
- Problem Definition (Chapter 3)
- Project Outreach (Chapter 4)
- Formulation and Evaluation of Alternatives (Chapter 5)
- Staff-Recommended Project (Chapter 6)
- Description of the Maintenance Program (Chapter 7)
- Project Cost, Funding, and Schedule (Chapter 8)
- Conclusions and Recommendations (Chapter 9)

1.2 Project Origin

In November 2000, the voters of Santa Clara County approved the Clean, Safe Creeks, and Natural Flood Protection Program (CSC Program), 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, the District initiated the Project to address flooding problems, potentially improve water quality, potentially restore habitat areas, and provide recreation opportunities.

The District completed flood protection and erosion protection projects on San Francisquito Creek in 1955, 1958, 1969, and 2003. Erosion along the creek, which is influenced by Searsville Dam, is common and flooding along the creek has occurred in 1955, 1958, 1982, 2002 and 2005.

1.3 Project Objectives and Relevant Board End Policies

The mission of the District is a healthy, safe, and enhanced quality of living in Santa Clara County through watershed stewardship and comprehensive management of water resources in a practical, cost-effective, and environmentally sensitive manner.

The objectives of the SFC Project are listed below:

- Prepare a planning study to provide one-percent riverine flood protection to over 3,000 homes and businesses. CSC Program Commitment and Board Ends Policy No. E-3, Article 3.2—“Reduced potential for flood damages”.

• Restore ecosystem quality, habitat, and function where possible. Board Ends Policy E-4, Article 4.1—“Protect and restore creek, bay, and other aquatic ecosystems”.

• Minimize project impacts on the environment – both long range and during construction. Board Ends Policy No. E-3, Article 3.1.2—“Preserve flood conveyance capacity and structural integrity of stream banks, while minimizing impacts on the environment and protecting habitat values”.

• Identify opportunities to provide recreation and access to San Francisquito Creek. Board Ends Policy No. E-4, Article 4.2.1—“Support healthy communities by providing access to additional trails, parks and open space along creeks and in the watersheds”.

1.4 Project Location

As delineated in Figure 1-1, the project area limits for the SFC Project include approximately 14 miles of San Francisquito Creek as it extends from the base of the Searsville Dam (built in 1892) within Stanford University’s Jasper Ridge Preserve to its terminus in South San Francisco Bay approximately 2.5 miles south of the Dumbarton Bridge.

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Figure 1-1: Map of San Francisquito Creek Project Limits
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2 Study Background

This chapter provides a description of the San Francisquito Creek watershed. Information on the creek, watershed hydrology, geology, utilities, biological resources, hazardous materials, and related projects is provided in the following sections.

2.1 Description of the Creek

2.1.1 Map of Channel Reaches
For planning purposes, the creek within the project area has been divided into reaches, as shown in Figure 2-1 and described in Section 2.1.2. Although the reaches were delineated for uniformity of channel characteristics such as cross section dimensions, slope, and hardscape, erosion and flooding problems can vary significantly within each reach, and similar erosion and/or flooding problems may occur within different reaches.

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2.1.2 San Francisquito Creek
San Francisquito Creek begins at the confluence of Corte Madera Creek and Bear Creek below Searsville Dam in the Jasper Ridge Preserve on land purchased by Stanford University in 1892. The creek is joined by Los Trancos Creek at a location just north of Interstate 280. From its beginning, the creek runs approximately 14 miles from southwest to northeast, and after exiting the foothills of the Santa Cruz Mountains near Junipero Sera Boulevard and Alpine Road, runs...
in an incised channel in a broad alluvial fan before emptying into the San Francisco Bay south of the Dumbarton Bridge and north of the Palo Alto Flood Basin.

The San Francisquito Creek watershed is approximately 45 square miles in extent and includes areas of Santa Clara and San Mateo counties. In one stretch it forms the boundary between the city of Palo Alto and the cities of Menlo Park and East Palo Alto, and between Santa Clara and San Mateo counties, reflecting the fact that it was originally used as the boundary between the lands of the Spanish Missions at Santa Clara and San Francisco.

San Francisquito Creek can generally be characterized as a channel with straight alignment, trapezoidal cross sections, and levees with maintenance roads between the San Francisco Bay and U.S. Hwy 101, an incised channel with extensive concrete channel protection between U.S. Hwy 101 and El Camino Real, and natural channel with extensive bank erosion between El Camino Real and Searsville Dam.

The creek has been divided into four primary reaches to reflect the general characteristics described above. Reach 2 has been additionally divided into five sub-reaches for alternative formulation and evaluation, Figure 2-2.

Each of the eight reaches are defined below.

**Figure 2-2:** Map of Reach 2

**Reach 1-** (San Francisco Bay to U.S. Hwy 101) includes:
- A 1.5 mile earthen channel with levees
- Four bridge crossings (one pedestrian, and a concrete culvert at U.S. Hwy 101 that extends beneath three roadways)
- A very flat invert slope of 0.05%
Daily tidal influence

Reach 2A- (U.S. Hwy 101 to Newell Road) includes:
- A 0.6 mile open channel that has been heavily encroached upon by urban residential development
- An 84% hardscape channel lining (e.g. sacked-concrete, concrete walls, rock slope protection)
- A 1,000 foot long floodwall extending upstream from U.S. Hwy 101 in Santa Clara County
- Two bottle-neck channel constrictions
- One bridge crossing with abutments located in the channel
- One potential fish passage barrier (concrete curb) located near Clarke Avenue
- A flat slope of 0.2%
- Daily tidal influence

Reach 2B- (Newell Road to University Avenue) includes:
- A 0.4 mile open channel that has been heavily encroached upon by urban residential development
- A 62% hardscape channel lining
- Two bottle-neck channel constrictions
- One bridge crossing with abutments located in the channel
- A flat slope of 0.1%

Reach 2C- (University Avenue to Pope/Chaucer Street) includes:
- A 0.8 mile open channel that has been heavily encroached upon by urban residential development
- A 49% hardscape channel lining
- Two bottle-neck channel constrictions
- One bridge crossing with a culvert and two pedestrian bridges
- A flat slope of 0.2%
- A residence that is situated in the low flow channel

Reach 2D- (Pope/Chaucer Street to Middlefield Avenue) includes:
- A 0.9 mile open channel that has been heavily encroached upon by urban residential development
- A 24% hardscape channel lining
- One bridge crossing with a culvert
- A flat slope of 0.3%

Reach 2E- (Middlefield Avenue to El Camino Real) includes:
- A 1.0 mile open channel that has been heavily encroached upon by urban residential development
- A 11% hardscape channel lining
- One bridge crossing with abutments located in the channel, one pedestrian bridge, and one Cal Train bridge
- Two fish passage barriers:
  - downstream from Waverly Street (three concrete weirs)
  - at the El Camino Real crossing (bridge apron)
- A flat slope of 0.3%
Reach 3- (El Camino Real to Sand Hill Road) includes:
- A 2.0 mile open channel that has been heavily encroached upon by urban residential development
- A 26% hardscape channel lining
- Two bridge crossings (one with abutments located in the channel)
- A flat slope of 0.5%
- Numerous creek bank erosion sites

Reach 4- (Sand Hill Road to Searsville Dam) includes:
- A 6.8 mile open channel that has been moderately encroached upon by urban residential development from Sand Hill Road to Alpine Road
- Hardscape channel lining is undetermined but expected to be no more than 10%
- Eleven bridge crossings (four with piers in the channel, four golf cart/pedestrian bridges, two pedestrian bridges, and one with abutments located in the channel)
- Four fish passage barriers:
  - approximately 300 feet downstream from Junipero Serra Blvd (golf cart crossing)
  - approximately 300 feet upstream from Junipero Serra Blvd (USGS gage weir)
  - approximately 300 feet downstream from the confluence with Los Trancos Creek (denil fish ladder)
  - at Searsville Dam
- A flat slope of 0.6%

(The remainder of page intentionally left blank.)

Table 2-1 below gives a description of the general characteristics of each reach. Following the table are photos (Figures 2-3 to 2-11) characterizing the channel in each reach.
Table 2-1: Existing Reach Characteristics for San Francisquito Creek

<table>
<thead>
<tr>
<th>Reach</th>
<th>Downstream Limit</th>
<th>Upstream Limit</th>
<th>Length (mi)</th>
<th>Tidally Flushed</th>
<th>Number of bridges</th>
<th>Number of Bottle-necks</th>
<th>Flood-walls</th>
<th>Leves</th>
<th>Percent of Hard-scape</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>San Francisco Bay</td>
<td>u/s face West Bayshore Road</td>
<td>1.5</td>
<td>YES</td>
<td>4</td>
<td>0</td>
<td>NO</td>
<td>YES</td>
<td>NA</td>
</tr>
<tr>
<td>2A</td>
<td>u/s face West Bayshore Road</td>
<td>u/s face Newell Road</td>
<td>0.6</td>
<td>YES</td>
<td>1</td>
<td>2</td>
<td>YES</td>
<td>NO</td>
<td>84%</td>
</tr>
<tr>
<td>2B</td>
<td>u/s face Newell Road</td>
<td>u/s face University Avenue</td>
<td>0.4</td>
<td>NO</td>
<td>1</td>
<td>2</td>
<td>YES</td>
<td>NO</td>
<td>62%</td>
</tr>
<tr>
<td>2C</td>
<td>u/s face University Avenue</td>
<td>u/s face Pope/Chaucer Street</td>
<td>0.8</td>
<td>NO</td>
<td>3</td>
<td>2</td>
<td>YES</td>
<td>NO</td>
<td>49%</td>
</tr>
<tr>
<td>2D</td>
<td>u/s face Pope/Chaucer Street</td>
<td>u/s face Middlefield Avenue</td>
<td>0.9</td>
<td>NO</td>
<td>1</td>
<td>0</td>
<td>NO</td>
<td>NO</td>
<td>24%</td>
</tr>
<tr>
<td>2E</td>
<td>u/s face Middlefield Avenue</td>
<td>u/s face El Camino Real</td>
<td>1.0</td>
<td>NO</td>
<td>3</td>
<td>0</td>
<td>NO</td>
<td>NO</td>
<td>11%</td>
</tr>
<tr>
<td>3</td>
<td>u/s face El Camino Real</td>
<td>u/s face Sand Hill Road</td>
<td>2.0</td>
<td>NO</td>
<td>2</td>
<td>0</td>
<td>NO</td>
<td>NO</td>
<td>26%</td>
</tr>
<tr>
<td>4</td>
<td>u/s face Sand Hill Road</td>
<td>Searsville Dam</td>
<td>6.8</td>
<td>NO</td>
<td>11</td>
<td>0</td>
<td>NO</td>
<td>NO</td>
<td>NA</td>
</tr>
</tbody>
</table>

Percent of Hardscape: This refers to the percentage of the reach length that is lined with hard-scape (e.g. concrete wall, sacked-concrete, rock slope protection, rip-rap, etc.). Date taken from the Bank Stabilization and Channel Characteristics.
Figure 2-3: Reach 1, Earthen Channel in tidal zone: Looking southwest (upstream) from a location north of the Friendship Bridge, note bay mud bottom and brackish tidal vegetation.

Figure 2-4: Reach 2A, Concrete lined channel with District Floodwall within tidal zone: Looking southwest (upstream) from Highway 101.
Figure 2-5: Reach 2A, Concrete lined channel with dense vegetation. Looking northwest (upstream) approx. 1,500 feet upstream from Highway 101.

Figure 2-6: Reach 2C, Channel partially lined with concrete. Looking west (upstream) near Emma Lane.
Figure 2-7: Reach 2D. Channel banks covered with dense vegetation and moderate bank erosion. Looking west (upstream) from Pope/Chaucer Street crossing.

Figure 2-8: Reach 2E, Channel partially lined with concrete. Looking west (upstream) from Middlefield Road.
Figure 2-9: Reach 2F, Incised channel with bank erosion and dense vegetation. Looking west (downstream) from El Camino Real.

Figure 2-10 Reach 2G,

INSERT PHOTO

Figure 2-11 Reach 3,

INSERT PHOTO

Comment [KS1]: Confirm location with KM Murray
2.2 Hydrology

2.2.1 Historical Background
The hydrology of San Francisquito Creek began to experience modifications as a result of early Spanish settlers who established large Ranchos in the 1830s. These early ranchers likely constructed irrigation ditches to transport water and ford crossings at creeks. In 1876, former Governor Leland Stanford acquired 8,800 acres which later became the Stanford University campus. In 1887, the Manzanita Water Company (later the Crystal Springs Water Company) constructed Searsville Dam on Stanford land. The dam, completed in 1891, was intended to supply water to Stanford University. Due to fine suspended sediment and odor, the water was non-potable and was therefore used for irrigation purposes. Today the dam is nearly filled with sediment which has created wetland habitat for water fowl, bats, and other species.

2.2.2 General Watershed Description
The Bay Area has a Mediterranean climate with mild wet winters and warm dry summers. Coastal ocean currents moderate the effects of seasonal changes in temperature. The Santa Cruz Mountains impose a moderate rain-shadow (or orographic) effect to their east in the San Francisquito Creek watershed. This orographic effect contributes to variability in average annual precipitation in the watershed, ranging from about 40 inches at the crest of the mountains to approximately 15 inches in Palo Alto (National Weather Service, Palo Alto Gage 046646).

As shown in Figure 2-1, the San Francisquito Creek watershed drains the eastern slope of the Santa Cruz Mountains between Kings Mountain and Russian Ridge. The three largest tributaries to San Francisquito Creek are Bear, Corte Madera, and Los Trancos creeks.

The largest sub-watershed in the upper basin (roughly 15 square miles) drains via Corte Madera Creek to Searsville Reservoir. San Francisquito Creek starts at the confluence of Corte Madera Creek and Bear Creek, downstream from Searsville Dam, and flows into the South Bay about 2.5 miles south of the Dumbarton Bridge. Bear Creek contributes unregulated flows from the northwestern portion of the watershed. Los Trancos Creek joins San Francisquito Creek between Interstate 280 and Junipero Serra Boulevard. Downstream from this point, there are no additional large tributaries and the drainage basin narrows dramatically.

Continuous-record stream flow stations historically operated by USGS on San Francisquito Creek and its tributaries are summarized in Table 2-2. From 1931 to 1941, and then from 1951 to the present, USGS has maintained a continuous-record stream flow station along San Francisquito Creek at Stanford University, just upstream from Junipero Serra Boulevard, about 1.1 miles downstream from Los Trancos Creek in Reach 3 (USGS Station 11164500).

(The remainder of page intentionally left blank.)
Table 2-2: Continuous-Record Streamflow Stations on San Francisquito Creek and Tributaries

<table>
<thead>
<tr>
<th>Station Name</th>
<th>USGS Station Number</th>
<th>Period of Record</th>
<th>Area (square miles)</th>
<th>River Mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Francisquito Creek at Searsville Dam (staff gage on spillway crest)</td>
<td>None 11164500</td>
<td>1892 – 1913</td>
<td>–</td>
<td>12.7</td>
</tr>
<tr>
<td>San Francisquito Creek at Stanford University</td>
<td>11165000</td>
<td>1931 – 1941; 1950 to present</td>
<td>37.5</td>
<td>7.6</td>
</tr>
<tr>
<td>San Francisquito Creek at Menlo Park</td>
<td>11165000</td>
<td>1931 – 1941</td>
<td>38.3</td>
<td>5.4</td>
</tr>
<tr>
<td>San Francisquito Creek at Palo Alto</td>
<td>11165500</td>
<td>1934 – 1936</td>
<td>38.4</td>
<td>4.6</td>
</tr>
<tr>
<td>Los Trancos Creek near Stanford University</td>
<td>11163000</td>
<td>1930 – 1941</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Los Trancos Tributary near Stanford University</td>
<td>11163200</td>
<td>1958 – 1966</td>
<td>0.42</td>
<td>–</td>
</tr>
<tr>
<td>Los Trancos Creek at Stanford University</td>
<td>11163500</td>
<td>1930 – 1941</td>
<td>7.46</td>
<td>–</td>
</tr>
</tbody>
</table>

Key:
– = Not applicable
USGS = U.S. Geological Survey

The maximum instantaneous peak flow recorded at San Francisquito Creek at the Stanford University station occurred February 3, 1998, with a peak of 7,200 cfs. Other notable floods exceeding 5,000 cfs occurred in 1894, 1895, and 1911 (based on reconstructed records), and measured floods greater than 5,000 cfs occurred on December 22, 1955 (5,560 cfs), and January 4, 1982 (5,220 cfs) (JPA, 2004a; Kittleson et al., 1996; USACE, 1972). Daily flow measurements at San Francisquito Creek at the Stanford University station demonstrate strong seasonal variation in stream flow, with portions of the creek drying up during summer months. Low-flow measurements at San Francisquito Creek at the Stanford University station typically occur in the late summer or early fall, before winter rains begin.

2.2.3 Design Flows
The District has modeled peak flow rates and probabilities of exceedance for San Francisquito Creek and three tributaries using a rainfall-runoff model (District, 2007). Modeled peak flows for various return periods are shown in Table 2-3.

(The remainder of page intentionally left blank.)
## Table 2-3: Peak Flows for San Francisquito Creek

<table>
<thead>
<tr>
<th>Location</th>
<th>Drainage Area (square miles)</th>
<th>Peak Flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2.3 year</td>
</tr>
<tr>
<td>Bear Creek upstream from San Francisquito Creek</td>
<td>11.85</td>
<td>620</td>
</tr>
<tr>
<td>San Francisquito Creek upstream from Searsville Reservoir</td>
<td>14.65</td>
<td>840</td>
</tr>
<tr>
<td>San Francisquito Creek downstream from Searsville Reservoir</td>
<td>14.65</td>
<td>840</td>
</tr>
<tr>
<td>San Francisquito Creek downstream from Bear Creek</td>
<td>26.5</td>
<td>1,600</td>
</tr>
<tr>
<td>San Francisquito Creek upstream from Los Trancos Creek</td>
<td>29.61</td>
<td>1,600</td>
</tr>
<tr>
<td>Los Trancos Creek upstream from San Francisquito Creek</td>
<td>7.65</td>
<td>200</td>
</tr>
<tr>
<td>San Francisquito Creek downstream from Los Trancos Creek</td>
<td>37.26</td>
<td>1,800</td>
</tr>
<tr>
<td>San Francisquito Creek at Stanford University station</td>
<td>37.62</td>
<td>1,800</td>
</tr>
<tr>
<td>San Francisquito Creek at El Camino Real</td>
<td>41.2</td>
<td>1,900</td>
</tr>
<tr>
<td>San Francisquito Creek at U.S. Route 101</td>
<td>44.55</td>
<td>1,900</td>
</tr>
<tr>
<td>San Francisquito Creek at Palo Alto Airport in Santa Clara County</td>
<td>46.17</td>
<td>2,100</td>
</tr>
</tbody>
</table>

Source: District 2007

Key:
cfs = cubic feet per second
USGS = U.S. Geological Survey

### 2.3 Geology

San Francisquito Creek flows out of the Santa Cruz Mountains and onto a coalesced alluvial fan or apron near Junipero Serra Boulevard (Fio and Leighton, 1995; Metzger, 2002). The creek has deeply incised the alluvial fan sediments along much of its course, leaving steep banks that are often 25 feet high. Metzger (2002) prepared a geological profile along San Francisquito Creek downstream from Alameda de Las Pulgas Road based on well records. It shows a layer of coarse channel bed material (gravel, cobbles, and boulders) extending downstream from Alameda de Las Pulgas Road as far downstream as Middlefield Road. The coarse pavement (armor layer) on the channel bed was formed by a winnowing of finer sediment from the bed surface; the underlying subsurface material appears to be considerably finer. The 1892 completion of Searsville Dam on Corte Madera Creek, and subsequent reduction of coarse sediment supply while peak flows were maintained, is thought to be a contributing factor to formation of the pavement. The coarse sediments overlie a sandy deposit that continues in the streambed to downstream from U.S. Route 101 to the Palo Alto Municipal Golf Course. A thick layer of bay sediments with lenses of alluvium extends at depth beneath the sand upstream to about San Mateo Drive, forming a shallow aquifer beneath the fan (Metzger, 2002). These bay sediments are underlain at depth by older, more consolidated alluvium. The channel has had
roughly the same alignment on the fan since the end of the nineteenth century (nhc et al., 2002).

2.4 Soils

The soils of the flatlands along lower San Francisquito Creek are relatively young and undeveloped. They consist of undeveloped loam north of the creek and silty clay loam and loam to the south (Helley et al., 1979). These soils are composed of fine particles (e.g., silt, clay) that were transported as suspended sediment derived from upstream sources and deposited overbank during flood events. The texture and characteristics of these soils affect how quickly water can infiltrate the ground surface. As a result, the soil is important for determining the volume of storm runoff, its timing, and its peak rate of flow.

The soils along lower San Francisquito Creek have textures that imply average water-holding properties. As a result, they offer some buffering capabilities for controlling runoff and subsequent flooding. Underlying soils in the Palo Alto area include natural levee deposits, which are porous and permeable and provide conduits for transport of groundwater, alluvium, and fluvial deposits, consisting of gravelly and clayey sands, clayey gravel, and sandy clays; alluvium and fluvial deposits, consisting of brown, dense, gravelly and clayey sand, or clayey gravel that fines upward to sandy clay; and artificial fill, consisting of gravels, sands, silts, clays, rock fragments, organic matter, and man-made debris.

2.5 Subsidence

Land subsidence has occurred in the study area as a result of overdraft pumping of the groundwater basin. It is estimated that subsidence began around 1920. The ground level has dropped as much as 2.5 feet in the study area since that time, with the greatest amount of subsidence occurring in the tidal area near the South Bay.

The result of land subsidence is a higher water surface elevation in the creek relative to the now lower adjacent land. Land subsidence is an irreversible process and once it has occurred, the loss in ground surface elevation is permanent. It is estimated that subsidence around the South Bay was stopped in approximately 1970, when groundwater pumping decreased substantially due to successful management of the water supply by the District. Since 1958, when the earthen levee channel was first constructed in Reach 1 between U.S. Hwy 101 and the South Bay, approximately 1 foot of subsidence has occurred near these levees.

2.6 Utilities

As San Francisquito Creek runs through an urban environment of a major cities, a plethora of utilities run adjacent to or over them. The relocation, protection, or avoidance of these utilities could have a significant impact on work in or around the creek.

The typical utilities are expected to cross San Francisquito Creek at major road crossings. In addition, there are known utilities running over or adjacent to the creek. Significant utilities include:

- In Reach 1 - High-tension overhead electric lines and high-pressure gas transmission lines are within an easement adjacent to and over the channel.
• In Reach 2 - Sanitary sewer, water service, and surface water drainage conduit occur beneath Woodland Avenue.
• In Reach 2 – Overhead electric lines occur adjacent to Woodland Avenue.

2.7 Biological Resources

San Francisquito Creek originates in the Jasper Ridge Preserve and flows eastward through a mix of agricultural, business park, light industrial, and residential settings before reaching the coastal habitat associated with South San Francisco Bay. A number of special-status plant and animal species have been recorded, or have the potential to occur in the project area. These species include Central California Coast steelhead, California red-legged frog, California tiger salamander, California clapper rail, salt marsh harvest mouse, western burrowing owl, and western leatherwood. Additionally, species covered under the Migratory Bird Treaty Act likely use habitats within the project area for roosting, nesting, and foraging. Occurrences of these species within the project area may restrict or preclude the development of flood management improvements within specific locations.

Approximately 140 acres of jurisdictional wetlands and other waters of the U.S. (Section 404 of the Clean Water Act) have been identified within the project area (south of U.S. Hwy 101). Construction of flood management improvement facilities in these areas may result in the loss of wetlands and other waters of the U.S.

2.8 Hazardous Materials (Soil and Water)

2.8.1 Soil

The study area encompasses a significant amount of urban lands. As a first step toward a Phase I Environmental Site Assessment, a records review was conducted for properties along a corridor of 500 feet on either side of San Francisquito Creek. The types of environmental impacts, or potential impacts, within the project area were found to be wide-ranging.

No properties within the creek corridor were determined to have higher than a “moderate” risk in the assessment. Nine properties near the creek received a risk of “moderate” in the assessment, and twelve near-creek properties received a relative risk of “low-moderate.” These properties all had documented land use that involved hazardous materials, but none had significant documented contamination. Most of these properties are very close to San Francisquito Creek. Properties determined to have a “low” or “probably low” relative risk comprise more than half of the properties in the corridor and do not warrant further investigation.

San Francisquito Creek does not traverse any true industrial areas, and well over 50 percent of the corridor is of very little pertinent concern (i.e., residential, open space). Within older residential areas, some of the residences had, or may still have, small fuel oil tanks (for former heating systems). These tanks have an overall low likelihood of creating significant contamination problems because the heating oil has both a low mobility and relatively low toxicity. Therefore, the older residential areas with heating oil tanks were not deemed to be a Hazardous Toxic Radioactive Waste (HTRW) concern.

Due to the highly developed nature of the project study area, follow up work is recommended. The next step in the Environmental Site Assessment process will be to conduct a Phase 1 Hazardous Substance Liability Assessment (HSLA) to determine potential concerns related to the recommended project.
2.8.2  Water
The San Francisquito Creek watershed includes urban, agricultural, and rural land use areas. Urban areas contribute storm water and urban dry weather runoff that can carry contaminants, including trace metals, industrial chemicals, lawn and garden care chemicals, nutrients, and trash. The Long-Term Monitoring and Assessment Program (LTMAP) is a water quality sampling program for San Francisquito Creek sponsored by Stanford University and the City of Palo Alto, and managed by the San Francisquito Watershed Council. Additional water quality monitoring has been funded by the Clean Estuary Partnership, an organization formed by a memorandum of understanding among the San Francisco Bay Regional Water Quality Control Board (RWQCB), Bay Area Storm Water Management Agencies Association, and Bay Area Clean Water Agencies.

Numerous water quality standards and objectives have been established for the study area, and several established and planned programs address water quality concerns, including development of TMDLs for contaminants. The contaminants and parameters of interest to both the region and the study area are grouped into four broad categories:

- Fisheries habitat parameters, including, turbidity, water temperature, and DO.
- Bioaccumulative contaminants, including mercury/methylmercury, PCBs, and legacy organochlorine pesticides (chlordane, dichloro-diphenyl-trichlorethene (DDT), dieldrin).
- Nonbioaccumulative toxic contaminants, including diazinon and other contemporary use pesticides, and trace metals
- Other contaminants including trash

2.9  Related/Nearby Projects

This section briefly describes past and present studies, projects, and programs that are relevant to the project.

San Francisquito Creek General Investigation Study

The San Francisquito Creek Feasibility Study is a congressionally authorized feasibility study conducted by the U.S. Army Corps of Engineers (Corps), with the San Francisquito Creek Joint Power Authority (JPA) as the local sponsor. This study will determine the feasibility of a federally funded project to reduce flood damages, restore ecosystems and create recreational opportunities within the San Francisquito Creek watershed. Many of the tasks being completed for the feasibility study are informing the planning of capital projects on which the JPA and its member agencies may begin construction ahead of final federal appropriations for the feasibility study. These capital projects will be considered elements of the preferred plan, and will be eligible for future federal credit against final construction costs of the preferred plan.

Early Implementation Project

The Early Implementation Project (EIP) was initiated by the JPA to provide a limited flood damage reduction effort as an interim measure to the U.S. Army Corps of Engineers San Francisquito Creek General Investigation Study. The EIP project will complete design 2012. This project is supported by the District’s Early Implementation Flood Protection Project (project number 26284002).
The EIP project’s goals include improving flood protection, habitat, and recreational opportunities within the reach from East Bayshore Road to the South Bay. Specific objectives include protecting properties and infrastructure between U.S. Route 101 and the South Bay from San Francisquito Creek flows resulting from the one-percent flow event, in conjunction with a one-percent tide event and projected sea level rise; accommodating future flood protection measures farther upstream from the project that may be constructed; enhancing habitat along the project reach, particularly habitat for threatened and endangered species; enhancing recreational uses; and minimizing operational and maintenance requirements.

Caltrans Highway 101 Project

The California Department of Transportation (Caltrans) is currently planning and designing a project to replace the U.S. Route 101 (and frontage roads) crossing over San Francisquito Creek to improve traffic flow. Caltrans will coordinate with the JPA so that the U.S. Route 101 bridge structure will match JPA improvements for the channel to provide flood protection, should a one-percent flow event occur at the same time as a high-tide event (JPA, 2011). Construction is scheduled to begin in 2013. The JPA will be responsible for designing and constructing the inlet from the creek at the upstream face of West Bayshore Road and the downstream face of East Bayshore Road.

Upstream of U.S. Highway 101 Project

Since the fall of 2009, the JPA and Water District have been analyzing capital improvements necessary to provide one-percent flood protection for the flood prone reach of San Francisquito Creek upstream of U.S. Highway 101. Creek capacity improvements being analyzed include bridge replacement, channel widening and naturalization, floodwall construction or enhancement, a bypass culvert, and an upstream detention facility. It is likely that a suite of these alternatives will be required to address the flooding problem.

This analysis is being conducted locally, but adheres to Corps planning standards such that the analysis can be included as a component of the Corps Feasibility Study, making the costs of the analysis eligible for credit against future federal appropriations for the Study. It is also important to note that improvement to the flow capacity would not be constructed until project improvements at U.S. Highway 101 and downstream to the San Francisco Bay are completed. This project is supported by this Planning Study Report (project number 26284001).

South San Francisco Bay Shoreline Study

The South San Francisco Bay Shoreline Study (Shoreline Study) is a congressionally-authorized study being performed by the District with the Corps and other local sponsors to identify and recommend, for Federal funding, one or more projects for flood damage reduction, ecosystem restoration and related purposes such as public access. The Shoreline Study will be funded through a partnership among the District, the Corps, and the Conservancy. The U.S. Fish and Wildlife Service, the State Department of Fish and Game and the City of San Jose are also involved in the planning process.

The purpose of the Shoreline Study is to identify and recommend projects for funding which meet the following goals:

- Restore up to 3.5 square miles of wetland habitat
- Protect urban areas next to north San Jose and Alviso from tidal flooding and the critical waste water treatment plant—a one-percent high tide could cause an estimated $34.5 million (1981 value) in flood damages
- Provide public access, education and recreation
- Adapt to sea level rise
- Create the west coast’s largest restored wetland with extensive habitat for federally endangered species and migratory birds and enhanced public access

The study shares common goals with the South Bay Salt Pond Restoration Projects, such as tidal flood protection, habitat improvement and wildlife oriented public access, education and recreation.

South Bay Salt Pond Restoration Project

The South Bay Salt Pond Restoration Project (SBSP Project) is a currently active project encompassing approximately 15,100 acres of former salt ponds located around the edge of South San Francisco Bay. The SBSP Project is led by the California State Coastal Conservancy (Conservancy), the U.S. Fish and Wildlife, and the California Department of Fish and Game. The SBSP Project is the largest wetlands restoration project on the West Coast of the United States. The SBSP Project is intended to restore and enhance wetlands in South San Francisco Bay while providing for flood management and wildlife-oriented public access and recreation. The SBSP Project objectives are:

1. Create, restore, or enhance habitats of sufficient size, function, and appropriate structure to:
   - Promote restoration of native special-status plants and animals that depend on South San Francisco Bay habitat for all or part of their life cycles.
   - Maintain current migratory bird species that utilize existing salt ponds and associated structures such as levees.
   - Support increased abundance and diversity of native species in various South San Francisco Bay aquatic and terrestrial ecosystem components, including plants, invertebrates, fish, mammals, birds, reptiles and amphibians.

2. Maintain or improve existing levels of flood protection in the South Bay Area.
3. Provide public access and recreational opportunities compatible with wildlife and habitat goals.
4. Protect or improve existing levels of water and sediment quality in the South Bay, and take into account ecological risks caused by restoration.
5. Implement design and management measures to maintain or improve current levels of vector management, control predation on special status species, and manage the spread of nonnative invasive species.
6. Protect the services provided by existing infrastructure (e.g., power lines, railroads).

Bay Division Pipeline Reliability Upgrade Project

The San Francisco Public Utilities Commission (SFPUC) is undertaking a water system improvements project to upgrade major distribution pipelines and bore a new tunnel under San Francisco Bay to carry Hetch Hetchy water to over 2.5 million residents in Alameda, Santa Clara, San Mateo, and San Francisco counties. The Bay Division Pipeline Reliability Upgrade
Project is among the largest of the SFPUC Water System Improvement Program projects to seismically upgrade, repair, and replace the aging Hetch Hetchy water system. The pipeline will replace the current Bay Division Pipelines 1 and 2, between Fremont and Redwood City, and Bay Division Pipelines 3 and 4, through the South Bay and Silicon Valley. The pipeline is planned to begin at the Irvington Portal in Fremont, pass through Don Edwards San Francisco Bay National Wildlife Refuge (Refuge), and end at the Bay Peninsula, with a tunnel segment under San Francisco Bay beneath Menlo Park. The 5-mile-long portion of the proposed tunnel under San Francisco Bay and adjacent marshlands is referred to as the “Bay Tunnel” project. The project Notice of Preparation (NOP) was released in 2006 and construction is scheduled to be completed in 2015 (SFPUC, 2008).

Don Edwards San Francisco Bay National Wildlife Refuge Comprehensive Conservation Plan

The U.S. Fish and Wildlife Service (USFWS) is initiating the planning process for preparation of a comprehensive conservation plan (CCP) for the Refuge. The Refuge comprises approximately 30,000 acres of tidal wetland, mudflat, salt pond, seasonal wetland, upland grassland, and subtidal habitat bordering portions of Alameda, Santa Clara, and San Mateo counties in the South Bay. It is one of the seven refuges within the San Francisco Bay National Wildlife Refuge Complex. Several Federally listed species and state species of concern use the Refuge, and it is also a significant Pacific Flyway stopover for migratory waterfowl and shorebirds.

The CCP will include a detailed 15-year management plan with specific direction on protecting and managing listed species and migratory birds, habitat enhancement and restoration, climate change, public access, water quality, historic and cultural resources, land use, and land acquisition. The CCP Notice of Intent (NOI) was released in 2010 and the CCP is scheduled to be completed in September 2012 (USFWS, 2010).

East Palo Alto Bay Access Master Plan

Created by the City of East Palo Alto Redevelopment Agency, the East Palo Alto Bay Access Master Plan (BAMP) was designed to organize a vision for San Francisco Bay access and future development of the Ravenswood Business District (RBD). Its direction is a guide for East Palo Alto policy makers and the Bay Conservation Development Commission (BCDC). BAMP includes plans for a series of San Francisco Bay pocket parks that are connected by pedestrian trails. The three main goals of BAMP are to assist BCDC by prioritizing San Francisco Bay access and RBD projects to reflect the needs of East Palo Alto residents, provide guidance to policy makers who are analyzing and shaping projects and plans along San Francisco Bay and within the RBD, and create a vision of an open space "emerald necklace" that will make RBD-planned new office space and communities more attractive and desirable. Because the BAMP is a conceptual planning document only, it is exempt from National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA), (City of East Palo Alto Redevelopment Agency, 2007).

Palo Alto Emergency Water Supply Project

The California Department of Health Services designated the City of Palo Alto as not having the recommended amount of water supply for emergency water situations. The Palo Alto Emergency Water Supply Project was led by the City of Palo Alto to address the deficiency in the city’s emergency water supply. The Hetch Hetchy aqueduct system provides 100 percent of the City of Palo Alto’s water supply. Specific project goals included allocation of a stand-alone
emergency water system, 8-hour supply of maximum-day water demand for all areas during an emergency shutdown of the Hetch Hetchy system, maintaining city fire system reserves, and possible water supply supplementation for drought needs. To achieve these goals, the project included the following actions: rehabilitating existing city wells, constructing new wells, constructing a new 2.5-million-gallon (MG) water storage reservoir and pump station, and altering the existing Mayfield Pump Station. The project NOP was released in 2006 and project construction was completed in 2010 (City of Palo Alto, 2010a).

**San Francisco Bay Area Regional Rail Plan**

The San Francisco Bay Area Regional Rail Plan was a joint effort, created by the Metropolitan Transportation Commission (MTC), the Peninsula Corridor Joint Powers Board (Caltrain), the Bay Area Rapid Transit District (BART), and the California High-Speed Rail Authority (CHSRA). The plan was finalized in September 2007 and includes a long-range vision for improving and expanding the passenger rail system in the San Francisco Bay Area (Bay Area) to address travel demands and an anticipated population growth in the region of 40 percent by 2050. This population growth will place tremendous pressure on the existing transportation network. Specific plans include construction of a rail network that connects San Francisco, Oakland, and San Jose, using Caltrain and BART as the network’s backbone. The plan NOI/NOP was released in 2005. Overall, the plan reviewed improvements and extensions of railroad, rapid transit, and high-speed rail services for the near term (5 to 10 years), intermediate term (10 to 25 years), and long term (25 years and beyond).

**Stanford University Habitat Conservation Plan**

Stanford University, in partnership with USFWS and the National Marine Fisheries Service (NMFS), developed a habitat conservation plan (HCP) for Stanford University lands in April 2010. The HCP is intended to ensure the land’s long-term protection of endangered species as the university grows, and includes concentrated conservation efforts in high-priority areas, long-term habitat protection, restoration and protection of riparian areas, habitat enhancement, implementation of a conservation credit system, and monitoring and adaptive management practices. The HCP NOI was released in 2006 and implementation of the HCP began in 2009.

**Steelhead Habitat Enhancement Project**

Stanford University HCP actions for structural modifications and operational changes to the Los Trancos Creek and San Francisquito Creek Pumping Station diversions, and accompanying maintenance to restore storage capacity at Felt Reservoir, are known as the Steelhead Habitat Enhancement Project (SHEP). Design for the proposed modifications and operating protocols for SHEP were finalized by Stanford, in consultation with the California Department of Fish and Game (DFG), and NFMS. NMFS issued a Biological Opinion (BO) to the Corps for the project in April 2008, and the CEQA process was completed in August 2008. Construction of SHEP was completed in late 2009. The new protocols substantially increase flows through the fish ladder, which enhances conditions for steelhead migration and spawning. These enhancements also accommodate the upstream and downstream movement of juvenile steelhead.

**Other District Flood Protection Projects in the San Francisquito Creek Watershed**

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 are described below.

**Interim Flood Channel Improvements, 1955**

After the 1955 flood, the District lined approximately 800 linear feet of the south bank in Santa Clara County with sacked concrete upstream of Highway 101; in Reach 2 between Highway 101 and Newell Road.

**Interim Flood Channel Improvements, 1958**

Following the floods of 1958, the District constructed about 800 linear feet of low berm along the south bank which was previously lined with sacked concrete in 1955. The District also placed approximately 2,200 linear feet of sacked concrete along the south bank between this berm and the bridge at Newell Road (Figure 2-11). In the same year, the SMCFCD constructed low floodwalls along Woodland Avenue in Menlo Park in San Mateo County, upstream of Highway 101 (Figure 2-12).

![Figure 2-11: 1955, 1958 Channel Improvements in Reach 2a](Image)

(The remainder of page intentionally left blank.)
Also in 1958, Reach 1 was excavated, graded, and widened in a cooperative effort between the District and the SMCFCD (Figure 2-13). Levees were repaired and improved to carry a design flow of 7,100 cfs with 1.5 to 2 feet of freeboard. Based on the terms of an agreement made in September of 1958, the District prepared plans and specifications, advertised for bids, inspected construction, and advanced all necessary funds for the project. The SMCFCD agreed to reimburse the District for half of the construction costs. In addition, each party was responsible for acquiring rights-of-way within its respective jurisdiction. The District agreed to maintain the levee on the southeasterly side of the creek in Santa Clara County, and the SMCFCD agreed to maintain the levee on the northwesterly side of the creek in San Mateo County.

(The remainder of page intentionally left blank.)
Interim Flood Channel Improvements, 1969

In 1969, "Interim Flood Control Measures" were implemented in Reach 2 between Highway 101 and Middlefield Road, in a cooperative effort between the SMCFCD and the District. The project included the 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 (Figure 2-14). The improvements were designed to increase the capacity of San Francisquito Creek to 6,000 cfs. It is not known if design freeboard was provided. The project was designed as an interim measure to reduce residential flooding while a permanent solution was to be studied and implemented.
These interim projects reduced the risk of damage to many residential properties and, in 1972 the USACE did not find economic justification to fund a project on San Francisquito Creek.

San Francisquito Creek Levee Project, 2003

In 2003, members of the SFCJPA completed a levee restoration project in Reach 1. The primary objectives of the project were to partially restore the original level of flood protection to the area downstream of Highway 101 by restoring the levees to their 1958 elevations and to provide supplemental flood protection to the area until a comprehensive multiyear planning study could be completed for the entire watershed. In addition to levee improvements in Reach 1, the project also constructed approximately 1,000 linear feet of concrete floodwall extending upstream from West Bayshore Road along the Santa Clara County side of Reach 2.

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3 Problem Definition

3.1 Creek Flooding

This section describes the past and current flooding problems along San Francisquito Creek. It is broken into four sub-sections describing flooding which has occurred along the channel in the past, existing hydraulic structures, the existing District floodplain/Federal Emergency Management Agency (FEMA) Federal Insurance Rate Map [FIRM], and the locations of potential flooding either due to channel overtopping or freeboard deficiency.

3.1.1 Historic Flooding
San Francisquito Creek has a history of recurring floods which have adversely impacted the safety and economic stability of the residents, businesses, and government property within the flood plain. Flooding within the watershed has been documented as far back as 1910, and historical flood events reported for the creek are summarized below.

Reach 1 and 2 - December 1955

The largest flood on record for San Francisquito Creek prior to 1998 occurred during December 1955. The San Francisquito Creek flow at the USGS station (#11164500) located at the Stanford University golf course measured 5,560 cfs. During this flood, San Francisquito Creek overtopped its banks in several locations in Reaches 1 and 2, including the bridge at Middlefield Road, the bridge at Pope/Chaucer Street, the bridge at U.S. Route 101, and two locations along the low levees upstream from U.S. Hwy 101 (Corps, 2005). The flood inundated about 1,200 acres of commercial and residential property, about 70 acres of agricultural property, and the Palo Alto Airport and Palo Alto Municipal Golf Course.

Reach 1 - April 1958

In April 1958, a flow of 4,460 cfs, measured at the USGS station (#11164500), caused a levee failure in Reach 1, with subsequent flooding of the Palo Alto Airport, Palo Alto Municipal Golf Course, and City of Palo Alto Landfill to depths of up to 4 feet. In addition, water backed up behind the U.S. Hwy 101 bridge over San Francisquito Creek, causing over-banking upstream from the highway.

Reach 1 and 2 – 1878, 1980, 1982

Several high-flow events caused scour and erosion problems in 1978, 1980, and 1982. During each of these events, erosion occurred along Palo Alto Avenue, especially near Waverly Street and between Fulton Street and Middlefield Road. In 1982, the creek overtopped its banks near Alpine Road, at University Avenue, and downstream from U.S. Route 101, at a flow of 5,220 cfs measured at USGS station (#11164500). Flows were probably several hundred cfs greater at locations downstream from El Camino Real. Extensive erosion caused damage to private and public property, undermining roads and destroying fences, retaining walls, and private bridges.

Reach 2 – 1995

In 1995, a flow of 3,320 cfs, measured at USGS station (#11164500), caused water to back up in the local drainage system, resulting in localized flooding near U.S. Route 101.
Reach 1 and 2 – February 1998

The maximum instantaneous peak flow recorded at the San Francisquito Creek at USGS station (#11164500) occurred on February 3, 1998, with a peak of 7,200 cfs. After record rainfalls, San Francisquito Creek overtopped its banks and inundated over 11,000 acres of land in Palo Alto, East Palo Alto, and Menlo Park, affecting approximately 1,700 residential and commercial structures. The 1998 flood caused an estimated $28 million in damages in Palo Alto, East Palo Alto and Menlo Park; $25.5 million of this was residential damages, largely in Palo Alto where 1,155 homes were damaged. In East Palo Alto (San Mateo County), 533 homes were damaged and 325 people were evacuated. In Menlo Park seven homes were damaged. U.S. Hwy 101 was also closed, as were numerous other streets (DISTRICT, 2000). The peak flow as measured by the USGS gaging station located near the Stanford University golf course was 7,200 cfs, which is approximately a 25-year to 50-year event (Corps, 2010). It is likely that flows in Reaches 1 and 2 occurring downstream from the USGS station (#11164500) were several hundred cfs greater during this event.

3.1.2 Flood Photos

![Figure 3-1: High Flow Event at Upstream Face of Pope/Chaucer Street (2003)](image)

(The remainder of page intentionally left blank.)
Figure 3-2: High Flow Event at Upstream Face of West Bayshore Road (2005)

Figure 3-3: High Flow Event at Upstream Face of West Bayshore Road (2010)
3.1.3 Existing Hydraulic Structures
This section describes structures that influence San Francisquito Creek hydraulics, including levees and bank protection, bridges, water management reservoirs, and pump stations.

Levees and Pump Stations

In Reach 1, from U.S. Hwy 101 to the South Bay, San Francisquito Creek is lined with earthen levees, as shown in Figure 3-4. The District maintains the levee on the southeastern side of the creek, and SMCFCD is responsible for maintenance on the northwestern side of the creek.

Two pump stations that alleviate local flooding from the storm drain system are located in Reach 1, in East Palo Alto and Palo Alto (Figure 3-4). The East Palo Alto pump station is located next to the O’Connor Street pedestrian bridge, which is roughly 3,000 feet upstream from the mouth of the creek. It was designed to handle approximately 230 cfs of local storm water runoff.

In 2009, a new pump station was constructed in Palo Alto on the south side of San Francisquito Creek immediately downstream from U.S. Route 101. This pumping facility is designed to handle up to 300 cfs of local storm water runoff, with submersible axial flow pumps discharging through an energy dissipating structure, and a constructed wetland channel to provide mitigation habitat and prevent creek erosion. This pump station shuts down when San Francisquito Creek water levels are high at East Bayshore Road (Schaaf and Wheeler, 2007).

Figure 3-4: Existing hydraulic structures in Reach 1
Floodwalls and Bank Protection

In 2003 the JPA constructed a concrete masonry unit (CMU) floodwall on the south side of the creek which extends from U.S. Hwy 101 to about 1,000 feet upstream from U.S. Hwy 101 in Reach 2a (Figure 3-5). A sacked concrete floodwall continues upstream from the end of the CMU floodwall to approximately 900 feet downstream from University Avenue. On the north side of the creek, a concrete gravity wall (constructed by SMCFCD in 1958) extends from approximately 1,000 feet upstream from U.S. Hwy 101 to approximately 1,400 feet downstream from University Avenue.

![Figure 3-5: Existing hydraulic structures in Reach 2](image-url)
Bridges

Several bridges in Reach 2 do not have adequate capacity to allow passage of the one-percent flood event. Existing bridge and upstream creek conveyance capacities and their corresponding design flows are shown in Table 3-1.

Table 3-1: San Francisquito Creek Design Flows and Existing Bridge and Creek Capacities

<table>
<thead>
<tr>
<th>Bridge</th>
<th>Reach</th>
<th>Design Flow¹ (cfs)</th>
<th>Existing Capacity (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1%</td>
<td>10%</td>
</tr>
<tr>
<td>El Camino Real</td>
<td>2e</td>
<td>9,200</td>
<td>4,700</td>
</tr>
<tr>
<td>Middlefield Road</td>
<td>2d</td>
<td>9,300</td>
<td>4,800</td>
</tr>
<tr>
<td>Pope/Chaucer Street</td>
<td>2c</td>
<td>9,300</td>
<td>4,800</td>
</tr>
<tr>
<td>University Avenue</td>
<td>2b</td>
<td>9,300</td>
<td>4,800</td>
</tr>
<tr>
<td>Newell Road</td>
<td>2a</td>
<td>9,300</td>
<td>4,800</td>
</tr>
<tr>
<td>U.S. Hwy 101</td>
<td>1</td>
<td>9,300</td>
<td>4,800</td>
</tr>
</tbody>
</table>

Source: SCVWD (2012)

Notes:
1. Per District (2012)
2. Bridge capacities are defined as the maximum quantity of flow prior to weir flow over the bridge deck.
3. Creek capacities are defined at the top of the channel immediately upstream from the corresponding bridge.

Figure 3-6: Existing bridge constrictions in Reach 2
The locations of Reach 2 bridges are shown in Figure 3-6. The San Francisquito Creek channel has limited stream flow capacity in Reach 2 near Middlefield Road and Pope/Chaucer Street; bridges at these locations present significant flow constriction points. As described above, San Francisquito Creek overtopped its banks at the Middlefield Road and Pope/Chaucer Street bridges during the 1955 and 1998 flood events. The openings under these two bridges are limited compared to the adjacent channel cross sections.

Bridges in Reaches 1 and 2 are undersized to convey the one-percent flow event, however, overtopping at Middlefield road and Pope/Chaucer streets combine to effectively reduce flows such that downstream bridges, with the exception of U.S. Hwy 101, are not expected to be overtopped in a 100-year flood event.

**Hwy 101 (Reach 1)**

In 1959, the Bayshore Freeway was widened by several lanes. The resulting three bridges are structurally connected and span San Francisquito Creek at West Bayshore road, U.S. Highway 101, and East Bayshore road. The new bridgework was added to the upstream side of the existing Bayshore Freeway leaving the inadequate bridge undisturbed. As a result, the limited flow area remained unchanged and subsequent overtopping has occurred both upstream and downstream from the bridge. To complicate matters further, sediments deposited by fluvial transport from upstream reaches and tidal forces from the San Francisco Bay tend to collect beneath the bridge system and effectively reduce the bridge cross sectional area and conveyance.

The bridge system at U.S. Hwy 101 includes three rectangular bays with wingwalls at the upstream and downstream faces. Each bay is approximately 14 feet tall and 30 feet wide and extends continuously from the upstream bridge face at West Bayshore road to the downstream bridge face at East Bayshore road with the exception of a gap in the roof of each bay between West Bayshore road and U.S. Hwy 101.

Under existing bridge and creek conditions, loss of flow due to upstream breakouts reduce the one-percent design flow (9,300 cfs) to 6,292 cfs. Under these conditions, the one-percent flow is expected to overtop the bridge deck at West Bayshore road by approximately 1.7 feet. The fully developed project design flow (9,300 cfs) would overtop the bridge deck by 3.9 feet.

The existing flow capacity of the system of bridges at U.S. Hwy 101 is about 4,600 cfs (DISTRICT, 2012). However, Caltrans is currently planning and designing a project to replace U.S. Hwy 101 (and both frontage roads) crossing over San Francisquito Creek to improve traffic flow, and has agreed to improve the floodwater capacity of U.S. Hwy 101 bridge structure to provide flood protection should a one-percent flood event occur at the same time as a high-tide event (JPA, 2011). The District is working with Caltrans via the JPA to coordinate inlet and outlet transitions from the new bridge at U.S. Hwy 101 with this planning study and the District’s EIP.

**Newell (Reach 2a)**

The Newell Road bridge over San Francisquito Creek, owned by the City of Palo Alto, is approximately 100 years old and includes a single span with abutments located within the creek banks. The road profile is situated approximately 2.2 feet above the top of bank.
University Avenue (Reach 2b)

The University Avenue bridge over San Francisquito Creek, owned by the City of East Palo Alto, is approximately 87 years old and includes a single span with abutments located within the creek banks. The road profile is situated approximately at the top of bank.

Pope/Chaucer Street (Reach 2c)

The Pope/Chaucer Street bridge over San Francisquito Creek, owned by the City of Palo Alto, is approximately 105 years old and includes a single span with abutments located within the creek banks. The road profile is situated approximately at the top of bank.

Middlefield Road (Reach 2d)

The Middlefield Road bridge over San Francisquito Creek, owned by the City of Menlo Park, is approximately 76 years old and includes a single span with abutments located within the creek banks. The road profile is situated approximately at the top of bank.

The remaining bridges within the project reaches are not significantly impacted by one-percent flow events for existing conditions or the fully developed design flow.

Water Management Reservoirs

There are four major water management reservoirs in the San Francisquito Creek watershed: Searsville Reservoir, Felt Reservoir, Lagunita Reservoir, and Bear Gulch Reservoir. Reservoir information is detailed in Table 3-2. Additionally, there are several small reservoirs and water diversion structures in the watershed. The four reservoirs described below have a minor effect on flood risk management because their volumes are not very large compared to inflows, and they are often already full when large floods occur. Additionally, flood flows are diverted around Felt Lake to avoid siltation (JPA, 2004a; Corps, 1972). Bear Gulch Reservoir is located upstream from Searsville Reservoir and is outside the study area.

<table>
<thead>
<tr>
<th>Structure Name</th>
<th>Purpose</th>
<th>Capacity (acre-feet)</th>
<th>Year Built</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Searsville Reservoir</td>
<td>Irrigation, Fire Protection</td>
<td>175¹</td>
<td>1890</td>
<td>Located on San Francisquito Creek; historically, flashboards installed during spring and removed during fall</td>
</tr>
<tr>
<td>Felt Reservoir</td>
<td>Irrigation</td>
<td>1,050</td>
<td>1930</td>
<td>Offstream reservoir that stores diversion from Los Trancos Creek</td>
</tr>
<tr>
<td>Lagunita Reservoir</td>
<td>Recreation</td>
<td>360</td>
<td>1880s</td>
<td>Offstream reservoir that stores diversions from San Francisquito Creek during spring, drained during summer</td>
</tr>
<tr>
<td>Bear Gulch Reservoir</td>
<td>Domestic</td>
<td>660</td>
<td>1896</td>
<td>On Bear Gulch Creek</td>
</tr>
</tbody>
</table>

Source: USACE (2011)

Notes:
1. Capacity of 250 acre-feet to be restored through maintenance dredging.
3.1.4 District Floodplain Map
Section 3.1.4 identifies channel overtopping locations along San Francisquito Creek. Due to updated hydraulic modeling, the project team has judged that the areas mapped upstream of El Camino Road do not experience channel overtopping and have adequate freeboard to meet FEMA requirements.

Figure 3-7 shows the 100-year (or one-percent) FEMA floodplain area for San Francisquito Creek. The one-percent FEMA flood map includes areas that have a one-percent chance of experiencing flooding at a one foot or greater depth for any given year. Residents and businesses within the FEMA one-percent flood zone are required to purchase costly flood insurance.

![District One-Percent Flood Risk Areas](image)

**Figure 3-7: District One-Percent Flood Risk Areas**

3.1.5 Locations of Channel Overtopping and Freeboard Deficiency
Based on hydraulic modeling of San Francisquito Creek using HEC-RAS (Corps, 2010), 25-year or greater flood events are expected to result in levee overtopping at multiple locations along the creek. Flows would break out of the channel at six locations for the 100-year (one percent) flood event, five locations for the 50-year flood event, and four locations for the 25-year flood event; all breakout locations are located in Reaches 1 and 2, and are shown in Figure 3-8.
Channel Overtopping

The six breakout locations for the one-percent flood event (Figure 3-8) are located on the left and right banks (looking downstream) of San Francisquito Creek upstream from the Middlefield Road bridge, on the left and right banks upstream from the Pope/Chaucer Street bridge, and on the left and right banks downstream from U.S. Route 101.

**Figure 3-8:** Flood Breakout Locations in Reaches 1 and 2

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As illustrated in Figure 3-9, Reach 1 has inadequate flow capacity for the 100-year (one-percent) flow event. In fact, the maximum flow capacity is approximately 4,400 cfs, which is between the 5-year and 10-year flood events (Corps, 2010).

In Reach 2, the floodwalls upstream from U.S. Hwy 101 to about 1,000 feet downstream from the University Avenue crossing are high enough to prevent water overtopping up to the 50-year flood event (Corps, 2010). However, earthen levees downstream from U.S. Hwy 101 are not high enough to prevent water overtopping during 25-year or greater flood events. Breakout flow characteristics are shown in Table 3-3. Bridges in Reach 2 at Middlefield Road, Pope/Chaucer Street, and U.S. Hwy 101 each present flow constriction and break out points for the one-percent event (Figure 3-8).

Riverine floodplain inundation modeling was conducted using the FLO-2D numerical model (Corps, 2010). Breakout hydrographs from the hydraulic modeling described above were input to the FLO-2D model to predict areas of inundation and flood-wave attenuation.

As mentioned, based on hydraulic modeling results (Corps, 2010), levee overtopping would occur in several locations in Reach 4, and in multiple locations along Reaches 1 and 2. No levee overtopping would occur in Reach 3. In Reach 4, the creek is confined by high ground; in-channel flows and overland flows are hydraulically interconnected.
In the northern floodplain area connected to breakout flows upstream from U.S. Route 101, overland flows would travel northeast as sheet flow in a broad band toward U.S. Route 101. At U.S. Route 101, floodwaters would pond in front of the highway noise walls and median barrier, and travel northwest along the highway, before spilling over the highway at the railroad crossing. Flows spilling over the highway would spread into commercial and industrial areas between U.S. Hwy 101 and State Route (SR) 84. Some flows would spill over U.S. Hwy 101 in the vicinity of Willow Road and cause minor flooding in residential and commercial areas on the north side of the highway. Maximum water depths would generally be less than 1 foot in areas of sheet flow; about 2 to 5 feet in ponded areas upstream from highways; and as deep as 7 to 16 feet in the topographic depression at U.S. Hwy 101 near the railroad crossing in Menlo Park. Maximum flow velocities would generally be less than 1 to 2 feet per second.

In the northern floodplain area connected to breakout flows downstream from U.S. Route 101, over-bank outflows would inundate residential areas located north of the highway and east of Clarke Avenue. Maximum inundation depths here would generally be 1 to 5 feet in the residential areas and 5 to 11 feet in topographic depressions along the outboard levee. Maximum flow velocities would generally be from 1 to 3 feet per second.

On the southern floodplain, the inundated area would include extensive residential areas between San Francisquito Creek and Matadero Creek south of U.S. Route 101, undeveloped lands on the north side of U.S. Route 101, and the Palo Alto Airport and Municipal Golf Course area. No water would spill over the outboard levee into Matadero Creek or the South Bay. Maximum flow depths would be up to about 1 to 3 feet in the inundated residential areas between San Francisquito Creek and Embarcadero Road; 1 to 4 feet near the Palo Alto Airport and Municipal Golf Course; and up to 3 to 6 feet in the ponded areas along the Matadero Creek.

### Table 3-3: Breakout Flow Summary for One-Percent event

<table>
<thead>
<tr>
<th>Breakout Location</th>
<th>Volume (acre-feet)</th>
<th>Duration (hours)</th>
<th>Peak Flow Rate (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upstream from Middlefield Road, Right</td>
<td>287</td>
<td>6.0</td>
<td>1,107</td>
</tr>
<tr>
<td>Upstream from Middlefield Road, Left</td>
<td>45</td>
<td>5.0</td>
<td>208</td>
</tr>
<tr>
<td>Upstream from Pope/Chaucer Street, Right</td>
<td>668</td>
<td>9.0</td>
<td>1,178</td>
</tr>
<tr>
<td>Upstream from Pope/Chaucer Street, Left</td>
<td>230</td>
<td>9.0</td>
<td>415</td>
</tr>
<tr>
<td>Downstream from U.S. Hwy 101, Right</td>
<td>221</td>
<td>12.5</td>
<td>293</td>
</tr>
<tr>
<td>Downstream from U.S. Hwy 101, Left</td>
<td>674</td>
<td>13.0</td>
<td>830</td>
</tr>
</tbody>
</table>

Source: USACE (2010)

Notes:
- Left and right with respect to facing downstream
levee. Maximum flow velocities would be about 0.5 to 2 feet per second in areas of shallow flooding and up to 2 to 5 feet per second in areas of deep flooding.

**Freeboard Deficiency**

Potential locations of flooding and/or freeboard deficiency along San Francisquito Creek have been identified using hydraulic engineering numerical analysis software (HEC-RAS). Table 3-4 summarizes locations where the channel does not meet FEMA freeboard standards (3.5 feet of freeboard in sections of channels with levees or floodwalls, 4 feet of freeboard within 100-feet of structures in sections of channels with levees or floodwalls), lack one-percent flow capacity, or both.

In addition, Table 3-4 summarizes the main cause(s) of the high water; “one-percent” refers to the 100-year flows, “tidal currents” refers to high tide effects, and “backwater” refers to channel constrictions.

Freeboard deficiency in each reach was determined by first adding the required freeboard to the one-percent water surface elevation and then subtracting the lowest top of bank elevation at each hydraulic cross section. Freeboard deficit calculations reported in Table 3-4 exclude the existing sacked-concrete floodwall and gravity wall in Reaches 2a and 2b because these structures are considered to be structurally insufficient for FEMA certification. Instead, calculations reference the existing ground at the outside base of either structure. For brevity of reporting, only the maximum freeboard deficiency for each reach is reported. The required freeboard heights used were: 4 feet within 100 feet of a bridge face of a leveed section, 3.5 feet in the main channel of a leveed section, and 1 foot along non-leveed sections of channel. These criteria are the same as the design criteria listed in Section 6.1. It should be noted that in some sections, it is possible for the channel to have one-percent flow capacity but to lack the required freeboard; for example the water surface could be a half-foot below the bank in a non-leveed section but would still require a half foot of freeboard.

The HEC-RAS model was originally developed by Noble Consultants under contract to Corps (2009). Geometric data was developed based on a channel topographic survey (Bestor Engineers) which was performed in 2008 and LIDAR data for the project area, both provided by Corps. The model extends from the creek mouth at San Francisco Bay to approximately one mile upstream of Interstate Hwy 280, with a total length of approximately 55,000 feet. To ensure accuracy, the model was calibrated and validated to three and four historic flooding events, respectively.

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3.2 Erosion Problems

This section is split into two sub-sections. The first describes erosion sites identified by the project team and the second describes the causes of erosion on the channel.

3.2.1 Erosion Sites

The project team has identified the locations and general sources of erosion problems within the project area. Significant bank erosion was not identified in Reach 1 and Reaches 2a through 2d where high flows access floodplains (Reach 1) and the channel is hardened by concrete protection (Reaches 2a through 2d). Serious bank erosion was identified for reaches located upstream from the bridge at Pope/Chaucer Street (Reaches 2d-2f) where bank protection is less frequent.

The level of erosion per reach is summarized in Table 3-5. Identified erosion sites are generally either slumping failures, toe erosion, or scour near structures or roads. These erosion problems have been determined based on review of the Bank Stabilization and Revegetation Master Plan (2000), the Geomorphic and Sediment Yield Analysis (2009), annual maintenance investigations performed by the JPA, and field visits by the project team.

As the extent of erosions along the creek is continually changing due to channel flows, the information in this section is considered preliminary and the exact locations and dimensions of the erosion will be finalized during the design phase of the project. While erosion is evident in reaches upstream from Middlefield Road, it is beyond the scope of this project to analyze all of
the erosion sites in San Francisquito Creek. As such, the project team has focused on erosion occurring downstream from Middlefield Road (Reaches 1 through 2d) where flood improvements are anticipated and on critical bank failures identified by the JPA in Reach 2f (Table 3-6).

Table 3-5: Level of Erosion along San Francisquito Creek

<table>
<thead>
<tr>
<th>Reach</th>
<th>Insignificant</th>
<th>Mild</th>
<th>Significant</th>
<th>Serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>R2a</td>
<td>94%</td>
<td>6%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>R2b</td>
<td>73%</td>
<td>5%</td>
<td>14%</td>
<td>9%</td>
</tr>
<tr>
<td>R2c</td>
<td>50%</td>
<td>22%</td>
<td>13%</td>
<td>15%</td>
</tr>
<tr>
<td>R2d</td>
<td>18%</td>
<td>18%</td>
<td>25%</td>
<td>39%</td>
</tr>
<tr>
<td>R2e</td>
<td>15%</td>
<td>17%</td>
<td>24%</td>
<td>44%</td>
</tr>
<tr>
<td>R2f</td>
<td>12%</td>
<td>15%</td>
<td>28%</td>
<td>45%</td>
</tr>
<tr>
<td>3</td>
<td>75%</td>
<td>25%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Source: Bank Stabilization Master Plan (2000)

(The remainder of page intentionally left blank.)
3.2.2 Causes of Erosion

Erosion problems along San Francisquito Creek Channels are pervasive and include historic invert erosion, localized scour, slumping failures, toe erosion, and undermining of hardscape features. They present a significant maintenance issue for the District because the erosion problems frequently threaten structures located adjacent to the top of the channel banks; i.e., the channel lacks sufficient floodplain.

Bank erosion occurs throughout the San Francisquito Watershed, primarily during extreme floods. On San Francisquito Creek significant bank damage occurred in February 1940, December 1955, April 1958, January 1982 and again during the 1997-98 El Nino storms (Corps 1972; San Francisquito Creek Coordinated Resource Management and Planning 1998; Cushing 2000). Erosion also occurred during earlier floods but was likely not documented because of the lack of damage to structures or property.

### Table 3-6: Erosion Sites along San Francisquito Creek Channel

<table>
<thead>
<tr>
<th>Reach</th>
<th>Station (ft)</th>
<th>Description</th>
<th>Side of Creek</th>
<th>Erosion Repair Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Begin</td>
<td>End</td>
<td></td>
<td>Length (ft)</td>
</tr>
<tr>
<td>R1</td>
<td></td>
<td></td>
<td>NO SIGNIFICANT EROSION</td>
<td></td>
</tr>
<tr>
<td>R2a</td>
<td></td>
<td></td>
<td>NO SIGNIFICANT EROSION</td>
<td></td>
</tr>
<tr>
<td>R2b</td>
<td>119+80</td>
<td>123+50</td>
<td>Toe erosion and slump failure</td>
<td>North</td>
</tr>
<tr>
<td>R2b</td>
<td>126+00</td>
<td>130+50</td>
<td>Toe erosion and slump failure undermining Woodland Avenue in East Palo Alto</td>
<td>North</td>
</tr>
<tr>
<td>R2c</td>
<td>134+50</td>
<td>135+50</td>
<td>Toe erosion and slump failure</td>
<td>North</td>
</tr>
<tr>
<td>R2c</td>
<td>141+00</td>
<td>142+80</td>
<td>Toe erosion and slump failure undermining Woodland Avenue in East Palo Alto</td>
<td>North</td>
</tr>
<tr>
<td>R2c</td>
<td>159+00</td>
<td>161+60</td>
<td>Toe erosion and slump failure undermining Woodland Avenue in East Palo Alto</td>
<td>North</td>
</tr>
<tr>
<td>R2c</td>
<td>164+50</td>
<td>166+50</td>
<td>Toe erosion and slump failure</td>
<td>North</td>
</tr>
<tr>
<td>R2c</td>
<td>164+50</td>
<td>166+50</td>
<td>Toe erosion and slump failure</td>
<td>South</td>
</tr>
<tr>
<td>R2c</td>
<td>169+50</td>
<td>171+00</td>
<td>Toe erosion and slump failure</td>
<td>South</td>
</tr>
<tr>
<td>R2c</td>
<td>174+00</td>
<td>176+50</td>
<td>Toe erosion and slump failure</td>
<td>North</td>
</tr>
<tr>
<td>R2c</td>
<td>178+00</td>
<td>180+00</td>
<td>Toe erosion and slump failure</td>
<td>North</td>
</tr>
<tr>
<td>R2c</td>
<td>186+00</td>
<td>208+00</td>
<td>Toe erosion and slump failure</td>
<td>South</td>
</tr>
<tr>
<td>R2c</td>
<td>188+00</td>
<td>194+00</td>
<td>Toe erosion and slump failure</td>
<td>South</td>
</tr>
<tr>
<td>R2d</td>
<td>198+00</td>
<td>202+20</td>
<td>Toe erosion and slump failure</td>
<td>North</td>
</tr>
<tr>
<td>R2d</td>
<td>204+00</td>
<td>206+00</td>
<td>Toe erosion and slump failure</td>
<td>South</td>
</tr>
<tr>
<td>R2d</td>
<td>206+00</td>
<td>208+00</td>
<td>Toe erosion and slump failure</td>
<td>North</td>
</tr>
<tr>
<td>R2d</td>
<td>208+00</td>
<td>210+00</td>
<td>Toe erosion and slump failure</td>
<td>South</td>
</tr>
<tr>
<td>R2d</td>
<td>218+00</td>
<td>220+00</td>
<td>Toe erosion and slump failure</td>
<td>South</td>
</tr>
<tr>
<td>R2d</td>
<td>222+00</td>
<td>224+00</td>
<td>Toe erosion and slump failure</td>
<td>South</td>
</tr>
</tbody>
</table>

The project team has identified several main causes of erosion problems along San Francisquito Creek, as detailed below. Each of the erosion sites identified by the project team may be due to one or more of these causes.

- Lack of an upstream sediment supply. Previous studies indicate that San Francisquito Creek is lowering its slope by incising from Sand Hill Road to Pope-Chaucer Road and by depositing sand and fine gravel on the bed downstream from Pope-Chaucer Bridge to the delta. The incision is assumed to result from slope adjustments that are a response to the capture of coarse sediment from Corte Madera and other creeks in Searsville Lake and also from increased peak flows from development. San Francisquito Creek is now incising into coarse, partly indurated gravels in the bed between El Camino Real and University Avenue and rates of incision have been quite slow, averaging about 0.012 feet/year from 1964 to 1998 (1.2 feet per century), and seem nearly negligible since 1998. Incision rates were likely greater earlier in the twentieth century.

- Insufficient floodplain or right-of-way corridor. This prevents the constructed channels from naturally evolving to a stable, geomorphic geometry.

- Intermittent hardscape and natural reaches of channel. Largely due to the existing narrow right-of-way corridor, the District has repaired bank erosion at many locations by lining the channels with sacked concrete, rip-rap, or concrete in areas where structures or property are threatened by erosion. This has led to reaches of channel with intermittent sections of hardscape and natural channel, leaving natural channel reaches particularly subject to further erosion problems.

- Multiple road crossings. San Francisquito Creek has 23 road, pedestrian, and golf cart bridges combined, three of which are concrete culverts. A number of these bridges (Piers Lane, El Camino Real, University Avenue, and Newell Road) include abutments located within the channel that effectively constrict and accelerate flow velocities and increase the potential for scour and deposition upstream and downstream from the bridges. Each of the culverts (Middlefield Road, Pope/Chaucer Street, and U.S. Hwy-101) provide similar scour and deposition hydraulics.

- Hydromodification of the watershed area due to urbanization and land development. For storms of the same recurrence interval, urbanization and land development decrease the watershed’s time of concentration and increase the peak flow rates.

- The project team relied on bank erosion information presented in the JPA’s Bank Stabilization and Revegetation Master Plan (2000) which was based on site evaluations conducted during 1998 and 1999. The project team recognizes that creek conditions may have worsened or improved since the Master Plan was completed.

- Chinese Mitten crab (Eriocheir sinensis) infestation may have a significant impact on bank stability within the project area.

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3.3 Sedimentation Problems

Sedimentation problems exist along San Francisquito Creek at Searsville Dam, between Pope/Chaucer Street bridge and U.S. Hwy 101 (Reach 2a through Reach 2c), and in Reach 1. Sedimentation in these areas is generally due to either the deposition of coarse gravels from incising beds and bank erosion occurring between El Camino Real and Sand Hill Road (Reach 2f and Reach 2g) or the sedimentation of silts and clays which form bay mud in tidally influenced reaches (Reach 1 and Reach 2a).

U.S. Hwy 101

Sediment deposition and the resulting loss of channel conveyance in the vicinity of U.S. Hwy 101 has been a long term problem for the District. On average, the District removed 1,700 cubic yards of sediment per year near U.S. Hwy 101 between 1997 and 2007.

Reach 1

Deposition has also occurred from Highway 101 to the mouth of San Francisquito Creek, a distance of some 7,500 feet. In 1958, this reach was lowered to an elevation of -3 to -4 feet and widened (San Francisquito Creek CRMP 1998). The excavated channel has since re-filled and has bars or berms of silty clay along the channel margins.

Searsville Lake

Searsville Lake is expected to fill with sediment in the next 15 to 40 years (NHC 2010). This will increase the volume and caliber of sediment contributed to San Francisquito Creek from the Searsville Lake subwatershed. The immediate geomorphic responses expected to result from Searsville filling (i.e. change to existing creek bed incision and bank erosion rates) are undetermined at this time, however, fifty-year sediment transport simulations (HEC-6T) indicate continued incision and lower flood levels upstream from Pope/Chaucer Street and continued aggradation and raised flood levels downstream of Pope/Chaucer Street (Figure 3-10).

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3.4 Sea Level Rise and Starting Water Surface Elevation

Modeling the effects of climate change on sea level rise is a complicated and evolving process. Many reputable government agencies and organizations, such as the Corps, the National Research Council (NRC), the Intergovernmental Panel on Climate Change (IPCC), and the Pacific Institute, are currently studying the effects of climate change due to global warming. A list of the sea level rise projections from these and other agencies entitled “Projections of Future Sea Level Rise,” was obtained from the District’s Office of Stewardship Planning. This list includes projections from 34 separate studies, all with varying results. For example, for the year 2050, low estimates of sea level rise range from 2.4 inches to 11.8 inches, and high estimates range from 12.0 inches to 23.6 inches.

Corps has published guidance for incorporating sea level rise considerations into Civil Works projects in the following document:

EC 1165-2-212, Sea-level Change Considerations for Civil Works Programs 01 Oct 11 (exp. 30 Sep 13).

Per FEMA’s Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix C, page C-36, November 2009, the following tidal boundary condition is applicable for flood insurance studies:

When the downstream boundary of a modeled stream is within a coastal tidal reach, the tidal boundary of the model is taken as equal to the Mean Higher High Water (MHHW) level of the nearby tide station. Location of the tide station(s)
must be verified to represent true downstream conditions. The tide level can be transferable to other locations along open coast...

Note that MHHW is the average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch (approximately 19 years) at the station.

In 2000, the Corps determined that the Mean Higher High Water (MHHW) tidal level to be 7.1 feet (NAVD 88). The tidal level of 7.1 feet was determined using the long-term record data from the Redwood City tidal level Station (Station ID: 9414523), administrated by the National Oceanic and Atmospheric Administration (NOAA). The Redwood City Station is the closest station to the creek mouth. For the historical flood events, the water levels at the creek mouth were assigned to be the highest tidal elevations measured at the NOAA Redwood City Station during these flood events.

A study conducted by the Corps in October 1984, San Francisco Bay, Tidal Stage vs. Frequency Study, determined the one-percent tidal water surface elevation for the San Francisco Bay near East Palo Alto as 10.35 feet (NAVD 88). Upon further investigation, the Corps discouraged the use of data in this document due to the dated nature of the report.

In 2010, the JPA directed HDR to assume a sea level rise equal to 26 inches (based on NRC Curve III). The 26 inches was added to the one-percent tidal elevation of 10.35 feet to produce a total tidal elevation of 12.52 feet.

Per the Draft Design Criteria Technical Memorandum (HDR, 2012) prepared for the District's EIP:

SFCJPA wishes to incorporate consideration of a coincident 100-year tide elevation and sea level rise into the Project design. SFCJPA has requested HDR to move forward using the results from Corps Shoreline Study. At the time this technical memorandum was released, the SFCJPA has directed the use of starting water surface elevation of 11.30 feet (NAVD 88), which is the Corps’s Shoreline Study determination of the 100-year tidal elevation including a yet undetermined value of sea level rise.

Hydraulic analysis provided in this planning study report include a starting water surface elevation of 11.3 feet.

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4 Project Outreach

One of the most important aspects of the planning process is the identification and participation of the interested parties within the project area. Interested parties include individuals, agencies, and organizations which may affect or be affected by the Project. These entities may have a vested interest in the goals, activities, implementation and outcomes of the project. The success of the project depends on the collaboration of these identified parties. Involving interested parties:

- Facilitates better decisions and better implementation of decisions;
- Facilitates buy-in and support for the project;
- Allows interested parties greater ownership of the project;
- Guards against the project becoming too inwardly focused and aids decentralized decision making; and
- Helps to identify issues not addressed by the project staff.

The majority of the stakeholder(s) are those affected by the project and those interested in possible impacts to the site from an environmental or regulatory perspective. Throughout the planning process, outreach activities have been conducted to inform the public of project progress and solicit public feedback. Several public meetings were held at milestones along the planning process. Finally, specific outreach activities have been conducted with local groups and resource agencies.

The Project will also hold public meetings as required by the CEQA. Other outreach efforts will be aimed at the appropriate regulators and environmental resource groups. The Project will continue to include outreach to the residential, commercial, and industrial districts within the Project area during the design and construction phases of this project.

4.1 Outreach to Public

The project team conducted outreach with the public for various project field investigations through flyers. Outreach materials were sent to property owners living adjacent to the creek or where work took place. Members of the public were also provided with status updates regarding the project at regularly scheduled JPA Board meetings and via the JPA website.

- **Topographic Field Work (May, 2007):** JPA mailed a flyer to approximately 340 residents adjacent to San Francisquito Creek and in the work area notifying them about topographic field work to be performed in their area.

- **Topographic Field Work (May, 2010):** District mailed a flyer to approximately 1,100 residents adjacent to San Francisquito Creek and in the work area notifying them about the topographic field work to be performed in their area.

- **Geotechnical Field Work (May, 2012):** District mailed a flyer to approximately 300 residents adjacent to San Francisquito Creek and in the work area notifying them about the geotechnical field work being performed in their area.

- **Regularly Scheduled JPA Board Meetings (Ongoing):** The JPA Board meets frequently throughout the year, and agency staff host and participate in discussion with community groups, city councils, and others.
4.2 Outreach to Public Agencies

Planning meetings were held with various affected local jurisdictions. These meetings were opportunities to discuss potential project benefits and impacts with the cities to collect feedback and comments. Local jurisdictions were also informed and represented at regularly scheduled JPA Board meetings by their respective JPA Board members.

- **Joint Study Session between JPA and Palo Alto City Council (Jan, 2006):** The study session reviewed background material regarding potential interim flood control improvements on San Francisquito Creek.

- **Regularly Scheduled JPA Board Meetings (Ongoing):** The JPA Board meets frequently throughout the year, and agency staff host and participate in discussion with community groups, city councils, and others.

Further outreach will continue, culminating in the official CEQA process.

4.3 Outreach to Regulatory Agencies

- **Joint Public NEPA/CEQA Scoping Meeting (Apr, 2006):** The scoping meeting was held in order to solicit comments and feedback on the appropriate scope for the EIS/EIR.

The project will require permits and consultation from several regulatory agencies including the United States Fish and Wildlife Service, the Army Corps of Engineers, the California Department of Fish and Game, the Regional Water Quality Control Board and the San Francisco Bay Conservation and Development Commission.

4.4 Outreach to Watershed Stakeholders

The project team has conducted outreach with various environmental and civic stakeholders in the project area. This effort was undertaken to inform the stakeholders of the project and its progress and to solicit early feedback.

- **Neighborhood Association Meeting (Jan, 2006):** A presentation was made to the Crescent Park Neighborhood Association highlighting the flood issues facing Palo Alto residents. The presentation also included hydraulic analysis prepared by Stanford University Professor (Steve Monismith) and recommended replacement of the Pope/Chaucer Street bridge.

- **Neighborhood Association Meeting (2009, 2010, 2011):** Presentations to the Crescent Park Neighborhood Association including project updates and conceptual planning developments were made in 2009, 2010, and 2011.

- **Neighborhood Association Meeting (Jun, 2012):** A presentation was made to the Crescent Park Neighborhood Association including an update of project alternatives and discussion of the District’s advertisement for consultant services to design a new bridge at Pope/Chaucer Street.
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5 Formulation and Evaluation of Alternatives

The District's planning process generally has three stages: the development of conceptual alternatives, the development of feasible alternatives and finally the development of a staff-recommended alternative. This chapter provides details on the alternatives developed in these processes and documents the evaluation used to select the staff-recommended project.

To date, the JPA has completed planning and is now preparing 90 percent designs for the Early Implementation Project (EIP) in Reach 1. As such, plan formulation tasks included in this planning study report begin in Reach 2 and continue upstream. A brief description of the conceptual alternatives evaluated for the EIP follows.

5.1 Alternative Selection for the Early Implementation Project (Reach 1)

District and JPA staff analyzed a number of conceptual plans to meet flood management objectives within the infrastructure and habitat constraints of Reach 1. To lower peak water levels relative to existing conditions, each alternative considered flood improvement features including excavated terraces, levee setbacks, floodwalls, and a bypass channel. The following conceptual alternatives were developed by the JPA ¹ for the EIP in Reach 1.

Alternative EIP-1: Floodwalls, offset levees with flood terraces, and an overflow bypass channel at Friendship Bridge

Under Alternative EIP-1, Reach 1 would be improved to provide one-percent channel conveyance and additional ecological habitat areas. This alternative included: floodwalls downstream from East Bayshore Road (upper Reach 1) where existing buildings and other infrastructure limit the project area; offset levees with terraced flood benches in the middle reach; and an overflow spillway to the Faber Tract near the creek’s outlet to San Francisco Bay (labeled 1 in Figure 5-1).

¹ Additional details for the EIP in Reach 1 are available in the San Francisquito Creek Flood Reduction Alternatives Analysis (Philip Williams and Associates, Ltd and Harvey and Associates, 2009).
Natural stream function would be improved under this alternative as the channelized creek would gain access to new floodplain areas via terraced flood benches provided by offset levees. This alternative would enable the creation of new tidal marshland habitat in areas where the widened creek channel is subject to daily tidal action. Additional stream function would be added by re-connecting San Francisquito Creek to the Faber Tract via an overflow bypass channel located just downstream from the Friendship Bridge. This alternative would reestablish connectivity between the high quality habitats of the Baylands Preserve and the creek channel. It would also restore a fluvial sediment source to the Baylands Preserve, which would serve to maintain equilibrium between marshplain elevations and rising sea levels.

Alternative EIP-2: *Increased offset levees with flood terraces, and an overflow bypass channel at Friendship Bridge*

Alternative EIP-2 improvements included one-percent channel conveyance by constructing offset levees and an overflow spillway to the Faber Tract similar to Alternative EIP-1 (Figure 5-2). Alternative EIP-2 however, replaces the floodwalls in the upper reach with setback levees and widens the setback extent of levees in the middle reach.
As a result of modifications to Alternative EIP-1, water surface levels for Alternative EIP-2 during high flow events were reduced (via increased conveyance area) and natural stream function improvements to marshland and riparian habitat area were increased due to widened floodplains.

Alternative EIP-3: Floodwalls, offset levees with flood terraces, bypass channel through golf course, and an overflow bypass channel at Friendship Bridge

Alternative EIP-3 improvements included one-percent channel conveyance by constructing floodwalls, offset levees, and an overflow spillway to the Faber Tract similar to Alternative EIP-1 (Figure 5-3). However, Alternative EIP-3 includes a bypass channel that would extend through the Palo Alto Golf Course.

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As a result of Alternative EIP-3 modifications to Alternative EIP-1, water surface levels during high flow events were reduced (via increased conveyance area) and natural stream function improvements were potentially increased due to new seasonal wetland habitat within the bypass channel. However, Alternative EIP-3 was determined to be significantly more costly than Alternative EIP-1 and Alternative EIP-2 and habitat improvements provided by the bypass channel were expected to be offset by potential impacts to steelhead migration.

Of the three conceptual alternatives evaluated by the JPA, hydraulic analysis of Alternative EIP-1 demonstrated an optimal tradeoff between reduction to peak water levels, habitat improvements, cost, and public acceptance. This alternative was approved by the JPA Board of Directors on July 23, 2009 and is completing CEQA/NEPA environmental documents and 90% designs at the time of this report. Pending funding acquisition, the JPA expects to begin construction in 2014.

5.2 Conceptual Alternative Development (Reaches 2-4)

A number of efforts have been completed to develop conceptual flood protection alternatives along San Francisquito Creek.

5.2.1 Conceptual Alternatives Previously Developed by the CRMP

In 1997, the Coordinated Resource Management and Planning group (CRMP), a group of representatives from various local agencies including the cities of East Palo Alto, Palo Alto, and
Menlo Park and the San Mateo County Flood Control District, prepared a reconnaissance investigation report\(^2\) which identified numerous alternatives to reduce flooding including the following:

- Expanding the Searsville Dam
- Detention at Webb Ranch
- Upstream Diversions and Offstream Storage
- Concrete Channel Modification
- Natural Channel Widening
- Willow Road Diversion Conduit
- Replacing Bridges at Pope/Chaucer Street and Middlefield Road
- Raising Levees Downstream from U.S. Hwy 101

A brief summary of the CRMP opportunities, listed above, occurring upstream from Reach 1 follows\(^3\).

**Expand Searsville Dam**

This alternative included a partial solution to flooding. The existing Searsville Dam would be replaced with a new dam that is 20 feet higher to capture upstream flood waters during high flow events. The new dam would inundate approximately 250 acres during a one-percent flood event (about 215 acres additional land) and the new earth dam would cover about 300 feet of riparian corridor.

This alternative would require combination with other solutions to fully address a one-percent event. The dam would inundate part of the Jasper Ridge Biological Preserve during peak events, and it would require acquisition of numerous hillside properties.

**Detention at Webb Ranch**

This alternative included two options for dams at the Webb Ranch, located upstream from Interstate 280.

One option included a high dam that would provide necessary storage to prevent downstream overbanking between El Camino Real and U.S. Hwy 101 during a one-percent event. The high dam would be up to 70 feet at its maximum, approximately 610 feet long in the direction of creek flow, and approximately 1,760 feet wide along its crest. The high dam would include an approximately 8-foot diameter outlet pipe with a maximum flow conveyance of 1,500 cfs under 100-year event conditions.

The second option included a low dam with a maximum height of 60 feet, a length of 530 feet (in the direction of creek flow), and width of 1,690 feet. The low dam would include an approximately 12-foot diameter outlet pipe with a maximum flow conveyance of 4,000 cfs under one-percent event conditions. This option would not provide full one percent flood protection.

**Upstream Diversions and Offstream Storage**

\(^2\) Additional details are available in the document “Reconnaissance Investigation Report of San Francisquito Creek” (CRMP, 1997).

\(^3\) CRMP opportunities developed for Reach 1 are not included because the JPA has already selected a project and begun design and environmental clearance for the EIP in Reach 1.
This alternative would construct offstream facilities for storage of flood waters during peak events and reduce flows downstream of El Camino Real. High flows would be diverted from the natural channel into detention basins. As the high flows recede and water in the creek channel lowers, the detention basin would drain back into the natural channel. This alternative would require up to 1,400 acres of land that was not identified at the time of the CRMP report.

Concrete Channel Modification

This alternative would convey one-percent flows in a deepened concrete channel between El Camino Real and U.S. Hwy 101. It would also require replacement of bridges at Middlefield and Pope/Chaucer Street.

This alternative would have significant environmental impacts requiring mitigation of more than 3 miles of instream habitat destruction, including fishery and special species habitats.

Natural Channel Widening

This alternative would acquire sufficient creekside right-of-way to allow the creek to erode and seek its own stable configuration between Pope/Chaucer Street and Highway 101. It would also require replacement of bridges at Middlefield Road and Pope/Chaucer Street and construction of levees or floodwalls between Pope/Chaucer Street and Highway 101.

This alternative would require the acquisition of more than 107 creekside properties in Palo Alto and Menlo Park. This acquisition and relocation could take many years to complete and would have significant social impacts. It would have minimal environmental impacts and could provide public access to the creek for recreational purposes. It would also require permanent closure of sections of Woodland Avenue.

Willow Road Diversion Conduit

This alternative included diverting floodwaters from the channel upstream from Middlefield Road into an underground conduit beneath Willow Road and then delivering the water via an earthen channel with levees downstream of U.S. Hwy 101 to the Ravenswood Slough.

This alternative would have major construction impacts along Willow Road. It would require acquisition of multi-unit residential structures and assisted relocation of low income residents in East Menlo Park, with significant social impacts.

Replacing Bridges at Pope/Chaucer Street and Middlefield Road

This alternative would replace bridges at Middlefield Road and Pope/Chaucer Street to increase bridge conveyance.

This alternative would relocate existing flood break out points from the Middlefield Road and Pope/Chaucer Street bridges, causing worse flooding downstream. This could create liability issues for Menlo Park, Palo Alto, and East Palo Alto. As a result, this effort would have to be combined with other solutions to fully address a one-percent flood event.
5.2.2 Conceptual Alternatives Developed by the JPA

In 2008, during the EIP conceptual alternative planning stage⁴, JPA member agencies including the cities of East Palo Alto, Palo Alto, and Menlo Park, the San Mateo County Flood Control District, and the District brainstormed new alternatives and refined some of the conceptual alternatives previously formulated by the CRMP above (Section 5.2.1).

A brief summary of the EIP alternatives occurring upstream from Reach 1 follows⁵.

- Off-channel Detention Basin at the Old Webb Ranch
- Underground storage below Alma Street
- Modify existing reservoir (Felt) for floodwater detention
- Modify existing reservoir (Lagunita) for floodwater detention

Off-channel Detention Basin at the Old Webb Ranch

This alternative included an off-channel detention basin formed by 15-foot high levees along its perimeter. The detention basin would include a gravity fed open channel inlet and spillway and would not require pumping. The basin would cover approximately 20 acres and would fill to a depth of 13 feet with a storage area equal to 260 acre-feet. Construction of the detention basin would require an easement from Stanford University.

Underground storage below Alma Street

This alternative included an underground storage basin beneath Alma Street in Menlo Park. The storage basin would be approximately 2,000 feet long, 58 feet wide, and approximately 23 feet deep. Total storage would be 53 acre-feet and would fill in approximately 38 minutes. The storage basin would need to be mechanically pumped out once filled.

Modify existing reservoir (Felt) for floodwater detention

This alternative included increasing the height of the dam and the capacity of the existing diversion system. This alternative would require that a new inlet be constructed at an upstream location in order to raise the existing reservoir dam. Additional inspection of local topography failed to locate a cost effective inlet location and the alternative was determined to be infeasible.

Modify existing reservoir (Lagunita) for floodwater detention

This alternative included increasing the existing reservoir capacity by undetermined means. Unknowns affecting the feasibility of this alternative included:

- Maximum capacity of Lagunita basin
- Available capacity during large storm events

Due to the elevation of the basin and the surrounding lands, water from San Francisquito Creek would have to be actively pumped into Lagunita Basin. Because this detention basin is only

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⁴ Additional details are available in the document prepared in 2008 by the JPA titled “Early Implementation Project (EIP) Preliminary Analysis Document”.

⁵ EIP opportunities developed for Reach 1 are not included because the JPA has already selected a project and begun design and environmental clearance for the EIP in Reach 1.
expected to mitigate some of the flood damages on San Francisquito Creek and increasing the capacity will require pumping, this alternative was determined to be infeasible.

In 2009, the JPA retained consultant services to prepare an evaluation of flood management strategies in the upper and lower portions of the San Francisquito Creek watershed\(^6\). The specific objectives of that effort included reducing out of bank flooding in Reach 1 and reducing peak flow rates in the creek through flood water detention in the upper portion of the watershed.

Results of the watershed and detention basin analysis identified three potential locations for detention basins. These basins are included in the conceptual alternative planning elements that follow.

### 5.2.3 Conceptual Alternative Planning Elements

Upon review of the prior planning efforts completed by the CRMP and JPA, a number of approaches to meet the project objectives were identified. Each of these approaches is referred to in this report as a Conceptual Project Elements (CPE). The following CPEs were developed during the conceptual stage.

**CPE-1  Floodwalls from U.S. Hwy 101 to Pope/Chaucer Street**

This CPE would provide flood protection by creating a concrete barrier that would contain flow within the channel thereby increasing overall channel capacity. The floodwalls would be constructed at a minimum distance of 3 feet from the inboard top of bank and would include a 14 foot wide maintenance road along the outboard side of the floodwall (unless adjacent to an existing roadway) to provide access for maintenance activities.

\(\text{Figure 5-4: Typical Floodwall with Maintenance Road}\)

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\(^6\) Additional details are available in the document prepared in 2009 by the PWA and H.T. Harvey and Associates titled “San Francisquito Creek Flood Reduction Alternatives Analysis”. 

San Francisquito Creek Flood Protection Project  
DRAFT Planning Study Report –Chapter 5  
October 2012
CPE-2  **Levees from U.S. Hwy 101 to Pope/Chaucer Street**

This CPE would provide flood protection by creating new or raising existing levees (earthen barriers that contain flow within the channel) thereby increasing the overall channel capacity. Levees would be designed with 2:1 (H:V) side slopes and a minimum top width of 15 feet. While practical in Reach 1, where sufficient lands are available, this CPE was eliminated from planning considerations upstream from U.S. Hwy 101 (Reaches 2, 3, and 4) due to right-of-way constraints and to minimize anticipated impacts to riparian vegetation.

CPE-3  **Detention Basins on Stanford Lands**

This CPE would provide flood protection by diverting high flows during flood events into one or more below ground level detention areas where flood water would be temporarily stored during the flooding event. Potential detention basin construction areas include two sites located approximately 0.5 miles upstream from Interstate 280 along each side of the creek (Figure 5-5, Figure 5-6) and at the Stanford Golf Course on the north side of the creek (Figure 5-7). The land at each site is owned by Stanford University.

Depending on the number of detention basins, the total combined detention area could be up to 54.2 acres in footprint area. Each basin would average 14 feet in depth, and would include mild side slopes of 5:1 (H:V).

![Figure 5-5: Stanford Detention Area Upstream from Interstate 280 (north side of creek)](image)
Figure 5-6: Stanford Detention Area Upstream from Interstate 280 (south side of creek)

Figure 5-7: Stanford Detention Area Upstream at Stanford Golf Course
During a storm event, flows higher than approximately the seven-year event would spill over weirs alongside the creek and into energy dissipation areas at each detention basin. These detention areas would then fill with water over a short period and would drain stored flood flows by gravity within one day after flood waters had receded in the channel. During the one-percent flood event, the combined detention areas would reduce the downstream peak flow rate at Middlefield Road by 20%.

Upstream detention could reduce the scale of downstream improvements needed to contain a one-percent flood event. For example, a 20% reduction in one-percent flow at Middlefield Road would bring the peak flow down to approximately the 50-year event level. This suggests that downstream channel improvements designed for the 50-year event, combined with a detention basin could cumulatively contain a one-percent flood event.

**CPE-4  Bypass Culvert beneath City Street**

This CPE would divert approximately 1/3 of the one-percent flow out of the creek at a point just upstream from University Avenue. High flows would exit the north side of the creek via an inlet located along the creek bank in East Palo Alto. Floodwaters would then be conveyed via a box culvert beneath a city street and returned to the creek via a downstream outlet structure.

![Figure 5-8: Typical Bypass Inlet](image)

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CPE-5  Bank Stabilization at Erosion Sites

This CPE would provide erosion protection and bank stability by using rock toe and earth fill protection methods described by the JPA’s Bank Stabilization and Revegetation Master Plan including rock placement with vegetation along and beneath the channel bottom. An example of rock toe and earth fill protection can be seen in Figure 5-10.
Additional bank stabilization measures would be designed where bank erosion slopes exceed 1.5:1 (horizontal:vertical). Near vertical to vertical banks would be stabilized using mechanically stabilized earth, planted cribwalls, planted gabion baskets, or vertical retaining walls.

**CPE-6 Replace/Modify Bridges With Less Than One-Percent Capacity**

The primary source of San Francisquito Creek flooding occurs at the Middlefield Road and Pope/Chaucer Street bridges. These two bridges and the remaining downstream bridges including University Avenue, Newell Road, and U.S. Hwy 101 cannot convey the 100-year flow and contribute to upstream increases in water levels and local flooding when flows approach the 50-year event. This CPE would replace or modify all or most of these bridges.

![Figure 5-11: Typical Bridge Modification to Provide One-Percent Protection](image)

**CPE-7 Channel Widening to Remove Bottle-necks**

The project team has identified six constrictions in the project reach (referred to as “bottlenecks”) that impede flow and result in elevated upstream water surface elevations. This CPE includes excavating bank materials at selected bottlenecks to increase cross sectional areas and improve flow conveyances at five of the six bottle-neck locations. Channel widening would likely include erosion protection along creek banks.
The construction of any single CPE would not meet the project objectives. Therefore, each conceptual alternative was composed of several CPE’s used in combination to meet the project objectives. Six conceptual alternatives were developed and analyzed in the conceptual phase of the project, as shown in Table 5-1.

### Table 5-1: Conceptual Alternatives

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Conceptual Project Elements (CPEs)</th>
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<tbody>
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<tr>
<td><strong>B</strong></td>
<td>Floodwalls and Channel Widening</td>
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<tr>
<td><strong>C</strong></td>
<td>Floodwalls, Channel Widening, and Detention Basins</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>Floodwalls, Channel Widening, and Woodland Ave Bypass Culvert</td>
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<tr>
<td><strong>E</strong></td>
<td>Floodwalls, Channel Widening, and West Bayshore Ave Bypass Culvert</td>
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<tr>
<td><strong>F</strong></td>
<td>Floodwalls, Channel Widening, and O’Connor Street Bypass Culvert</td>
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</tbody>
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#### 5.2.4 Conceptual Alternatives Evaluation

The project goals, objectives, and cost were used as evaluation criteria. To allow for a range of alternatives, the maximum cost criteria was set at $168 million which is 1.5 times the project budget included in the District’s 2012 Safe Clean Water Program ballot initiative.

Under conceptual alternative A, no new project elements would be implemented in the study area. Flood flows would continue to overtop channel banks and inundate adjacent properties, resulting in flood-related damages to residences and businesses. Current maintenance activities include sediment removal, erosion repair, and vegetation maintenance would continue. The estimated cost to continue these activities over the 50-year design life of the project is
$21,510,000. This alternative was eliminated from further plan formulation because it fails to meet all of the project’s objectives.

Alternative C initially included all three detention basins described for CPE-3 (see Section 5.2.3) and failed to meet cost criteria. Under this alternative, the greatest reduction to peak flows would be attained resulting in minimum floodwall heights in Reach 2. However, the combined construction cost of these three basins was estimated to exceed $168 million, making it cost prohibitive. To meet cost criteria, Alternative C was revised to include only one 440 acre-foot detention basin. The revised cost estimate for Alternative C was determined to be less than $20 million over the threshold limit. A ten percent reduction in cost would bring the alternative to within the cost criteria limit. As such, the project team included Alternative C in the feasibility analysis.

Of the three bypass alternatives considered during preliminary alternatives analysis, only Conceptual Alternative D was carried forward to feasible analysis. Closer inspection of the ground elevation along West Bayshore Road and technical challenges associated with tunneling beneath Hwy 101 resulted in elimination of Alternative E, and Alternative F, respectively.

Alternatives B, C (revised), and D met all evaluation criteria and were moved forward to the feasible planning phase for development and analysis. Descriptions of each of the alternatives to be carried forward for feasible analysis can be found in the next section of the report.

5.3 Feasible Alternatives Description

The purpose of this section is to provide descriptions of each feasible alternative. At the end of this section, Table 5-2 provides a summary comparison of the alternatives.

5.3.1 Alternative B: Floodwalls, Bridge Modification, and Bottle-neck Widening

Alternative Description

Alternative B combines floodwalls, bridge replacement/modification, bottle-neck widening, and erosion protection to increase the capacity of Reaches 2a, 2b, and 2c to the 100-year flow, and provide channel stability.

This alternative would include construction of 1.5 miles of new floodwalls with an average height equal to 5.7 feet on both sides of the creek. New floodwalls would extend from approximately 1,000 feet upstream of U.S. Hwy 101 to approximately 1,500 feet downstream from Pope/Chaucer Street.

Five vehicular bridges and two pedestrian bridges would be replaced or modified to convey San Francisquito Creek’s 100-year flow. Vehicular bridges would include the crossings at U.S. Hwy 101, Newell Road, University Avenue, Pope/Chaucer Street, and Middlefield Road. The two pedestrian bridges that would be modified are located on private properties between University Avenue and Pope/Chaucer Street.

San Francisquito Creek includes six bottle-necks between U.S. Hwy 101 and Pope/Chaucer Street. Under this alternative, four of the six bottle-necks would be widened to improve channel hydraulics and effectively reduce water surface elevations. Details for this alternative are provided in Appendix A.
Operation and Maintenance

Under Alternative B, long term maintenance activities along the creek would include clearing vegetation and removing graffiti from floodwalls, removing sediment from the creek bed in Reach 1, and clearing debris from bridges.

The District currently performs this type of maintenance: annually at the 1,000 foot long floodwall located upstream from West Bayshore Road, approximately every three years removing accumulated sediment just downstream from East Bayshore Road, and when debris collects/jams at the upstream face of bridges within the District’s jurisdiction.

Alternative B would require increased graffiti removal and vegetation removal due to the installation of 2.9 miles of new floodwalls. New short term maintenance activities will be required at widened bottle-neck locations and where plantings are installed. Short term activities will include monitoring erosion control features after significant flow events and maintaining temporary irrigation systems until vegetation is established.

Land Ownership/Access

It is expected that strips of land from 66 parcels along San Francisquito Creek would need to be acquired by the District in fee or easement for the construction of Alternative B. Detailed land ownership and access information can be found in Appendix A.

Cost Estimate

Cost estimates are in 2010 dollars and the maintenance costs were escalated using a 3.7% compounding escalation rate. A detailed cost estimate can be found in Appendix B.

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<th>Cost</th>
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Figure 5-13: Feasible Alternative B: Floodwalls, Bridge Modification, and Bottle-neck Widening

(The remainder of page intentionally left blank.)
5.3.2 Alternative C: Detention Basin, Floodwalls, Bridge Modification, and Bottle-neck Widening

Alternative Description

Alternative C combines a detention basin, floodwalls, bridge replacement/modification, bottle-neck widening, and erosion protection to increase the capacity of all project reaches to the design flow, and provide channel stability.

The proposed detention basin would temporarily contain 440 acre-feet of water during the one-percent flow event and would be constructed below ground level and adjacent to San Francisquito Creek at a location approximately one half mile upstream from Interstate 280 near Stanford University’s Jasper Ridge Biological Preserve (Figure 5-15). Hydraulic conditions downstream from the basin would be improved as the one-percent flood event would be reduced to nearly the 50-year event.

This alternative would also include 1.1 miles of new floodwalls with an average height equal to 4.9 feet on both sides of the creek. The new floodwalls would extend from approximately 1,000 feet upstream of U.S. Hwy 101 to approximately 3,200 feet downstream from Pope/Chaucer Street.

Each of the five vehicular bridges (U.S. Hwy 101, Newell Road, University Avenue, Pope/Chaucer Street, and Middlefield Road) and both pedestrian bridges described for Alternative B would be replaced or modified to convey San Francisquito Creek’s one-percent flow.

This alternative would widen each of the four bottle-necks described for Alternative B.

Details for this alternative are provided Appendix A.

Operation and Maintenance

Under Alternative C, maintenance activities currently performed on San Francisquito Creek (described for Alternative B) including floodwall maintenance, sediment removal, and bridge maintenance would continue.

Alternative C would require increased graffiti removal and vegetation removal due to the installation of 2.0 miles of new floodwalls. New short term maintenance activities required at widened bottle-neck locations and for plantings would be similar to those described for Alternative B.

In addition, the 54 acre detention area upstream from Interstate 280 would require event-driven maintenance of the inlet and outlet, and clearing of silt and other flood debris from the facility.

Land Ownership/Access

It is expected that strips of land from 58 parcels along San Francisquito Creek would need to be acquired by the District in fee or easement for the construction of Alternative C. Detailed land ownership and access information can be found in Appendix A.
Cost Estimate

Cost estimates are in 2010 dollars and the maintenance costs were escalated using a 3.7% compounding escalation rate. A detailed cost estimate can be found in Appendix B.

<p>| | |</p>
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Figure 5-14: Feasible Alternative C: Floodwalls, Bridge Modification, and Bottle-neck Widening

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Figure 5-15: Feasible Alternative C: 54 Acre Detention Basin Upstream from Interstate 280

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5.3.3 Alternative D: Woodland Avenue Bypass Culvert, Floodwalls, Bridge Modification, and Bottle-neck Widening

Alternative Description

Alternative D combines a bypass culvert, floodwalls, bridge replacement/modification, bottle-neck widening, and erosion protection to increase the capacity of all project reaches to the design flow, and provide channel stability.

Under Alternative D, a bypass conduit would be constructed to reduce the one-percent flow event by one third where bridge conveyance or channel capacity is currently inadequate. The bypass would consist of one or more concrete culverts located beneath West Bayshore Road (approximately between University Avenue and 1,000 feet upstream from U.S. Hwy 101). A concrete inlet (Figure 5-16) would divert high flows out of the creek to the concrete culverts where high flows would then be conveyed and returned to the creek via a downstream outlet (Figure 5-16).

This alternative would also include 0.6 miles of new floodwalls with an average height equal to 4.4 feet on both sides of the creek. The new floodwalls would extend from approximately 1,000 feet upstream of U.S. Hwy 101 to Newell Road and for approximately 800 feet in Reach 2c.

Three of the five vehicular bridges (U.S. Hwy 101, Pope/Chaucer Street, and Middlefield Road) and both pedestrian bridges described for Alternative B would be replaced or modified to convey San Francisquito Creeks one-percent flow. Under Alternative D, bridges at Newell Road and University Avenue would not be changed.

This alternative would widen each of the four bottle-necks described for Alternative B and would also require that a fifth bottle-neck be widened near the bypass outlet.

Details for this alternative are provided Appendix A.

Operation and Maintenance

Under Alternative D, maintenance activities currently performed on San Francisquito Creek (described for Alternative B) including floodwall maintenance, sediment removal, and bridge maintenance would continue.

Alternative D would require increased graffiti removal and vegetation removal due to the installation of 0.6 miles of new floodwalls. New short term maintenance activities required at widened bottle-neck locations and for plantings would be similar to those described for Alternative D.

In addition, the 4,000 foot long bypass culvert would require annual maintenance and inspection of the bypass inlet, underground section, and outlet structure. Depending on flow conditions additional maintenance may include clearing of silt and other debris from the facility.

Land Ownership/Access

It is expected that strips of land from 31 parcels along San Francisquito Creek would need to be acquired by the District in fee or easement for the construction of Alternative D. Detailed land ownership and access information can be found in Appendix A.
Cost Estimate

Cost estimates are in 2010 dollars and the maintenance costs were escalated using a 3.7% compounding escalation rate. A detailed cost estimate can be found in Appendix B.

<table>
<thead>
<tr>
<th></th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>$96,400,000</td>
</tr>
<tr>
<td>Land Acquisition</td>
<td>$9,400,000</td>
</tr>
<tr>
<td>50 Yr Maintenance</td>
<td>$24,900,000</td>
</tr>
<tr>
<td>Total Lifetime Cost</td>
<td>$130,700,000</td>
</tr>
</tbody>
</table>

**Figure 5-16:** Feasible Alternative D: Bypass Culvert, Floodwalls, Bridge Modification, and Bottle-neck Widening

(The remainder of page intentionally left blank.)
<table>
<thead>
<tr>
<th>Alternative Element</th>
<th>Alt B</th>
<th>Alt C</th>
<th>Alt D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Floodwalls</strong></td>
<td>5.7 ft high (average)</td>
<td>4.9 ft high (average)</td>
<td>4.4 ft high (average)</td>
</tr>
<tr>
<td>Impacted bridges</td>
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<td>Vehicular</td>
<td>5</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Private</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Bottle-necks widened</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Residential</td>
<td>66</td>
<td>59 *</td>
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<tr>
<td># of homes</td>
<td>no homes taken</td>
<td>no homes taken</td>
<td>no homes taken</td>
</tr>
<tr>
<td>Detention Pond</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bypass Culvert</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Operations and Maintenance activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional graffiti removal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional vegetation removal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sediment removal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debris removal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O&amp;M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual</td>
<td>$149,000</td>
<td>$194,000</td>
<td>$171,000</td>
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<tr>
<td>Over 50 years</td>
<td>$21.7 Million</td>
<td>$28.7 Million</td>
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<tr>
<td>Construction cost</td>
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<td>$96.4 Million</td>
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<tr>
<td>Land Acquisition cost</td>
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<td>$9.4 Million</td>
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<td>Total Lifetime Cost</td>
<td>$103.6 Million</td>
<td>$187.8 Million</td>
<td>$130.7 Million</td>
</tr>
</tbody>
</table>

Note: * The detention basin will include land acquisition from one or more parcels owned by Stanford University.

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5.4 Feasible Alternatives Analysis

5.4.1 Natural Flood Protection Evaluation Process

The District’s Board of Directors (Board) has adopted an Ends Policy No. E-3 which states, “There is a healthy and safe environment for residents, businesses and visitors, as well as for future generations.” As part of this policy, the Board has adopted a goal that states that “natural flood protection” is to be the method the District uses to provide flood protection.

To comply with the ends policy and CEO interpretation, the Natural Flood Protection (NFP) evaluation process (QEMS work instruction WW75125 - Guidance on Alternative Evaluation and Selection for Natural Flood Protection Projects) was developed to rate and compare flood protection project alternatives. Various criteria were developed to help rate each objective. The objectives and corresponding criteria are listed below.

Objective 1: Homes, schools, businesses, and transportation networks are protected from flooding and erosion.

- Criterion 1: Safety – protection of public safety if conditions exceed design assumptions
- Criterion 2: Economic protection – protection from damage due to floodwaters, erosion or sediment for homes, schools, businesses, transportation systems and other infrastructure
- Criterion 3: Durability – future effort required to maintain design level of protection
- Criterion 4: Resiliency – adaptability to future changes
- Criterion 5: Local drainage – support of local storm drain systems
- Criterion 6: Time to implementation – how quickly flood protection elements could become effective

Objective 2: Support ecological functions and processes

- Criterion 1: Local habitat goals – ability to meet habitat goals as defined from examining the watershed as a whole
- Criterion 2: Quality of habitat – quality of habitat provided by alternative
- Criterion 3: Sustainability of habitat – intensity of future action required to maintain design habitat quality
- Criterion 4: Connectivity of habitat – integration of habitat elements into surrounding landscape

Objective 3: Integrate physical stream functions and processes

- Criterion 1: Floodplain – inclusion of appropriately sized floodplain
- Criterion 2: Active channel – appropriateness of size and configuration of active channel
- Criterion 3: Stable side slopes – stability of side slopes
- Criterion 4: Transitions – stability of channel’s integration with upstream and downstream reaches
Objective 4: Minimize maintenance requirements

Criterion 1: Structural features – maintenance associated with structural features
Criterion 2: Natural processes – maintenance associated with vegetation, erosion and sediment
Criterion 3: Urban flows – maintenance resulting from small storms and outfall flows
Criterion 4: Access – incorporation of adequate access for maintenance crews and equipment

Objective 5: Integrate within watershed

Criterion 1: Meets watershed goals – ability to meet watershed goals as defined in a process that examines the watershed as a whole

Objective 6: Protect the quality and availability of water

Criterion 1: Water availability – impact on groundwater recharge
Criterion 2: Instream water quality – water quality protected through vegetation and instream hydraulic complexity
Criterion 3: Offstream water management – ability to enhance water supply and quality and reduce peak flows through local retention of rainfall
Criterion 4: Flow regime – ability to maintain geomorphically and biologically appropriate range of flows

Objective 7: Cooperate with other local agencies to achieve mutually beneficial goals

Criterion 1: Mutual local goals – ability to achieve project-specific goals and objectives developed jointly by the District and local agencies
Criterion 2: Supports general plan – ability to support goals and policies as stated in general plans of partner agencies

Objective 8: Community benefits beyond flood protection

Criterion 1: Community safety – overall safety for appropriate access and recreation
Criterion 2: Recreation – quality of recreation experience provided by alternative
Criterion 3: Aesthetics – quality of aesthetic form provided by alternative
Criterion 4: Social and cultural benefits – opportunity to provide community involvement
Criterion 5: Local economic effects – potential effect on property values and/or local business climate
Criterion 6: Green construction and operation – reflection of District’s commitment to minimize its impacts on the environment
Criterion 7: Open space – inclusion of open space into alternative
Criterion 8: Community support – alternative reflects community
developed objectives and ideas

Objective 9: Minimize life-cycle costs

Criterion 1: Capital cost - net present value of capital costs
Criterion 2: Maintenance cost – net present value of all maintenance
costs over the life of the project

5.4.2 Natural Flood Protection Evaluation Results
The first step of the NFP evaluation process is to establish relative weights (high, medium, or low) for each of the objectives. The project team determined initial NFP weights. The weights were then presented to the watershed deputy operating officer for approval. The approved weights can be seen in Table 5-3.

The second step of the NFP evaluation process is to rate the alternatives based on the individual criteria and overall objectives. Some of the criteria required comparative ratings between the alternatives (e.g., which alternative has the least or the most cost) while others were stand-alone ratings (e.g., how well does the alternative meet community goals). Each alternative was rated in accordance with how well it accomplished each criterion. The ratings for the criteria under each objective were then assimilated into a summary objective rating per the predefined NFP evaluation process (see Attachment C for NFP rating details). The result is a matrix (see Table 5-3) which shows a comparison of how well the alternatives rated on each of the nine NFP objectives.

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With the exception of life-cycle costs, there was very little difference among the feasible alternatives with respect to the NFP evaluation. Alternative scores all ranged from poor to adequate and four out of nine objectives (Objectives 1, 6, 7, and 8) scored identically for each alternative.

For NFP Objective 1 (protect from flood damage), one alternative received a “Fair” rating, while the other three alternatives received an “Adequate” rating because they all provide 1 percent flood protection with additional freeboard\(^7\).

For NFP Objective 2 (support ecological functions), each Alternative was credited for removing bottle-necks which will reduce in channel velocities and improve conditions for fish migration.

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\(^7\) Three feet of additional freeboard would enable each alternative to convey the 0.5 percent or 200 year event before overtopping.
Alternative B earned a “Poor” rating because it includes the greatest length of floodwalls and resulting loss of riparian corridor habitat. Alternative C earned a “Fair” rating because it would reduce the total length of floodwalls needed (as compared to Alternative B) and the detention basin would provide reduced channel flows during peak events which would lessen channel erosion and improve fish passage conditions. Alternative D earned a “Poor” rating because, in spite of reduced floodwall lengths (as compared to Alternative B) and reduced channel flows as a result of the bypass culvert, fish passage is expected to be degraded by the bypass culvert.

For NFP Objective 3 (integrate physical stream functions), Alternative B received a “Poor” rating compared to Alternatives C and D which both earned “Fair”. The “Poor” rating was determined because other than bottleneck widening, which is common to each alternative, Alternative B does not include improvements that would contribute to physical stream functions. Alternatives C and D earned a “Fair” rating because, in addition to bottleneck widening, these alternatives would reduce peak flows in the channel which are expected to contribute to bank erosion.

For NFP Objective 4 (minimize maintenance requirements), Alternatives B and C received a “Fair” rating compared to “Poor” for Alternative D. Alternative B received a “Fair” rating because maintenance associated with floodwalls would be relatively simple however frequent. Alternative C received a “Fair” rating because in addition to floodwall maintenance (relatively less than Alternative B) it would also require occasional detention basin maintenance to remove sediment. Alternative D received a “Poor” rating because in addition to floodwall maintenance (relatively less than Alternative B) it would also require regular bypass inspections and occasional maintenance to remove sediment that will be difficult due to access.

For NFP Objective 5 (integrate within the context of the watershed), Alternative C received a “Fair” rating compared to “Poor” for Alternatives B and D due to Alternative C’s better alignment with watershed goals established by stakeholder’s general plans, management plans, stewardship plans, and the District’s Ends Policies.

For NFP Objective 6 (protect the quality and availability of water), each alternative received an “Adequate” rating. None of the alternatives have a significant impact on groundwater supply and they all maintain a minimum separation for natural protection of groundwater. Each of the alternatives would retain existing water quality conditions and not affect low flows which contribute most to geomorphology.

For NFP Objective 7 (cooperate with local agencies), each alternative received a rating of “Poor” due to the fact that no memorandums of consensus have been established to meet local goals and objectives. This score is misleading however, because the project team has maintained close cooperation with the JPA throughout the entire planning process.

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8 Stakeholders included: Santa Clara County, San Mateo County, the Watershed Management Initiative, City of Palo Alto, City of East Palo Alto, City of Menlo Park, Lower Peninsula Watershed Stewardship Plan, Santa Clara Valley Water District.

9 San Francisquito Creek in the project area is in the confined zone of the Santa Clara Valley groundwater subbasin. As this is not a recharge zone, there is not potential to increase recharge.

10 The JPA represents the cities of Palo Alto, East Palo Alto, the counties of Santa Clara and San Mateo, the San Mateo Flood Control District, and the Santa Clara Valley Water District.
For NFP Objective 8 (community benefits beyond flood protection), each alternative received an "Adequate" rating. Each of the alternatives will include:

- Safety features such as barriers (fences or floodwalls) to prevent public access to steep slopes and flood flows.
- Bridge replacements/modifications that will include widening for bicycle lanes and pedestrian walkways.
- Bridge replacements/modifications that will involve the local community to determine aesthetics which may include cultural motifs and or viewing locations for improved visual access to the riparian corridor.
- Improvement to the property value of approximately 4,000 residents currently living within the FEMA one percent floodplain.
- Native plant landscaping, reuse of top soil, local plant stock, and removal of some non-native plants.

For NFP Objective 9 (life-cycle costs), each alternative received an estimated dollar amount that accounts for capital costs (construction and land acquisition) and 50-years of maintenance.

Difference in Alternatives with respect to NFP Objective 1
Each alternative scored the same with respect to NFP Objective 1.

Difference in Alternatives with respect to NFP Objective 2
The roughly 1.5-miles of floodwalls proposed by Alternative B will not provide any ecological benefit to the San Francisquito Creek riparian corridor. However, this Alternative (along with Alternatives C and D) includes widening the channel at bottle-neck constrictions which funnel flows and increase channel velocity. Because a decrease in channel flows is considered to be an improvement to fish passage, an NFP Evaluation of “Poor” rather than “Unacceptable” was determined for Alternative B.

In addition to removing bottle-necks, the detention basin proposed by Alternative C would improve ecological functions by lowering peak flows. This change to channel hydraulics would effectively lower water surface elevations and reduce floodwall heights and lengths in Reach 2. As a result of these ecological improvements, Alternative C received an NFP evaluation of “Fair”.

Similar to Alternatives B and C, Alternative D would remove bottle-necks in the creek. Similar to Alternative C, Alternative D would reduce peak flows to create ecological improvements; however, the bypass culvert component of this alternative would most likely pose an impediment to fish migration. These and other combined ecological attributes resulted in a “Poor” NFP evaluation of Alternative D.

Difference in Alternatives with respect to NFP Objective 3
Because Alternative B is primarily a floodwall alternative, it does not contribute any benefits to the physical stream functions and process of San Francisquito Creek. Due to this, an NFP Evaluation of “Poor” was determined for Alternative B. Alternatives C and D however, will provide some benefit due to reduced peak flows and therefore resulted in a “Fair” NFP evaluation.
Both Alternatives C and D initially received an NFP evaluation of “Poor” with respect to maintenance considerations because in addition to simple floodwall maintenances (graffiti and vegetation removal), each of these alternatives included additional work following high flow events. For Alternative C, this will include clearing debris from the detention basin inlet and outlet and excavating deposited sediments from the basin. For Alternative D, this will include clearing debris from the bypass culvert inlet and outlet and cleaning deposited sediments within the 4,000 foot long culvert. The NFP evaluation for Alternative C was improved to “Fair” because it includes a significant amount of floodwalls and maintenance roads that will serve to improve access. Alternative B received an NFP evaluation of “Fair” because maintenance is limited to basic floodwall maintenance work.

Difference in Alternatives with respect to NFP Objective 4

Alternative C also scored slightly higher for NFP Objective 5 (integration within the context of the watershed) and cooperation with other local agencies to meet mutual goals when measured against goals and policies described by the:

- General plans for the counties of San Mateo and Santa Clara
- General plans for the cities of East Palo Alto, Palo Alto, and Menlo Park
- Watershed Management Initiative
- Santa Clara Valley Water District Board of Directors Ends Policies

Alternative B and Alternative D received nearly identical scores under the NFP evaluation process. The bypass culvert included in Alternative D reduces floodwall heights and lengths in Reach 2b and 2c as compared to Alternative B; however these positive attributes were cancelled by negative impacts associated with the bypass culvert and fish migration.

Alternative D also scored lower than Alternative B in terms of structural durability and resiliency (Objective 1), additional maintenance efforts required for the bypass culvert (Objective 4), and less recreation potential (Objective 8) because the bypass culvert would eliminate the need to remove bridges at Newell Road and University Avenue and thereby reduce opportunities for pedestrian and bicycle improvements.

In terms of NFP Objective 9 (minimizing life-cycle costs), Alternative C was the most expensive. By comparison, Alternative B and Alternative D would cost 44% and 30% less than Alternative C, respectively.

Difference in Alternatives with respect to NFP Objective 6

Each alternative scored the same with respect to NFP Objective 6.

Difference in Alternatives with respect to NFP Objective 7

Each alternative scored the same with respect to NFP Objective 7.

Difference in Alternatives with respect to NFP Objective 8

Each alternative scored the same with respect to NFP Objective 8.
5.5 Staff Recommended Alternative Development and Selection

The purpose of this section is to document the evaluation and refinement of the top three feasible alternatives.

Risk identification and assessment for the project focused on three major areas: the Detention Pond on Stanford University Land, the bypass Culvert, and right of way acquisition. Based on these areas, the following risks were identified; Table 5-4 identifies which risks apply to each of the top three alternatives.

**Detention Basin**
- The detention basin will require large scale excavation of soil of unknown quality. The hazardous toxic and radioactive waste assessment prepared for this study was not allowed to investigate the proposed detention basin area. As such, increased risk associated with polluted soils exists for this Alternative.
- The groundwater level at the location of the detention basin is expected to be below the creek bottom, however if final designs for this alternative are prepared, additional groundwater investigations will be necessary.

**Bypass Culvert**
- The alignment extends beneath University Avenue and Woodland Avenue and is likely to intersect numerous municipal utilities including water distribution, sanitary sewer, and gas and electric systems.
- The proximity of the bypass culvert is close to the creek top of bank. As such, construction of the bypass culvert may require removing and rebuilding portions of the creek bank. This will include significant negative impacts to the riparian corridor and habitat.

**Right-of-Way**
- Property owners are not willing to sell property to the District. For example, the 1985 Stanford University Land Use Policy Agreement under General Policy 1.a states “its lands are to be held in perpetual trust for educational purposes and may not be sold”.

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Once risks were identified, the project team determined the probability of occurrence and the potential impact of each risk for the alternatives. The product of the risk probability and the risk impact is called the risk rating Table 5-5.

### Table 5-4: Risks by Alternative

<table>
<thead>
<tr>
<th>Risk</th>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large scale excavation of potentially hazardous soils</td>
<td>B  C  D</td>
</tr>
<tr>
<td>Groundwater level may interfere with construction</td>
<td>YES  YES</td>
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<tr>
<td>Disruption of numerous municipal utilities</td>
<td></td>
</tr>
<tr>
<td>Unanticipated impacts to riparian corridor during construction</td>
<td>YES</td>
</tr>
<tr>
<td>Property owners are not interested to sell to District</td>
<td>YES  YES</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk</th>
<th>Probability of Occurrence</th>
<th>Potential Impact</th>
<th>Risk Rating</th>
</tr>
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<tbody>
<tr>
<td>Large scale excavation of potentially hazardous soils</td>
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<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Groundwater level may interfere with construction</td>
<td>High</td>
<td>Medium</td>
<td>Medium-High</td>
</tr>
<tr>
<td>Disruption of numerous municipal utilities</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Unanticipated impacts to riparian corridor during construction</td>
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<td>Medium-High</td>
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<tr>
<td>Property owners are not interested to sell to District</td>
<td>High</td>
<td>Medium</td>
<td>Medium-High</td>
</tr>
</tbody>
</table>

### 5.6 Refined Alternative Details

Currently, very few of the creekside residents in Reach 2a, 2b, and 2c (West Bayshore Road to Pope/Chaucer Street) are situated within the FEMA flood zone. This is due to the fact that bridge constrictions at Middlefield Road and Pope/Chaucer Street cause upstream flooding which effectively reduces downstream water surface elevations in Reach 2a, 2b, and 2c to below the tops of bank during peak flow events. Floodwalls and other improvements proposed by Alternatives B, C, or D will be necessary before increased peak flows result when these bridges are modified or replaced.
The District holds continuous right of way along the Santa Clara County side of the creek from West Bayshore Road to Marlowe Street (approximately 1,000 feet downstream from the bridge at Pope/Chaucer Street). Unfortunately, this right of way extends from the toe of bank to the top of bank and does not include sufficient area to construct a new floodwall and maintenance road. As a result, any new floodwalls or maintenance roads will require land acquisition from numerous residents living near the creek.

Alternatives B, C, and D each include, to various extents, the construction of floodwalls at the top of both creek banks. These floodwalls will require routine maintenance and possibly structural repair at some point during their design lifetime. To facilitate these efforts, District floodwalls are typically constructed with a maintenance road that runs adjacent to the floodwall structure. Typically, the right of way needed to install floodwalls is at least 19 feet (15 for the road + 1 foot of floodwall width + 3 feet between the wall and property line to allow for access for vegetation maintenance. For the purpose of this planning study however, the typical road width was reduced from 15 feet to 10 feet (14 in total) to limit impacts to the riparian corridor along the top of bank and to minimize private property acquisition.

In 2003, the District constructed a floodwall and maintenance path along the Santa Clara County side of San Francisquito Creek. The floodwall extends from West Bayshore Road to a point approximately 1,000 feet upstream. Alternatives B, C, and D all include constructing a new floodwall that will tie into this existing floodwall. The 2003 project originally included a standard floodwall and maintenance road; however local residents raised concern about the extent of property needed for the new floodwall and maintenance road. As a result of negotiations with local residents, the design was revised to include an approximately 5 foot wide maintenance path.

In an effort to minimize right of way impacts to creekside residents, to reduce impacts to the riparian corridor, and to tie the new floodwall into the existing floodwall, the project team revised Alternatives B, C, and D to include a 5 foot wide maintenance path rather than a 14 foot wide maintenance road.

5.6.1 Refined Alternative B: Floodwalls, Bridge Modification, and Bottle-neck Widening

Alternative Description

The only refinement made to Alternative B included reducing the width of the maintenance road from 14 feet to 5 feet. As a result of land acquisition savings the estimated total cost of Alternative B would be decreased from $103.6 million to $93.7 million for a total savings of $9.9 million or 10%. In addition to this, approximately 1.7 acres of private property and or riparian corridor would remain intact.

Operation and Maintenance

Maintenance activities would remain unchanged however access to floodwalls would be limited to a 5 foot wide pathway. This would lead to decreased efficiency associated with removing vegetation and graffiti. As a result, total annual maintenance costs would be increased from $149,000 to $161,000 for a total increase of $12,000 or 8%.
Cost Estimate

Cost estimates are in 2010 dollars and the maintenance costs were escalated using a 3.7% compounding escalation rate. A detailed cost estimate can be found in Appendix B.

<table>
<thead>
<tr>
<th>Cost Item</th>
<th>Cost (2010 USD)</th>
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<tbody>
<tr>
<td>Construction</td>
<td>$60,300,000</td>
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<tr>
<td>Land Acquisition</td>
<td>$10,000,000</td>
</tr>
<tr>
<td>50 Yr Maintenance</td>
<td>$23,400,000</td>
</tr>
<tr>
<td>Total Lifetime Cost</td>
<td>$93,700,000</td>
</tr>
</tbody>
</table>

5.6.2 Refined Alternative C: Detention Basin, Floodwalls, Bridge Modification, and Bottle-neck Widening

Alternative Description

The only refinement made to Alternative C included reducing the width of the maintenance road from 14 feet to 5 feet. As a result of land acquisition savings the estimated total cost of Alternative C would be decreased from $187.8 million to $181.3 million for a total savings of $6.5 million or 3%. In addition to this, approximately 1.2 acres of private property and or riparian corridor would remain intact.

Operation and Maintenance

Maintenance activities would remain unchanged; however access to floodwalls would be limited to a 5 foot wide pathway. This would lead to decreased efficiency associated with removing
vegetation and graffiti. As a result, total annual maintenance costs would be increased from $194,000 to $202,000 for a total increase of $8,000 or 4%.

Cost Estimate

Cost estimates are in 2010 dollars and the maintenance costs were escalated using a 3.7% compounding escalation rate. A detailed cost estimate can be found in Appendix B.

<table>
<thead>
<tr>
<th></th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>$130,400,000</td>
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<tr>
<td>Land Acquisition</td>
<td>$21,500,000</td>
</tr>
<tr>
<td>50 Yr Maintenance</td>
<td>$29,400,000</td>
</tr>
<tr>
<td>Total Lifetime Cost</td>
<td>$181,300,000</td>
</tr>
</tbody>
</table>

Figure 5-18: Revised Feasible Alternative C: 54 Acre Detention Basin Upstream from Interstate 280
5.6.3 Refined Alternative D: Woodland Avenue Bypass, Floodwalls, Bridge Modification, and Bottle-neck Widening

**Alternative Description**

The only refinement made to Alternative D included reducing the width of the maintenance road from 14 feet to 5 feet. As a result of land acquisition savings the estimated total cost of Alternative D would be decreased from $130.7 million to $127.3 million for a total savings of $3.4 million or 3%. In addition to this, approximately 0.6 acres of private property/riparian corridor would remain intact.

**Operation and Maintenance**

Maintenance activities would remain unchanged; however access to floodwalls would be limited to a 5 foot wide pathway. This would lead to decreased efficiency associated with removing vegetation and graffiti. As a result, total annual maintenance costs would be increased from $171,000 to $176,000 for a total increase of $5,000 or 3%.

**Cost Estimate**

Cost estimates are in 2010 dollars and the maintenance costs were escalated using a 3.7% compounding escalation rate. A detailed cost estimate can be found in Appendix B.

- **Construction:** $96,400,000
- **Land Acquisition:** $5,300,000
- **50 Yr Maintenance:** $25,600,000
- **Total Lifetime Cost:** $127,300,000
5.6.4 Natural Flood Protection Evaluation Results for Revised Alternatives

The NFP evaluation process was repeated to incorporate revisions to each of the alternatives (Table 5-7).

Table 5-6: Refined Alternatives Summary

<table>
<thead>
<tr>
<th>Alternative Element</th>
<th>Alt B</th>
<th>Alt C</th>
<th>Alt D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodwalls</td>
<td>5.7 feet high (average) for 1.5 miles</td>
<td>4.9 feet high (average) for 1.1 miles</td>
<td>4.4 feet high (average) for 0.6 miles</td>
</tr>
<tr>
<td>Bridges Impacted</td>
<td>Vehicular: 5</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Private: 2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Bottle-necks Widened</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Land Acquisition</td>
<td>Residential: 66</td>
<td>59</td>
<td>31</td>
</tr>
<tr>
<td>Detention Pond</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>New Operations and Maintenance Activities</td>
<td>Additional graffiti removal</td>
<td>Additional vegetation removal</td>
<td>Additional vegetation removal</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>$361,000 annual</td>
<td>$202,000 annual</td>
<td>$176,000 annual</td>
</tr>
<tr>
<td></td>
<td>Over 50 years: $23.4 Million</td>
<td>$29.4 Million</td>
<td>$25.6 Million</td>
</tr>
<tr>
<td></td>
<td>Construction Cost: $60.3 Million</td>
<td>$130.4 Million</td>
<td>$96.4 Million</td>
</tr>
<tr>
<td></td>
<td>Land Acquisition Cost: $10.0 Million</td>
<td>$21.5 Million</td>
<td>$5.3 Million</td>
</tr>
<tr>
<td>Total Lifetime Cost</td>
<td>$93.7 Million</td>
<td>$181.3 Million</td>
<td>$127.3 Million</td>
</tr>
</tbody>
</table>

Note: * The detention basin will include land acquisition from one or more parcels owned by Stanford University.
The only refinement made to each of the alternatives was to reduce the maintenance access width adjacent to floodwalls from a 14 foot wide maintenance road to a 5 foot wide path. As a result of this revision, each alternative earned an improved evaluation for NFP Objective 2 (support of ecological function) due to the overall reduction to riparian corridor impacts (see alternative descriptions for details) and scores for Alternatives B and Alternative D were improved from “Poor” to “Fair”. The loss of access capability resulting from this refinement negatively affected each alternative with respect to NFP Objective 4 (minimize maintenance requirements) and consequently, the score for Alternative B was degraded from “Fair” to “Poor”. 

Table 5-7: NFP Evaluation Refined Alternative Matrix

<table>
<thead>
<tr>
<th>Objective</th>
<th>Objective Weight Rank</th>
<th>No Project</th>
<th>Alt A</th>
<th>Alt B</th>
<th>Alt C</th>
<th>Alt D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Provide protection from flood damage</td>
<td>High</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2. Support ecological functions and processes</td>
<td>High</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3. Integrate physical stream functions and processes</td>
<td>Med</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4. Minimize maintenance requirements</td>
<td>High</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5. Integrate within the context of the watershed</td>
<td>Med</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6. Protect the quality and availability of water</td>
<td>High</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7. Cooperate with other local agencies to achieve mutual goals</td>
<td>High</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8. Maximize community benefits beyond flood protection</td>
<td>Med</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9. Minimize life-cycle costs</td>
<td>High</td>
<td></td>
<td>101.7 Million</td>
<td>151.9 Million</td>
<td>70.3 Million</td>
<td></td>
</tr>
</tbody>
</table>

Ratings Key:
- 5 Outstanding
- 4 Very Good
- 3 Adequate
- 2 Fair
- 1 Poor
- 0 Unacceptable

The only refinement made to each of the alternatives was to reduce the maintenance access width adjacent to floodwalls from a 14 foot wide maintenance road to a 5 foot wide path. As a result of this revision, each alternative earned an improved evaluation for NFP Objective 2 (support of ecological function) due to the overall reduction to riparian corridor impacts (see alternative descriptions for details) and scores for Alternatives B and Alternative D were improved from “Poor” to “Fair”. The loss of access capability resulting from this refinement negatively affected each alternative with respect to NFP Objective 4 (minimize maintenance requirements) and consequently, the score for Alternative B was degraded from “Fair” to “Poor”.
5.7 Alternatives Comparison

Alternative B

Alternative B includes only one of the five identified risks, right of way acquisition, which has been reduced significantly by refining the maintenance area adjacent to floodwalls from a maintenance road to a maintenance path. Alternative B also provides flood protection by the most basic means available by increasing the channel capacity with floodwalls.

This alternative is also the lowest cost alternative, with a capital cost of $70.3 million and a 50-year maintenance cost of $23.4 million, for a total of $93.7 million. Alternative B would cost approximately:

- $87.6 million less than Alternative C
- $33.6 million less than Alternative D

Alternative B does not provide significant ecological or habitat improvements to San Francisquito Creek and will include significant impacts to the riparian corridor as trees and other vegetation will be removed to accommodate floodwalls.

Alternative C

Alternative C includes three of the five identified risks, right of way acquisition, excavation of hazardous soils, and potential for groundwater interference.

While the risk of right of way acquisition is common among each of the alternatives, compared to Alternative B, Alternative C requires less right of way acquisition for floodwalls. However, this alternative would require approximately 54 acres of land from Stanford University to construct the detention basin which goes against the university’s land use policy. The right of way risk is greatest for Alternative C because Stanford University may refuse land and or delay the project significantly.

The detention basin will require excavation of approximately 1 million cubic yards of soil. At this large volume there is a significant risk associated with the excavation of hazardous soils.

Because the detention basin will extend to a depth of roughly 8 feet with close proximity to San Francisquito Creek, there is potential for groundwater interference during construction activities. While preliminary groundwater studies indicate that groundwater levels in the vicinity of the detention basin are below the creek invert, additional groundwater investigations will be necessary to avoid considerable cost associated with lining the detention basin.

This alternative is by far the most costly with a capital cost of $151.9 million and a 50-year maintenance cost of $29.4 million for a total of $181.3 million. Alternative B would cost approximately:

- $87.6 million more than Alternative B
- $54.0 million more than Alternative D
Alternative D

Alternative D includes four of the five identified risks, right of way acquisition, and excavation of hazardous soils, potential for groundwater interference, and unanticipated impacts to the riparian corridor.

Similar to Alternative C, Alternative D compared to Alternative B requires less right of way acquisition for floodwalls. However, this alternative would require considerable cooperation with the city of East Palo Alto and possibly the city of Menlo Park to obtain right of way for the bypass culvert.

The bypass culvert inlet, main conduit, and outlet would require excavation of approximately 99 thousand cubic yards of soil. At this large volume and in a mixed residential use area there is a significant risk associated with the excavation of hazardous soils.

The bypass culvert excavation will extend to a depth of roughly 14 feet along the top of bank of San Francisquito Creek and there is potential for groundwater interference during construction activities, however preliminary groundwater investigations indicate that the groundwater table may range between 12 and 31 feet beneath the ground surface.

Alternative D includes a risk of unanticipated impacts to the riparian corridor during construction because of the close proximity of Woodland Avenue to the top of bank. At many locations, the edge of pavement is within 15 feet of the top of bank and excavation for the bypass culvert may destabilize the entire creek bank. This presents a significant threat to the riparian corridor.

This alternative is the second lowest cost with a capital cost of $101.7 million and a 50-year maintenance cost of $25.6 million for a total of $127.3 million. Alternative D would cost approximately:

- $33.6 million more than Alternative B
- $54.0 million less than Alternative C

5.8 Staff Recommended Alternative

The project team recommends Alternative B, which includes floodwalls, modification of bridges, and bottle-neck widening and as the staff-recommended alternative. The basis of this recommendation is a combination of the results of the NFP evaluation process, the risk analysis performed by the team, and the project team’s judgment.

As discussed above, the NFP process did not clearly identify a single, best alternative, but rather identified strengths and weaknesses for each Alternative. A risk assessment was performed to further refine the selection process. The initial assessment suggested that from a risk perspective Alternative B was preferable to Alternatives C and D, because it has fewer risks; specifically, it does not include risks associated with large scale soil excavation, groundwater interference to construction, disruption to numerous municipal utilities, and unanticipated impacts to the riparian corridor.

Alternative C scored best with respect to NFP objectives, but it is the most expensive and would include the most significant level of risks. Alternatives B and D scored nearly the same with respect to NFP Objectives, however, Alternative D would include a greater risk to fish migration and a significantly greater life-cycle cost.
It is the judgment of the project team that, although all of the feasible alternatives provide the same level of flood protection, the mechanisms for doing so under Alternative B are the most comprehensive and cost effective. In summary, the project team concludes that these additional benefits and the method for providing flood protection outweigh the risks associated with this alternative and thereby recommends Alternative B – Floodwalls, Bridge Modification, and Bottle-neck Widening as the staff-recommended alternative.

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6 Staff-Recommended Alternative

This section provides the design basis, project element details, and right-of-way needs for the staff-recommended alternative. A description of the maintenance program for the project is included in Section 7 and cost details are included in Section 8.

6.1 Design Criteria

The following design criteria was used to develop the staff-recommended alternative.

6.1.1 General

- The design life of the project is assumed to be 50 years.
- Flood protection facilities for the San Francisquito Creek flood protection project will be designed to meet FEMA and District standards.
  - 1.0 foot of freeboard in section of channel without levees
  - 3.5 feet of freeboard in sections of channel with levees.
  - 4 feet of freeboard in sections of channel with levees within 100 feet of structures or wherever flow is constricted.
- The maintenance path width will be approximately 5 feet.
- The project team has evaluated the project per BAO/CEO Strategy No. S-3.2, and determined that based on currently available information, anticipated sea level rise over the next 50 years will be accommodated within the project design (Section 3.4).

6.1.2 Floodwalls

- The floodwalls would be constructed on the inboard side of the access path.
- Settlement
  - Locations along the creek requiring floodwalls will be pre-loaded to account for settlement for primary consolidation. Cost estimates for this work have not been included at this phase of the project; however it is assumed that the 40% construction contingencies will cover this work.
  - Permissible settlement under service load may be limited to 1 inch for spread footing floodwalls and 0.5 inches for cast in drilled hole floodwalls. The actual permissible settlement (typically 2 inches) will be based on recommendations from the District’s geotechnical report.
- The following documents will be used to form the basis for floodwall design:
  - EM 1110-2-2502, Retaining and Flood Walls (Corps 1989)
  - EM 1110-2-2100, Stability Analysis of Concrete Structures (Corps 2005)
  - Corps EM 1110-2-2104, Strength Design for Reinforced Concrete Hydraulic Structures (Change 1) (Corps 2003)
  - EM 1110-2-2105, Design of Hydraulic Steel Structures (Change 1) (Corps 1994)
  - EM 1110-2-2504, Design of Sheet Pile Walls (Corps 1994)
6.1.3 Appurtenant Structures

- For any additional structural components, or when supplemental design criteria is appropriate, the following documents shall be referenced:
  - EM 1110-2-2906, Design of Pile Foundations (Corps 1991)
  - ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures (American Society of Civil Engineers 2005)
  - ACI 318-08, Building Code Requirements for Structural Concrete and Commentary (American Concrete Institute, 2008)

6.1.4 Hydraulic Design Criteria

- Hydraulic design for the project will be based on but not limited to the following guidelines:
  - Santa Clara Valley Water District Hydraulic Design Manual
  - EM 1110-2-1601, Hydraulic Design of Flood Control Channels (Corps 1994)
  - ER 1110-2-1405, Hydraulic Design for Local Flood Protection Projects (Corps 1982)
  - EM 1110-2-1416, River Hydraulics (Corps 1993)

6.1.4.1 Hydraulic Modeling

Hydraulic modeling is to be completed using Hydrologic Engineering Centers River Analysis System (HEC- RAS) Version 4.1 developed by Corps. Three recent hydraulic analyses have been conducted within the project reach and are to be considered for this design of this project. The previous hydraulic analyses that have been developed are as follows:

- Noble Consultants, Inc. (2009) – A hydraulic analysis was prepared for Corps. The modeling provides the existing conditions of the channel capacity.
- HDR (2012) – 90% plans and specifications for the EIP project in Reach 1 were prepared for SFCJPA. This planning study report incorporates draft hydraulic model geometry for the recommended alternative in Reach 1 (provided by HDR in 2010). Design phase hydraulic modeling for this project will require incorporation of HDR’s final hydraulic model in Reach 1.
- Caltrans (2010 – not yet released) – An analysis is under development for the design of a new bridge at West Bayshore Road, U.S. Hwy 101, and East Bayshore Road. Design phase hydraulic modeling for this project will require incorporation of Caltrans final hydraulic model at U.S. Hwy 101.

6.1.4.2 Design Flows

Design flows for the project will be determined in reference to the Santa Clara Valley Water District San Francisquito Creek Hydrology Report (2007).

6.1.4.3 Starting Water Surface Elevation

The HEC-RAS hydraulic model will include HDR’s final design geometry and starting water condition for Reach 1. As such, the starting water surface elevation for this project will combine the one-percent fluvial event of 9,400 cfs with the one-percent tide elevation plus 26-inches to account for sea-level rise.

---

1 The JPA directed HDR to assume a sea level rise of 26 inches. This value is consistent with the methodology that is being used by the District’s Shoreline Study.
6.2 Staff-Recommended Project Description

The staff-recommended project for the San Francisquito Creek Flood Protection Project is Alternative B: Floodwalls, Bridge Modification, and Bottle-neck Widening. Details of the floodwalls and bottle-neck widening elements are described below.

![Figure 6-1: Staff-Recommended Alternative B](image)

6.2.1 Floodwalls
Upstream of West Bayshore Road along San Francisquito Creek, floodwalls would be installed to a location approximately 1,500 feet downstream from the bridge at Pope/Chaucer Street. Floodwalls were chosen in this area over levees because there is very limited right-of-way along the creek and floodwalls have a smaller footprint as compared to levees. In addition, most of the land adjacent to the creek includes existing floodwalls, fencing, or landscaping, which block views of the channels. The installation of floodwalls along the creek would in most cases replace existing floodwalls, however new floodwalls at most locations would be significantly higher (see Tables 6-1, 6-2 for details).

6.2.1.1 Floodwall at West Bayshore Road
The bridge replacement project at U.S. Hwy 101 will be planned, designed, and constructed by Caltrans. Construction is expected to begin in 2014. Replacement of the bridge at U.S. Hwy 101 will also include replacement of the two frontage road bridges (East Bayshore Road, West Bayshore Road) which parallel the highway. Bridge replacements will include road widening to improve traffic conditions and hydraulic widening to ensure that the new bridges will convey the one-percent design flow (9,400 cfs).

As a result of bridge widening, the upstream face of West Bayshore Road will require channel modification along the Santa Clara County top of bank (Figure 6-2. The recommended
alternative includes widening the channel with a 100 foot long vertical concrete wall (station 80+50 to station 81+50) and 280 foot long warped wing wall (station 81+50 to station 84+30) that will conform with the existing upstream channel. Bank widening at this location would include removing existing sacked-concrete bank protection (Figure 6-3), excavating soil, and removing 380 feet of the District’s concrete masonry unit (CMU) floodwall.

Figure 6-2: Channel Modifications along Santa Clara County bank

A new floodwall would extend 380 feet upstream from the new bridge face at West Bayshore Road (station 80+50) along the top of the new vertical concrete wall and warped wing wall to tie into the District’s CMU floodwall (station 84+30) (Figure 6-2).

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6.2.1.2 **Raise the District’s CMU Floodwall**

The existing CMU floodwall would be retained for approximately 200 feet from the end of the warped wing wall to a point 440 feet downstream from the upstream end of the CMU floodwall (station 84+30 to station 86+30). The remaining 440 feet (station 86+30 to 90+75) of CMU floodwall would be modified by adding reinforced concrete blocks along the top of the wall to meet freeboard requirements for the one-percent design flow (see Figure 6-4). Preliminary structural analysis suggests that structural modification to the floodwall foundation will not be necessary for these improvements.

**Figure 6-4: New Raised Existing CMU Floodwall**
6.2.1.3 Replace Existing Floodwalls

As discussed previously (Section 2.9), in the late 1960s the District and San Mateo County Flood Control District coordinated efforts to install sacked-concrete floodwalls and concrete gravity walls along their respective creek banks. Today, nearly 50 years later, these floodwalls remain intact (Figure 6-5) and extend from approximately the upstream limit of the District’s CMU floodwall (station 90+75) to 900 feet downstream from the bridge at University Avenue (Figure 6-6). While these antiquated floodwalls appear to be in fair condition today, they are too low to provide one-percent flood protection and fail to meet FEMA floodwall specifications.

![Figure 6-5: Example of Existing Sacked Concrete Floodwall and Concrete Gravity Floodwall.](image)

(The remainder of page intentionally left blank.)
Under Alternative B, both the existing sacked concrete floodwall on the Santa Clara County side of the creek (station 90+75 to 124+50) and the existing concrete gravity wall (Figure 6-6) on the San Mateo County side of the creek (station 89+80 to station 118+80) would be removed and replaced with new floodwalls.

On the Santa Clara County side, 1.3 miles of new floodwalls would extend from the upstream limit of the District’s CMU floodwall to 1,780 feet downstream from the bridge at Pope/Chaucer Street (Table 6-1). On the San Mateo County side, 1.4 miles of new floodwalls would extend from the downstream limit of the existing gravity floodwall to 1,510 feet downstream from the bridge at Pope/Chaucer Street (Table 6-2).

The bridge at Pope/Chaucer Street would also require new floodwalls which would extend for 210 feet and 490 feet downstream and upstream direction from the bridge, respectively (Tables 6-1, 6-2).

(The remainder of page intentionally left blank.)
### Table 6-1: New Floodwall Height Above Ground on Santa Clara County Side of Creek

<table>
<thead>
<tr>
<th>Reach</th>
<th>Floodwall Location (Santa Clara County side)</th>
<th>Station (ft)</th>
<th>Average Floodwall Height (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2a</td>
<td>West Bayshore Road to conform with existing CMU wall</td>
<td>80+50 84+30</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>Beginning of raised CMU floodwall to end of CMU floodwall</td>
<td>86+30 90+75</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>End of CMU wall to Newell Road</td>
<td>90+75 112+40</td>
<td>6.6</td>
</tr>
<tr>
<td>2b</td>
<td>Newell Road to University Avenue</td>
<td>112+40 134+68</td>
<td>6.3</td>
</tr>
<tr>
<td>2c</td>
<td>University Avenue to 1,780 feet downstream from Pope/Chaucer Street</td>
<td>134+68 160+60</td>
<td>5.5</td>
</tr>
<tr>
<td>2c/2d</td>
<td>210 feet downstream from Pope/Chaucer Street to 490 upstream from Pope/Chaucer Street</td>
<td>176+25 183+25</td>
<td>4.2</td>
</tr>
</tbody>
</table>

### Table 6-2: New Floodwall Height Above Ground on San Mateo County Side of Creek

<table>
<thead>
<tr>
<th>Reach</th>
<th>Floodwall Location (San Mateo County side)</th>
<th>Station (ft)</th>
<th>Average Floodwall Height (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2a</td>
<td>Downstream end of existing gravity wall to Newell Road</td>
<td>89+80 112+40</td>
<td>7.4</td>
</tr>
<tr>
<td>2b</td>
<td>Newell Road to University Avenue</td>
<td>112+40 134+68</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>University Avenue to 1,510 feet downstream from Pope/Chaucer Street</td>
<td>134+68 163+30</td>
<td>4.6</td>
</tr>
<tr>
<td>2c/2d</td>
<td>210 feet downstream from Pope/Chaucer Street to 490 upstream from Pope/Chaucer Street</td>
<td>176+25 183+25</td>
<td>4.1</td>
</tr>
</tbody>
</table>

### 6.2.1 Bridge Modification

Under Alternative B, five vehicular bridges and two private pedestrian bridges would be modified or replaced to provide one-percent flood conveyance. Vehicular bridges would include the crossings at U.S. Hwy 101, Newell Road, University Avenue, Pope/Chaucer Street, and Middlefield Road. The two pedestrian bridges that would be modified are located on private properties between University Avenue and Pope/Chaucer Street. A brief description of each bridge follows.

(The remainder of page intentionally left blank.)
The three-span bridge at U.S. Hwy 101 is approximately 85 feet long (span distance) by 140 feet wide (in direction of creek flow) and accommodates eight lanes of vehicular traffic (Figure 6-7). West Bayshore Road crosses San Francisquito Creek just upstream from U.S. Highway 101 and includes a three-span bridge that is approximately 90 feet wide and 35 feet long and accommodates two lanes of vehicular traffic.

The bridges over U.S. Hwy 101 and West Bayshore road are structurally connected by their center piers which extend across the approximately 15 foot wide gap between the two bridges. A third bridge at East Bayshore Road crosses the creek just downstream from U.S. Hwy 101. This bridge is approximately 80 feet wide by 35 feet long, supports a two lane road, and is most likely connected to U.S. Hwy 101 by its center piers.

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Caltrans is in the design and environmental review phases to replace all three bridges with a widened bridge. The new bridge is expected to begin construction in 2014 and will include a widened roadway and bridge span to improve traffic flow and hydraulic conveyance to pass the one-percent flow (Figure 6-8). Currently, the flow capacity at the U.S. Hwy 101 bridge is 4,600 cfs or about half of the one-percent design flow (9,300 cfs) (Figure 6-8).

Newell Road Bridge Replacement Project (Station 112+20)

The single span bridge at Newell Road is approximately 40 feet long by 22 feet wide and accommodates one lane of traffic (Figures 6-9 and 6-10). The bridge, which was originally constructed in 1911, is owned by the City of Palo Alto and considered by Caltrans to be functionally obsolete. The traffic lanes are substandard, and the bridge has no provision for bicycle or pedestrian traffic. In addition, the sight distances from the bridge are poor, and the bridge alignment creates an undesirable offset in the horizontal alignment of Newell Road.
Figure 6-9: Newell Road Bridge Plan View

Figure 6-10: Newell Road Bridge Elevated Roadway
In 2010, at the request of the JPA, the City of Palo Alto applied for a Caltrans Highway Bridge Program grant for preliminary engineering, including engineering design and environmental assessment, for the replacement of the Newell Road bridge over San Francisquito Creek. As part of the program, Caltrans required that 11.5% of the cost of the work be paid by the agency receiving the grant. In consideration of the City of Palo Alto applying for the grant, the JPA offered to pay the local match.

The replacement bridge is tentatively proposed to include two 16 foot wide traffic lanes (for shared vehicular/bicycle traffic) and 5 foot wide sidewalks on each side of the road. The proposed bridge length is 75 feet, which is the approximate distance between the top of the creek banks, allowing the new abutments to be constructed outside the creek channel. The new bridge will be designed to pass the one-percent flow event and accommodate future channel improvements both upstream and downstream from the bridge which may include floodwalls.

Under Alternative B, approximately 6 foot tall floodwalls on either bank would tie into the bridge at Newell Road at both the upstream and downstream bridge faces.

University Avenue Replacement/Modification (Station 134+00)

The single span bridge at University Avenue is approximately 50 feet long by 110 feet wide and accommodates 5 lanes of vehicular traffic. The bridge was originally constructed in 1925 and is owned by Caltrans. The bridge includes sidewalks along both edges of the roadway and a bicycle lane which crosses the bridge adjacent to the upstream sidewalk. According to Caltrans, there are no improvements planned for this bridge.

**Figure 6-11:** University Avenue Bridge Plan View
Under Alternative B, the bridge at University Avenue would be modified or replaced to pass the one-percent flow event and would accommodate approximately 6 foot tall floodwalls on either bank which would tie into the bridge at both the upstream and downstream bridge faces.

Two Private Pedestrian Bridges Replacement/Modification (Station 149+00, Station 151+80)

Two privately owned single span pedestrian bridges are located in the reach between University Avenue and Pope/Chaucer Street (Figures 6-13, 6-14 and 6-15). The downstream and upstream bridges; both appear to be in good condition; are approximately 5 feet wide; and are 60 feet by 80 feet long, respectively. The date of construction of each bridge is unknown.

Under Alternative B, both bridges would be modified or replaced to pass the one-percent flow event and accommodate approximately 6 foot tall floodwalls on either bank which would tie into the bridges at both the upstream and downstream bridge faces.

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Figure 6-13: Private Pedestrian Bridges Plan View

Figure 6-14: Private Pedestrian Bridge Elevation View Looking Upstream
Figure 6-15: Private Pedestrian View Bridge Footing

Pope/Chaucer Street Bridges Replacement (Station 177+70)

The single span bridge at Pope/Chaucer Street is approximately 35 feet long by 60 feet wide and accommodates two lanes of vehicular traffic (Figure 6-16). The bridge was originally constructed in 1907 as a single span reinforced concrete arch structure (Figure 6-17), and was modified in 1948 to include a narrower opening (Figure 6-18). The bridge is owned by the City of Palo Alto and appears to be in good condition. The bridge includes sidewalks along both edges of the roadway; however there are no bicycle lanes.

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Figure 6-16: Pope/Chaucer Street Bridges Plan View

Figure 6-17: Pope/Chaucer Street Bridges Elevation View (circa 1907)
The bridge at Pope/Chaucer Street is a known break out point for flooding during peak flow events (Table 6-3) and was identified early on in the planning phase as a necessary component to provide one-percent flood protection for each of the feasible alternatives (Figure 6-19). As such, the project team has retained consultant services to begin preparing engineering plans and specifications to replace the bridge.

In order to increase the hydraulic capacity of the bridge, the existing arch structure, fill, and adjacent plantings will be removed. The new bridge will likely include a three span bridge structure rather than a single span. The three span bridge may be chosen over a single clear span bridge to minimize the bridge thickness and thus maintain the lowest possible roadway elevation which will reduce grading impacts to local residents.
Under Alternative B, approximately 6 foot tall floodwalls on either bank would tie into the bridge at Newell Road at both the upstream and downstream bridge faces.

Middlefield Road Modification (Station 222+80)

The single span bridge at Middlefield Road is approximately 30 feet long by 36 feet wide and accommodates three lanes of vehicular traffic (Figure 6-20). The bridge was constructed in 1936. The bridge is owned by the City of Palo Alto and appears to be in good condition. The bridge includes a dirt path and sidewalk along the downstream and upstream edge of the roadway, respectively; however there are no bicycle lanes.

![Figure 6-20: Middlefield Road Bridge Plan View](The remainder of page intentionally left blank.)
Similar to the bridge at Pope/Chaucer Street, the bridge at Middlefield Road is a known break out point for flood flows. The project team has identified this bridge as necessary for each of the feasible alternatives (Section 5.8), and will likely retain consultant services to replace or modify the bridge following the completed Pope/Chaucer Street bridge design.

### 6.2.2 Bottle-neck Widening

The project team has identified six constrictions in the project reach (referred to as "bottle-necks") that impede flow and result in elevated upstream water surface elevations. Under Alternative B, four of the six bottle-necks will be widened to match typical existing channel dimensions. As a result of bottle-neck widening, floodwall heights at some locations will be reduced by more than one foot and in-stream channel velocities will be reduced by up to 2.9 feet per second to improve fish passage conditions.

#### Table 6-3: Bottle-neck Reductions to Channel Velocity

<table>
<thead>
<tr>
<th>Bottle-neck</th>
<th>Station Begin</th>
<th>Station End</th>
<th>Maximum Velocity Reduction (ft/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>104+23</td>
<td>109+23</td>
<td>2.6</td>
</tr>
<tr>
<td>3</td>
<td>113+23</td>
<td>118+23</td>
<td>1.9</td>
</tr>
<tr>
<td>4</td>
<td>122+25</td>
<td>127+27</td>
<td>1.9</td>
</tr>
<tr>
<td>5</td>
<td>138+25</td>
<td>143+26</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Note: Calculated for one percent flow conditions

At each bottle-neck location, the finished grade would likely include a 1:1 (H:V) slope with erosion control along the bank and toe of slope and native vegetation plantings. Some locations, however, may require steeper slopes due to the creek’s proximity to Woodland Avenue. At these locations, a combination of retaining walls and toe and slope protection will be constructed.
Bottle-neck 2 (Station 104+23 to Station 109+23)

Channel widening for bottle-neck 2 would occur for five hundred feet along Woodland Avenue between Clark Avenue and Newell Road (Figures 6-22 and 6-23). Approximately 2,500 cubic yards of bank materials would be removed from the bank.

Figure 6-22: Aerial Plan View of Bottle-neck 2

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Bottle-neck 3 (Station 113+23 to Station 118+23)

Channel widening for bottle-neck 3 would occur for five hundred feet along Woodland Avenue between Newell Road and Cooley Avenue (Figures 6-24 and 6-25). Approximately 2,000 cubic yards of bank materials would be removed from the bank.
Bottle-neck 4 (Station 122+25 to Station 127+27)

Channel widening for bottle-neck 4 would occur for five hundred feet along Woodland Avenue between Cooley Avenue and Southwood Drive (Figure 6-26 and 6-27). Approximately 3,100 cubic yards of bank materials would be removed from the bank.
Bottle-neck 5 (Station 138+25 to Station 143+26)

Channel widening for bottle-neck 5 would occur for five hundred feet along Woodland Avenue between Manhattan Avenue and Euclid Avenue (Figures 6-28 and 6-29). Approximately 4,700 cubic yards of bank materials would be removed from the bank.
Bottle-neck 5 includes concrete terraces with iron handrails on both banks and sacked concrete erosion protection along the low flow channel. Opportunities to widen the channel are limited by residential structures along the Santa Clara County top of bank. The San Mateo County top of bank, however, includes no residential structures, is not located at the edge of Woodland Avenue; and appears to be abandoned (Figure 6-30).

Figure 6-30: Concrete Terracing at Bottleneck 5 (looking upstream)
6.2.1 Erosion Protection
San Francisquito Creek bank erosion mainly occurs upstream from the bridge at Pope/Chaucer Street which is about 1,500 feet upstream from where floodwalls are recommended under Alternative B. This pattern is supported by the Bank Stabilization and Revegetation Master Plan (2000) which included a detailed investigation of the creek in 1998 and 1999 and suggests that areas of high erosion potential in Reach 2a, 2b, and 2c which have already received sacked-concrete treatment are generally considered to be stable. Annual maintenance walks conducted by the JPA (including participation from JPA member agencies and interested members of the public) support this pattern and report only occasional small scale erosion at the toe of some sacked concrete bank protection. The JPA has identified erosion sites upstream from El Camino Real as candidates for bank stabilization projects.

The Bank Stabilization and Revegetation Master Plan suggests that the “No Action” Alternative or an alternative emphasizing revegetation or non-native species removal be applied to Reaches 2a, 2b, and 2c. However, the project team recommends continued inspection of these reaches, with specific attention to locations where continued bank erosion may pose a threat to safety or property.

Field inspections performed by the project team in 2009, 2010 and 2011 have identified one such area of concern near the downstream face of the bridge at University Avenue where the creek bank is nearly vertical and in close proximity to Woodland Avenue (Figure 6-32).
Under Alternative B, this section of creek bank would be treated as part of modifications or replacement of the bridge at University Avenue. Because construction funding for Alternative B has not yet been identified, the project team recommends that the JPA continue to monitor this area to mitigate future damage to Woodland Avenue. The project team also recommends that potentially significant erosion areas identified by the Bank Stabilization and Revegetation Master Plan (2000) in Reach 2b, and 2c be inspected for further consideration during the design phase. For planning purposes, the rock toe bank protection method is recommended for all such erosion repairs. This method is appropriate for the identified erosion sites, which have steep side slopes (1.5:1, H:V, or steeper) and velocities lower than 7 ft/sec. It consists of protecting the toe and lower banks with rock up to the 10-year flow level and repairing the slope above this level with a combination of earth fill, erosion protection fabric, native vegetation, and hydroseed.

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6.3 Right-of-Way Requirements

It is expected that strips of land from 66 parcels along San Francisquito Creek would need to be acquired by the District in fee or easement for the construction of the staff-recommended alternative.

Along the Santa Clara County side of the creek (Table 6-4), acquired lands would include residential property between the upstream limit of the District’s CMU floodwall (Station 90+75) and the upstream limit of the new floodwall and maintenance path at Maple Street (Station 160+63).

Along the San Mateo County side of the creek (Table 6-5), acquired lands would include commercial and residential properties located at the apartment complex near West Bayshore Road and just upstream from the bridge at University Avenue, respectively. Additional right of way will be required along a significant portion of Woodland Avenue from the City of East Palo Alto, and the City of Menlo Park.

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6.4 Identification of Environmental and Recreational Enhancement Opportunities

The San Francisquito Creek Project objectives include the identification of feasible opportunities for environmental and recreational enhancements.

6.4.1 Environmental Enhancement Opportunities

Trash Reduction

Opportunities exist to improve the water quality in San Francisquito Creek by reducing the amount of trash that enters the channels through municipal storm drain system. As an example, the City of Sunnyvale recently initiated a pilot study which installed StormTek catch basin inserts at eight locations in the Sunnyvale East Channel watershed and five locations in the Sunnyvale West watershed. The StormTek catch basin insert consist of a perforated metal screen attached to the catch basin outlets that allows water to flow from the catch basin, but traps trash for removal and proper disposal.

An environmental enhancement opportunity is to improve water quality by partnering with the City of East Palo Alto, Menlo Park, and Palo Alto to implement a trash abatement program using similar technology.

Storm-water Runoff Reduction

Another environmental opportunity is to reduce the quantity of storm-water runoff and improve water quality by implementing a storm-water runoff reduction incentive program. If local municipalities implement such a program, the District could consider partnering to support this effort.

---

| Table 6-4: Average Right of Way Width on Santa Clara County Side of Creek |
|---|---|---|
| Reach | Location | Right of Way |
| 2a | Upstream limit of District CMU floodwall to Newell Road | 5 ft strip |
| 2b | Newell Road to University Avenue | 5 ft strip |
| 2c | University Avenue to Maple Street | 5 ft strip |

| Table 6-5: Average Right of Way Width on Santa Mateo County Side of Creek |
|---|---|---|
| Reach | Location | Right of Way |
| 2a | Apartment complex near West Bayshore Road | 5 ft strip |
| 2b | Private property on creekside of Woodland Avenue near end of Manhattan Avenue | 0.5 acre |
| 2c | University Avenue to Maple Street | 5 ft strip |

Comment [KS2]: check reference to project name. Make consistent throughout report.
The program would be based on a program currently being implemented by the City of Palo Alto. The Palo Alto program offers rebates for the installation of rain barrels and underground or above-ground cisterns, the replacement of traditional pavement with permeable pavement, and the replacement of traditional roofing material with “green roofs”.

6.4.2 Recreational Enhancement Opportunities
Recreational enhancement opportunities, including pedestrian and bicycle trails, access ramps to the creek, and observation stations were considered for this project during the initial planning phase. Trails and access ramps could be constructed along Woodland Avenue and along the Santa Clara top of bank; however the high capital cost and various impacts related to right of way acquisition, trail construction, and loss of privacy are expected to be prohibitive. As such continuous trails along the creek and access ramps to the channel are not considered under the recommended alternative.

The recommended alternative does, however, include opportunities to create new or improved bicycle lanes, pedestrian walk ways, and viewing stations where bridges would be modified or replaced. These betterments have been included in the project cost estimate.

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7 MAINTENANCE PROGRAM

7.1 MAINTENANCE HISTORY

7.2 ONGOING MAINTENANCE ACTIVITIES

7.3 STAFF-RECOMMENDED ALTERNATIVE MAINTENANCE ACTIVITIES

7.4 LONG TERM INFRASTRUCTURE MAINTENANCE

7.5 STAFF-RECOMMENDED ALTERNATIVE MAINTENANCE COST
7 MAINTENANCE PROGRAM

7.1 Maintenance History

Maintenance work has likely been conducted within the San Francisquito Creek watershed since the first levees were constructed in the late 1800s. At around this time channel dredging also took place in the vicinity of the South San Francisco Bay. The first major flood protection projects were coordinated between the San Mateo Flood Control District and the District in the 1950s which included earthen levees, sacked concrete bank protection, and concrete gravity walls. While it is undocumented, these and additional flood protection facilities completed in the late 1960s are expected to have required maintenance inspections and occasional repairs.

7.2 Ongoing Maintenance Activities

The District performs regular maintenance inspection and vegetation removal and graffiti removal along the improved levees and CMU floodwall which was constructed in 2003. The District also removes approximately 1,700 cubic yards of sediment at U.S. Hwy 101 every three years on average.

![Sediment Removal Chart 1984 - 2007](image)

**Figure 7-1:** Sediment Removal 1984 - 2007
Sediment Maintenance: The Stream Maintenance Program (SMP) allows for sediment removal on San Francisquito Creek where sediment deposition has 1) reduced flood conveyance capacity; 2) impeded function of facilities and/or structures (e.g. flap gates, culverts); or 3) impede fish passage and/or access to fish passage structures.

Watershed staff evaluate channel conditions semi-annually to identify necessary future maintenance activities and sediment removal is performed on an as needed basis per the SMP.

Sediment removal was performed in the vicinity of U.S. Hwy 101 to ensure flood conveyance in the creek and to maintain continued operation of the City of Palo Alto floodwater pipeline which outlets with a flap gate just downstream from the bridge. In 2009, the City of Palo Alto completed construction of a new pump station and abandoned the pipeline. As a result, District staff may discontinue sediment removal at this location.

Vegetation Maintenance: The District typically removes vegetation in and adjacent to streams and canals to: 1) maintain flood conveyance capacity; 2) maintain water conveyance for supply purposes; 3) reduce fuel loads on adjacent banks to meet local fire code requirements; and 4) control invasive nonnative vegetation. Specific vegetation management activities generally include mowing, diskng, hand clearing, or herbicide application.

CMU Floodwall: The 1,000 foot long CMU floodwall and approximately 5 foot wide access path located on the Santa Clara side of the creek upstream from U.S. Hwy 101 (Reach 2a) is cleared of vegetation on an annual basis. Vegetation is removed by hand labor and includes herbicide application.

Natural and Low-flow Channels: San Francisquito Creek is monitored for hazardous tree conditions, channel blockages and other conditions that would impede flow or create local drainage problems.

Structural Maintenance: The following structural maintenance is performed on an annual cycle (unless otherwise noted):

Levees: Levee tops and slopes are monitored for erosion damage in Reach 1 (along the Santa Clara side of the creek) and repaired as needed.

CMU Floodwall: The existing CMU floodwall (Reach 2a) is monitored for structural damage and repaired as needed.

Maintenance Access Roads: Asphalt-paved, concrete-paved and soil-cement roads in Reach 1 are monitored for cracking and potholes and repaired as needed. Aggregate base roads are monitored for erosion and potholes and repaired as needed; measures are taken to prevent vegetation growth.

Sacked-Concrete: Other than annual JPA maintenance walk inspections, sacked-concrete erosion protection is not monitored.

Debris/Graffiti Removal: Debris and graffiti removal is performed per the District’s Good Neighbor Program. It consists of monthly and quarterly cleanup events, response to graffiti and trash complaints, and repairs/installation of fences and signs around District facilities.
7.3 Staff-Recommended Alternative Maintenance Activities

The following maintenance activities would be required by the staff-recommended alternative.

**Sediment Maintenance:** No additional maintenance required.

**Vegetation Maintenance:** The construction of floodwalls would require additional vegetation removal. The right-of-way corridor adjacent to the outside face of floodwalls would be regularly maintained by clearing it of weeds and trash. Woody vegetation would be removed from within five feet of the inside face of walls, except where such vegetation is intentional.

**Structural Maintenance:**

*Levees/Berms:* No additional maintenance required.

*Maintenance Access Paths:* No additional maintenance required.

*Sacked-Concrete:* No additional maintenance required.

*Floodwalls:* The construction of floodwalls would require visual monitoring for cracks, spalls and other types of damage; repairs would be performed as needed.

**Debris/Graffiti Removal:** Graffiti removal would increase due to the construction of floodwalls. The maintenance activities would be incorporated as part of the Good Neighbor Program. Maintenance activities such as trash and debris removal would be the same as under the existing condition.

7.4 Long Term Infrastructure Maintenance

Like all man-made structures, the new floodwalls, and other infrastructure that would be built by this project would eventually require replacement. Therefore, the calculated project maintenance costs (see Table 7-1 below) include provisions for structural replacement costs estimated for the project’s design lifespan of 50 years.

7.5 Staff-Recommended Alternative Maintenance Cost

The estimated additional annual maintenance cost for the staff-recommended alternative is itemized and summarized below in Table 7-1. Costs were escalated to the 50-yr total value using a 3.7 percent compounding interest rate. Additional information on how each activity was calculated can be found in Appendix B.

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Table 7-1: Estimated Additional Annual Maintenance Costs

<table>
<thead>
<tr>
<th>Activity</th>
<th>Staff Recommended Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graffiti Removal</td>
<td>$ 5,280</td>
</tr>
<tr>
<td>Vegetation Removal</td>
<td>$ 10,900</td>
</tr>
<tr>
<td>Sediment Removal</td>
<td>$ 145,270</td>
</tr>
<tr>
<td><strong>Total per Year</strong></td>
<td><strong>$ 161,450</strong></td>
</tr>
<tr>
<td><strong>Total per Year</strong></td>
<td><strong>$ 161,000</strong></td>
</tr>
<tr>
<td><strong>Over 50-Years</strong></td>
<td><strong>$ 23,403,616</strong></td>
</tr>
<tr>
<td><strong>Total over 50 Years</strong></td>
<td><strong>$ 23,400,000</strong></td>
</tr>
</tbody>
</table>

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8.2 PROJECT FUNDING .................................................................................................................................. 3

8.3 PROJECT SCHEDULE ................................................................................................................................. 3
8 PROJECT COST, FUNDING, AND SCHEDULE

8.1 Project Cost

8.1.1 Capital Cost

The overall capital cost for the staff-recommended project would be $70.3 million in 2012 dollars including construction, land acquisition, and contingencies. The overall cost for the EIP would be $31.9 million in 2012 dollars including construction, land acquisition, and contingencies.

The capital cost estimate is summarized below in Table 8-1. A detailed cost estimate is provided in Appendix B.

### Table 8-1: Staff-Recommended Project Capital Cost Estimate

<table>
<thead>
<tr>
<th>Project Element</th>
<th>Cost ($ million, 2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge Modification/Replacements</td>
<td>12.7</td>
</tr>
<tr>
<td>Bottle-neck Channel Widening</td>
<td>6.3</td>
</tr>
<tr>
<td>Floodwalls</td>
<td>24.9</td>
</tr>
<tr>
<td>Land Acquisition</td>
<td>10.0</td>
</tr>
<tr>
<td>Construction Mobilization, Design Specifications, Geotechnical Investigation, Construction Management</td>
<td>16.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>70.3</strong></td>
</tr>
</tbody>
</table>

### Table 8-2: EIP Capital Cost Estimate

<table>
<thead>
<tr>
<th>Project Element</th>
<th>Cost ($ million, 2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boardwalk</td>
<td>0.3</td>
</tr>
<tr>
<td>Levees</td>
<td>11.9</td>
</tr>
<tr>
<td>Floodwalls</td>
<td>10.3</td>
</tr>
<tr>
<td>Landscape</td>
<td>0.7</td>
</tr>
<tr>
<td>Land Acquisition</td>
<td>2.9</td>
</tr>
<tr>
<td>Construction Mobilization, Design Specifications, Geotechnical Investigation, Construction Management</td>
<td>5.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>31.9</strong></td>
</tr>
</tbody>
</table>
8.1.2 Maintenance Cost
The annual maintenance cost for the staff-recommended alternative would be $161,450 per year, as shown in Table 8-2.

Table 8-2: Staff-Recommended Project Annual Maintenance Cost Estimate

<table>
<thead>
<tr>
<th>Activity</th>
<th>Annual Cost ($ , 2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graffiti Removal</td>
<td>$ 5,280</td>
</tr>
<tr>
<td>Vegetation Removal</td>
<td>$ 10,900</td>
</tr>
<tr>
<td>Sediment Removal</td>
<td>$ 145,270</td>
</tr>
<tr>
<td>Total</td>
<td>$ 161,450</td>
</tr>
</tbody>
</table>

The total maintenance cost for the 50-year life of the project would be $23.4 million dollars, assuming a 3.7% compounding interest rate to account for escalation.

Table 8-3: EIP Annual Maintenance Cost Estimate

<table>
<thead>
<tr>
<th>Activity</th>
<th>Annual Cost ($ , 2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graffiti Removal</td>
<td>TBD</td>
</tr>
<tr>
<td>Vegetation Removal</td>
<td>TBD</td>
</tr>
<tr>
<td>Sediment Removal</td>
<td>TBD</td>
</tr>
<tr>
<td>Total</td>
<td>TBD</td>
</tr>
</tbody>
</table>

8.2 Project Funding
Planning and design elements of the recommended alternative and the EIP would be paid for by funds from the 2000 voter-approved Clean, Safe Creeks Program. The cost of construction, land acquisition, and design of the staff-recommended alternative and EIP in 2012 dollars is estimated at $70.3, and 31.9 million, respectively. The total funding allocation for the Project includes $10.6 million from the Clean Safe Creeks Program and $6.7 million from the Watershed Fund.

8.3 Project Schedule
Project design began in FY 2013 and is anticipated to be completed in FY 2014. Pending funding availability, construction of some project elements could begin as soon as FY 2013.

The EIP is in the final design phase and is on schedule to begin construction in FY 2013.