3.3 Hydrology, Flood Management and Infrastructure

3.3.1 Physical Setting

Methodology

This section describes existing hydrology and flood management in the SBSP Restoration Project Area. It includes a summary of the physical setting at regional and project levels, as well as a description of the regulatory setting. The primary sources of data used in the preparation of this section include:

Hydrology

- The scientific literature regarding South Bay hydrodynamics and sediment dynamics;
- Monitoring data and reports from the San Francisco Bay Regional Monitoring Program;
- Monitoring data and reports from the United States Geological Survey (USGS) Long-term Water Quality Program (1968 – present), and Continuous Monitoring Program (1989 – 2001);
- South Bay Salt Ponds Initial Stewardship Plan (Life Science! 2003);
- South Bay Salt Ponds Initial Stewardship Plan: Environmental Impact Report/ Environmental Impact Statement (Life Science! 2004);
- Baylands Ecosystem Habitat Goals (Goals Project 1999);
- Feasibility Analysis, South Bay Salt Pond Restoration (Siegel and Bachand 2002);
- Proposed San Francisco International Airport Runway Reconfiguration Project Draft Impact Analysis (URS 2002);
- Inventory of Water Conveyance Facilities (Moffatt & Nichol Engineers 2005);
- Previous modeling studies of the South Bay (Cheng and others 1993; Gross 1997; Gross and others 1999; Gross and Schaaf & Wheeler 2003a; Gross and Schaaf & Wheeler 2003b; Gross and Schaaf & Wheeler 2003c; URS 2002; etc.); and
- Communications with the various water districts and agencies (*i.e.*, Santa Clara Valley Water District [SCVWD], City of San Jose).

Flood Management/Infrastructure

- The US Army Corps of Engineers (Corps) San Francisco Bay Shoreline Studies (1988b; 1989);
- The US Army Corps of Engineers San Francisco Bay Tidal Hydrology Study (1984b);
- Federal Emergency Management Agency (FEMA) Community Flood Insurance Studies;
- Inventory of Water Conveyance Facilities (Moffatt & Nichol Engineers 2005);
- Urban Levee Flood Management Requirements (Moffatt & Nichol Engineers 2005);
- Communications and documents from SCVWD and Alameda County Flood Control and Water Conservation District (ACFCWCD) regarding flood protection issues and facilities;

- Communications with San Mateo County, Redwood City and Menlo Park regarding flood protection issues and facilities;
- Type 16 Flood Insurance Study, Corps WES Report H-74-3 (Houston 1974);
- Type 19 Flood Insurance Study, Corps WES Report HL-80-18 (Houston 1980); and
- Final Draft Guidelines for Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States. Available at http://www.fema.gov/fhm/frm_cfham.shtm (Federal Emergency Management Agency 2005).

Additional detail regarding South Bay hydrology and flood management practices may be found in the Hydrodynamics and Sediment Dynamics Existing Conditions Report (PWA and others 2005b) as well as the Flood Management and Infrastructure Existing Conditions Report (PWA and others 2005a).

Regional Setting

The regional setting provides information relating to South San Francisco Bay (South Bay). The South Bay is defined as the portion of San Francisco Bay south of Coyote Point on the western shore and San Leandro Marina on the eastern shore (Goals Project 1999).

Hydrology and Sediment Dynamics

The South Bay is both a geographically and hydrodynamically complex system, with freshwater tributary inflows, tidal currents, and wind interacting with complex bathymetry (*i.e.*, bed surface elevation below water) to create circulation patterns that vary over time. The most obvious hydrodynamic response to these forcing mechanisms is the daily rise and fall of the tides, although much slower residual circulation patterns also influence mixing and flushing processes of the South Bay.

Bathymetry. The South Bay is a large shallow basin, containing a now inundated deep relict river channel surrounded by broad shallow areas, mudflats, and fringing tidal marsh (Figure 3.3-1). The width of the Bay ranges from less than 1.2 miles (2 km) near the Dumbarton Bridge (the Dumbarton Narrows) to more than 12 miles (20 km) north of the San Mateo Bridge. The mean depth of the South Bay is less than 13 ft (4 m), with a channel depth of 33–50 ft (10–15 m). The areas between mean high and low tide contain a network of small branching channels that effectively drain the South Bay at low water, leaving an expanse of exposed mudflats.

Historical hydrographic surveys of the South Bay were conducted by the National Ocean Service (NOS, formerly called the US Coast and Geodetic Survey) in 1857 to 1858, 1897 to 1899, 1931, 1954 to 1956, and 1981 to 1985; details of the surveys are given by Foxgrover and others (Foxgrover and others 2004). The California Coastal Conservancy, in cooperation with USGS and the National Oceanic and Atmospheric Administration (NOAA), recently completed three surveys of the Project Area: a sonar survey of the wet salt ponds in 2003 and 2004, a LiDAR survey of the dry ponds and intertidal mudflats in May 2004 (Foxgrover and Jaffe 2005; TerraPoint 2005), and a hydrographic survey of the South Bay in winter 2005.

Sea Level Rise. Sea level rise refers to an increase in mean sea level with respect to a land benchmark. Global sea level rise can be a result of global warming through the expansion of sea water as the oceans warm and the melting of ice over land. Local sea level rise is affected by global sea level rise plus tectonic land movements and subsidence, which can be of the same order as global sea level rise. Atmospheric pressure, ocean currents and local ocean temperatures also affect local rates of sea level rise.

The rate of global sea level rise is expected to continue along a global-warming-induced trajectory, possibly attaining an average rate of about 0.01 ft per year over the next 50 years (2000 to 2050), and rising to an average rate of about 0.015 ft per year over the following 50 years (2050 to 2100) (IPCC 2001). Although significant uncertainty exists regarding these rates, ongoing research regarding the primary factors affecting global sea level rise continues to narrow the uncertainties and refine future estimates.

For the purpose of this EIS/R, the Intergovernmental Panel on Climate Change (IPCC) mid-range estimate of 0.5 ft of future global sea level rise over the next 50 years was selected (IPCC 2001). In May 2007, the IPCC released revised sea level rise estimates for the twenty-first century (2000 to 2100) (IPCC 2007). The revised estimates were compared with the previous IPCC (2001) estimates used in the EIS/R. The 2007 IPCC estimates are not substantially different from the 2001 estimates, although the band of uncertainty has been narrowed in the 2007 estimates (IPCC 2007). IPCC (2007) does not specify a 50-year mid-range estimate for direct comparison with the 2001 value. However, the midpoint of each of the 2007 climate change scenarios is within ten percent of the corresponding 2001 estimate (IPCC 2007). Ongoing monitoring efforts in and around San Francisco Bay by others would also inform local estimates of sea level rise. Changes in estimates of sea level rise would be addressed in subsequent phases of the Project.

Burgmann and others (2006) resolved vertical tectonic land movements around South and Central San Francisco Bay. Regions adjacent to the South Bay have experienced tectonic uplift rates of approximately 0.001 ft to 0.005 ft per year. Uplift rates of around 0.003 ft per year were found in the Santa Cruz Mountains bordering the Santa Clara Valley and rates between 0.001 and 0.005 ft per year were observed in the vicinity of the Hayward and Calaveras Faults in the East Bay. Because the regional tectonic movements are upward, they decrease relative sea level rise. To be conservative from a planning perspective, a value of zero land movement is used in the EIS/R. This approach is considered conservative because it results in a somewhat higher rate of sea level rise being used in the planning process.

Historically, subsidence has occurred in the Santa Clara Valley due to groundwater withdrawals, leaving parts of Alviso about 8 ft below the adjacent sea level. The rate of groundwater withdrawals has since been reduced and the aquifers artificially recharged. Recent estimates of vertical land movements in the Santa Clara Valley (Schmidt and Burgmann 2003) show that only small amounts of subsidence are likely to be occurring in the South Bay due to groundwater extraction. Therefore, in this EIS/R, it is assumed that no local subsidence would occur over the 50-year planning horizon.

Tides. Tides move as shallow water waves through the narrow opening at the Golden Gate, but are modified by the bottom bathymetry, shoreline and the Earth's rotation as they move through the Estuary.

The enclosed nature of the South Bay creates a mix of progressive and standing wave behavior, where waves are reflected back upon themselves (Walters and others 1985), causing an amplification of the tidal wave and an increase in tidal range with distance from the Golden Gate, as shown in Table 3.3-1 (Figure 6 of Appendix E. Flood Analyses Report shows the locations of tide gauges in the South Bay).

Table 3.3-1 Tidal Water Levels for Tide Gauges Near the Project Area for Two Datums

TIDE	PRESIDIO	ALAMEDA	SAN MATEO BRIDGE, WEST	DUMBARTON BRIDGE	COYOTE CREEK, ALVISO SLOUGH
ft MLLW					
Mean Higher High Water	5.84	6.59	7.72	8.51	9.00
Mean High Water	5.23	5.97	7.09	7.88	8.42
Mean Tide Level	3.18	3.55	4.14	4.54	4.83
Mean Sea Level	3.12	3.45	4.11	4.57	4.92
Mean Low Water	1.14	1.13	1.19	1.20	1.24
NAVD88	-0.06	0.23	0.75	1.24	1.52
Mean Lower Low Water	0.00	0.00	0.00	0.00	0.00
ft NAVD88					
Mean Higher High Water	5.90	6.36	6.97	7.27	7.48
Mean High Water	5.29	5.74	6.33	6.64	6.90
Mean Tide Level	3.24	3.32	3.38	3.30	3.31
Mean Sea Level	3.18	3.22	3.36	3.33	3.40
Mean Low Water	1.19	0.90	0.43	-0.04	-0.28
NAVD88	0.00	0.00	0.00	0.00	0.00
Mean Lower Low Water	0.06	-0.23	-0.75	-1.24	-1.52

The tides in San Francisco Bay are mixed semidiurnal, with two high and two low tides of unequal heights each day. The tides exhibit strong spring-neap variability, with the spring tides (larger tidal range) occurring approximately every two weeks during the full and new moon. Neap tides (smaller tidal range) occur approximately every two weeks during the moon's quarter phases. The tides also vary on an annual cycle, in which the strongest spring tides occur in late spring/early summer and late fall/early winter, and the weakest neap tides occur in spring and fall.

The volume of water in the South Bay between mean low water and mean high water, or "tidal prism", in combination with bathymetry, determines the patterns and speed of tidal currents and subsequent sediment transport. The tidal prism for the South Bay is approximately 666,000 acre-ft (ac-ft) (8.22×10^8 m^3), the majority of which is contained between the San Francisco–Oakland Bay Bridge and San Mateo Bridge (Schemel 1995). At mean lower low water (MLLW), the volume of water in the far South Bay (south of the Dumbarton Bridge) is less than half the volume present at mean higher high water

(MHHW). In addition, surface water area coverage at MLLW is less than half that at MHHW, indicating that over half of the far South Bay consists of shallow mudflats exposed at low tides (Schemel 1995).

Climate and Precipitation. The San Francisco Bay Area, like much of California's central coast, experiences a Mediterranean climate characterized by mild, wet winters and dry warm summers. Air temperatures are mild due to proximity to the ocean and are seldom below freezing. Winter weather is dominated by storms from the northern Pacific Ocean that produce nearly all the annual rainfall, while summer weather is dominated by sea breezes caused by differential heating between the hot interior valleys and the cooler coast. The prevailing wind direction over the South Bay is typically from the west to northwest in the late spring through early fall, with more variable conditions in the winter (Cheng and Gartner 1985).

The South Bay typically receives about 90 percent of its precipitation in the fall and winter months (October through April); with the greatest average rainfall occurring in January. The average annual rainfall in the counties surrounding the South Bay is approximately 20 inches, although the actual rainfall can be highly variable due to El Niño (wet) and La Niña (dry) years and the influence of local topography.

Salinity. Salinity in the South Bay is governed by salinity in the Central Bay, exchange between the South and Central Bays, freshwater tributary inflows to the South Bay, and evaporation. In general, the South Bay is vertically well mixed (*i.e.*, there is little tidally-averaged vertical salinity variation) with near oceanic salinities due to low summer and fall freshwater inputs to the far South Bay.

Seasonal variations in salinity are driven primarily by variability in freshwater inflows (Life Science! 2003). High freshwater inflows can cause salinity to vary substantially and results in three-dimensional circulation patterns driven by density gradients between South and Central Bay (Walters and others 1985). This typically occurs in winter and early spring in wet years when fresh water from the San Francisco Bay Delta can intrude into the South Bay (Figure 11 in the Hydrodynamics and Sediment Dynamics Existing Conditions Report) (PWA and others 2005b). Therefore, salinity conditions during winter and spring are often dynamic, characterized by unsteady flows, variable salinity and periodic vertical stratification (Life Science! 2003). As Delta and tributary inflows decrease in late spring, salinity increases to near oceanic salinities. The largest source of fresh water to the South Bay during summer comes from the local municipal wastewater treatment plants. In the sloughs near the outfall of the San Jose/Santa Clara Water Pollution Control Plant (WPCP) (Artesian Slough, Mud Slough and Coyote Slough), the water is becoming fresher, allowing freshwater- and brackish-tolerant plants to colonize areas previously vegetated by salt marsh species. Additional factors, such as the restoration of Warm Springs Lagoon upstream on Coyote Slough, have also had an effect on the hydrodynamics and salinity dynamics in the Coyote Slough system. The volume of inflow from the treatment plants to the South Bay in general is essentially equivalent to that lost through evaporation, and therefore, salinities in the South Bay overall remain close to those of the ocean (33 parts per thousand, [ppt]) (Cheng and Gartner 1985).

USGS operates several salinity, temperature, and suspended sediment concentration (SSC) monitoring sites in San Francisco Bay as part of the Continuous Monitoring Program (Buchanan 1999; Buchanan and Schoellhamer 1999; U.S. Geological Survey 2004a). The time series of salinity was measured at Pier 24 on the western end of the San Francisco-Oakland Bay Bridge until January 2002, and in November 2003 the sensor was moved to Alcatraz. Salinity time series are also collected at Pier 20 on the San Mateo Bridge and from the fishing pier on the south east side of the Dumbarton Bridge. A salinity sensor was added to Channel Marker 17 in the far South Bay in 2004; however, data collection at this station was discontinued in April 2005. Vertical profiles of salinity in the main South Bay channel have been collected since 1969 as part of the Regional Monitoring Program, and the USGS Long-term Water Quality Monitoring Program (Buchanan 2003; U.S. Geological Survey 2004c).

An analysis of the historical data shows that during dry years when Delta outflows are small, near surface salinity in the South Bay remains high (> 20 ppt) near oceanic[1]. However, during wet years when Delta outflow exceeds approximately 200,000 cubic ft per second (cfs), fresh water from the Delta intrudes into the South Bay during the winter and spring months, pushing surface salinities below 10 ppt.

Circulation. Currents in the South Bay are driven predominantly by tidally- and wind-forced flows and their interaction with the bathymetry. These interactions create a series of four circular water movement patterns in the South Bay, located north of the San Bruno shoal (*i.e.*, the shallow region in the Bay northwest of the San Mateo Bridge), between the San Bruno shoal and the San Mateo Bridge, between the San Mateo Bridge and Dumbarton Bridge, and south of the Dumbarton Bridge (Cheng and Gartner 1985; Powell and others 1986).

These currents affect the tidal excursion – the horizontal distance a water particle travels during a single flood or ebb tide – which differs between the channel and the shoals in the South Bay (Walters and others 1985). In the channel, the tidal excursion varies between 6.2 and 12.4 miles (10 and 20 km), and in the subtidal shoals it ranges between 1.9 and 4.8 miles (3 and 7.7 km), with much smaller excursions occurring on the intertidal mudflats (Cheng and others 1993; Fischer and Lawrence 1983; Walters and others 1985). Tidal excursions exhibit strong spring-neap variability, especially in the channel where tidal excursions on the spring tides can be double those on neap tides.

Residual currents in the South Bay are primarily a product of tidal processes and wind-driven and density-driven circulation patterns. Winds alter water circulation when able to blow over a long distance or "fetch" that is unobstructed (Krone 1979). Typically, winds drive a surface flow which then induces a return flow in the deeper channels (Walters and others 1985). In terms of circulation, the most significant winds are onshore breezes which create a horizontal clockwise circulation pattern during the spring and summer. Density-driven currents occur when adjacent water bodies have differing densities, such as differences in temperature and/or salinity. Although density-driven currents are generally uncommon in the South Bay, in years of heavy rainfall, fresh water can flow from the Delta through the Central Bay and into South Bay (Walters and others 1985). In such events, the freshwater flows southward along the surface, while the more saline South Bay water flows northward along the bottom.

Residence Times. Residence time is usually characterized as the average length of time a water parcel spends in a given water body or region of interest (Monsen and others 2002). In the South Bay, spatial

[1] Delta refers to the Sacramento and San Joaquin Rivers delta through which much of inland California drains to North San Francisco Bay.

and temporal variability in the speed and direction of tidal currents disperse water parcels. Tidal dispersion is the dominant form of transport in the South Bay and the primary mechanism that controls residence times.

Residence times in the South Bay fluctuate both spatially and seasonally. Spatially, the residence time of a substance released to the South Bay from the eastern shore (*e.g.*, from the Eden Landing pond complex), will be different than the residence time of a substance released on the western shore (*e.g.*, from the Ravenswood pond complex), or from the far South Bay (*e.g.*, from the Alviso pond complex). Similarly, residence time varies with seasonal freshwater inflow and wind conditions. It is typically shorter during the winter and early spring during wet years and considerably longer during summer and/or drought years (Powell and others 1989; Walters and others 1985).

Wind Waves. The majority of waves within the South Bay are generated locally by wind, as opposed to swells generated by weather systems far offshore that spread into the Estuary. As stated above, the wind direction over the South Bay is typically from the west and northwest in late spring through early fall, with more variable conditions in winter (Cheng and Gartner 1985). URS (2002) analyzed wind conditions between 1992 and 1998 and found that the average wind speeds were 3.8 meters per second (m/s) in the winter, 5.2 m/s in the spring, 6.0 m/s in the summer and 4.2 m/s in the fall with peak winds occurring in the afternoon.

The wind-wave climate of the South Bay has not been extensively studied, although wind-waves in the broad South Bay shoals are recognized as a mechanism for sediment resuspension. USGS collected wave data between the Dumbarton and San Mateo Bridges in 1993 and 1994 during the winter, spring and fall. Winter conditions produced significant wave heights between 0.55 and 1.0 m with wave periods ranging from 2 to 5 seconds. Spring conditions produced slightly bigger waves ranging from 0.2 to 0.8 m, with wave periods between 0.1 and 2.5 seconds. Fall wave conditions were similar to those of spring. There were no measurements taken during the summer in the South Bay (south of Coyote Point on the western shore). URS (2003) measured wind-waves near San Francisco Airport (just north of the area considered the South Bay as defined by the Project) during the summer of 2000. Measurements reflect summer wind-wave heights of 0.02 to 0.7 m with wave periods between 2 and 7 seconds.

Sediment Transport. Suspended Solids Concentration (SSC) in the South Bay exhibits highly dynamic short-term variability, primarily in response to sediment input from tributaries and sloughs, and tidally-driven and wind-driven resuspension (Cloern and others 1989; Powell and others 1989; Schoellhamer 1996). USGS collected SSC data near the bed and at mid-depth at the Oakland-Bay Bridge until January 2002, and at the San Mateo Bridge until October 2005. SSC data collection was initiated at Channel Marker 17 in 2004; however, data collection at this station ended in October 2005. Currently, USGS only collects SSC data for the South and Central Bays at the Alcatraz and Dumbarton Bridge stations (U.S. Geological Survey 2004a).

A review of the historical data shows that SSCs are typically higher near the bed than at mid-depth and decrease with northward distance from the far South Bay (Figures 25–28 in the Hydrodynamics and Sediment Dynamics Existing Conditions Report) (PWA and others 2005b). SSCs are temporally variable on tidal as well as seasonal scales. SSCs exhibit strong diurnal and spring-neap variability, with the highest SSCs occurring on spring tides. On a seasonal time scale, SSCs are higher in the summer months when average wind speeds and wind-wave action are greatest. Greater wind-wave action increases resuspension and re-working of the sediment deposited during the previous winter months. Wind is the most dynamic factor affecting temporal and spatial variability in SSC (May and others 2003). In general, increases in fetch and wind speed will result in larger wind-waves, and in the South Bay's broad shoals, these wind-waves resuspend sediments creating more turbid conditions.

Lateral exchange is also an important mechanism for sediment transport (Jassby and others 1996; Schoellhamer 1996). Lateral surface flows (between the channel and the shoal) result from the differing velocities in the channel relative to the shoals, and the interaction of the tidal flow with the channel-shoal bathymetry. These lateral flows can transport a significant amount of sediment to the channel (Jassby and others 1996), which can in turn lead to an export of sediment to the Central Bay.

Sediment Budget. A sediment budget is essentially an accounting of all sediment delivery, export, and storage. For the South Bay, this includes mostly waterborne sediments in tributary inflows, outflows to the Central Bay, dredging and deposition within open water areas, existing marshes, and restored ponds. The most recent published sediment budgets for San Francisco Bay cover the period 1955 to 1990 (Krone 1979; Krone 1996; Ogden Beeman & Associates and Ray B. Krone & Associates 1992). These budgets include estimates of fluvial sediment inputs from the Delta and local watersheds, bathymetric change, upland disposal of dredge material, and loss of sediment through the Golden Gate. Recent research by Foxgrover and others (2004) proposes significant revisions to earlier sediment budgets with important implications for the SBSP Restoration Project.

Foxgrover and others (2004) suggest that the South Bay has undergone net erosion from 1956 to 1983, rather than deposition as presented in Krone (1996), although both studies agree that the far South Bay south of the Dumbarton Bridge has remained a net depositional environment. The historic erosion and deposition patterns within the South Bay are currently a topic of scientific research and debate. Estimates of total fluvial sediment inputs to the Bay (Krone 1996; McKee and others 2002; Ogden Beeman & Associates and Ray B. Krone & Associates 1992) have decreased over time due to reservoir construction and watershed recovery from 19th century land use changes in the Central Valley (McKee and others 2002; Wright and Schoellhamer 2004). A far greater volume of sediment is continually resuspended into the water column and subsequently reworked and redistributed internally (Krone 1996).

Flood Management/Infrastructure

Coastal Flood Hazards. Much of the Project Area is within the 100-year coastal floodplain. However, floods resulting solely from coastal processes have been rare due to the de facto flood protection provided by existing pond levees (U.S. Army Corps of Engineers 1988b). Coastal flooding in South San Francisco Bay can occur due to the combination of effects from both high Bay water levels and wind waves. High Bay water levels in concert with wind waves can lead to erosion and/or overtopping of coastal barriers. High Bay water levels result from a superposition of high astronomical tides, storm surge and climatic conditions. The highest astronomic tides occur for a few days each summer and winter due to the relative positions of the earth, moon and sun. The highest Bay water levels typically occur in the winter when storm surges are coincident with the higher astronomic tides. Storm surge is an increase in water level caused by atmospheric effects including low barometric pressure and strong winds over shallow areas which combine to raise water elevations along the Bay shore.

The primary climatic condition affecting San Francisco Bay flood risk is the El Niño phase of the El Niño Southern Oscillation (ENSO) in the Pacific Ocean Basin. The highest water levels measured by tide gauges in San Francisco Bay occurred during the 1982–83 and 1997–98 El Niño events, which resulted in flooding in many areas. A peak water level of 10.88 ft NAVD88 was measured on Coyote Creek at Alviso Slough on December 3, 1983 (U.S. Army Corps of Engineers 1984b).

Tsunamis are another potential flood source for South San Francisco Bay. Historically, tsunamis were considered to result in a lower flood risk than storm conditions due to lower calculated runup elevations (the water elevation above the stillwater level) (Houston 1980; U.S. Army Corps of Engineers 1988b; U.S. Army Corps of Engineers 1989). More recently, the risk of tsunami-induced flooding is being reassessed in California and may be higher than previously thought (State of California 2006). Borrero and others (2006) evaluated historical and hypothetical tsunami-induced wave heights in San Francisco Bay, focusing on the locations of marine oil terminals in the central and northern regions of the Bay. The largest hypothetical tsunami-induced wave was caused by a very large earthquake (greater than 9.0 on the Richter scale) on the Alaska-Aleutian subduction zone (Borrero and others 2006). Modeling results predicted a 16.4 ft (5.0 m) wave entering San Francisco Bay, and the wave height was quickly reduced to less than 3.2 ft (1 m) as it passed under the San Francisco–Oakland Bay Bridge. The modeling study did not extend to the far South Bay; however, previous relationships based on compiled runup data from tsunamis in 1960 and 1964 suggest that tsunami-induced wave heights are reduced to less than ten percent of the height at the Golden Gate in the far South Bay below the Dumbarton Bridge (Borrero and others 2006; Magoon 1966).

South Bay Coastal Floodplains. FEMA and the Corps have developed flood maps (Figure 3.3-2) for the South Bay region that show a predicted 100-year floodplain. FEMA delineation of the coastal floodplain in the South Bay is based on the assessment that the pond levees provide for a reduction of wave action, but do not prevent inundation from high Bay water levels. Therefore, the coastal floodplain subject to the National Flood Insurance Program (NFIP) is based on a projection of the 100-year Base Flood Elevation (BFE) onto the surrounding landscape. The 100-year BFEs are a function of the 100-year stillwater elevations, presented for several locations in the South Bay in Table 3.3-2. FEMA is currently pursuing flood re-mapping projects of the north and central portions of San Francisco Bay coastal flood hazards, and may pursue a similar study of the South Bay in the future. The information in Table 3.3-2 is therefore based on analysis accomplished about 20 years ago and the elevations will likely increase when the new studies are completed. Elevations are in NGVD as published by the source. Conversions between NGVD 29 and NAVD 88 vary geographically. To maintain the integrity of the published values, attempts at converting the elevations for the specific locations below have not been made (see footnote in table).

The Corps (1988a) report for Southern Alameda and Santa Clara County presents both a “worst case” scenario and a “most likely” condition in defining the 100-year coastal floodplain (see Figure 3.3-2). The Ravenswood pond complex was outside of the Corps study area and is therefore not included within the Corps’s 100-year coastal floodplains shown on Figure 3.3-2. The “worst-case” scenario assumes that all

Table 3.3-2 San Francisco Bay Stillwater Elevations

COMMUNITY	EFFECTIVE DATE	100-YEAR BASE FLOOD ELEVATION, FEET (FT) NATIONAL GEODETIC VERTICAL DATUM (NGVD)[1]	LOCATION
Hayward	2/9/2000	6.5	North Corporate Limits to West Jackson St.
Union City	2/9/2000	7.2	At Union City
Fremont	2/9/2000	8.0	From Thornton Road to Coyote Creek SPRR Crossing
Santa Clara County Unincorporated	8/17/1998	8.1	At Confluence of Coyote Creek and Guadalupe Slough
Milpitas	6/22/1998	8.6	At Milpitas
Sunnyvale	12/19/1997	8.0	At Sunnyvale
Palo Alto	6/2/1999	7.7	At Palo Alto
East Palo Alto	8/23/1999	7.6	Near San Francisquito Creek
Redwood City	11/17/1981	6.7	At Redwood Shores

Notes:
[1] *Conversion to NAVD88 used for each Pond Complex:*
Ravenswood: *NAVD = NGVD + 2*.68 ft (Source: Vertcon)
Eden Landing: *NAVD = NGVD + 2*.68 ft (Source: Vertcon)
Alviso: *NAVD = NGVD + 2*.7 ft (Source: SCVWD)
Source: FEMA Community Flood Insurance Studies & Corps (1984a)

low-lying areas which are not completely protected from tidal flooding would be flooded during extreme high tides to the elevation of the tide. This case ignores any factors that would decrease the extent of tidal flooding such as physical barriers between the Bay and the low-lying areas and water-volume limitations. Although most of the shoreline in the South Bay consists of levees that do not meet FEMA or Corps flood protection standards, the absence of a history of significant tidal flooding indicates that these levees do provide flood protection (U.S. Army Corps of Engineers 1988a). The Corps's "most likely" condition therefore evaluated the extent of tidal flooding most likely to occur given the existence of the salt ponds, pond levees, high ground and other non-engineered and engineered levees. The Corps evaluated actual tides, storm surge, wind waves, physiographic conditions (*e.g.*, water depths and fetch), levee conditions, levee overtopping, floodplain storage and existing topography. The Corps separated the study area into specific reaches and eliminated reaches from further study that were either not subjected to tidal flooding or where significant development did not exist to warrant economic justification for a tidal flood damage reduction plan. Figure 3.3-2 shows the most likely 100-year coastal floodplain in those reaches where the Corps determined a reduced flood risk under their "most likely" condition analysis.

Fluvial Flood Hazards. Fluvial flooding has been the primary source of historical flood damages around the developed Baylands. Fluvial discharges result when rainfall runoff is carried to the Bay via natural or constructed channels (Figure 3.3-3). In the South Bay, an extensive network of levees has been constructed along various reaches of these channels to protect adjacent developed areas from the overtopping of fluvial discharges. Although these levees separate the channel from its natural floodplain, and constrict flows to an unnaturally narrow corridor, these levied reaches are designed to convey large

fluvial discharges during high Bay tides. During large rainstorms, high runoff flows constricted by the channel levees result in higher water surface elevations and potential overtopping of the levees, when coincident with high Bay tides, extreme runoff conditions exceed the design capacity of the levied channel. Overtopping can result in the inundation of the adjacent areas. Out-of-bank flooding has occurred in areas adjacent to non-levied channels when the runoff exceeds the carrying capacity of the channel. Flooding also results from local drainage that collects behind the bay front levees when discharges to the Bay (either by pumps or gravity flow) are inadequate.

The capacity of many streams and flood channels has been gradually reduced by the deposition of sediment constricting its channels and reducing the cross-sectional area. Sediment may be derived either from the landward side (watersheds) or from the Bay. One common problem is deposition in the fluvial channels throughout the salt ponds. Under natural conditions, the channels experienced daily tidal scouring flows from the adjacent marsh lands. When these areas were diked off to create salt ponds, the scouring flows were eliminated and sedimentation has decreased channel conveyance. This reduced flow capacity causes floodwater to back up, raising water surfaces and increasing flood hazards upstream. To maintain capacity in Santa Clara County streams, reaches upstream of the salt ponds are typically maintained by sediment removal and vegetation management activities.

For fluvial systems, FEMA determines the BFE by using Mean Higher High Water (MHHW) as the downstream tidal water surface elevation (tidal boundary), coupled with a 10-, 50-, 100-, or 500-year flood discharge for the upstream flow conditions. In order to provide a national standard without regional discrimination, the 100-year flood profile was adopted by FEMA as the base flood for delineation of the 100-year floodplain and for purposes of flood management measures (FEMA 1988). The stillwater flood elevation is defined by FEMA as the projected elevation that floodwaters would assume in the absence of waves resulting from wind or seismic effects.

Levees and Infrastructure. There are approximately 150 total miles of levees (internal and external) located within the SBSP Restoration Project Area (Siegel and Bachand 2002) (Figure 3.3-4). The levees are typically constructed with Bay mud (weak clays and silts) dredged from adjacent borrow ditches or pond areas. During levee construction, the soils were not compacted and presently continue to settle and deform. The levees have been augmented from time to time with Bay mud fill to compensate for inboard land subsidence and to compensate for consolidation of levee-fill material and weak underlying Bay mud deposits. In general, levees are low to moderate in height and have fairly flat, stable slopes. Some dikes were constructed from imported soil, riprap, broken concrete and other predominantly inorganic debris, and therefore typically have steeper slopes than the levees constructed of Bay mud.

Outboard levees (*i.e.*, bayfront and slough/creek levees adjacent to tidal waters) were built to enclose evaporation ponds on former tidal marshes and mudflats and to protect the salt ponds from Bay inundation. Inboard levees (*i.e.*, pond levees constructed inland along the old Bay margin) are predominantly former salt pond levees that offer the last line of defense against flooding of low-lying, inland areas. Internal levees separate the individual salt ponds from each other and are typically smaller than the outboard levees. Generally, pond levees were not designed, constructed, or maintained following a well-defined standard and will almost certainly require retrofit to provide an adequate level of flood

protection. Levee construction methods, levee materials and subsurface conditions are further detailed in reports by Tudor Engineering Company (Tudor Engineering Company 1973), the Corps (U.S. Army Corps of Engineers 1988b), and Moffatt & Nichol Engineers (Moffatt & Nichol Engineers 2004). Furthermore, levee maintenance is documented in Cargill Inc.'s (Cargill) annual "maintenance work plan" and "completed maintenance" reports, which have been summarized in the SBSP Restoration Project Levee Assessment Report (Geomatrix 2006).

The existing levees provide a measure of flood protection (U.S. Army Corps of Engineers 1988b), and act as temporary storage during coastal flooding conditions. As the ponds fill, waves may overtop internal levees in a sequence, causing erosion and reducing flood protection capabilities. If tidal action is introduced to the salt ponds, either through restoration or passively through deterioration of the levees, the effectiveness of the salt pond complexes as flood protection mechanisms would be substantially reduced. The flood protection benefit of the pond levees is dependent on regular maintenance. Within the area outside of the SBSP Restoration Project Area, many of the salt ponds are currently used for salt production and are therefore being maintained by Cargill.

The pond levees would not meet FEMA criteria and are not certified as flood protection facilities as defined in FEMA's certification requirements (FEMA 1988). This is because (1) levee failure comprised of overtopping, degradation and breaching is likely to result in flooding of inland areas (analysis by the Corps in the original San Francisco Bay Shoreline Study (U.S. Army Corps of Engineers 1988a; U.S. Army Corps of Engineers 1989), and there are no calculations to show that they are designed for the 100-year event, and (2) maintenance records indicate frequent maintenance is required (Geomatrix 2006), yet the required maintenance program for certification, including a commitment by a public entity, does not exist.

Project Setting

The SBSP Restoration Project Area includes three geographically distinct pond complexes.

- The Eden Landing pond complex, located on the east shore of the Bay immediately south of the San Mateo Bridge;
- The Alviso pond complex, located at the southern end of the South Bay from Mountain View to Fremont; and
- The Ravenswood pond complex, located at the western end of the Dumbarton Bridge.

The combination of existing salt ponds, surrounding levees, and existing adjacent marshplains comprise the Project Area. The following sections summarize the hydrodynamic, sediment dynamic and flooding conditions within the above pond complexes in general, with particular emphasis on the ponds affected by planned Phase 1 actions.

Eden Landing

The 5,500-acre Eden Landing (formerly Baumberg) pond complex owned by the California Department of Fish and Game (CDFG) is located on the eastern shore of the South Bay, between the San Mateo Bridge and the Alameda Creek Flood Control Channel (ACFCC).

Tributaries. The tidal sloughs located within the Eden Landing pond complex are the ACFCC, Old Alameda Creek (OAC), Mt. Eden Creek, and North Creek (Figure 3.3-3). Dry Creek is a right bank tributary to Alameda Creek, about six miles upstream of its mouth.

The largest of these sloughs is the ACFCC (also known as Coyote Hills Slough), which receives flow from Alameda Creek – the largest tributary to the South Bay, which drains an area of 633 square miles with an average annual discharge of 125 cfs (U.S. Geological Survey 2004b). The US Army Corps of Engineers (Corps) constructed the ACFCC after storms in 1955 and 1958 caused severe flooding in the region (Life Science! 2003). The Corps constructed the 12-mile ACFCC originally to provide protection from the “Standard Project Flood” (SPF) or a flood discharge with a recurrence interval of 200- to 500-years downstream of Dry Creek. The SPF corresponds approximately to the 500-year event based on URS’s 1999 study and is equivalent to a discharge of 52,000 cfs downstream of Dry Creek and 51,000 cfs upstream of Dry Creek. (See Figure 3.3-3 for location of the Dry Creek tributary.) Upstream of the “salt pond” reach, the SPF is contained in the channel. The reach adjacent to and through the salt ponds (the lower 3 to 4 miles of the ACFCC project) is the only segment that has experienced significant sedimentation since the project was constructed. In this reach, the carrying capacity has been reduced to approximately 30,000 cfs which corresponds approximately to the 100-year event (Johnson 2005). The lower portion of the ACFCC adjacent to the salt ponds is tidally influenced, with high tide elevations slightly lower than those at San Mateo Bridge, and low tide elevations considerably higher than those at San Mateo Bridge (Life Science! 2004).

Before Alameda Creek was diverted into the ACFCC, it entered San Francisco Bay through OAC, located to the north of the ACFCC. Currently, OAC receives limited freshwater input because the majority of the runoff from the watershed has been diverted to the ACFCC. Additional tidal channels are currently under construction as part of an ongoing tidal restoration project, the Eden Landing Ecological Reserve (ELER) Restoration Project (Life Science! 2003). When this work is complete (expected in 2007), Mt. Eden Creek and North Creek will connect the ELER to the South Bay. North Creek will connect directly to OAC, and Mt. Eden Creek will enter the Bay.

Tributary Sediment Load and Sediment Characteristics. USGS collected SSC data in Alameda Creek near Niles, California between 1965 and 1973 and again beginning in 2000. The data indicate that SSCs are highly correlated with discharge and also that SSCs have decreased over the past four decades. The average SSC measurement between 1965 and 1973 was 1,370 mg/L whereas the average SSC measurement collected in 2000 was 290 mg/L.

Sediment from the Alameda Creek watershed historically deposited within the Eden Landing pond complex is a mix of sand, silt, and clay. USGS collected sediment data between April and June 2003 which indicate that the ponds within the Eden Landing pond complex are composed of 38 percent sand, 39 percent silt, and 23 percent clay (U.S. Geological Survey 2005). This is a marked difference from area slough channels, which on average are composed of 13 percent sand, 54 percent silt, and 33 percent clay (U.S. Geological Survey 2005).

Marsh Sedimentation. Sediment supply is important for allowing wetland areas to accrete and persist with rising sea level. It allows mudflat areas and pond bottoms to accrete to elevations at which marsh vegetation can establish itself. The rate of estuarine sedimentation in natural and restored marshes depends on sediment supply, settling velocities, and the period of marsh inundation. Sediments are carried into a marsh and deposited during flood tides as currents slacken. The rate of sedimentation decreases as mudflats and marsh plains rise in elevation and the period of tidal inundation decreases. Colonizing vegetation on accreting mudflats increases the rate of sedimentation by enhancing sediment trapping and contributing organic material to the sediment. Sediment deposits consolidate over time and can reduce the rate of net accretion.

Measured sedimentation data are available from restored tidal marshes and dredged marinas in the South Bay. Sedimentation data were reviewed from the Cooley Landing Salt Pond Restoration (PWA 2004), Palo Alto Yacht Harbor (PWA 1987), Stevens Creek Marsh Restoration (Brown & Caldwell and others 2005), Alviso Marina (Ruth and Going Inc. and others 1980), and Warm Springs Marsh restoration (*aka.* Coyote Creek Lagoon) (PWA and Phyllis Faber & Associates 2003) (see Figure 40 in the Hydrodynamics and Sediment Dynamics Existing Conditions Report for location map). PWA collected sedimentation data near the Eden Landing pond complex from the Cargill Pond B-1 Marsh Restoration site as part of this study to supplement data previously collected by Wetland Research Associates (2000). Wind-wave conditions within these sites are not expected to limit sedimentation rates. The sites all have full tidal connections to the Bay (*i.e.*, a full tide range within the site).

Measurements indicate that between June 2000 and December 2004, 3.8 ft (1.16 m) of sediment accumulated in Cargill Pond B-1. This is approximately equivalent to a sediment accretion rate of 0. 7 ft/yr (0.21 m/yr). In general, this rate is lower than sedimentation rates measured near the Ravenswood (0.11–0.17 ft/yr or 0.03–0.05 m/yr) and the Alviso pond complexes (0.4–7.0 ft/yr or 0.12–2.1 m/yr).

Coastal Flooding. The Eden Landing pond complex is exposed to wind wave action due to westerly and northwesterly winds crossing the Bay. Consequently, the outboard levees and exposed tidal marshes are prone to erosion and potential flooding. However, flood studies completed by the Corps in the 1980s found little risk of coastal flood damage in the vicinity of the Eden Landing pond complex due to the lack of adjacent development and the presumption that the levees would be maintained to facilitate salt production (U.S. Army Corps of Engineers 1988b). Based on the 100-year stillwater elevations for the Eden Landing area, Figure 3.3-2 shows the projected, potential floodplain neglecting the levees.

Fluvial Flooding. The Eden Landing pond complex lies within the Alameda Creek watershed over which ACFCWCD has jurisdiction. FEMA has also published flood study results for the tributaries to Eden Landing in the community specific Flood Insurance Studies. The studies provide available fluvial flood event discharges for various recurrence intervals at the time of the effective date of the study and may not represent current conditions. ACFCWCD has the authority to set the appropriate flow criteria for current conditions.

The Alameda Creek watershed is the largest drainage basin in the southern San Francisco Bay region, encompassing 633 square miles and stretching from Mt. Diablo in the north to Mt. Hamilton in the south, and east to Altamont Pass. The watershed includes wildlands, developing areas and urbanized areas. Most of the watershed is undeveloped rangeland or public lands and parks, with a smaller portion used to grow crops. About seven percent of the total acreage consists of residential, commercial, and industrial land uses.

The major channels through the Eden Landing pond complex include Mt. Eden Creek, OAC, and the ACFCC.

The Mt. Eden Creek tributary drains a small area south of State Route (SR) 92 in the City of Hayward. The slough receives flood flows from only one local pump station and is not considered a source of flood hazards. CDFG is sponsoring the Mt. Eden Creek and OAC restoration efforts to restore and enhance tidal marsh habitat outside of the northeast corner of the Eden Landing pond complex.

OAC is a tidal slough that drains a watershed area of about 22 square miles. It is the former channel of Alameda Creek, which is now diverted into the ACFCC. The creek consists of two excavated channels, lined by outside levees with an interior marshplain "island." The creek conveys urban runoff from southern Hayward and the Alvarado district of Union City. On the landward side of the salt pond complex, 3.4 miles upstream of the Bay, a large gated structure has been installed to prevent tidal waters from extending further upstream. The structure consists of twenty 4-ft diameter culverts with flap gates on the downstream side which allow upstream runoff to enter the lower reaches but prevent tidal water from penetrating upstream. The current channel capacity is estimated at the 15-year flood (4,000 cfs), although effective conveyance is reduced during high flow events due to the gated structure. All tributary inflow connections to OAC are located upstream from the tidal gates.

The 12-mile-long ACFCC is the primary flood conveyance channel for the Alameda Creek watershed. The flood protection project was constructed from the west end of Niles Canyon and extends through the City of Fremont to San Francisco Bay. The ACFCC is enclosed with levees for most of its length and is tidally influenced in the vicinity of the SBSP Restoration Project Area. It was originally constructed by the Corps to provide protection from the "Standard Project Flood", a 200- to 500-year flood; however due to significant sedimentation, channel capacity through the salt ponds has been reduced to approximately the 100-year flood. The ACFCC is currently owned and maintained by ACFCWCD and an operations and maintenance (O&M) agreement between ACFCWCD and the Corps requires that ACFCWCD restore channel flow capacity to the original Standard Project Flood (SPF) protection level. SPF is defined as a major flood that can be expected to occur from a severe combination of meteorological and hydrological conditions that is considered reasonably characteristic of the geographical area. This is equal to a flood flow of 52,000 cfs. SBSP Restoration Project efforts in the Eden Landing pond complex would be closely linked with potential levee reconfiguration efforts for the ACFCC.

Pond E8A-E9. The paragraphs below describe the history, topography, levees and operation of Ponds E8A, E9, and E8X.

Site History. Historic tidal marsh in the Eden Landing vicinity was leveed to create Ponds E8A, E9, and E8X. Ponds E8A, E9, and E8X were historically operated by Cargill as evaporator ponds where the residue of saltwater evaporation (brine) was produced and harvested prior to the final processing and crystallization of salt. Existing conditions at Ponds E8A and E9 are shown in Figure 3.3-5.

Pond Topography. The average elevations of Ponds E8A, E9, and E8X is 5.7 ft (1.7 m) NAVD, which is 6.5 ft (2 m) above MLLW and 1.3 ft (0.4 m) below MHHW. Ponds E9 and E8X on average, are approximately 1 ft lower in elevation (5.3 ft or 1.6 m) than the majority of Pond E8A (6.3 ft or 1.9 m). A portion of the southeast corner of Pond E8A is at approximately the same elevation as Ponds E9 and E8X. Figure 1 in Appendix G (Topography of Phase 1 Action Restoration Sites) shows the topography of Pond E8A and E9. West of Ponds E9 and E8A, sedimentation behind a degraded levee has accreted to colonization levels forming Whale's Tail Marsh. Within the ponds, remnants of the historic tidal channel network are evident in the topography which appear as meandering, shallow depressions. One of the larger relict meanders of OAC within Pond E8A was bermed off (as shown in the topography) from the rest of the pond for salt production purposes. Borrow ditches were excavated in the ponds along the entire perimeter of Ponds E9 and E8A to obtain fill material for levee construction and maintenance. The depths of the borrow ditches are approximately 1 to 2 ft (0.3–0.61 m) below the bed of Ponds E8A, E9 and E8X.

Levees. Ponds E8A, E9 and E8X are surrounded by a mix of external and internal pond levees and flood management levees. OAC is lined by a flood protection levee adjacent to Pond E8A which is between 10 and 13 ft (3.0 and 4.0 m) NAVD (3 to 6 ft or 0.9 to 1.8 m above MHHW and 0 to 3 ft or 0 to 0.9 m above the 100-year water level). An external pond levee lines the western perimeter of Ponds E8A and E9. This levee, between Ponds E9 and E8A, and Whale's Tail Marsh is on average 10.7 ft (3.25 m) NAVD. This same levee extends up and around Ponds E14, E13 and E12 and then south along the eastern perimeter of Ponds E8X and E8A, where it is on average 11.5 ft (3.5 m) NAVD. The internal pond levees are approximately 10.7 ft (3.25 m) NAVD. These levees provide Ponds E8A, E9 and E8X with protection from tidal and fluvial overtopping, but it is likely that wave run-up and wind set-up during extreme high Bay waters would result in overtopping.

Existing Operation. Under current ISP operations, Ponds E9 and E8A are managed as system ponds while Pond E8X is managed as a seasonal pond as part of the Eden Landing (Baumberg) System 8A. The Eden Landing System 8A also includes Ponds E12, E13 and E14, all of which are presently managed as seasonal ponds. As with other seasonal ponds, water from direct precipitation and groundwater infiltration accumulates within seasonal ponds during the wet season. During the dry season, evaporation causes the seasonal ponds to dry out.

System ponds are operated to maintain continuous tidal circulation by the management of tidal flow through water control structures. Water levels in system Ponds E9 and E8A are managed seasonally. The system E8A intake (a set of four 48-inch gates) is located at the northwest end of Pond E9 and connects to Mt. Eden Creek near the Bay. Inflows are limited to high tides due to the high elevations of the ponds. The system outlet (one 48-inch gate) is located at the northeastern end of Pond E8A. This structure can

act as both an intake and discharge structure, but primarily discharges water because the normal flow through the system is from Pond E9 to Pond E8A. Pond E9 is connected to Pond E8A through two gates, a 42-inch pipe at the western end and a 48-inch gate at the eastern end. The western culvert gate is rusted open while the eastern culvert gate is rusted closed. During the summer, water levels are kept low (6 ft or 1.8 m NAVD in Pond E9 and essentially average bed elevation in Pond E8A) to increase the gravity inflow during the higher evaporation season. During the winter, water levels in Pond E9 are maintained at approximately 7.2 ft (2.2 m) NAVD.

Pond E14 is connected to Pond E9 by a set of 58-inch wood gates and Pond E8X through two sets of two 42-inch wood gates in the northeast corner of the pond near the brine pump. Water control structures providing a potential hydraulic connection between seasonal and system ponds remain closed throughout both winter and summer seasons, preventing tidal exchange between Ponds E9 and E8A and Ponds E12, E13 and E14.

Ponds E12 and E13. The paragraphs below describe the history, topography, levees, and operation of Ponds E12 and E13.

Site History. Historic tidal marsh in the Eden Landing vicinity was leveed to create Ponds E12 and E13. Ponds E12 and E13 were historically operated as evaporator ponds where the residue of saltwater evaporation (brine) was produced and harvested prior to the final processing and crystallization of salt. Cargill operated Ponds E12 and E13 as salt ponds in the Eden Landing (Baumberg) pond complex. Existing conditions at Ponds E12 and E13 are shown in Figure 3.3-5.

Pond Topography. The elevation of the Pond E12 and Pond E13 gently slopes from east to west and averages 5.7 ft (1.7 m) NAVD, which is approximately 6.4 ft (2.0 m) above MLLW and 1.3 ft (0.4 m) below MHHW. Figure 2 in Appendix G (Topography of Phase 1 Action Restoration Sites) shows the topography of Ponds E12 and E13. Ponds E12 and E13 contain remnants of both historic tidal marsh channels and abandoned salt pond infrastructure. The remnant historic tidal channels are shallow depressions in the pond topography. Remnants of the abandoned levee between Ponds E12 and E13 are 0.1 to 1 ft (0.03 to 0.3 m) above the pond bed. Borrow ditches were excavated in the ponds along the western perimeter and the abandoned levee to obtain fill material for levee construction and maintenance. The depths of the borrow ditches are approximately 0.5 to 1.5 ft (0.15 to 0.5 m) below the bed of Ponds E12 and E13. The historic divisions between the salt crystallizer cells within Ponds E12 and E13 (low wall constructed with wood plank fences and filled with earth) were abandoned, leaving degraded remnants of the wood posts and raised earth berms.

Levees. Ponds E12 and E13 are surrounded by managed pond levees. The elevation of the managed pond levee between Ponds E12 and E13 and Mt. Eden Creek is approximately 11.6 ft (3.5 m) NAVD (4.6 ft, or 1.4 m above MHHW and 1.7 ft, or 0.5 m above the 100-year tide level). This levee continues around Ponds E14, E9, E8A, and E8X and provides vehicle access. Although this managed pond levee is not designed as a flood protection levee, it is high enough to protect these ponds from tidal overtopping, but will likely be vulnerable to overtopping during extreme storm events due to wave run-up and wind set-up. The internal levee between Ponds E13 and E14 is a former salt pond levee that has not been improved for access. The elevation of this levee is on average 8.2 ft (2.5 m) NAVD. The former salt pond levee between Ponds E12 and E13 has been abandoned and multiple gaps exist.

Existing Operation. Under current ISP operations, Ponds E12 and E13 are managed as seasonal ponds as part of the Eden Landing (Baumberg) System 8A. The Eden Landing System 8A also includes Ponds E14, E9, E8A, and E8X. As with other seasonal ponds, water from direct precipitation and groundwater infiltration accumulates in Ponds E12 and E13 during the wet season. During the dry season, evaporation causes Ponds E12 and E13 to dry out. Ponds E12 and E13 are operated as a single pond, as numerous gaps in the abandoned levee between Ponds E12 and E13 allow exchange between the ponds. Ponds E12 and E13 are hydraulically connected to Pond E14 by a set of two 42-inch wood box culverts with slide control gates which remain closed during the summer. Pond E14 is connected to Pond E9 by a set of 58-inch wood gates which remain closed during the summer as well. During the winter, both of these sets of culverts are operated to provide some circulation flow and to maintain the water levels in Ponds E8A and E9 near the historic levels for habitat values. The 10,000 gallons per minute (gpm) brine pump, used for former salt pond operations, can be used to pump water into Pond E13 from Pond E8X or from the former brine ditch east of Ponds E12 and E13 (between Mt. Eden Creek and North Creek) to supplement water levels in Pond E13 during the winter.

Alviso

The Alviso pond complex is located in the South Bay, south of the Dumbarton Bridge. The pond complex covers 8,000 acres and is owned and operated by the US Fish and Wildlife Service (USFWS).

Tributaries. Several tidal sloughs are located within the Alviso pond complex, including Coyote Creek, Mud Slough, Artesian Slough, Alviso Slough, Guadalupe Slough, Stevens Creek, Mountain View Slough, and Charleston Slough (Figure 3.3-3). Because the tidal range in the far South Bay is substantially amplified as compared to the Golden Gate (Table 3.3-1), the tidal range in these sloughs is particularly large.

The largest tributary in the Alviso pond complex is Coyote Creek, which provides a substantial amount of fresh water during winter and spring, particularly during wet years (average annual discharge is approximately 85 cfs or 55 million gallons per day [mgd]). Mud Slough connects to Coyote Creek near the Island Ponds (A19, A20, and A21), and receives limited freshwater input from Laguna Creek during all seasons (Life Science! 2003; 2004). The San Jose/Santa Clara WPCP discharges into the upstream end of Artesian Slough, which is a tributary of Coyote Creek. The plant has a capacity of 167 mgd, although the amount of treated effluent that can be discharged to the far South Bay is limited by regulation. The plants discharge permit allows 120 mgd average dry weather effluent flow (the average of the 3 lowest months between May and October) in order to protect sensitive and endangered species habitat. The plant has been discharging approximately 100 mgd during the dry weather season over the last five years. If the 120 mgd average dry weather effluent flow is exceeded, the plant must engage in specific mitigation activities, such as increases in recycled water. The peak winter discharge from the San Jose/ Santa Clara WPCP has been approximately 140 mgd over the last five years. While the discharge is not extreme from a flood hazard perspective, the continuous freshwater discharge is reducing the salinities along the slough, resulting in a gradual conversion of saline to brackish vegetation.

The Guadalupe River, the second largest tributary in the Alviso pond complex in terms of drainage area and flow, discharges to Alviso Slough (average annual discharge is approximately 70 cfs or 45 mgd). Alviso Slough then drains to Coyote Creek, and subsequently to the South Bay. Overflow from the Guadalupe River, Alviso Slough and Coyote Creek flooding historically represent the most significant flood hazards to the City of San Jose and the community of Alviso. Flood protection projects have been constructed by SCVWD to reduce the risk of flooding along Coyote Creek, the Guadalupe River, and the upper reaches of Alviso Slough.

Guadalupe Slough receives water from Calabazas Creek, San Tomas Aquino Creek, Sunnyvale East Channel, and Sunnyvale West Channel. The Sunnyvale WPCP discharges into Moffett Channel, which connects to Guadalupe Slough, and provides the primary source of fresh water during the summer and fall (Life Science! 2003; 2004). The average seasonal daily flows from the Sunnyvale WPCP are 12 mgd during the summer/fall and 15 mgd during the winter/spring. The remaining sloughs in the Alviso pond complex – Whisman Slough, Mountain View Slough, and Charleston Slough – are relatively shallow and narrow with limited freshwater inflows and small drainage areas (Life Science! 2003; 2004). The far South Bay also receives water from San Francisquito Creek and the Palo Alto Regional Water Quality Control Plant, both of which discharge from the west side of the Bay between the Ravenswood and Alviso pond complexes, outside of the SBSP Restoration Project Area. The Palo Alto Regional Water Quality Control Plant discharges average seasonal daily flows of 25 mgd during the summer/fall and 26 mgd during the winter/spring.

Tributary Sediment Loads and Sediment Characteristics. USGS collected SSC data in the Guadalupe River near San Jose between 1979 and 1992 (Data record provided in Figure 37 in the SBSP Hydrodynamics and Sediment Dynamics Existing Conditions Report) and began again to collect measurements near US 101 in 2002. Additionally, USGS recently began to collect SSC data in Coyote Creek where a SSC station was added in 2004 (pers. comm. Schoellhamer 2005). Measurements at both stations in the Guadalupe River over both periods of record indicate that SSCs are strongly correlated with discharge, with higher SSCs found during times of higher discharge. Figure 36 in the Hydrodynamics and Sediment Dynamics Existing Conditions Report (PWA and others 2005b) graphically illustrates the correlation between discharge and suspended sediment concentrations in the Guadalupe River at US 101 between November 2002 and July 2003.

The sediment historically deposited within the Alviso pond complex is a mix of sand, silt, and clay. USGS collected sediment data between April and June 2003 which indicate that the ponds within the Alviso pond complex are composed of 38 percent sand, 36 percent silt, and 26 percent clay (U.S. Geological Survey 2005). These ponds are slightly higher in clay content and lower in silt content than the Eden Landing pond complex and slightly lower in clay content and higher in silt content than the Ravenswood pond complex. These grain size distributions show a marked difference from those of area sloughs, where channels are composed of 13 percent sand, 54 percent silt, and 33 percent clay (U.S. Geological Survey 2005).

Marsh Sedimentation. Estimates of future sedimentation rates are important to predict the evolution of salt ponds re-opened to tidal circulation. Estimates can be made using measured rates where available, or computer simulations. Measured sedimentation data are available from Palo Alto Yacht Harbor (PWA 1987), Steven`s Creek Marsh (Brown & Caldwell and others 2005), Alviso Marina (Ruth and Going Inc. and others 1980), and Warm Springs Marsh (*aka*. Coyote Creek Lagoon) (PWA and Phyllis Faber & Associates 2003), all of which are within or close to the Alviso pond complex (see Figure 40 in the Hydrodynamics and Sediment Dynamics Existing Conditions Report) (PWA and others 2005b). Sedimentation data from these locations are summarized in Table 3.3-3 below.

Table 3.3-3 Measured Sedimentation Data

SAMPLE LOCATION	SEDIMENTATION		
	DATES	ELEVATIONS (FT NAVD88)	RATE (FT/YR)
Palo Alto Yacht Harbor			1–2
Stevens Creek Marsh	1994	2.1	--
	2004	6.4	0.4
Alviso Marina	1968	-7.3	--
	1976	3.7	1.4
	November 1976[1]	-7.3	--
	May 1979	-0.3	2.7
Warm Springs Marsh	October 1987	-10	--
	June 1988	-5.3	7.0
	June 1992	0.3	2.2
	August 1999	4.7	1.9
	March 2002[2]	4.7	0

Notes:
[1] Alviso Marina was dredged to an elevation of -10 ft NGVD in 1976 (Ruth and Going, Inc. and others, 1980)
[2] Net accretion in Warm Springs Marsh from 1999–2002 was approximately 0 ft due to consolidation of deep mudflat deposits.
Sources: (PWA 1987), (PWA 2004), (PWA and Phyllis Faber & Associates 2003), (Brown and Caldwell and others 2005), (Ruth and Going Inc. and others 1980)

The rate of sedimentation in natural and restored marshes depends on sediment supply in the water column, settling velocities and the period of marsh inundation. Rates of sedimentation decrease over time as mudflats and marsh plains accrete and the period of tidal inundation decreases. Sedimentation rates near the Alviso pond complex are generally higher at present than those near the Eden Landing and Ravenswood pond complexes due to higher suspended sediment concentrations (sediment availability); historically, this was due to subsidence. Aquifer overdraft resulted in as much as 13 ft of subsidence in the Santa Clara valley since the turn of the last century (Watson 2004). Subsidence was largely arrested by the 1970s, but the effects remain. The subsidence of the land relative to water levels in the Bay moderates sedimentation deceleration by maintaining low land elevations (relative to tidal water levels). This subsequently results in higher average sedimentation rates over specific periods of time.

Coastal Flood Hazards. The 1988 Shoreline Study (U.S. Army Corps of Engineers 1988b) determined that tidal flooding is a hazard in Alviso and its surrounding areas due to the potential for overtopping of the outboard pond levees near Alviso Slough and lower Coyote Creek (downstream of Artesian Slough). Historical coastal flooding in the area has been limited by the existence of pond levees. During the January and December events in 1983, which included the highest tides of record, flooding occurred in northern Santa Clara County and the Alviso area. However, the relative importance of the high tides versus fluvial flows in causing the floods was not determined, as it is not known whether the peak tides during these events coincided with the peak discharges (U.S. Army Corps of Engineers 1988b).

For the 100-year event, the 1988 Shoreline Study estimated that Alviso could incur up to six ft of flooding and that most of the flooding would be limited to the area north of SR 237. Tidal flooding also could occur at the Sunnyvale sewage treatment ponds, the northern portion of the NASA Ames Research Center, Moffett Federal Airfield, the Lockheed Missiles and Space Company Plant, and the industrial park area north of Java Drive and west of Sunnyvale East Channel under extreme tide and wind conditions (U.S. Army Corps of Engineers 1988b). Based on the 100-year stillwater elevation projections for Alviso, Figure 3.3-2 shows the potential floodplain extending well inland of the Alviso pond complex.

Fluvial Flood Hazards. FEMA has published flood study results for the tributaries to the Alviso pond complex in the community specific Flood Insurance Studies. The studies provide available fluvial flood event discharges for various recurrence intervals at the time of the effective date of the study and do not represent current conditions. The FEMA discharge values also may include historic levee overtopping and therefore may underestimate peak flows which are now contained within the channel due to recent flood protection projects. SCVWD has conducted recent basin specific hydrologic studies on some of the watersheds and has the authority to set the appropriate design flow criteria for current conditions. The studies provide watershed hydrology data in support of the one percent design flow rates for creeks terminating before the Baylands. However, these data do not include flows at sloughs or in the mixing zone covering different watersheds. These flows are under review by the Corps for certification as part of the Shoreline Study. Further details on specific fluvial channels are provided below.

Located on the west side of the Diablo Mountain range, Coyote Creek drains an area of 322 square miles. It conveys a substantial amount of fresh water to the Bay during the winter and spring and also receives discharges from the WPCP via Artesian Slough. Coyote Creek connects several sloughs, channels, and creeks to the Bay including Laguna Creek, Mud Slough, Lower Penitencia Creek, Fremont Flood Control Channel, Artesian Slough, Alviso Slough, and the Coyote Creek bypass channel.

Coyote Creek (referred to as Coyote Slough in the tidal reaches) enters the extreme southern tip of San Francisco Bay. Following flooding in 1982, a major channel remediation project was completed which included levee setbacks and excavation of an overflow and bypass channel to reduce flood hazards. The project prevented potential damages caused by flooding during record runoff in 1997 and 1998. However, SCVWD staff is concerned that the community may be at risk during combined fluvial-tidal flooding if the Coyote Creek levees downstream of Dixon Landing Road (Alameda County jurisdiction) are overtopped and flood waters backflow behind the current protective works and cause flooding along I-880 in Milpitas. Following a joint meeting with SCVWD and Alameda County Public Works

Department (ACPWD) staff, it was agreed that this hazard would be assessed during a current Fremont development project and in the Corps Shoreline Study.

The Lower Guadalupe River reach receives runoff from a highly urbanized region comprising a steep upper watershed, an urban residential and light commercial zone (the Upper Guadalupe River), and a developed downtown commercial zone. Stormwater drainage from these areas and from stormwater pump flows within the Project Area adds to the runoff volume of the Lower Guadalupe River. Historically, many floods occurred along the Guadalupe River, which resulted in construction of major flood protection projects consisting of channel modifications, bank stabilization and new levees. The recent Lower Guadalupe River Flood Protection Project is designed to provide 100-year flood protection along the lower river system. Inadequate internal drainage backing up in zones of low elevation remains a local problem.

In the lower reaches, the Guadalupe River enters the Bay via Alviso Slough. Tidal influence extends about 3.5 miles from the Bay upstream to Montague Expressway (Santa Clara Valley Water District 2001). The combination of low channel slope, low flow velocity conditions and availability of Bay sediments creates a depositional environment. Ongoing sediment deposition and vegetation encroachments in Alviso Slough can reduce flow capacity, though channel capacity continues to be maintained annually by SCVWD.

As part of the Lower Guadalupe River Flood Protection Project, SCVWD has constructed a series of floodwalls and levees along the river banks, replaced the SR 237 eastbound bridge, modified 19 storm drain outfalls, improved and constructed maintenance roads and undercrossings, improved the west perimeter levee around Alviso, and constructed grade-control weirs (gradual drops in the stream elevation). SCVWD reconfigured the existing left bank levee (looking downstream) to act as a weir, allowing high flows in the Guadalupe River to exit Alviso Slough and enter Pond A8. The estimated design discharge for Alviso Slough at the UPRR Bridge at the community of Alviso is 18,350 cfs, which includes the Corps derived peak discharge of 17,000 cfs (Northwest Hydraulic Consultants 2002) and contributions from fourteen interior drainage facilities (pumps and gravity outfalls) that adds another 1,350 cfs. The reconfigured left bank diverts approximately 8,500 cfs of the 100-year flow in Alviso Slough to Pond A8, thereby decreasing peak discharges and water surface elevations downstream of the UPRR. Large floods (such as the one percent event) that exceed the storage capacity of Pond A8 will top the internal levees and convey flood flows into Ponds A5, A6, and A7. Flood waters will be held in the Pond A8 system and then pumped out (or conveyed via culverts with flap gates) over a period of time (about one month). Also as part of the Lower Guadalupe River Flood Protection Project, in-stream wetland vegetation is removed in the vicinity of the SCVWD overflow weir to maintain flood conveyance.

Several communities including Sunnyvale, Cupertino, San Jose, Santa Clara, and Saratoga lie within the 85-square-mile West Valley watershed. Historically, the Guadalupe River drained through Guadalupe Slough, the primary conveyance from the watershed, to the Bay. However, the river was diverted to Alviso Slough in the early 1900s during construction of the salt ponds. Presently, Guadalupe Slough conveys flow from San Tomas Aquino Creek, Calabazas Creek, Sunnyvale East and West Channels and pumped flow from the independent storm-drainage systems of the City of Sunnyvale (the Sunnyvale Stormwater Pump Station that pumps into Calabazas Creek, the Lockheed Stormwater Pump Station that pumps into Moffett Channel, and a small pump station operated by the Twin Creeks Sports Complex that pumps into the Sunnyvale East Channel). The flows from all three pump stations eventually flow into Guadalupe Slough. Guadalupe Slough continues to lose capacity as salt marsh vegetation and sediment deposits accumulate in the channel.

Since 1950, flooding has occurred during four major storms. Several flood protection projects were developed and constructed as a result. For example, FEMA approved a Letter of Mapped Revision (LOMR) that removed split flow conditions from San Tomas Aquino Creek in the City of Santa Clara. SCVWD, as part of the Calabazas Creek Flood Control Project, has completed a flood protection project from Guadalupe Slough to Miller Avenue with a flood wall, levee, and channel enlargement to improve the capacity of Calabazas Creek to the 100-year event, reduce bank erosion, and provide for long-term riparian habitat. SCVWD is currently in the planning stages for extending the Calabazas Creek flood protection project upstream of Miller Avenue. SCVWD is also currently planning upgrades to Sunnyvale East and West Channels to protect against the one percent flood.

The Lower Peninsula watershed has a drainage area of about 100 square miles, and includes the cities of Los Altos Hills, Palo Alto, Mountain View, Los Altos, and Cupertino.

Stevens Creek flows northerly from the City of Mountain View and drains an area of 27 square miles. Additional overflow discharge is delivered from Permanente Creek through a diversion. The watershed contains a high percentage of natural area and its upper zone is largely undeveloped forest or rangeland. Much of the creek downstream of SR 237 is channelized and armored for bank stabilization and flood protection (PWA and others 2005a).

The Permanente Creek tributary encompasses 28 square miles and includes portions of the cities of Los Altos, Mountain View, Cupertino, and Los Altos Hills. Permanente Creek has a history of recurring floods in Los Altos and Mountain View, in particular during the winters of 1955 and 1958. In response to these floods, SCVWD and other agencies have improved several sections of the creeks. Improvements include channel lining and construction of the Permanente Diversion, as well as erosion control, structural repair, sediment reduction, and habitat restoration. While Permanente Creek does not have 100-year capacity throughout the channel, SCVWD has begun work on additional projects to increase channel capacity. The planning and initial design phases of this work are expected to be complete by June 2008.

Pond A6. The paragraphs below describe the site history, topography, levees and operation of Pond A6.

Site History. Historic tidal marsh in the Alviso vicinity was leveed to create Pond A6. Pond A6, prior to acquisition by USFWS, was the site of a duck hunting club. Existing conditions at Pond A6 are shown in Figure 3.3-6.

Pond Topography. The elevation of Pond A6 gently slopes southward and averages 2.33 ft (0.71 m) NAVD, which is approximately 3.85 ft (1.17 m) above MLLW and 5.15 ft (1.57 m) below MHHW (Foxgrover and Jaffe 2005). Figure 3 in Appendix G (Topography of Phase 1 Action Restoration Sites)

shows the topography of Pond A6. Fringe marsh has developed outboard of the levee due to sediment deposition within the far South Bay and Alviso and Guadalupe Sloughs. Pond A6 contains remnants of historic tidal marsh channels which appear as shallow depressions lined by natural berms in the pond topography. Pond A6 topography also reflects the remnants of a constructed berm extending longitudinally down the center of the pond averaging between 1.5 and 3 ft (0.46 and 0.90 m) above the bed. The internal berm forms a diamond shape at the northern end of the pond, in which are the remains of the Knapp Tract Duck Club, which is no longer in use. A boardwalk extends from the western levee which served as access to the duck club as well as to the PG&E power towers which traverse the pond from the northeast corner through the duck club. Borrow ditches were excavated along the entire perimeter of the pond and adjacent to the internal berms to obtain fill material for levee construction and maintenance. The depths of the borrow ditches are approximately 1.1 ft (0.35 m) below the bed of Pond A6.

Levees. Pond A6 is surrounded by external pond levees. The elevation of the external pond levee ranges between 10 and 12.5 ft (3.05 and 3.8 m) NAVD and is generally higher on the western and southern sides where it provides vehicle access. The external pond levee system extends southward from both sides of Pond A6, between Pond A7 and Alviso Slough and Pond A5 and Guadalupe Slough. Vehicle access is provided from Pond A8 along the eastern perimeter of Pond A7.

Existing Operation. Under current ISP operations, Pond A6 is managed as a seasonal pond as part of the Alviso A7 System. The Alviso A7 system also includes Ponds A7, A5, and A8. As with other seasonal ponds, water from direct precipitation and groundwater infiltration accumulates in Pond A6 during the wet season. During the dry season, evaporation causes Pond A6 to dry out. Pond A6 is not hydraulically connected to Pond A5 or A7. There are no water control structures connecting Pond A6 to adjacent sloughs or ponds.

As part of the Lower Guadalupe River Project, SCVWD installed a weir between Alviso Slough and Pond A8 to allow overflow from Alviso Slough during approximately 10-year storm events or greater (>11,000 cfs) to enter Pond A8. As Pond A8 fills, water flows from Pond A8 over the Pond A8 west levee, into Ponds A5 and A7. If water levels within these three ponds become higher than 9.8 ft (3.0 m) NAVD (the minimum elevation of the Pond A6 southern levee), overtopping into Pond A6 occurs. Flood water retained in the ponds requires pumping by the 4,000 gpm pump connecting Pond A8 to Ponds A7 and A11. The entire Alviso A7 System has a flood control capacity of 13,200 ac-ft for a 18,350 cfs flood hydrograph (Schaaf & Wheeler 2004).

Pond A8. The paragraphs below describe the site history, topography, levees, and operation of Pond A8.

Site History. Historic tidal marsh in the Alviso vicinity was leveed to create Pond A8. Pond A8 was historically operated by Cargill as an evaporator pond where the residue of saltwater evaporation (brine) was produced and harvested prior to the final processing and crystallization of salt. Existing conditions at Pond A8 are shown in Figure 3.3-7.

Pond Topography. Typical bed elevations within Pond A8 are approximately -1.5 ft (0.46 m) NAVD88 (Foxgrover and Jaffe 2005; TerraPoint 2005). Pond A8 lies approximately at MLLW and 9 ft (2.75 m) below MHHW. This is slightly lower than adjacent Ponds A5 and A7, which have typical bed elevations of 0.5 ft and -0.2 ft NAVD88 (TerraPoint 2005). Figure 4 in Appendix G (Topography of Phase 1 Action Restoration Sites) shows the topography of Pond A8. An internal levee divides Pond A8 and residual internal salt pond berms break up the topography of the southern part of Pond A8. Historic tidal marsh channels remain within the interior of the pond (demarcated by the meandering shallow depressions), although not continuously, even though the entire bed has subsided. Borrow ditches were excavated along the entire perimeter of the pond and adjacent to the internal berms to obtain fill material for levee construction and maintenance. The depths of the borrow ditches are approximately 9 ft (2.75 m) below the bed of Pond A8.

Levees. External pond levees have been constructed adjacent to Pond A8 along Alviso and Guadalupe Sloughs. These levees were originally constructed to protect Pond A8 from fluvial flooding and therefore crest elevations are on average 12.3 ft (3.75 m) NAVD, which is 4.8 ft (1.5 m) above MHHW and 1.3 ft (0.4 m) above the 100-year water level, except at the location of the engineered weir. While a levee of this elevation would protect Ponds A8 from tidal overtopping, it is likely that the 100-year water level would cause overtopping because of wave run-up and wind set-up. Internal pond levees separate Pond A8 from Ponds A5 and A7. The levee between Pond A8 and Ponds A7 and A5 is on average 4.3 ft (1.3 m) NAVD. The internal levee dividing Pond A8 is on average 3.4 ft (1.0 m) NAVD.

Existing Operation. Under ISP operations, Pond A8 is operated as a seasonal pond within the Alviso System A7. Seasonal ponds are passively managed as seasonal wetlands that receive only direct precipitation and groundwater inflows during the wet season. During the dry season, seasonal ponds are allowed to dry out by evaporation.

The Alviso System A7 also includes Ponds A6, A5, and A7. Pond A6 is operated as a seasonal pond. Ponds A5 and A7 are presently managed to maintain tidal circulation via two sets of 48-inch gates located at the northwest and northeast corners of Ponds A5 and A7 respectively. ISP Operation Plans indicate that originally, the Alviso System A7 was operated to intake tidal waters from Guadalupe Slough into Pond A5 only. Tidal waters would flow southeastwardly through Pond A5 toward a cut in the internal levee between Ponds A5 and A7, into Pond A7. They then would flow north through Pond A7 and discharge through the outlet gates to Alviso Slough. Due to a broken structure at Pond A7, pond operations have been recently modified to intake and discharge through both structures. To the extent possible, the gates are operated to maintain water levels lower than 3.3 ft NAVD88 within both Ponds A5 and A7. A 24-inch control gate through the levee between Ponds A7 and A8 remains closed under normal operating conditions. The USFWS Operation Plan calls for this gate to be opened if bird monitoring indicates the need to operate Pond A8 as a high salinity pond. USFWS occasionally operates a 4,000 gpm pump to convey water from Pond A7 to Pond A8 when flow through the 24-inch control gate is insufficient. Since water is not discharged from Pond A8, evaporation of the pumped water gradually increases soil salinities. Existing water levels within Pond A8 average 0-1 ft NAVD88 (Schaaf & Wheeler 2004). Additionally, SCVWD operates a pump in cooperation with USFWS that conveys water from Pond A4 to Pond A5 via a siphon under Guadalupe Slough.

As part of the Lower Guadalupe River Project, SCVWD installed a weir between Alviso Slough and Pond A8 to allow overflow from Alviso Slough during 10-year storm events or greater (>8,600 cfs) to enter Pond A8. During significant flood overflows, water levels in Pond A8 may overtop the levees between Pond A8 and Ponds A5 and A7 and between Ponds A5 and A7 and Pond A6. Flood water retained in the ponds is pumped out via the 4,000 gpm pump connecting Pond A8 to Ponds A7 and A11. The entire Alviso System A7 has a flood control capacity of 13,200 ac-ft for a 18,350 flood hydrograph (Schaaf & Wheeler 2004).

Pond A16. The paragraphs below describe the site history, topography, levees, and operation of Pond A16.

Site History. Historic tidal marsh in the Alviso vicinity was leveed to create Pond A16. Pond A16 was historically operated by Cargill as an evaporator pond where the residue of saltwater evaporation (brine) was produced and harvested prior to the final processing and crystallization of salt. Existing conditions at Pond A16 are shown in Figure 3.3-8.

Pond Topography. The elevation of Pond A16 gently slopes southeastwardly and averages 0.9 ft (0.3 m) NAVD, which is approximately 2.5 ft (0.75 m) above MLLW and 6.5 ft (2.0 m) below MHHW. Figure 5 in Appendix G (Topography of Phase 1 Action Restoration Sites) shows the topography of Pond A16. Pond A16 is topographically divided into four cells by remnants of the historic tidal marsh channels. The relict channels form shallow depressions in the topography extending in three arms from the borrow ditch lining the northeast levee to the borrow ditches adjacent to the south and west levees. Borrow ditches were excavated along the entire perimeter of the pond to obtain fill material for levee construction and maintenance. The depths of the borrow ditches are approximately 2.6 ft (0.8 m) below the bed of Pond A16.

Levees. Pond A16 is surrounded by external and internal pond levees. The external pond levee extends up the eastern side of Pond A16 adjacent to Artesian Slough and then down the western perimeter of the pond adjacent to the New Chicago Marsh drainage ditch. The average elevation of the external pond levee is 10.7 ft (3.25 m) NAVD (3.2 ft or 1.0 m above MHHW and 0.3 ft or 0.1 m below the 100-year water level). The internal pond levee along the southern perimeter of Pond A16 separates Pond A16 from New Chicago Marsh. The average elevation of this levee is 9.8 ft (3.0 m) NAVD (2.3 ft or 0.7 m above MHHW).

Existing Operation. Under current ISP operations, Pond A16 is managed as a system pond within the Alviso System A16. Alviso System A16 also includes Pond A17. System ponds are operated to maintain continuous tidal circulation by the management of tidal flow through water control structures.

Pond A17 is hydraulically connected to Coyote Creek via a 48-inch culvert with an adjustable tide gate which is located in the northeast corner of the pond. Pond A16 is connected to Artesian Slough through a 48-inch culvert with an adjustable tide gate located in the southeastern corner of the pond, just upstream of the Pond A18 south intake/outlet structure (USFWS 2006). Water within the Alviso System A16 flows between the two ponds through an existing gap in both the Pond A16 and Pond A17 levees. A siphon

exists between Ponds A17 and A18 which is planned to be plugged and closed (pers. comm. Clyde Morris 2006; USFWS 2006).

During the summer of 2005, water from Coyote Creek was circulated through Ponds A16 and A17 and discharged to Artesian Slough. During summer operations in 2006, the gates on both the Pond A16 and Pond A17 water control structures were opened to allow muted tidal exchange between Pond A16 and Artesian Slough, and between Pond A17 and Coyote Creek, to manage dissolved oxygen (DO) levels (pers. comm. Mruz 2006). During winter operations, Pond System A16 is operated to intake water from Artesian Slough and discharge to Coyote Creek through Pond A17 to avoid the entrainment of fish in Coyote Creek.

Ravenswood

The Ravenswood pond complex (formerly West Bay) is owned by USFWS and covers 1,600 acres on the western side of the Dumbarton Bridge.

Tributaries. The largest tidal slough in the Ravenswood pond complex is Ravenswood Slough. No major drainages flow directly to the Ravenswood pond complex, but the slough receives limited localized runoff from the adjacent terrain. Local drainage from the upstream area, north and south of the Ravenswood pond complex, is generally conveyed to the Bayfront Canal, which runs along the landward perimeter of Ponds R3 and R5 and outfalls to Flood Slough. Relatively little freshwater input is discharged from Ravenswood Slough into the Bay (Figure 3.3-3).

San Francisquito Creek and Matadero Creek are located between the Ravenswood and Alviso pond complexes on the west side of the Bay, with average annual discharges of 22 cfs and 5 cfs, respectively.

Tributary Sediment Load and Sediment Characteristics. Because tributaries to the Ravenswood Slough discharge very little fresh water to the slough, sediments within the Ravenswood Slough and adjacent ponds originate primarily from the Bay. USGS collected sediment data between April and June 2003 which indicate that sediments within the Ravenswood ponds are sandier than those within the Eden Landing and Alviso pond complexes and have a grain size distribution of 55 percent sand, 32 percent silt, and 13 percent clay (U.S. Geological Survey 2005).

Marsh Sedimentation. Measured sedimentation data are available for Cooley Landing Salt Pond Restoration (PWA 2004), a marsh restoration site south of the Ravenswood pond complex (see Figure 40 in Hydrodynamics and Sediment Dynamics Existing Conditions Report) (PWA and others 2005b). Between December 2000 and September 2001, the site experienced 0.08 ft (0.02 m) of sediment deposition whereas between September 2001 and September 2003, the site experienced 0.4 ft (0.12 m) of sediment deposition. The rate of sediment deposition increased over time from 0.11 to 0.17 ft/year (0.03 to 0.05 m/yr). These rates are consistent with the regional sediment transport and availability patterns.

Coastal Flooding. Flooding near the Ravenswood pond complex occurs when large frontal storms coincide with high tides resulting in broad shallow street flooding and local ponding. This is due to the reduced conveyance from inland areas of low relief. The salt pond perimeter levee may also be overtopped at extreme high tides, adding to the potential flood risks. Existing levees do not meet FEMA standards for flood protection and therefore, major urban areas are included in the tidal flood zone, including the Bohannon Industrial Park between SR 84 and US 101 and the Belle Haven neighborhood in Menlo Park. Tidal flooding related to overflows from the Moseley Tract has occurred along the frontage road to the Dumbarton Bridge. High water from the Moseley Tract and the Caltrans collection ditches generally overtops into Pond R1 at the southern end of the Cargill levee separating the pond from Moseley Tract as well as along the southern edge of the Cargill pond (along the SR 84 frontage road). When the collection ditches backs up and the frontage road along the southern side of SR 84 floods, water spills over into Pond SF2 near the frontage road exit. The Corps currently has no Coastal Flood Limit delineated for the Ravenswood pond complex. However, the entire area and inland areas are within the FEMA floodplain based on projections of the 100-year still water level (Figure 3.3-2).

Fluvial Flooding. The Ravenswood pond complex is located north of the San Francisquito watershed. Areas of Redwood City and Atherton are tributary to Bayfront Canal/Flood Slough. Flood Slough drains to the Bay through Westpoint Slough. The Ravenswood Slough Flood Control Zone includes areas of Menlo Park and East Palo Alto. Flooding of inland areas results from the inability of the slough channels to convey local drainage to the Bay during periods of concurrent high tide. The FEMA FIS (effective 1999) for City of Menlo Park provides more historical flood information for the areas adjacent to the Ravenswood pond complex.

Pond SF2. The paragraphs below describe the site history, topography, levees, and operation of Pond SF2.

Site History. Historic tidal marsh in the Ravenswood vicinity was leveed by Cargill to create Pond SF2. Pond SF2 was historically operated by Cargill as an evaporator pond where the residue of saltwater evaporation (brine) was produced and harvested prior to the final processing and crystallization of salt. Pond SF2 is currently managed as a seasonal pond in the Ravenswood SF2 System. Existing conditions at Pond SF2 are shown in Figure 3.3-9.

Pond Topography. Typical bed elevation within Pond SF2 are on average 5.2 ft (1.6 m) NAVD, which is approximately 6.4 ft (2 m) above MLLW and 2.1 ft (0.6 m) below MHHW. The northeastern corner of Pond SF2 is approximately 0.5 ft (0.15 m) higher than the rest of the pond. Figure 6 in Appendix G (Topography of Phase 1 Action Restoration Sites) shows the topography of Pond SF2. Outboard fringe marsh on the bay side of the external pond levee has developed since the pond was leveed due to sediment deposition and accretion to colonization elevations. Pond SF2 contains remnants of historic tidal marsh channels which appear in the topography as sinuous, shallow depressions. Borrow ditches were excavated adjacent to the entire length of the perimeter levee to supply fill material for levee construction and maintenance. The depths of the borrow ditches are unclear due to gaps in the available topographic data.

Levees. Pond SF2 is bordered by internal pond levees on the south, west and north and by an external pond levee on the west. The elevation of the external pond levee is about 10.7 ft (3.26 m) NAVD (3.4 ft or 1.0 m above MHHW and 0.5 ft or 0.15 m above the 100-year water level). This levee provides Pond SF2 with protection from tidal overtopping however it is likely that wave run-up and wind set-up

during extreme high Bay waters would result in overtopping. The average elevation of the internal pond levee is 9.2 ft (2.8 m). The internal pond levee connects to the flood protection levee at the northeast and southeast corners of the pond.

Existing Operation. Pond SF2 is not actively managed under the ISP. It has been decommissioned as a Cargill salt pond and presently acts as a seasonal pond, filling with precipitation during the winter and drying out in the summer.

3.3.2 Regulatory Setting

This section provides a description of the implementing agencies involved in flood management in the Project Area and a brief summary of the regulatory setting: the primary laws and regulations related to flood management, hydrodynamics and sediment transport in the region.

Flood Management Implementing Agencies

Flood risk assessments and some flood protection projects are conducted by federal agencies including FEMA and the Corps of Engineers. The flood management agencies and cities implement the National Flood Insurance Program (NFIP) under the jurisdiction of FEMA and its Flood Insurance Administration.

FEMA is responsible for responding to emergencies and natural disasters, including flooding. FEMA has developed Flood Hazard Factors to assign risk to the potentially flooded areas along the Bay. The flood risk assigned to geographic areas is illustrated on Flood Insurance Rate Maps (FIRMs). FEMA FIRMs show Base Flood Elevations (predicted water surface elevations landward of shoreline and river barrier crests) and separate flood hazard zones. This risk assessment is also used to set actuarial insurance premium rate tables.

The Corps also conducts studies on flood hazards and participates in flood management projects in which they have regulatory jurisdiction as stated in Section 10 of the Rivers & Harbors Act. All significant Corps construction projects are subject to authorization by Congress pursuant to the Water Resources Development Act. Additionally, the Corps is given authority to pursue projects in which Congress has determined a Federal Interest in joint flood protection / ecosystem restoration (Executive Order 11988). The Corps has developed principles and guidelines for designing and constructing flood protection measures for coastal, estuarine and river environments. The Corps also has previously conducted studies on flood hazards and risks as part of the original San Francisco Bay Shoreline Study (U.S. Army Corps of Engineers 1988b; U.S. Army Corps of Engineers 1989; U.S. Army Corps of Engineers 1992).

Although documentation from both FEMA and the Corps are valuable resources in evaluating flood hazards, the FIRMs for the South Bay and the flooding analyses from the original Shoreline Study are dated and therefore, may not be current in all areas.

Other agencies responsible for flood management include the local flood control districts and city public works departments. The local flood control districts have local jurisdiction for the development of flood protection projects. The districts' authority is derived from enabling legislation passed by the State of California (see subsequent section on Local Regulations for more details). In the SBSP Restoration

Project Area, the relevant flood control districts include SCVWD (Alviso pond complex), ACFCWCD (Eden Landing pond complex) and the County of San Mateo Public Works Department (Ravenswood pond complex). (SCVWD is a special district that oversees flood protection and watershed management in Santa Clara County, but is not part of the county government.) These agencies are responsible for providing flood protection to the counties and cities in their jurisdiction, and are the issuing agencies for encroachment permits for storm drain outfalls into flood protection channels. However, in San Mateo County, cities are responsible for most aspects of flood protection.

San Francisquito Creek presents jurisdictional challenges in that the channel forms the boundary between San Mateo and Santa Clara counties, and is therefore within both jurisdictions. The San Francisquito Joint Powers Authority (JPA) was created in 1999 to address these challenges. The JPA is a coalition of local government agencies formed to plan and implement flood management and watershed protection in the San Francisquito Creek watershed.

Laws and Regulations

The SBSP Restoration Project falls under the jurisdiction of many local, state and federal agencies with respect to specific aspects of planning, restoration and management. The following section summarizes the primary laws and regulations affecting flood management, hydrodynamics and sediment transport within the Project Area. Local laws and regulations are provided for the locations of Phase 1 actions for use in the project-level impact assessment.

Federal Regulations

Federal Clean Water Act. Section 404 of the Clean Water Act (CWA) regulates all activities resulting in the discharge of dredged or fill material into waters of the United States, which includes wetlands. Section 404 gives the Corps the principal authority to regulate discharges of dredged or fill material, under oversight by USEPA. While the Corps is given authority to issue permits allowing such discharges, USEPA is given the authority to veto permit decisions.

Rivers & Harbors Act. The Rivers and Harbors Act (RHA) of 1899 prohibits the unauthorized alternation or obstruction of any navigable waters of the United States. As defined by the RHA, navigable waters include all waters that are:

- Historically, presently, or potentially used for interstate or foreign commerce; and
- Subject to the ebb and flow of tides.

Regulations implementing Section 10 of the RHA are coordinated with regulations implementing CWA Section 404. The RHA specifically regulates:

- Construction of structures in, under, or over navigable waters;
- Deposition or excavation of material in navigable waters; and
- All work affected the location, condition, course, or capacity of navigable waters.

The RHA is administered by the Corps. If a proposed activity falls under the authority of RHA Section 10 and CWA Section 404, the Corps processes and issues a single permit. For activities regulated only under RHA Section 10, such as installation of a structure not requiring fill, permit conditions may be added to protect water quality during construction.

Coastal Zone Management Act. The Coastal Zone Management Act (CZMA) of 1972 requires that federal actions be consistent with state coastal plans. The San Francisco Bay Conservation and Development Commission (BCDC) Bay Plan is approved under the CZMA. To implement this provision, federal agencies make "consistency determinations" on their proposed activities and applicants for federal permits, licenses, other authorization or federal financial assistance make "consistency certifications". BCDC then has the opportunity to review the consistency determinations and certifications and to either concur with them or object to them.

Executive Order 11988-Floodplain Management. Executive Order 11988 requires federal agencies to recognize the values of floodplains and to consider the public benefits from restoring and preserving floodplains. Under this order the Corps is required to take action and provide leadership to:

- Avoid development in the base floodplain;
- Reduce the risk and hazard associated with floods;
- Minimize the impact of floods on human health, welfare, and safety; and
- Restore and preserve the beneficial and natural values of the base floodplain.

National Flood Insurance Acts. The National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973 were enacted to reduce the need for flood protection structures and to limit disaster relief costs by restricting development on floodplains. FEMA was created in 1979 to administer the NFIP and to develop standards for fluvial and coastal floodplain delineation.

State Regulations

McAteer-Petris Act. The McAteer-Petris Act of 1965 established BCDC as a temporary state agency in charge of preparing the Bay Plan. In 1969, the Act was amended to make BCDC a permanent agency and to incorporate the policies of the Bay Plan into state law.

Under the McAteer-Petris Act and the Bay Plan, any agency or individual proposing to place fill in, to extract materials from, or to substantially change the use of any water, land or structure in BCDC's jurisdiction is required to secure a San Francisco Bay Permit. BCDC grants San Francisco Bay permits for projects that meet either of the following guidelines:

- The project is necessary to the safety, welfare, or health of the public in the entire Bay Area; or
- The project is consistent with the provisions of the implementing regulations and the Bay Plan.

The types of San Francisco Bay permits include region-wide, administrative, and major permits. The type of permit issued depends on the nature and scope of the proposed activities.

California Water Code. The California Water Code ensures that the water resources of the state are put to beneficial use to the fullest extent of which they are capable and that the conservation of water is exercised in the interest of the people and for public welfare. All projects in California must abide by Division 5 of the State of California Water Code (Santa Clara Valley Water District 2003) which sets the provisions for flood control. The Code includes a number of provisions that pertain to local and state flood management, and flood protection. Section 8100 et seq. of the Code contains guidelines for the construction of public works and improvements including: the protection and restoration of watersheds, levees or check dams to prevent overflow or flooding, conservation of the floodwaters, and the effects of construction projects on adjacent counties (especially upstream and downstream along a river). Section 12840 et seq. of the Code contains provisions related to flood prevention projects.

California Fish and Game Code Sections 1600–16016. In accordance with Sections 1601–1607 of the California Fish and Game Code, CDFG regulates projects that affect the channel, flow, or banks of rivers, lakes, or streams. Sections 1602 and 1603 require public agencies and private individuals to notify and enter into a streambed or lake alteration agreement with CDFG before beginning construction that would:

- Change, divert, or obstruct the natural flow or the bed, bank, or channel of any river, lake, or stream;
- Use materials from a streambed; or
- Result in the deposition or disposal of debris, waste, or other material containing flaked, crumbled, or ground pavement where it can pass into any river, lake, or stream. Lake or streambed alteration agreements may impose conditions to protect water quality during construction.

Sections 1600–1616 may apply to any work undertaken within the 100-year floodplain of a body of water or its tributaries, including intermittent stream channels. In general, they are construed as applying to work within the active floodplain and/or associated riparian habitat of a stream, wash, or lake that provides benefit to wildlife and fish. Sections 1600–1616 typically do not apply to drainages that lack defined bed and banks, such as swales, or to very small bodies of water and wetlands.

Local Regulations

Santa Clara Valley Water District Act. The Santa Clara Valley Water District Act of 1951 established SCVWD, giving it the authority to implement the following SCVWD purposes identified by the Act:

- To protect Santa Clara County from flood and storm water;
- To provide comprehensive conservation and management of flood, storm and recycled waters for all beneficial uses;
- To increase and prevent the waste of the water supply in the District; and
- To enhance, protect and restore stream, riparian corridors, and natural resources in connection with other purposes of water supply and flood protection.

Under the Water Resources Protection Ordinance (Ordinance 06-1), SCVWD requires encroachment permits for modifications on SCVWD facilities and/or SCVWD easements. Activities requiring a permit include: grading, removing, dredging, mining, or extraction of any materials; constructions, reconstruction, demolition or alteration of the size of any structure, including any facility of any private, public or municipal utility; and the removal or installation of vegetation. Permits, if granted, may require mitigation for any disturbance to the health of the watercourse.

Alameda County Flood Control and Water Conservation District Act. The Alameda County Flood Control and Water Conservation District Act created ACFCWCD in order to:

- Provide for control of flood and storm waters of the district and of streams which flow into the district;
- Conserve waters for beneficial and useful purposes by spreading, storing, retaining and causing the waters to percolate into the soil within or without the district, or to save or conserve the waters in any manner and protect the watercourses, watersheds, harbors, public highways, life and property in the district from such waters;
- Prevent waste of water or diminution of the supply in, or exportation from, the district;
- To obtain, retain and reclaim drainage, storm, flood and other waters for beneficial use in the district;
- To engage in incidental recreation activities; and
- Control and distribute any water including sewage water, and to acquire and operate facilities for collection and disposal of sewage, waste, and storm water.

The ACFCWCD Land Development Division reviews design documents and issues permits for developments that may disturb watercourses. Where appropriate, permits issued for development may require mitigation for disturbances.

San Mateo County Flood Control District Act. The San Mateo County Flood Control District Act of 1959 establishes the San Mateo County Flood Control District (SMCFCD) in order to:

- Control and conserve storm and flood waters;
- Prevent waste or exportation of water;
- Retain drainage, storm, flood and other waters for beneficial use in the district; and
- Prevent pollution or diminution of water supply.

SMCFCD is a special district created by the State legislature. While SMCFCD has jurisdiction throughout all of San Mateo County, the cities within San Mateo County are not prohibited from undertaking flood control projects and regulating activities in the floodplain within their respective communities.

3.3.3 Environmental Impacts and Mitigation Measures

Overview

This section describes environmental impacts and mitigation measures related to hydrology, flood management and infrastructure. It includes a discussion of the criteria used to determine the significance of impacts. Potential impacts were characterized by evaluating direct, indirect, short-term (temporary), and long-term effects.

Significance Criteria

Hydrology and flood risk were assessed by comparing expected conditions in the future under each alternative against the baseline (Fall 2006) conditions.

For the purposes of this EIS/R, the Project is considered to have adverse impacts on hydrology or flooding if it would:

- Alter existing drainage patterns in a manner which would result in substantial erosion or siltation on- or off-site;
- Increase the risk of flooding that could cause injury, death, or substantial property loss;
- Create a safety hazard for people boating in the Project Area;
- Create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems; or
- Place structures within the 100-year flood hazard area that would impede or redirect flood flows.

The SBSP Restoration Project long-term alternatives would not create or contribute runoff, or be an impediment to flood flows. These criteria are intended for evaluation of urban land uses and do not apply to the proposed Project.

For the purpose of this NEPA/CEQA impact assessment, the thresholds of significance are applied to changes from baseline conditions that result from factors within the control of the Project proponents. Sea level rise, though part of the changes discussed in the impact sections, is considered outside the control of the Project proponents.

As explained in Section 3.1.2, while both CEQ Regulations for Implementing NEPA and the CEQA Guidelines were considered during the impact analysis, impacts identified in this EIS/R are characterized using CEQA terminology. Please refer to Section 3.1.2 for a description of the terminology used to explain the severity of the impacts.

Program-Level Evaluation

SBSP Long-Term Alternatives

SBSP Impact 3.3-1: **Potential for increased coastal flood risk landward of the SBSP Restoration Project Area.**

The existing levees within the SBSP Restoration Project Area were originally built to create ponds for commercial salt production. The pond levees were not constructed to provide flood protection, and were not engineered to conform to flood or other engineering standards. The levees and the salt ponds themselves, however, provide partial protection from coastal flooding (U.S. Army Corps of Engineers 1988b) as they are a barrier to waves incident from the Bay. The ponds also provide storage of water due to wave-induced overtopping and direct inundation resulting from limited breaching of bayfront levees. The effectiveness of the salt ponds as a flood management mechanism is contingent upon active maintenance of the levees.

FEMA (Federal Emergency Management Agency 1981; Federal Emergency Management Agency 1998a; Federal Emergency Management Agency 1998b; Federal Emergency Management Agency 1999a; Federal Emergency Management Agency 1999b; Federal Emergency Management Agency 2000) and the Corps of Engineers (U.S. Army Corps of Engineers 1988b) have both completed studies and mapping of 100-year coastal flood potential in the South Bay. FEMA maps the entire SBSP Restoration Project Area and adjacent areas landward of the site within the FEMA 100-year coastal floodplain (Figure 3.3-2). Since the pond levees do not meet certification criteria, FEMA mapping presumes that the pond levees are not present, thereby allowing inundation of Bay waters; wind waves are assumed to be limited and runup is neglected. The Corps's investigation takes into account the partial protection from coastal flooding provided by the pond levees and storage in the salt ponds themselves. The area mapped as subject to 100-year coastal flooding based on the Corps's analysis (which assumes the levees are well maintained) is substantially less extensive, but does include developed areas landward of the salt ponds. These assessments are about 20 years old and hence may underestimate flood risks and extents. Additional information can be found in the Physical Setting (Section 3.3.1), the Existing Conditions Report (PWA and others 2005a) and Flood Analyses Report (PWA 2006a).

Alternative A No Action. The pond levees are subject to rapid degradation under normal conditions. Under Alternative A, the landowners would solicit input from key stakeholders including local agencies to help the landowners focus their limited maintenance and improvement funds on pond levees with high priority to be maintained. At Eden Landing, CDFG would focus their levee maintenance on the levees along the east side of Ponds E4, E5, E6, and E6C, to reduce the potential for periodic overtopping into areas that currently provide flood detention for low-lying areas of Alameda County. They would also coordinate levee maintenance and land management activities with the proposed Alameda Creek Flood Control Channel project. At Alviso, the No Action Alternative assumes that the levees along Ponds A5, A6, and A7 are the least likely to be maintained and that the levee along the west side of Pond A8 would be raised to prevent frequent tidal overtopping. This approach maintains the existing flood detention storage in Pond A8, but not in Ponds A5, A6, and A7.

Levees within the SBSP Restoration Project Area that are not a priority to maintain would be increasingly prone to failure over the next 50 years due to continued levee settlement, wave-induced erosion and sea level rise. Unintentional breaching and periodic levee overtopping would be expected. Eroded levees would become less effective barriers to waves from the Bay and breached ponds would no longer provide a coastal flood storage function. Developed inland areas would be subject to higher wave action and higher water levels, increasing the risk of coastal flooding.

Alternative A Level of Significance: Potentially Significant

Alternative B Managed Pond Emphasis. Alternative B would provide a continuous system of shoreline levees designed and managed to maintain or improve levels of coastal flood protection landward of the SBSP Restoration Project Area. Beyond this, it is desirable by all entities to provide flood protection measures (levees, flood walls, high ground) meeting both FEMA and Corps criteria that would remove developed property from the effective FEMA mapped flood zone, resulting in a beneficial effect under both FEMA and Corps flood standards. The levees would be inspected and maintained regularly to provide continuous flood protection though time.

Adaptive Management Plan. Monitoring and adaptive management would be used to verify that the SBSP Restoration Project was performing as intended. Monitoring and adaptive management is described more fully in the Adaptive Management Plan and summarized here. The restoration target for the Project, as specified in the Adaptive Management Plan, is to maintain or improve levels of flood protection. In the event that flood performance was not as intended, the Project would identify and implement necessary flood reduction measures.

Initially, levee inspections would be monthly. Following months of consistent observations, inspection frequency would be reduced to annually. The levees would be resurveyed annually initially, then less frequently, to characterize settlement. The Project would monitor high water marks after large flood events, approximately 10-year events (10 percent annual probability) and larger. Sea level rise and regional land subsidence would be monitored by evaluating available literature and data from sources outside the SBSP Restoration Project, with new data collection by the Project as needed.

Results of the monitoring and inspection data would be used to evaluate the risk of coastal flooding. If the restoration target were not met, management actions would be triggered. In the event that a management trigger is tripped, potential management actions would include increasing the frequency of levee maintenance, or implementing other levee improvements (*e.g.* raise, widen, or armor the levee).

Alternative B Level of Significance: Less than Significant (CEQA); Beneficial (NEPA)

Alternative C Tidal Habitat Emphasis. Similarly to Alternative B, Alternative C would provide a continuous system of shoreline levees designed and managed to maintain or improve levels of coastal flood protection landward of the SBSP Restoration Project Area. Monitoring and adaptive management would be the same for Alternative C as for Alternative B.

Alternative C Level of Significance: Less than Significant (CEQA); Beneficial (NEPA)

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SBSP Impact 3.3-2: **Increased coastal flood risk due to regional changes in Bay bathymetry and hydrodynamics.**

The geomorphic assessment conducted for the SBSP Restoration Project (PWA 2006c) (Appendix I) analyzed potential changes in mudflat and fringing marsh area in the South Bay due to levee breaching (unintentional in Alternative A and intentional in Alternatives B and C), ongoing mudflat erosion and accretion due to continuing geomorphic processes, and sea level rise over the 50-year planning horizon. Since mudflats and fringing marsh serve to dissipate wave energy, a reduction in their area would cause greater wave energy from the Bay to be transmitted shoreward and would potentially increase rates of erosion on shoreline levees. Increased erosion would require more frequent levee maintenance by those entities responsible for maintaining the levees or, in the absence of more frequent maintenance, would increase the risk of levee failure and coastal flooding.

The Shoreline Study, a related but separate project in the South Bay (see Section 3.2 of the EIS/R), will assess whether there is a federal interest in funding coastal flood protection improvements in the South Bay. The Shoreline Study will assess potential measures for flood risk reduction and, depending on the findings, may or may not result in actual implementation of flood protection improvements. Thus, the Shoreline Study may result in a project to mitigate for any impacts associated with changes in Bay bathymetry and hydrodynamics, but whether or not this occurs will not be known until after the Corps, together with non-federal sponsors, completes a series of Feasibility Studies for the South Bay.

Potential impacts associated with changes in wave exposure of the shoreline levees were evaluated using the South Bay Geomorphic Assessment (SBGA) (PWA 2006c)(Appendix I) and Hydrodynamic Modeling Report (PWA 2006b)(Appendix J), conducted for the SBSP Restoration Project. The SBGA provides an overview of the potential magnitude of regional geomorphic changes in the South Bay 50 years into the future for the three alternatives, including gains and losses in mudflat and fringing marsh. The SBGA includes analysis of historical bathymetric changes, drawing on data and analysis by USGS (Foxgrover and others 2004; Jaffe and Fregoso in progress), and sediment budget calculations. The SBGA sediment budget analysis relies on assumptions concerning sediment dynamics to calculate sediment inputs and outputs. There is, therefore, considerable uncertainty in the predictions of long-term geomorphic response to these components.

The Hydrodynamic Modeling Report provides predictions of changes in Bay water levels for Alternatives A and C. Increases in water levels have the potential to increase wave exposure and shoreline erosion, since deeper water transmits wave energy more effectively. The modeling includes both a short-term “hypothetical” simulation of Alternative C with all tidally-restored ponds breached at Year 0 and no short-term bathymetric change in response to the restoration (*e.g.*, no channel scour in the tidal sloughs or main South Bay channel), and long-term simulations of Alternative A and C which assume that mature salt marsh habitat has developed within the tidally-restored ponds (both intentionally restored under Alternative C and unintentionally restored due to levee failures under Alternative A) and long-term tidal slough and South Bay bathymetric change has occurred. The bathymetric changes included in the model simulations are consistent with the tidal slough hydraulic-geometry calculations documented in Appendix G (Tidal Channel Hydraulic Geometry Analyses), and the SBGA predictions for the South Bay intertidal mudflat gains and losses. Results of the hydrodynamic modeling were evaluated to assess the potential for any additional increase in water levels and associated wave exposure due to modified hydrodynamics in the South Bay. However, increases in water depth due to hydrodynamic changes as a result of Project implementation are expected to be relatively small compared to increases in water depth due to 50 years of sea level rise and mudflat erosion.

The long-term, Year 50, hydrodynamic modeling results (PWA 2006b) for Alternative A predict relatively uniform increases in high water levels in the South Bay of 0.3 to 0.5 ft (10 to 15 cm) over 50 years (less than or equal to the amount of sea level rise), and increases in low water levels on the order of 0.5 to 0.7 ft (15 to 20 cm) north of the Dumbarton Bridge, and 0.7 to 0.8 ft (20 to 25 cm) in the far South Bay, south of the Dumbarton Bridge. Results for Alternative C predict reductions in high water levels of 0 to 0.1 ft (0 to 2 cm) and increases in low water levels of 0 to 0.1 ft (0 to 2 cm) compared to Alternative A. Any elevated water levels for Alternative B would likely be between those predicted for Alternative A and C. Based on this information, increases in water levels due to hydrodynamic changes are not expected to substantially affect the SBGA conclusions as the range of water level increases predicted for the South Bay (0.3 to 0.9 ft, or 10 to 26 cm) from the hydrodynamic modeling is within the sensitivity analysis range considered in the SBGA.

Alternative A No Action. The South Bay Geomorphic Assessment (PWA 2006c) (Appendix I) indicates that unplanned levee breaches under Alternative A would potentially result in either increases or decreases in wave exposure of the shoreline levees compared to baseline conditions, with changes varying by location. The effects of ongoing mudflat erosion and accretion due to continuing geomorphic processes and sea level rise on the extent of mudflats and fringing marsh are included in the SBGA results, which are described below in the context of wave energy. However, only the mudflat changes attributed to the unplanned levee breaches and tidal conversions are considered in the impact determination. The effects of ongoing mudflat erosion and accretion and sea level rise on coastal flood risks are considered in Chapter 4, Cumulative Impact 3.3-2.

North of the Dumbarton Bridge. Historically, fringing marsh along the east shoreline has eroded, while marsh along the west shoreline has eroded and accreted (equating to no net change). Mudflat losses are predicted for the area north of the Dumbarton Bridge, decreasing 60 percent, from about 6,200 acres (25 square kilometers [sq km]) to about 2,500 acres (10 sq km). Although the spatial distribution of mudflat losses are not specified in the SBGA analysis, the historical trend in marsh erosion suggests that more mudflat loss is expected along the higher-energy east shore than the west shore. Based on this information, levees along the east shore would likely experience higher wave energy over time compared to baseline conditions, while levees along the west shore would likely experience the same or higher wave energy. The loss of mudflat area and increase in wave energy north of the Dumbarton Bridge is attributed to ongoing mudflat erosion and sea level rise. These changes would occur with or without the unplanned levee breaches assumed to occur under Alternative A, and are therefore not directly attributable to Alternative A.

South of the Dumbarton Bridge. Historically, marsh along the south shoreline has eroded, while marsh along the north shoreline has eroded and accreted (no net change). Slight mudflat gains are predicted for the area south of the Dumbarton Bridge, increasing from 5,680 acres (23 sq km) to 6,180 acres (25 sq km). In the absence of the unplanned levee breaches, additional mudflat gains would be expected. The unplanned levee breaches under Alternative A are projected to reduce the historic rate of mudflat accretion within the far South Bay. Although the spatial distribution of mudflat gains and losses are not specified in the SBGA analysis, the historical trends in marsh erosion suggest that more mudflat loss is expected along the higher-energy south shore than the north shore. Based on this information, levees along the north shore would likely experience the same or lower wave energy over time compared to baseline conditions. Since the south shore appears to be experiencing marsh erosion and mudflat gain, it is not known whether levees along the south shore would experience lower or higher wave energy.

Coyote Creek. Historically, the mouth of Coyote Creek has been depositional, converting mudflats to marsh. Continuation of this trend would decrease wave exposure along this reach of shoreline compared to baseline conditions.

In summary, compared to baseline conditions, Alternative A would potentially result in an increase in wave exposure along the south shore south of the Dumbarton Bridge. Areas of increased wave exposure potentially require more frequent levee maintenance to reduce the risk of levee failure and coastal flooding.

Alternative A Level of Significance: Potentially Significant

Alternative B Managed Pond Emphasis. Alternative B would provide a continuous system of levees designed and managed to maintain or improve levels of coastal flood protection landward of the SBSP Restoration Project Area (see discussion in SBSP Impact 3.3-1 above). Thus, increases in wave exposure would not affect areas protected by the SBSP Restoration Project shoreline levees. The potential for regional changes in Bay bathymetry and hydrodynamics to affect areas outside the SBSP Restoration Project Area is considered below.

North of the Dumbarton Bridge Outside of the SBSP Restoration Project Area. Predicted changes in the areas of fringing marsh and mudflat north of the Dumbarton Bridge are the same for all three long-term alternatives (PWA 2006c), so the potential impacts compared to baseline conditions are the same as those discussed for Alternative A. The loss of mudflat area and increase in wave energy north of the Dumbarton Bridge would occur with or without implementation of Alternative B, and are therefore not directly attributable to the Project.

South of the Dumbarton Bridge Outside of the SBSP Restoration Project Area. The SBGA analysis predicts a slight decrease in mudflats for Alternative B (5,680 acres; 23 sq km) compared to Alternative A (6,180 acres; 25 sq km). In the absence of Alternative B, continued mudflat accretion and an increase in mudflat area would be expected over the 50-year horizon. Implementation of Alternative B is expected to arrest mudflat accretion, resulting in essentially no net change in the predicted acreage of mudflats for Alternative B when compared to baseline conditions. However, the Project would likely result in a change in the spatial distribution of mudflats due to changes in the overall trends of sediment deposition and erosion due to changes in far South Bay hydrodynamics. Based on this information, wave exposure for areas south of the Dumbarton Bridge would be slightly higher than under Alternative A.

Coyote Creek Outside of the SBSP Restoration Project Area. Predicted changes in fringing marsh and mudflats in the mouth of Coyote Creek are the same as those discussed for Alternative A (PWA 2006c); therefore the potential impacts are also the same.

In summary, compared to baseline conditions, Alternative B would potentially result in an increase in wave exposure along the south shore south of the Dumbarton Bridge. Compared to Alternative A, wave exposure would potentially increase south of the Dumbarton Bridge. Within the SBSP Restoration Project Area, potential increases in wave exposure would not adversely affect levels of flood protection. Outside the SBSP Restoration Project Area, areas of increased wave exposure would potentially require more frequent levee maintenance to reduce the risk of levee failure and coastal flooding. It is anticipated that the Shoreline Study will further evaluate this potential flood risk and identify appropriate solutions.

Alternative B Level of Significance: Potentially Significant

Alternative C Tidal Habitat. As in Alternative B, regional changes in Bay bathymetry and hydrodynamics would not affect areas protected by the SBSP Restoration Project shoreline levees. The potential for impacts outside the SBSP Restoration Project Area is considered below.

North of the Dumbarton Bridge Outside of the SBSP Restoration Project Area. Predicted changes in fringing marsh and mudflats north of the Dumbarton Bridge are the same for all three long-term alternatives (PWA 2006c) so potential impacts compared to baseline conditions are the same as discussed above for Alternatives A and B.

South of the Dumbarton Bridge Outside of the SBSP Restoration Project Area. The SBGA analysis predicts a decrease in mudflat area for Alternative C (about 3,700 acres; 15 sq km) compared to Alternative A (about 6,200 acres; 25 sq km), Alternative B (about 5,700 acres; 23 sq km) and baseline conditions (5,680 acres; 23 sq km). Based on this information, wave exposure for areas south of the Dumbarton Bridge would be greater than under both baseline conditions and Alternatives A and B.

Coyote Creek Outside of the SBSP Restoration Project Area. Tidal restoration of ponds along Coyote Creek would result in an increase in tidal prism, resulting in erosion of the existing fringe marsh and widening and deepening of Coyote Creek. Implementation of Alternative C would tidally restore all of the ponds along Coyote Creek within the SBSP Restoration Project Area. Wave exposure would therefore increase in the mouth of Coyote Creek.

In summary, compared to baseline conditions, wave exposure would potentially increase south of the Dumbarton Bridge and in the mouth of Coyote Creek. Compared to Alternatives A and B, wave exposure would potentially increase south of the Dumbarton Bridge. Within the SBSP Restoration Project Area, potential increases in wave exposure would not adversely affect levels of flood protection. Outside the SBSP Restoration Project Area, areas of increased wave exposure would potentially require more frequent levee maintenance to reduce the risk of levee failure and coastal flooding. It is anticipated that the Shoreline Study will further evaluate this potential flood risk and identify appropriate solutions.

Alternative C Level of Significance: Potentially Significant

SBSP Impact 3.3-3: **Increased fluvial flood risk.**

Levee breaching (unintentional in Alternative A and intentional in Alternatives B and C) would increase tidal flows in the downstream reaches of creek and river channels. Higher flows in the downstream channel reaches have the potential to raise water levels in creeks conveying runoff from the watershed to the Bay (PWA 2006b). The effect of levee breaching on creek flood water levels would depend on how much new conveyance is created through the channel and breached ponds. This conveyance would change over time in response to geomorphic changes – such as a tidal scour and sediment deposition. The impact assessment characterizes short-term changes to flooding (immediately after breaching) and long-term changes to flooding, taking into account geomorphic changes and their effects on flooding as the site evolves.

Levee breaching sets into action a series of geomorphic changes which, in turn, affect fluvial flooding. Many of the slough channels in the Project Area appear to be experiencing ongoing siltation, reducing the flood capacity of the channels (Foxgrover and others 2004). As channels continue to become smaller the fluvial risk in the short-term increases, before levee failures occur. Immediately after breaching, there is an increase in tidal flows through the downstream channel reaches and an increase in floodplain conveyance through the ponds. Over time, channel conveyance and increased tidal flows are expected to cause the creek channel to deepen and widen, increasing flood conveyance. At the same time, the ponds would fill with sediments, reducing floodplain conveyance. The net effect on flooding depends on the balance between changes in conveyance. Ongoing sea level rise is an additional factor in the long-term, and would raise water levels.

Potential impacts to fluvial flooding are assessed using the fluvial flood analyses conducted for the Project, presented in the Flood Analyses Report (PWA 2006a) (Appendix E). These analyses focus on demonstrating "proof of concept" for the Project approach to fluvial flood risk reduction. The lower Guadalupe River /Alviso Slough was modeled as a case study. Alviso Slough was selected for modeling because it is a flood control channel and the only creek system known to rely on ponds within the SBSP Restoration Project Area to provide flood detention. It is considered to have the greatest potential to be affected by conversion of ponds from managed to tidal, though actual changes in flood risks would vary by creek.

The flood impact assessment also uses results of baywide hydrodynamic modeling of the three long-term alternatives, as reported in the Hydrodynamic Modeling Report (PWA 2006b)(Appendix J). The results indicate that levee breaches affect water levels at locations throughout the Bay, particularly in the far South Bay. The analyses consider short and long-term conditions. The long-term conditions include an estimate of global sea level rise of 0.5 ft (0.15 m) over the next 50 years, based on median projections by the Intergovernmental Panel on Climate Change (IPCC 2001).

The short-term hydrodynamic modeling results for all alternatives indicate a slight decrease in high water levels in the South Bay compared to baseline conditions, with the decrease becoming more pronounced moving southward along the Bay and near the mouths of the sloughs. Water from the open Bay slows down as it reaches the sloughs, breaches, and ponds. This slow down, or dampening, of Bay tides results in a decrease in high water levels. The long-term results indicate that high water levels in the South Bay increase by slightly less than sea level rise for all alternatives. The long-term increase in tidal prism causes some dampening of bay tides, though less than for short-term conditions. Since the changes in high water levels are less than or equal to baseline for short-term and less than or equal to sea level rise for long-term, changes in Bay hydrodynamics are not expected to contribute to fluvial flooding impacts.

Alternative A No Action. At some point in the next 50 years, levees would likely fail under Alternative A. As described in Section 2.4.2, levees are assumed to fail along OAC, Mt. Eden Creek, North Creek, ACFCC, Guadalupe Slough, and Alviso Slough. These breaches would not be planned. As discussed above, geomorphic changes and sea level rise would affect flood performance over time.

Long-term flood performance for Alternative A was modeled for the Lower Guadalupe River / Alviso Slough (referred to as the Alviso Slough flood modeling) (PWA 2006a). The scenario assumes that Pond A8 is maintained as a managed pond, Ponds A5, A6, and A7 have breached and are tidal, and sedimentation has filled the ponds to natural marsh elevations. The flood model results depend on the extent of Alviso Slough scour downstream of the breaches. If the slough scours to the predicted long-term equilibrium depth and width, the model results show a slight decrease in 100-year flood water levels near the community of Alviso for the scenario modeled, though there is an increase in water levels near the mouth of the slough due to sea level rise. If the slough does not scour (not expected, but a possibility), the results show a slight increase in 100-year flood water levels near the community of Alviso (maximum increase of 0.22 ft/ 0.07 m at Gold Street Bridge). These are just two possible long-term scenarios. Long-term conditions for Alternative A are difficult to predict in the absence of an implementation plan, monitoring, and adaptive management. Results for other creek systems may show similar results, but this has not been confirmed.

Impacts to long-term fluvial flooding are considered potentially significant because, in the absence of design features and phasing to minimize changes to water levels, Alternative A would potentially result in increased flood water levels. The flood response would depend on the timing, location and extent (size) of the breaches, rates of channel erosion, and rates of deposition. These factors cannot be precisely predicted. In the absence of planned breaching, monitoring, and adaptive management, Alternative A would not include a means of identifying potential problems ahead of time and taking corrective management action.

Alternative A Level of Significance: Potentially Significant

Alternative B Managed Pond Emphasis. Alternative B would be designed and managed to maintain or improve levels of flood protection at all times during site evolution. Design features would be included to lower flood water levels, as needed. Alternative B would breach along the downstream reaches of OAC, Mt. Eden Creek, North Creek, ACFCC, Permanente Creek/Mountain View Slough, Steven Creek, Guadalupe Slough, and Alviso Slough/Guadalupe River. Fluvial flood studies would be conducted prior to each phase of implementation to confirm that the SBSP Restoration Project would improve levels of flood protection. Monitoring and adaptive management would be conducted to monitor ongoing flood performance, and to take management actions as needed to reduce flood levels to at or below baseline conditions. These items are discussed in additional detail below. Note that before levee breaches are constructed, fluvial flood risks may increase in lower stream channels that are currently experiencing ongoing siltation just as they would under Alternative A.

Alternative B includes design features to reduce fluvial flooding as needed. For example, implementation could include lowering levees along the mouths of creeks, setting levees back (further away) from the downstream creek reaches, dredging sloughs to add initial conveyance, raising levees along the creeks, breaching to the Bay to provide additional flow paths, and so on. Flood studies would confirm the effectiveness of the proposed combination of design features in maintaining or improving levels of flood protection compared to baseline conditions.

Short-term Project Effects. Results of the Alviso Slough modeling for Alternative B short-term conditions show a slight reduction in 100-year water levels compared to baseline conditions (Fall 2006). The Alternative B short-term scenario uses existing dimensions (no scour) for Alviso Slough and assumes that the breaches to Ponds A5, A6, A7, and A8 occur all at one time (no phasing). It is anticipated that other slough channels in the SBSP Restoration Project Area would experience similar flood hazard reductions as the confining levees are breached, allowing alternative routes for flood flows to reach the Bay. The flood response of other slough channels would be modeled prior to implementation of the Project in each respective area.

Adaptive Management Plan. Monitoring and adaptive management would be used to verify that the SBSP Restoration Project is performing as intended. The restoration target for the Project, as specified in the Adaptive Management Plan, is to maintain or improve levels of flood protection. In the event that flood performance was not as intended, the Project would identify and implement necessary flood reduction measures.

The SBSP Restoration Project would initially monitor slough channel cross-sections, marshplain accretion, and water surface elevations annually, then less frequently. Monitoring for these parameters would potentially be discontinued once the monitoring showed no further changes and no further changes were expected. High water marks would be collected after large flood events, approximately 10-year events (10 percent annual probability) and larger. Levee inspections would initially be monthly, then annually. Sea level rise and land subsidence would be monitored by evaluating available literature and data from sources outside the SBSP Restoration Project, with new data collection by the Project only as needed.

Flood performance and flood prediction modeling would be used to evaluate flood risk and, if needed, trigger management actions. Flood models would be updated by calibrating to the most recent monitoring data. Flood scenarios would be run using the updated, calibrated model. If actual flood performance were worse than expected or if updated flood modeling predicted an increase in flood risk, management actions would be triggered. Models would be developed during final design by, or in consultation with, the relevant local flood control agency and the Corps, as appropriate. Applied studies would evaluate actual post-Project flood performance.

In the event that a management trigger is tripped, potential management actions would include adjustments to phasing and design to improve flood protection to meet the target. For example, levees could be lowered or set back to increase flood conveyance, or channels could be dredged. The Project could increase the frequency of levee maintenance or implement other levee improvements (*e.g.*, widen shoulder, raise, armor, set back levee) for pond levees.

Long-term Project Effects. Long-term conditions for Alternative B were modeled at Alviso Slough. The scenario assumes that a mature marshplain would develop in the breached ponds (to MHHW) and Alviso Slough would scour to a long-term dynamic equilibrium depth and width. Model results show a slight decrease in 100-year flood water levels near the community of Alviso, though there is an increase in water levels near the mouth of the slough due to sea level rise. It is likely that other slough channels in the SBSP Restoration Project Area would experience similar flood hazard reductions as the confining levees are breached.

The Adaptive Management Plan activities discussed above for the short-term are even more important in the long-term, since site evolution is less predictable further into the future. In the Alviso Slough example above, should no scour occur in the slough (not expected, but a possibility), model results show a slight increase in 100-year flood water levels near the community of Alviso. Adaptive management would ensure that appropriate actions – such as removing constrictions in the slough or raising levees – were taken to avoid increasing flood hazards.

Alternative B would result in significant improvements to fluvial flooding in the long-term, once all phases of the Project had been implemented.

Alternative B Level of Significance: Less than Significant (CEQA); Beneficial (NEPA)

Alternative C Tidal Habitat Emphasis. Similarly to Alternative B, Alternative C would be designed and managed to maintain or improve levels of flood protection at all times during the 50-year Project implementation period. Monitoring and adaptive management would be the same for Alternative C as Alternative B.

Short-term Project Effects. The fluvial flood modeling conducted for Alviso Slough shows a definite water level reduction resulting from breaching at Year 0. Pond breaches along both of the confining levees allow more flow to leave the channel and enter the ponds, reducing the capacity needs of the channel and subsequently reducing water levels.

Long-term Project Effects. For Alternative B long-term conditions, the fluvial flood modeling results for Alviso Slough show a substantially reduced water surface profile at the upstream Project boundary. Reductions in water levels would propagate upstream to improve flood protection in the existing lower creek reaches near Gold Street Bridge. Similar results are expected along channels that breach along both of the confining levees.

Long-term fluvial flooding impacts for Alternative C are similar to those for Alternative B. However, since Alternative C includes more breaches to the downstream reaches of creeks than Alternative B, it has the potential for greater flood improvements. In addition to the creeks breached in Alternative B, Alternative C includes breaches to the downstream reaches of Coyote Creek and Ravenswood Slough.

Alternative C Level of Significance: Less than Significant (CEQA); Beneficial (NEPA)

SBSP Impact 3.3-4: **Increased levee erosion along channel banks downstream of tidal breaches.**

Levee breaching would increase tidal flows in the downstream reaches of tidal sloughs, widening and deepening the sloughs over time. This section assesses the potential for channel widening and deepening to erode pond levees along the tidal sloughs. These levees, although not necessarily designed or constructed to provide flood protection, do provide a level of flood protection to nearby developed areas, facilities and managed ponds. Erosion leading to breaches of downstream managed pond levees would cause unplanned discharges from the managed pond(s) and potentially degrade the managed pond habitat. It would also potentially affect flooding for developed areas and facilities, discussed in SBSP Impacts 3.3-1, 3.3-2, and 3.3-3 above.

This impact was analyzed using hydraulic-geometry relationships and hydrodynamic modeling of bed shear stress. Hydraulic geometry relationships are empirical correlations between tidal flows and channel dimensions specific to a geographic area, in this case San Francisco Bay (Williams and others 2002). They provide rough estimates of potential channel depths and widths. Hydraulic geometry calculations for the SBSP Restoration Project are documented in Appendix G (Tidal Channel Hydraulic Geometry Analyses). Hydrodynamic modeling for the SBSP Restoration Project is documented in the Hydrodynamic Modeling Report (PWA 2006b) (Appendix J).

Alternative A No Action. The landowners would solicit input from key stakeholders including local agencies to help the landowners focus limited maintenance funds on those pond levees designated as most important for flood protection. However, with continued subsidence, settlement, wave-induced erosion, and sea level rise, the levees would be increasingly prone to unplanned breaching.

As described in Section 2.4.2 and shown in Figures 2-4a through 2-4c, many of the levees would breach periodically and be repaired (shown on Figures 2-4a through 2-4c as Existing Pond Levee Most Likely to Be Maintained), while other levees would be less likely to be maintained, possibly permanently reintroducing tidal inundation to adjacent ponds (shown on Figures 2-4a through 2-4c as Tidal Through Uncontrolled Breaching).

Breaches that were later repaired would cause a temporary increase in tidal flows. This would potentially cause erosion of downstream levees, though the extent of channel scour would be limited by the small initial size of the unplanned breach and short duration of scouring flows. Breaches that were not repaired would cause a long-term increase in tidal flows and the greatest potential for downstream channel scour. Levees along certain reaches of the following sloughs are not expected to be repaired upon failure:

- Mt. Eden Creek, North Creek, OAC, and the lower reach of ACFCC in the Eden Landing pond complex; and
- Guadalupe Slough along the east bank downstream of Pond A8 and Alviso Slough along the west bank downstream of Pond A8 in the Alviso pond complex.

The hydrodynamic modeling (PWA 2006b) (Appendix J) shows the potential for increased channel scour and levee erosion in response to unplanned breaching along these creeks and sloughs. The following managed ponds are downstream of potential long-term breaches:

- Ponds E6A, E8, E10, and E11 in the Eden Landing pond complex; and
- Ponds A3W, A3N, and A9 through A12 in the Alviso pond complex.

In addition, the City of Sunnyvale WPCP levee and Pond A4 levee would potentially be subject to greater channel erosion due to downstream unplanned breaches. Levee maintenance would be needed to prevent unplanned breaches of the City of Sunnyvale WPCP and Pond A4 levees.

Channel scour in Alviso Slough downstream of Pond A8 was examined in detail to identify what portions of the east and west levees would be most susceptible to failure in the long-term. Figure 3.3-10 shows probable locations where levees would be encroached by channel widening, assuming channel widening occurs in equal amounts on both sides of the channel. Levees that would be most at risk are located at the outward side of sharp bends in the channel, where the marsh fringe is narrow.

Alternative A Level of Significance: Potentially Significant

Alternative B Managed Pond Emphasis. Under Alternative B, planning and design for each phase of implementation would evaluate the potential for the scour to cause levee erosion downstream of proposed breaches. To avoid impacts, Alternative B would be designed such that levees downstream of breaches are either no longer required for flood protection, are adequately maintained, or are protected from erosion (*e.g.*, by a band of marsh between the levee and the channel, setting the levee back from the eroding channel, or by armoring the levee).

Potential long-term levee failure locations were identified along the eastern levee of Alviso Slough for Alternative B and are shown in Figure 3.3-10. As mentioned above, this levee is not necessary for flood protection (see discussion in SBSP Impact Section 3.1-1 above) and failure at these locations would not contribute to inland flooding.

Adaptive Management Plan. Monitoring and adaptive management would be used to verify that the SBSP Restoration Project was performing as intended. In the event that flood performance was not as intended, the Project would identify and implement corrective management actions as specified in the Adaptive Management Plan. Initially, the Project would monitor slough channel cross-sections annually,

then less frequently. Levee inspections would be monthly initially, then annually. If levee erosion, or the potential for it, were observed, management actions would be triggered. Possible management actions would include increasing the frequency of levee maintenance or implementing other levee improvements (*e.g.* widen shoulder, raise, armor, set back levee).

Alternative B Level of Significance: Less than Significant

Alternative C Tidal Habitat Emphasis. The potential for levee erosion downstream of tidal breaches under Alternative C would be similar to the above discussion for Alternative B, with additional phases of planning and design as implementation progressed from 50 percent to 90 percent tidal habitat. The linear extent of Alternative C levee management would be substantially less than that required for Alternative B, since many of the slough levees would be breached intentionally and allowed to erode over time.

Alternative C Level of Significance: Less than Significant

SBSP Impact 3.3-5: **Potential interference with navigation.**

The SBSP Restoration Project Area currently contains few navigable sloughs and waterways. The major sloughs have silted in over a period of decades, reducing navigability. At low tide, navigation into or out of the shallow sloughs can be problematic. Small craft (*e.g.*, kayaks) are more amenable to the shallow water environments; however only a few launch points are currently available within or near the SBSP Restoration Project Area. The South Bay Yacht Club on Alviso Slough supports a limited number of shallow draft boats. As perimeter levees are breached, navigation within the restored ponds would be limited to activities explicitly allowed pursuant to a compatibility determination (*i.e.*, waterfowl hunting).

Alternative A No Action. As levee failures occurred over time, tidal scour would deepen and widen slough channels, improving navigation in Mt. Eden Creek, North Creek, OAC, and the Alameda County Flood Control Channel (ACFCC) in the Eden Landing pond complex, and in Alviso and Guadalupe Sloughs in the Alviso pond complex.

Immediately after breaching, stronger tidal currents through the breaches and in the sloughs downstream of the breaches would limit safe navigation of small watercraft to certain periods of the tide cycle (near slack tide). Currents would eventually return to baseline conditions as the sloughs scoured.

Benefits to navigation within the sloughs would be limited by the unplanned nature of the levee failures as the breaches would not be designed to maximize tidal scour in the sloughs. Navigation in the immediate vicinity of the breaches would be dangerous until the channel scoured sufficiently. Unless explicitly allowed pursuant to a compatibility determination, navigation within the restored ponds would not be allowed. USFWS and CDFG could restrict navigation according to season (*e.g.*, no access during breeding season), by type of access (*e.g.*, non-motorized versus motorized), or type of use (*e.g.*, waterfowl hunting only). The compatibility determination process would be included during subsequent project-level evaluation and planning documentation.

Alternative A Level of Significance: Less than Significant (CEQA); Beneficial (NEPA)

Alternative B Managed Pond Emphasis. Alternative B would offer greater long-term benefits to navigation than Alternative A. Because the breaches would be planned and located along the major slough channels, Alternative B would maximize slough deepening and widening for navigation benefits. Unlike Alternative A, this restoration alternative would be implemented in a phased manner to avoid causing significant increases in tidal currents and unsafe boating conditions. Long-term navigation benefits for small craft due to channel enlargement would be expected in Mt. Eden Creek, North Creek, OAC, and the ACFCC in the Eden Landing pond complex; in Ravenswood Slough in the Ravenswood pond complex; and in Alviso Slough, Guadalupe Slough, Stevens Creek, Mountain View Slough and Charleston Slough in the Alviso pond complex. As with Alternative A, navigation access to breached ponds would be contingent upon a compatibility determination and may be restricted.

Alternative B Level of Significance: Less than Significant (CEQA); Beneficial (NEPA)

Alternative C Tidal Habitat Emphasis. The long-term navigation benefits of Alternative C would be the same as those described for Alternative B, with the addition of channel enlargement and small craft navigation benefits in Coyote Creek, Mud Slough, and Artesian Slough. Alviso Slough would scour deeper and wider in Alternative C than in Alternative B. As with Alternative B, the restoration would be designed and phased to avoid causing unsafe boating conditions. As with Alternatives A and B, navigation access to breached ponds would be contingent upon a compatibility determination and may be restricted.

Alternative C Level of Significance: Less than Significant (CEQA); Beneficial (NEPA)

Project-Level Evaluation

Phase 1 Impact 3.3-1: **Potential for increased coastal flood risk landward of the SBSP Restoration Project Area.**

Phase 1 No Action

The following discussion addresses the No Action Alternative (Alternative A) at the project level.

Eden Landing. The Phase 1 No Action scenario assumes that the levees along Ponds E8A, E9, E8X, E12 and E13 are less likely to be maintained and would fail over time. These levees limit tidal inundation and wave action within the pond complex and provide a measure of flood protection (U.S. Army Corps of Engineers 1988b); however, these levees are not certified by FEMA as flood protection levees and FEMA floodplain boundaries neglect flood protection provided by these levees. It is assumed that construction of the ELER project will be completed in the near future, including an upgrade of the levee landward of the ELER project area (also referred to as the Bay Trail Levee designed by the East Bay Regional Park District (EBRPD) in cooperation with CDFG). As a result of the ELER project, the areas surrounding Ponds E8A, E9, E8X, E12 and E13 would be restored to tidal inundation (Mt. Eden Creek, North Creek, OAC, and the ELER). It is assumed that any potential for increased coastal flood risk as a result of the ELER project would be addressed as part of that project. Under the Phase 1 No action scenario, eroded levees would become less effective barriers to waves and breached ponds would no longer provide a coastal flood storage function. The levees that provide flood protection in the vicinity would be subject to higher wave action and higher water levels, potentially increasing the risk of coastal flooding. Flood risks would decrease as the marshplain developed, due to higher wave energy dissipation over the mature marsh plain.

Eden Landing Phase 1 No Action Level of Significance: Potentially Significant

Alviso. The paragraphs below discuss the No Action scenario for the Phase 1 Ponds at the Alviso pond complex.

Pond A6. The No Action scenario assumes that the levees along Pond A6 are less likely to be maintained and would fail over time. They were built for commercial salt production and are not levees that provide coastal flood protection. However, breaching Pond A6 would increase the frequency and volume of overtopping from Pond A6 into Ponds A5 and A7, during large coastal storm events, which could in turn increase water levels in Ponds A5, A7, and A8. The storage volume of Ponds A5, A7, and A8 is large compared to the potential increased overtopping from Pond A6. Any increase in water levels in Ponds A5, A7, and A8 as a result of the Phase 1 action at Pond A6 would likely be small and would not threaten developed areas (Appendix G – Alviso Pond A8 Hydrodynamic Modeling and Geomorphic Analysis). The surrounding areas are either already tidal (Alviso and Guadalupe Sloughs), or are high ground (the closed landfill to the east of Pond A8). Effects of Pond A6 breaching on coastal flooding are discussed in further detail in the Phase 1 impact discussion below. Breaching and degradation of the Pond A6 levee has the potential to increase wave action and wave erosion of the Ponds A9 and A10 levees along Alviso Slough. These levees would be monitored and maintained as needed, as described in Section 2.4.2. In the long-term, the formation of marsh plain habitat in Pond A6 is expected to limit wave action.

Pond A8. In the No Action scenario, the levee along the west side of Pond A8 would be raised to provide fluvial flood storage in Pond A8. The levees surrounding Pond A8 would be maintained. The Pond A8 levees, though not designated levees that provide flood protection, provide some level of coastal flood protection for the Legacy Partners property to the east of Pond A8. Since the Legacy Partners property is high ground, above the 100-year coastal flood elevation as defined by FEMA, the Phase 1 action at Pond A8 would not result in coastal flooding. However, the Highway 237 landfill landward of Pond A8S may be subjected to increased erosion due to wave action.

Pond A16. The levees around Pond A16 would be maintained. There would be no significant changes to water levels in the pond or surrounding areas.

Alviso Phase 1 No Action Level of Significance: Less than Significant

Ravenswood. The No Action scenario assumes the levees around Pond SF2 would be maintained. There would not be significant changes to water levels in Pond SF2 or adjacent areas.

Ravenswood Phase 1 No Action Level of Significance: Less than Significant

Phase 1 Actions

The following discussion addresses the Phase 1 actions (the first phase of Alternatives B and C) at the project level.

Eden Landing. The paragraphs below discuss Phase 1 actions at the Eden Landing pond complex that would affect coastal flood risk within and landward of the SBSP Restoration Project Area.

Ponds E8A, E9, and E8X. The Phase 1 action at Ponds E8A, E9, and E8X is proposed to be implemented after completion of the ELER tidal restoration. As described above for the Phase 1 No Action scenario, once the ELER project is completed, the area surrounding Ponds E8A, E9, and E8X and the managed ponds to the north (Pond E14 and Ponds E12 and E13) would be restored to tidal inundation. It is assumed that any potential increase to the coastal flood risk as a result of the ELER project would be addressed as part of that project.

Hydrodynamic modeling performed to evaluate fluvial flooding (see Phase 1 Impact 3.3-3 and Appendix G – Eden Landing Ponds E8A, E9 and E8X Hydrodynamic Modeling and Geomorphic Analysis) indicates that restoring tidal inundation to Ponds E8A, E9, and E8X would not increase high tide water levels. Modeling indicates that, in the short term, low tide drainage would be delayed in Ponds E8A, E9, and E8X and adjacent areas including the sloughs and ELER. However, delayed low tide drainage is not expected to adversely affect coastal flood risk.

The potential for the Phase 1 action to increase coastal flooding has not been specifically analyzed using modeling or calculations. The assessment of this potential is based on professional judgment. The Phase 1 action would upgrade the levee along the south side of Pond E14 (between Ponds E9 and E8X and Pond E14) and the levee along the south side of Pond E13 (between Pond E14 and Pond E13). These upgrades would reduce the risk of breaching these levees while allowing overtopping into Pond E14 and Ponds E12 and E13 for storage of coastal flood waters. The bayfront levee between Whale's Tail Marsh and Ponds E8A and E9 would be left in place in order to reduce the potential for waves from the Bay to propagate through the site and overtop into Pond E14 and Ponds E12 and E13. This bayfront levee would be allowed to degrade over time while tidal marsh establishes in Ponds E8A and E9. The existing managed pond levees around Pond E14, Ponds E12 and E13, Pond E8 and Pond E6B would be monitored and maintained as needed according to the process described in the Section 2.5.6 Operations and Maintenance and the Adaptive Management Plan (see discussion in SBSP Impact 3.3-4 and Appendix D) to prevent degradation and breaching, including degradation due to increased wave action as a result of restoring Ponds E8A, E9, and E8X to tidal inundation. The system of levees between Whale's Tail Marsh and Ponds E8A and E9, along the south side of Pond E14, and around the perimeter of Ponds E12 and E13 is expected to limit wave action and overtopping into the ELER to levels similar to baseline conditions.

As it is assumed that the ELER project would address any potential increase to the coastal flood risk as a result of the ELER project, and the Phase 1 action at Ponds E8A, E9, and E8X is not expected to increase wave action and overtopping into the ELER, levee breaching and the introduction of tidal inundation to Ponds E8A, E9, and E8X would not increase coastal flood risk.

If the ELER project is not completed before implementation of the Ponds E8A, E9, and E8X Phase 1 action, the potential effects on coastal flooding under these circumstances would be evaluated during future design phases prior to implementation and the design would be modified as needed to avoid increasing the risk of coastal flooding. The potential to increase coastal flooding due to successive overtopping from Ponds E9 and E8X into Pond E14, from Pond E14 to Ponds E12 and E13, from Ponds E12 and E13 to the ELER, and from the ELER to adjacent areas has not been analyzed, but is expected to be small. If the evaluation were to indicate a potential increase in coastal flood risk, the Ponds E8A, E9, and E8X design would be modified to mitigate for the potential increase. For example, the levee between Ponds E9 and E8A would be left in place (rather than lowered) to limit wave action from the Bay and/or the design elevation of the levee between Ponds E9 and E8X and Pond E14 would be increased to limit coastal overtopping.

Ponds E12 and E13. The Phase 1 managed pond restoration at Ponds E12 and E13 would not breach any levees and would not result in significant changes to water levels in the ponds or surrounding areas.

Alviso. The paragraphs below discuss Phase 1 actions at the Alviso pond complex that would affect coastal flood risk within and landward of the SBSP Restoration Project Area.

Pond A6. The levees that would be breached as part of the Phase 1 action at Pond A6 were built for commercial salt production and are not levees that provide coastal flood protection. However, breaching Pond A6 would increase the frequency and volume of overtopping from Pond A6 into Ponds A5 and A7 during large coastal storm events, which could in turn increase water levels in Ponds A5, A7 and A8. Storms producing water levels greater than the lowest part of the levee (~9.8 ft NAVD) would result in overtopping but because only a portion of the levee is low, the overtopping would have negligible and temporary effects on the water levels in Ponds A5, A7 and A8.

With the Phase 1 action, the south levee of Pond A6 would remain in place and would be exposed to high Bay water levels and wind waves generated with the pond or propagated through the pond from the Bay. The lowest part of the levee along the south side of Pond A6 is approximately 0.6 ft (0.2 m) below the 10-year still water level and 0.3 to 1.5 ft (0.1 to 0.5 m) lower than the perimeter levees that currently protect Ponds A5, A6, A7 and A8 from frequent tidal inundation. Immediately following the restoration of Pond A6, the bayfront managed pond levee would limit the propagation of large wind waves from the Bay into Pond A6. Over time, the bayfront levee would likely erode. The restoration of Pond A6 would maintain the internal berm which runs north to south down the center of the pond and acts as a wave-break berm. The berm would facilitate sediment deposition and vegetation colonization within Pond A6. Once established, vegetated marsh would further dissipate wave energy and limit the potential for large wind waves to propagate through Pond A6.

As part of the Operations and Maintenance Plan for Pond A6 restoration, the levee between Pond A6 and Ponds A5 and A7 would be regularly inspected for erosion and maintained as needed to limit the potential for unintentional levee breaching. Any breach would be repaired to prevent tidal inundation of Ponds A5, A7 and A8. The levee may be improved as part of the restoration design or as part of future levee maintenance to reduce maintenance requirements and the risk of coastal overtopping, erosion and breaching. Levee improvements could consist of raising low points along the levee crest, armoring the back side of the levee slope, and/or constructing an engineered overflow structure (*e.g.*, weir). Raising low points along the levee crest would be pursued only if hydrodynamic modeling confirmed that this action would not worsen fluvial flooding (Phase 1 Impact 3.3-3).

The storage volume of Ponds A5, A7 and A8 is large compared to the potential increased overtopping from Pond A6. Any increase in water levels in Ponds A5, A7 and A8 as a result of the Phase 1 action at Pond A6 would likely be small and would not threaten developed areas (Appendix G – Alviso Pond A8 Hydrodynamic Modeling and Geomorphic Analysis). The surrounding areas are either already tidal (Alviso and Guadalupe Sloughs) or are high ground (the closed landfill to the east of Pond A8).

Potential fluvial flood impacts due to the Pond A6 restoration and the effect of overtopping into Ponds A5, A7 and A8 on the Alviso Slough / Lower Guadalupe River system are discussed in SBSP Impact 3.3-3.

Pond A8. The perimeter levee separating Alviso Slough and Pond A8, though not a designated levee that provides flood protection, provides some level of coastal flood protection for the Legacy Partners property to the east of Pond A8. Since the Legacy Partners property is high ground, above the 100-year coastal flood elevation as defined by FEMA, the Phase 1 action at Pond A8 would not result in coastal flooding.

Pond A16. The Phase 1 managed pond restoration at Pond A16 would not breach any levees and would not result in significant changes to water levels in the pond or surrounding areas.

Ravenswood. The paragraph below discusses Phase 1 actions at the Ravenswood pond complex that would affect coastal flood risk within and landward of the Project Area.

Pond SF2. The Phase 1 action at Pond SF2 includes the installation of new water control structures that would facilitate flows between the pond and the Bay. For typical operations, target average water depths in the two eastern cells would be approximately six inches (15 cm), with some deeper and shallower areas and muted-tidal fluctuations of up to approximately six inches. The western cell would be periodically or seasonally inundated for vegetation management and/or to manage the area for alternate bird use or habitat goals outside of the nesting season. Water levels in the western cell would be similar to, or lower than, those described in the ISP (Life Science! 2003). The typical operation and periodic or seasonal management of Pond SF2 would not substantially increase winter-time water levels in Pond SF2 relative to Cargill or proposed ISP operations (Life Science! 2003). Continued levee maintenance of the Pond SF2 levees would prevent an increased risk of coastal flooding to adjacent properties during coastal storm events. Modeling of similar operations for Pond A16 indicated that high Bay water levels could result in increased within-pond water levels on the order of a few inches. An increase of this magnitude would not result in an increased risk of coastal flooding. However, the increase in Pond SF2 water levels may be greater than modeled for Pond A16. If necessary, the water control structures could be closed to prevent the inflow of Bay water during large storm events. Maintaining water levels within Pond SF2 may result in a small reduction in available flood storage within the pond for high coastal water levels that overtop the bayfront levee. The height of the bayfront levee would be increased on the order of 1 to 2 ft as part of levee maintenance and would be graded for trail construction as part of the Phase 1 Recreation and Public Access action (see Section 2.5.4 in the EIS/R). This increase in levee height as part of levee maintenance would reduce the risk and frequency of overtopping. The net effect of the Phase 1 actions would be no increase in flood risk to adjacent areas.

Phase 1 Actions Level of Significance: Less than Significant

Phase 1 Impact 3.3-2: **Increased coastal flood risk due to regional changes in Bay bathymetry and hydrodynamics.**

Phase 1 No Action

The following discussion addresses the No Action Alternative (Alternative A) at the project level.

Unplanned breaching and tidal inundation under Phase 1 No Action would not lead to substantial regional changes in mudflat elevations or Bay water levels. Phase 1 No Action would not result in substantial increases to coastal flooding in coastal areas between and adjacent to the SBSP Restoration Project Area.

Phase 1 No Action Level of Significance: Less than Significant

Phase 1 Actions

The following discussion addresses the Phase 1 actions (the first phase of Alternatives B and C) at the project level.

Implementation of the Phase 1 actions at the Eden Landing, Alviso, and Ravenswood pond complexes would not lead to substantial regional changes in mudflat elevations or Bay water levels. The Phase 1 actions would not result in substantial increases to coastal flooding in coastal areas between and adjacent to the SBSP Restoration Project Area.

Phase 1 Actions Level of Significance: Less than Significant

Phase 1 Impact 3.3-3: **Increased fluvial flood risk.**

Levee breaching would increase tidal flows through the adjacent sloughs, potentially affecting water levels in the downstream reaches of creek and river channels. This section assesses the potential for the Phase 1 No Action and Phase 1 tidal habitat restoration actions to increase fluvial flood risks.

Phase 1 No Action

The following discussion addresses the No Action Alternative (Alternative A) at the project level.

Eden Landing. Levees for Ponds E8A, E9, E8X, E12, and E13 would not be maintained and are assumed to fail along OAC, Mt. Eden Creek, and North Creek. Impacts to long-term fluvial flooding are considered potentially significant because, in the absence of design features and management to minimize changes to water levels, Phase 1 No Action would potentially result in increased flood water levels. The flood response would depend on the timing, location and extent (size) of the breaches, rates of channel erosion, and rates of deposition. These factors cannot be precisely predicted. In the absence of planned breaching, monitoring, and adaptive management, No Action would not include a means of identifying potential problems ahead of time and taking corrective management action.

Eden Landing Phase 1 No Action Level of Significance: Potentially Significant

Alviso. The paragraphs below discuss the No Action scenario for the Phase 1 ponds at the Alviso complex.

Pond A6. Flood modeling conducted for the Phase 1 action at Pond A6 (discussed in detail below) indicates that fluvial flooding on the Lower Guadalupe River / Alviso Slough would not be worsened with Pond A6 breached (Ponds A5, A7 and A8 not breached), as long as the Pond A6 south levee (between Ponds A6 and Ponds A5 and A7) remains intact. However, this levee would not be maintained in the No Action scenario and erosion of this levee could potentially worsen fluvial flooding. Erosion scenarios have not been modeled, but could potentially reduce flood storage in Ponds A5, A7 and A8 without measurably increasing flow conveyance, resulting in increased fluvial flooding.

Pond A8. Ponds A5, A6, A7 and A8 are currently used for flood water storage during high flow events in the Guadalupe River / Alviso Slough. In the No Action scenario, the levee along the west side of Pond A8 would be raised to provide flood storage in Pond A8 and the Pond A8 levees would be maintained. The Pond A5, A6, and A7 levees would be less likely to be maintained and are assumed to fail over time. One possible flood scenario for Pond A8 was modeled for Alternative A (discussed above). This scenario assumes that Ponds A5, A6, and A7 are breached and Pond A8 maintained as a managed pond. Model results indicate that flooding would potentially be worsened in the long-term. Other scenarios, such as with the Pond A5, A6, and A7 levees intact, could occur within the 50-year planning horizon. These scenarios have not been modeled, but reduce available flood storage, potentially increasing fluvial flooding.

Pond A16. Pond A16 would be maintained as a managed pond, resulting in no changes to fluvial flooding.

Alviso Phase 1 No Action Level of Significance: Potentially Significant

Ravenswood. The levees around Pond SF2 would be maintained. There would not be significant changes to water levels in Pond SF2 or adjacent areas.

Ravenswood Phase 1 No Action Level of Significance: Less than Significant

Phase 1 Actions

The following discussion addresses the Phase 1 actions (the first phase of Alternatives B and C) at the project level.

Eden Landing. As discussed above in SBSP Impact 3.3-3, the Phase 1 actions would be designed to maintain or improve existing levels of flood protection. Monitoring and adaptive management would be used to verify that the Project was performing as intended, and take corrective actions as needed. The paragraphs below discuss Phase 1 actions at the Eden Landing pond complex that would affect fluvial flood risk.

Ponds E8A, E9, and E8X. The Phase 1 action at Ponds E8A, E9, and E8X would route more flows through the adjacent sloughs and has the potential to affect water levels. The fluvial flood risk was evaluated along OAC, Mt. Eden Creek, and North Creek under Baseline and Project Conditions.

A tide gate structure spans the OAC channel approximately 3.4 miles upstream of the Bay, which prevents high tides from migrating upstream of that point. The primary area of interest for evaluating impacts to flood risk along OAC is the developed area upstream of the tide gate structure. Hydrodynamic modeling was performed to evaluate potential impacts on OAC water levels in this area for the short-term (Year 0) and long-term (Year 50) (Appendix G – Eden Landing Ponds E8A, E9 and E8X Hydrodynamic Modeling and Geomorphic Analysis). This modeling was performed for a previous version of the Phase 1 action in which Ponds E8A, E9, and E8X were breached to OAC, North Creek, and the small historic Mt. Eden Creek channel mouth to the south of Mt. Eden Creek. In this previous version of the Phase 1 action, Pond E9 was not breached to the current (larger) Mt. Eden Creek channel that was constructed as part of the ELER restoration project. Additional modeling will be performed during the design phase of the restoration to confirm the evaluation of potential impacts on OAC and Mt. Eden Creek water levels. If model results indicate a potential impact, the design would be modified to avoid potential impacts as discussed below.

Short-term Project Effects. The hydrodynamic model is a numerical simulation of water movement in this area where stormwater runoff in OAC meets the tides of San Francisco Bay. Potential Phase 1 action impacts to OAC flood water levels were evaluated using a 15-year design flood hydrograph (OAC flow occurring, on average, once every 15 years) and a time variable 10-year tidal signal (tide levels occurring, on average, once every 10 years). Results of the simulations indicate that the implementation of the Phase 1 action would cause no substantial change in the maximum water surface elevations along OAC in the short-term (Appendix G – Eden Landing Ponds E8A, E9 and E8X Hydrodynamic Modeling and Geomorphic Analysis). As discussed above, additional modeling will be performed during the design phase of the restoration to confirm that breaching Pond E9 to the current Mt. Eden creek channel instead of the historic Mt. Eden Creek channel mouth does not significantly change this finding. Breaching Pond E9 to the current Mt. Eden Creek is expected to improve tidal drainage and provide additional fluvial discharge capacity. The additional modeling is therefore not expected to indicate an increase in the maximum water surface elevations along OAC in the short-term.. If the results of the additional modeling indicate a significant increase in maximum water surface elevations, the Phase 1 action design would be modified to decrease water surface elevations. For example, the mouth of the current Mt. Eden Creek channel could be enlarged downstream of the Pond E9 breach to further increase the flow capacity of the channel.

Long-term Project Effects. Over time, OAC, Mt. Eden Creek, and North Creek would scour due to the increased tidal prism associated with the Phase 1 action at Ponds E8A, E9, and E8X. The sloughs are expected to reach an equilibrium slope and cross-sectional area consistent with the surrounding area of tidal restoration over the 50-year planning horizon. Ponds E8A, E9, and E8X are expected to accrete to the future MHHW elevation (includes sea level rise) where marshplain would be established.

Model simulations used to evaluate potential long-term impacts include higher tide levels (to account for sea level rise), and assume the site has evolved to mature marsh conditions. Results of the simulations indicate that the implementation of the Phase 1 action would cause slightly higher Year 50 maximum water surface elevations along OAC than in baseline conditions due to sea level rise (Appendix G – Eden Landing Ponds E8A, E9 and E8X Hydrodynamic Modeling and Geomorphic Analysis). Because sea level rise is not Project-related, the long-term increase in maximum water levels is considered less than significant. As discussed above, additional modeling would be performed to confirm this finding and the design would be modified if necessary. In addition, the program-level fluvial flood protection measures as implemented through the Adaptive Management Plan in later phases of the Project would mitigate for higher water surface elevations due to sea level rise. The effects of sea level rise on coastal flood risks are considered in Chapter 4, Cumulative Phase 1 Impact 3.3-2.

Ponds E12 and E13. The Phase 1 managed pond restoration at Ponds E12 and E13 would not breach any levees and would not result in significant changes to water levels in the ponds or surrounding areas (Appendix G – Eden Landing Ponds E12 and E13 Water and Salt Balance Modeling).

Alviso. The paragraphs below discuss Phase 1 actions at the Alviso pond complex that would affect fluvial flood risk.

Pond A6. Pond A6 provides offline storage during fluvial flood events on the Guadalupe River / Alviso Slough system. During the 100-year fluvial event, water spills over the engineered weir into Pond A8 and then to Ponds A5 and A7 and finally to Pond A6 by overtopping internal pond levees. Water entering Pond A6 during the 100-year flood event does not fill the pond high enough for water to flow over the outboard levees to Alviso Slough, Guadalupe Slough, or San Francisco Bay.

Under the proposed Phase 1 action, outboard levees surrounding Pond A6 would be lowered and breached, connecting the pond to full tidal inundation from San Francisco Bay. This would bring Bay tides to the levee currently separating Pond A6 from Ponds A5 and A7. While this levee is reinforced, it is not high enough to avoid overtopping to Ponds A5 and A7 during a 10-year or 100-year tidal event. Tidal water spilling into these ponds would reduce the available volume for storing fluvial floodwater from Alviso Slough. Hydraulic modeling of fluvial flooding on the lower Guadalupe River / Alviso Slough shows that this reduction in offline storage would not increase maximum water levels in Alviso Slough during a 10-year tidal and 100-year fluvial event (Appendix G). Fluvial flood water would spill from Ponds A5 and A7 over the new outboard levee directly into San Francisco Bay, which has a much greater storage volume than the volume lost (see Figures 26 and 27 of Appendix G).

During a 100-year tidal event, water would overtop the Pond A5 and A7 outboard levees but would not have the potential to impact fluvial flooding in Alviso Slough. The 100-year water level at the mouth of Alviso Slough is 11.02 ft (3.36 m), or 0.39 ft (0.12 m) higher than the 10-year tidal water level (PWA 2006a). Similar to the analysis of the loss of storage due to the 10-year tidal event, the reduction in storage from a 100-year tidal event would not be significant compared to the volume of fluvial flood water since the extreme water levels in the Bay would only persist for several hours. During this period, only a portion of the levee would be overtopped. The volume of fluvial flood storage lost in Ponds A5 and A7 due to inundation would not cause an increase in water levels in Alviso Slough (see Appendix G). The combined 100-year tidal and 100-year fluvial flood event was not analyzed in detail since this event is very unlikely and SCVWD has identified the 10-year tidal and 100-year fluvial event as the appropriate worst-case flooding scenario on Alviso Slough (Northwest Hydraulic Consultants 2002; PWA 2006a; Santa Clara Valley Water District 2001). The Pond A5 and A7 levees would be regularly inspected and maintained as needed to retain current levels of flood protection. As discussed in Phase 1 Impact 3.3-1, any breach in the levee between Pond A6 and Ponds A5 and A7 would be repaired to prevent tidal inundation of Ponds A5, A7 and A8. This levee may be improved as part of the restoration design or as part of future levee maintenance to reduce maintenance requirements and the risk of coastal overtopping, erosion and breaching. Levee improvements could consist of raising low points along the levee crest, armoring the back side of the levee slope, and/or constructing an engineered overflow structure (*e.g*., weir). Raising low points along the levee crest would be pursued only if hydrodynamic modeling confirmed that this action would not worsen fluvial flooding.

Under the proposed Phase 1 action, there would be little difference between short-term and long-term conditions that would affect fluvial flooding.

Pond A8. Ponds A5, A6, A7 and A8 along Alviso Slough are currently used for flood water storage during high fluvial flow events in the Guadalupe River / Alviso Slough system. Downstream of the Union Pacific Railroad Bridge, Alviso Slough flow is split between the main channel to the east and the engineered weir connecting Pond A8 to the west. This reduction of in-channel flows keeps flood waters from overtopping eastern levees and flooding the community of Alviso. During a 100-year flood event, water is routed from Pond A8 to Ponds A5 and A7 and eventually to Pond A6 by overtopping internal pond levees. As the ponds fill, water flows back into Alviso Slough through low spots in the Pond A7 and A8 perimeter levee and to Guadalupe Slough through low spots in the Pond A5 perimeter levee.

Implementation of the Phase 1 action at Pond A8 would open the pond to limited tidal flow through the armored notch and outboard pilot channel and would increase pond water levels over current operation levels. This increase in water levels would reduce the available off-line flood storage volume in Ponds A5, A7 and A8. However, the Phase 1 action would be reversible allowing the system to be managed seasonally and operated similar to baseline conditions or with a smaller notch width in the winter flood season. Operating the notch seasonally would allow the ponds to be drained in time for winter season when heavy rainfall and fluvial flooding events occur. In the event of a 100-year fluvial flood, there would be no significant impact from the Phase 1 action at Pond A8.

Hydraulic modeling results indicate that full seasonal closure of the notch may not be necessary due to flood routing improvements that would offset the loss in pond flood storage and decrease peak water levels along Alviso Slough. The Phase 1 action would result in muted tidal inundation of Ponds A5, A7 and A8 during normal tidal cycles. Since the crest of the proposed notch would be approximately one ft above the average bed elevation of Pond A8 (11.0 ft lower than the existing engineered weir crest), water from the Guadalupe River / Alviso Slough 100-year flood hydrograph would flow into the pond sooner than in baseline conditions. The low elevation of the notch crest allows for water to be diverted from the channel before and during the peak stage of the flood hydrograph, decreasing the peak in-channel flow rate in Alviso Slough downstream of the proposed notch. Modeling results show that with the Phase 1 action, Alviso Slough water levels are lowered in the vicinity of Pond A8 and more flow is diverted to Pond A8, although peak water levels along portions of Guadalupe Slough increase unless the notch width is reduced. (Appendix G – Alviso Pond A8 Hydrodynamic Modeling and Geomorphic Analysis). Under the Phase 1 action, less water would spill over the existing engineered weir compared to baseline conditions, but a substantial volume of water would flow from the channel through the proposed notch for a greater total diversion to Pond A8 (Appendix G – Alviso Pond A8 Hydrodynamic Modeling and Geomorphic Analysis).

As water from Alviso Slough flows into Pond A8, the pond would fill up and spill water to adjacent Ponds A5 and A7 and eventually water would begin to fill Pond A6 (see the next paragraph for a discussion of flooding with the Pond A6 Phase 1 action implemented). For Alviso Slough, water spilling into Pond A6 is effectively lost from the system. Water enters the pond and does not have a chance to spill out until it reaches an elevation greater than the surrounding levees. Under baseline conditions, the volume of water entering Pond A6 is less than the pond's total capacity. Under the Pond A8 Phase 1 action, Pond A6 would fill up completely to the level of the lowest point along the levee separating the pond from Alviso Slough and begin to spill back into Alviso Slough. The water spilling back into the slough channel would not have an effect on slough water levels. By more effectively transferring water to Pond A6 and utilizing the available offline storage of Pond A6, the Phase 1 action would lower in-channel flows (Appendix G – Alviso Pond A8 Hydrodynamic Modeling and Geomorphic Analysis).

Short-term Effects. In the event Pond A6 was restored to tidal habitat and the Pond A6 outboard levees and the levees adjacent to the Guadalupe Slough and Alviso Slough were breached (as proposed by the Phase 1 actions), there would be no defined storage volume. Water spilling from Ponds A5 and A7 would flow into San Francisco Bay, which has a much greater storage volume than the volume delivered from the watershed. In-channel flows and peak water levels would be lower than baseline conditions.

Adding the notch to the Pond A8 levee would divert more flood water from Alviso Slough than in baseline conditions. In the short-term, keeping the notch open but adjusting its width to 20 ft seasonally would result in slightly lower maximum water surface elevations in Alviso Slough and no significant change along Guadalupe Slough during the 100-year fluvial event compared to baseline conditions.

Long-term Project Effects. Over time, Alviso Slough would scour in response to the increased tidal prism associated with the proposed tidal connection to Pond A8. Hydraulic geometry calculations, which provide a rough estimate of potential long-term channel dimensions, predict the slough would widen by approximately 75 ft (23 m) and deepen by approximately two ft (0.6 m) just downstream of the notch. The enlarged channel cross-section would improve fluvial conveyance in the channel and further reduce flood levels below the short-term estimates.

The Phase 1 action would be reversible allowing the system to be managed seasonally and operated similar to baseline conditions or with a reduced notch width during the winter flood season if desired. This would allow managers to operate Pond A8 conservatively until channel scour was measured and they were certain flood levels would not increase under the Phase 1 action. Over time, a larger notch width (up to 40 ft) may be possible if increases in flood conveyance along Alviso Slough due to channel scour fully compensated for any potential effects to Guadalupe Slough.

Pond A16. The Phase 1 managed pond restoration at Pond A16 would not breach any levees and would not result in significant changes to water levels in the pond or surrounding areas (Appendix G – Alviso Pond A16 Hydraulic Modeling).

Ravenswood. The paragraphs below discuss Phase 1 actions at the Ravenswood pond complex that would affect fluvial flood risk.

Pond SF2. The Phase 1 managed pond restoration at Pond SF2 would not breach any levees and would not result in significant changes to water levels in the pond or surrounding areas (see Phase 1 Impact 3.3-1). However, Pond SF2 currently provides some rainfall runoff detention for the Dumbarton Bridge approach (SR 84) and the frontage roads both north and south of the Dumbarton Bridge approach (including portions of the bike path south of the Dumbarton Bridge approach and the frontage road). The storm drain system for the Dumbarton Bridge approach and frontage roads was designed such that drainage would be routed to the north side of the bridge approach and enter the southwest corner of the Moseley Tract, which previously provided runoff detention. Unintentional levee breaching and tidal inundation of the Moseley Tract has raised water levels in the Moseley Tract. Under current conditions, the frontage roads flood during combined rainfall and high tide events because there is no longer a low-lying area to provide runoff detention. When the storm drain system backs up and the frontage roads flood, water spills over into Pond SF2 near the exit onto the southern frontage road.

As discussed in Impact 3.3-1, the Phase 1 action at Pond SF2 would potentially result in a small reduction in available volume for flood storage within the pond. Because the available pond volume remains larger than the volume of total runoff from the drainage area estimated for the 100-year storm event, this reduction is not expected to affect the ability of the site to detain runoff. The construction of new berms within the cell would affect the hydraulics of storm water flow through the pond, with storm water runoff entering the SF2 outlet canal first before flowing over the weirs and into the cells. Based on calculations using weir equations, storm water from a 100-year runoff event would flow over the weirs from the outlet canal into the cells without causing water to back-up (pond) at the frontage road. These simple calculations provide a conservative (high) estimate of flood potential, since they ignore flow from the outlet canal to the Bay, which would create additional storage volume within the pond, and assume that all runoff from the 100-year event flows into Pond SF2, when actually only a portion of the runoff would overflow from the frontage road into Pond SF2. The Pond SF2 restoration is therefore expected to provide adequate runoff detention capacity to avoid worsening flooding of the frontage road.

The flood assessment above is for current storm runoff conditions. Accepting roadway drainage into Pond SF2 would not be ideal over the long term from an ecological and water quality perspective. It is assumed that the roadway drainage would be re-routed in the future, thereby eliminating the need to provide runoff detention capacity indefinitely.

Phase 1 Actions Level of Significance: Less than Significant

Phase 1 Impact 3.3-4: **Increased levee erosion along channel banks downstream of tidal breaches.**

Levee breaching in the Phase 1 No Action and Phase 1 tidal habitat restoration actions would increase tidal flows downstream of breaches, widening and deepening the sloughs over time. Slough width and depths upstream of the breaches would be less affected by levee breaching. This section assesses the potential for channel widening and deepening to erode pond levees along the tidal sloughs.

Phase 1 No Action

The following discussion addresses the No Action Alternative (Alternative A) at the project level.

Eden Landing. No Action would increase tidal flows in OAC, North Creek, and the historic Mt. Eden Creek channel downstream of the Pond E8A, E9, E8X, E12, and E13 breaches. Channel widening would be expected downstream of the breaches and would potentially threaten levees that protect managed ponds from inundation and provide some level of coastal flood protection. The extent of potential channel widening has not been quantified, but would be greater than that estimated for the Phase 1 actions, since Ponds E12 and E13 would also be breached under No Action. Impacts are considered potentially significant because of the potential extent of channel widening and because there would be no design features, monitoring, or increased maintenance to protect against any levee erosion that would occur.

Eden Landing Phase 1 No Action Level of Significance: Potentially Significant

Alviso. No Action would increase tidal flows in Alviso Slough, Guadalupe Slough, and Coyote Creek downstream of the Pond A6 breaches. These sloughs are wide at their mouths and have broad mudflat and marsh channel banks. Estimates of potential channel widening based on hydraulic geometry calculations for the Phase 1 action at Pond A6 (below) indicate that Alviso Slough, Guadalupe Slough, and Coyote Creek are sufficiently wide downstream of the Pond A6 breaches that they would easily accommodate expected channel widening from breaching of Pond A6. Ponds A8 and A16 would be maintained as seasonal and managed ponds, resulting in no changes to tidal flows at these locations.

Alviso Phase 1 No Action Level of Significance: Less than Significant

Ravenswood. The levees around Pond SF2 would be maintained. No change in tidal flows or increase in levee erosion would occur.

Ravenswood Phase 1 No Action Level of Significance: Less than Significant

Phase 1 Actions

The following discussion addresses the Phase 1 actions (the first phase of Alternatives B and C) at the project level.

As discussed above in SBSP Impact 3.3-4, the Phase 1 actions would be designed such that scoured slough widths, based on hydraulic geometry calculations using relationships from Williams and others (2002), are less than or equal to the available width between the toes of the adjacent levees downstream of planned breaches. Monitoring and adaptive management would be used to verify that the Project was performing as intended, and corrective actions would be taken if needed.

Eden Landing. The paragraphs below discuss Phase 1 actions at the Eden Landing pond complex that would affect the potential for levee erosion along channel banks downstream of tidal breaches.

Ponds E8A, E9, and E8X. The Phase 1 action tidal habitat restoration at Ponds E8A, E9, and E8X would increase tidal flows in OAC, North Creek, and Mt. Eden Creek downstream of the Ponds E8A, E9, and E8X breaches. Tidal habitat restoration implemented as part of the ELER Restoration Project, a separate project, is also expected to increase tidal flows in OAC, North Creek, and Mt. Eden Creek and the effects of the two actions are considered together in the following impact assessment. Levees along these creeks protect managed ponds from inundation and provide some level of coastal flood protection. Levees would be monitored and maintained as needed, according to the process described in the Section 2.5.6 Operations and Maintenance and the Adaptive Management Plan (see discussion in SBSP Impact 3.3-4 and Appendix D).

Downstream of the Pond E8A levee breaches, the levee along the southern bank of OAC protects Pond E1. OAC consists of two parallel channels separated by a marsh island. The width between the OAC levees, including the marsh island, is approximately 400 ft (120 m). The widths of the north channel and south channel are approximately 120 ft and 90 ft, respectively. Increased tidal flows would initially drain through the northern segment of the OAC channel. Based on hydraulic geometry calculations, the width of the northern channel downstream of the Pond E8A breaches would increase to approximately 265 to 295 ft (80 to 90 m). The lower end of this range assumes long-term conditions in Ponds E8A, E9, and E8X, with the ponds filled with sediments to natural marshplain elevations. The upper end of this range assumes the ponds do not fill with sediments (maximum tidal prism) before the channel scours fully. Erosion is expected to occur from both the marsh island and the breached Pond E8A levee. Erosion is expected to occur preferentially from the marsh island because the marsh sediments are less consolidated than the levee material. Tidal flows would potentially erode through the marsh island, and flows would split between the two channels. If this occurs, the Pond E1 levee would potentially be subject to erosion; however, this levee would be monitored and maintained according to the process described in Section

2.5.6 Operations and Maintenance and the Adaptive Management Plan (see discussion in SBSP Impact 3.3-4 and Appendix D).

The levee along the eastern bank of North Creek protects Ponds E6B and E8. Based on hydraulic geometry calculations, the width of North Creek downstream of the Ponds E8A and E8X breaches would increase to approximately 180 to 195 ft (55 to 60 m), which is approximately the same as the width between the North Creek levees in this reach. As described above, the lower end of this range assumes long-term conditions, with the ponds filled with sediments to natural marshplain elevations, while the upper end of this range assumes the ponds do not fill with sediments (maximum tidal prism) before the channel scours fully. The eastern North Creek levee would potentially be subject to erosion; however, this levee would be monitored and maintained according to the process described in Section 2.5.6 Operations and Maintenance and the Adaptive Management Plan (see discussion in SBSP Impact 3.3-4 and Appendix D).

Downstream of the Pond E9 breach, the Mt. Eden Creek channel is approximately 140 ft (43 m) wide. The existing Pond E10 levee is along the north bank of Mt. Eden Creek and a lowered levee and tidal marsh are along the southern bank. Based on hydraulic geometry calculations, the width of Mt. Eden Creek downstream of the Pond E9 breach would increase to approximately 200 to 320 ft (55 to 60 m). As described above, the lower end of this range assumes long-term conditions, with the ponds filled with sediments to natural marshplain elevations, while the upper end of this range assumes the ponds do not fill with sediments (maximum tidal prism) before the channel scours fully. The restoration would include measures to allow Mt. Eden Creek to scour and widen without eroding or breaching the Pond E10 levee. The exact measures would be determined in the design phase, but could consist of setting back the Pond E10 levee, reinforcing/armoring the Pond E10 levee, and/or enlarging the mouth of Mount Eden Creek to shift the creek centerline to the south, further away from the Pond E10 levee. Setting back the Pond E10 levee, for example, would consist of relocating the segment of the Pond E10 levee downstream of the Pond E9 breach approximately 360 ft (110 m) to the north of its current location. This would be expected to result in a width of at least approximately 180 to 300 ft between the scoured northern channel bank of Mt. Eden Creek and the new Pond E10 levee segment.

The hydraulic geometry calculations of channel widths for the Ponds E8A, E9, and E8X restoration are documented in Appendix G (Eden Landing Ponds E8A, E9 and E8X Hydrodynamic Modeling and Geomorphic Analysis).

Ponds E12 and E13. The Phase 1 managed pond restoration at Ponds E12 and E13 would not breach any levees and would not increase levee erosion along the channel banks.

Alviso. The paragraphs below discuss Phase 1 actions at the Alviso pond complex that would affect the potential for levee erosion along channel banks downstream of tidal breaches.

Pond A6. The Phase 1 action tidal habitat restoration at Pond A6 would increase tidal flows in the mouths of Alviso Slough, Guadalupe Slough, and Coyote Creek downstream of the Pond A6 breaches. These sloughs are wide at their mouths and have broad mudflat and marsh channel banks. The Phase 1 actions at Pond A8 would also increase tidal flows in Alviso Slough and Coyote Creek, and the effects of the two actions are considered together in the following impact assessment.

The Alviso Slough and Guadalupe Slough levees downstream of the Pond A6 breaches protect – Ponds A3N, A9, and A10 from Bay inundation and provide some level of coastal flood protection. These levees would be monitored and maintained as needed, according to the process described in the Section 2.5.6 Operations and Maintenance and the Adaptive Management Plan (see discussion in SBSP Impact 3.3-4 and Appendix D).

Estimates of potential channel widening based on hydraulic geometry calculations indicate that Alviso Slough, Guadalupe Slough, and Coyote Creek are sufficiently wide downstream of the Pond A6 breaches that they would accommodate expected channel widening from the Phase 1 action. The minimum width between the Alviso Slough levees downstream of Pond A6 is approximately 700 ft (215 m). This is much wider than predicted channel widths of 130 to 400 ft (40 to 122 m). The lower end of this range assumes long-term conditions in Ponds A6 and A8, with the ponds filled with sediments to natural marshplain elevations. The upper end of this range assumes the ponds do not fill with sediments (maximum tidal prism) before the channel scours fully. The minimum width between the Guadalupe Slough levees in this reach is approximately 550 ft (168 m). This is much wider than predicted channel widths of 265 to 315 ft (80 to 96 m), again with the range reflecting the potential range of sedimentation in Ponds A6 and A8.

The portion of the Pond A9 levee directly opposite the northern Pond A6 breach to Alviso Slough would possibly be subject to erosion from high velocities through the breach. This levee would be monitored and maintained according to the process described in Section 2.5.6 Operations and Maintenance and the Adaptive Management Plan (see discussion in SBSP Impact 3.3-4 and Appendix D).

The levee on the north side of Coyote Creek downstream of Alviso Slough protects active Cargill salt ponds. Coyote Creek is wide and filling in with sediment at its mouth. The Phase 1 actions at Ponds A6 and A8 are not expected to cause substantial erosion in Coyote Creek or adjacent levees.

The hydraulic geometry calculations of channel widths for the Pond A6 restoration are documented in Appendix G (Tidal Channel Hydraulic Geometry Analyses).

Pond A8. The Phase 1 action at Pond A8 would tidally scour Alviso Slough downstream of the proposed notch, bringing the channel edge closer to the levees along the banks of the slough along these reaches. Hydrodynamic modeling results discussed in Appendix G indicate that Phase 1 action at Pond A8 would increase the tidal prism in Alviso Slough downstream of the notch. The Alviso Slough levees downstream of the notch protect Ponds A7, A9, A10, A11, and A12 from flooding and daily tidal inundation. The east bank slough levee in this vicinity provides flood protection for the community of Alviso. The modeled tidal prism increases in Alviso Slough after Phase 1 action at Pond A8 steadily decrease from the notch to midway between the notch and the slough mouth, where increases are negligible. These results imply that scour would specifically occur between the notch and mid-slough, where increases in tidal prism have been modeled.

The notch would be sized such that the predicted scoured channel width for Alviso Slough would be less than or equal to the distance between the east bank and west bank levee toes. Based on preliminary analyses, the scoured channel width for Alviso Slough would be less than or equal to the distance between the east-bank and west-bank levee toes. In most places along Alviso Slough, the wide band of vegetated marsh between the slough channel and the levees would allow ample room for channel widening. The channel would scour closest to the toes of the levees between 1,700 ft (520 m) and 5,500 ft (1,675 m) downstream of the UPRR, near the existing marina and downstream of the old county marina. In this reach, the predicted channel width is 215 to 225 ft (66 to 68 m) and the minimum distance between the levee toes is 230 ft (70 m). Preliminary estimates indicate that the channel would scour to the toe of the levee, but would not erode the levee. These estimates are based on preliminary modeling of Project performance and use rough prediction tools. The size of the notch would be refined in the design phase and the potential for levee erosion assessed in greater detail. Depending on the results of assessment, the notch could be designed to be adjustable in size. The estimates of potential channel width should be considered the median of a range of possible widths, though there is evidence that channel widening downstream of levee breaches is less than would be predicted using hydraulic geometry relationships (Williams and others 2002).

Actual channel widening and potential for levee erosion would be monitored after implementation. As stated in Section 2.5.6 Operations and Maintenance and the Adaptive Management Plan (see discussion in SBSP Impact 3.3-4 and Appendix D), slough widening would be monitored and the levees would be inspected regularly. Notch width would be reduced and/or the perimeter levees downstream of the notch would be maintained or improved as needed (grading, armoring, or levee set back) to maintain flood protection.

The hydraulic geometry calculations of channel widths for the Pond A8 restoration are documented in Appendix G (Alviso Pond A8 Hydrodynamic Modeling and Geomorphic Analysis).

Pond A16. The Phase 1 managed pond restoration at Pond A16 would not breach any levees and would not increase levee erosion along the channel banks.

Ravenswood. The paragraphs below discuss Phase 1 actions at the Ravenswood pond complex that would affect the potential for levee erosion along channel banks downstream of tidal breaches.

Pond SF2. The Phase 1 managed pond restoration at Pond SF2 would not breach any levees and would not increase levee erosion along the channel banks.

Phase 1 Actions Level of Significance: Less than Significant

Phase 1 Impact 3.3-5: **Potential interference with navigation.**

Phase 1 No Action

The following discussion addresses the No Action Alternative (Alternative A) at the project level.

Eden Landing. Uncontrolled breaching of Ponds E8A, E9, E8X, E12, and E13 would widen and deepen Mt. Eden Creek, North Creek, and OAC, improving navigation. However, immediately following breaching and as the breaches scoured, tidal currents would be stronger in the vicinity of the breaches. CDFG would restrict navigation in the vicinity of the breaches in the short-term, if needed for safety. Navigation would not be allowed within Ponds E8A, E9 and E8X.

Eden Landing Phase 1 No Action Level of Significance: Less than Significant (CEQA); Beneficial (NEPA)

Alviso. Uncontrolled breaching of Pond A6 would result in negligible changes to Alviso Slough, Coyote Creek, and Guadalupe Slough. Navigation would not be allowed within Pond A6. Ponds A8 and A16 would be maintained as non-tidal ponds; no changes to navigation would occur at these locations.

Alviso Phase 1 No Action Level of Significance: Less than Significant

Ravenswood. The levees around Pond SF2 would be maintained. No changes to navigation would occur.

Ravenswood Phase 1 No Action Level of Significance: Less than Significant

Phase 1 Actions

The following discussion addresses the Phase 1 actions (the first phase of Alternatives B and C) at the project level.

Eden Landing. The paragraphs below discuss Phase 1 actions at the Eden Landing pond complex that would affect the potential for interference with navigation.

Ponds E8A, E9, and E8X. Implementation of the Phase 1 action at Ponds E8A, E9, and E8X would widen and deepen Mt. Eden Creek, North Creek, and OAC, which would improve navigation. The kayak launch on Mt. Eden Creek would make kayaking more accessible. Immediately following breaching, tidal currents would be slightly stronger adjacent to the breach, but they would remain in an acceptable range for kayaking then return to baseline values. Navigation would not be allowed within Ponds E8A, E9 and E8X.

Ponds E12 and E13. The Phase 1 managed pond restoration would not breach any levees and would have no effect on navigation.

Eden Landing Phase 1 Actions Level of Significance: Less than Significant (CEQA); Beneficial (NEPA)

Alviso. The paragraphs below discuss Phase 1 actions at the Alviso pond complex that would affect the potential for interference with navigation.

Pond A6. There would be negligible changes to current velocities in Alviso Slough, Coyote Creek, and Guadalupe Slough. Navigation would not be allowed within Pond A6.

Pond A8. The Alviso Marina is located on the eastern side of Alviso Slough adjacent to the community of Alviso. The UPRR Bridge, located approximately 1,000 ft (305 m) upstream of the Alviso Marina, limits boat passage, and therefore, there is little traffic upstream of the marina in the vicinity of the proposed notch. More importantly, sedimentation and vegetation establishment along the banks of Alviso Slough over the past decades has made navigation impractical except for the smallest water craft.

Implementation of the Phase 1 action at Pond A8 would temporarily increase velocities downstream of the Pond A8 notch. Although hydraulic modeling results show that there would not be significant increases in the cross-sectionally averaged in-channel velocity, localized velocity increases in the immediately vicinity of the proposed notch were not computed and could be high enough to affect small craft navigation.

High tidal current velocities (*i.e*. peak values up to approximately 5 to 7 fps) and turbulent flow are expected in the immediate vicinity of the notch. For boating safety, the Phase 1 action would include features to restrict access to the Pond A8 notch. Features could include structures to dissipate energy, multiple "bays" that could be opened/closed independently such that tidal currents change more gradually, or other design elements intended to limit the extent of high tidal currents. Additionally, the Pond A8 notch would initially be operated with only one bay open. Subsequent opening of additional bays would be contingent on avoiding hazards to boat safety in the vicinity of the Alviso Marina and ensuring that tidal scour does not threaten erosion of downstream levees that provide flood protection to the town of Alviso, as discussed in Impact 3.3-4. At the junction of the outboard pilot channel and slough, mitigation features could include fendering to restrict vessel access and hydraulic design elements to reduce the extent of local turbulence in Alviso Slough. Fendering could consist of vertical piles with horizontal floating racks to keep boat traffic from entering the channel. The outboard pilot channel could be placed at an oblique angle to the slough to maintain an efficient hydraulic junction. Design elements reducing localized velocities and turbulence would also reduce the potential for excessive erosion of the marsh area directly across from the junction. If unacceptable impacts to navigation along Alviso Slough could not be avoided by reducing the notch opening to a single bay, the Project would consider closing all bays. Navigation would not be allowed within Pond A8. Numerical modeling suggest that increases to existing tidal current speeds are expected to be substantially less downstream of the Pond A8 notch, with peak values of approximately 1 fps for a 40-ft notch opening (see Figure 9 in Appendix G-5).

Due to the extremely limited amount of boating along Alviso Slough under Baseline Conditions, Phase 1 actions would not result in significant adverse impacts to navigation. Over a period of years, Alviso Slough is expected to scour, increasing channel dimensions. Larger channel cross-sectional areas would reduce the short-term velocity increases associated with the notch and provide improved navigation in the long-term. Benefits to navigation would be further enhanced if the Phase 1 action at Pond A8 were coordinated with other planned activity, such as improvements to or relocation of the South Bay Yacht Club docks associated with vegetation removal along Alviso Slough, as part of the Alviso Slough Restoration Project.

Pond A16. The Phase 1 managed pond restoration would not breach any levees and would have no effect on navigation.

Alviso Phase 1 Actions Level of Significance: Less than Significant (CEQA); Beneficial (NEPA)

Ravenswood. The paragraph below discusses Phase 1 actions at the Ravenswood pond complex that would affect the potential for interference with navigation.

Pond SF2. The Phase 1 managed pond restoration would not breach any levees and would have no effect on navigation.

Ravenswood Phase 1 Actions Level of Significance: Less than Significant