3.4 Surface Water, Sediment and Groundwater Quality

Potential impacts to surface water, sediment, and groundwater quality by the SBSP Restoration Project are analyzed in this section. The physical setting related to surface waters and sediments is discussed separately from the physical setting for groundwater hydrology and quality. The regulatory authorities are outlined in the next section, including a summary of federal, state, and regional agencies and their roles in managing surface water, sediment, and groundwater quality. The state of California's Water Quality Standards Program is the primary basis for determining thresholds for impacts, although USEPA, can promulgate standards and intercede in NPDES permits and other federal actions. The state's program is a continuous planning process, and accounts for regional or site-specific differences that may affect water quality. Therefore, water quality objectives may also vary in space and in time. This needs to be considered for emerging programs such as the mercury Total Maximum Daily Load (TMDL), as well as management of algae and dissolved oxygen (DO) in the unique microenvironments of managed ponds, muted tidal marshes, and other habitats of the Baylands mosaic.

3.4.1 Physical Setting – Surface Water and Sediment Quality

Methodology

This section summarizes past data, and regulatory criteria applicable to evaluation of environmental impacts due to Project actions. Those actions consist of breaching levees, development of managed ponds to increase habitat density, and implementation of the Adaptive Management Plan to enhance benefits of restoration and to avoid impacts. Under the no-action alternative (Alternative A), it is assumed that CDFG and USFWS would operate and maintain the ponds in a manner similar to the ISP, although ongoing O&M activities would be scaled back. Ponds that require pumping for water circulation in the ISP would be dewatered or allowed to evaporate, becoming seasonal ponds that fill and dry. Water management would be discontinued on a pond by pond basis as hydraulic structures break, creating more seasonal ponds. Alternative B provides roughly a 50 percent each by area of tidal habitat and managed ponds, whereas Alternative C provides about 90 percent tidal marsh habitat and 10 percent managed ponds. Because of uncertainties about the sustainability of managed ponds, the final Project alternative is expected to be somewhere between the bookends defined by Alternatives B and C, if the Project is approved. The determination of where on the staircase to stop would be determined through implementation of the Project's Adaptive Management Plan.

Regional setting data were obtained through the San Francisco Estuary Institute (SFEI), the San Francisco Bay Regional Monitoring Program (RMP), the City of San Jose, and the United States Geological Survey (USGS). Project Setting data were obtained from sampling conducted as part of the ISP, as well as the SCVWD, USGS, and USFWS. Additional regional and Project Setting mercury data were available through a report produced for the Guadalupe River TMDL Project (Tetra Tech Inc. 2004).

Sediment quality data were assessed through comparison with the Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines (Guidelines) (RWQCB 2000). These guidelines define statistically determined San Francisco Bay ambient sediment concentrations and ecological thresholds. Defined ecological thresholds are the low effects range (ER-Ls), which represent the concentration below which adverse biological effects are unlikely, and median effects range (ER-Ms), which represent the concentrations above which adverse biological effects are likely.

Surface water quality data were evaluated against the water quality objectives presented in the Water Quality Control Plan for San Francisco Bay Basin (Basin Plan, June 21, 1995, RWQCB 1995), the California Toxics Rule (CTR), and US EPA Multi-Sector Permit Benchmark Values (for diesel only). There are often multiple water quality objectives or criteria for a given contaminant. When possible, the evaluation focused on water quality criteria for protection of aquatic life. When criteria specific to aquatic life were not available, the most applicable and/or most conservative criteria were chosen for the evaluation. Applicable water quality objectives are discussed in more detail in Section 3.5.

Regional Setting

The regional setting consists of areas that are outside and adjacent to the salt ponds to be restored. This setting primarily includes the surrounding South San Francisco Bay and urban and upland watershed source areas that generate urban runoff flows, as well as wastewater treatment plant effluent discharges. The data evaluated in the sections below were obtained from SFEI, the RMP conducted by SFEI, monitoring conducted by the City of San Jose, and monitoring conducted by USGS along the sloughs and Guadalupe River. The RMP has been conducted since approximately 1993 and includes both the collection of sediment and water samples from various stations throughout the entire San Francisco Bay. The South San Francisco Bay sample stations are shown on Figure 3.4-1.

Table 3.4-1 provides a summary of entities within the regional setting that participate in the RMP. Also presented in Table 3.4-1 are additional, individual programs that monitor water quality within the regional setting. Data from these individual programs are not included in this report, but they are listed as potentially interested stakeholders with water quality data. Likewise, most of the locally affiliated monitoring programs in Table 3.4-1 have only recently been initiated, so it is too soon to consider their data. Rather, they are noted as important resources for addressing data gaps identified through development of the Adaptive Management Plan.

Mercury

The primary concern with mercury contamination in San Francisco Bay is the accumulation of methylmercury (MeHg) in organisms, particularly at the top of aquatic food webs (*e.g.*, California clapper rail). Mercury occurs in many forms, but MeHg is the form which poses the highest bioaccumulation risk. Throughout this section, mercury concentrations are distinguished as MeHg or total mercury (THg), which is the sum of both inorganic and methylated mercury. The word mercury is used in this discussion when no specific form is implied.

Elevated levels of MeHg can adversely affect the health and fitness of fish and birds. Some studies suggest that elevated MeHg levels adversely affect the reproductive success of aquatic birds in the Bay-Delta (Schwarzbach and Adelsbach 2003). Elevated MeHg levels in fish can also result in mercury exposure in humans who consume contaminated fish (National Research Council Committee on the Toxicological Effects of Methylmercury 2000).

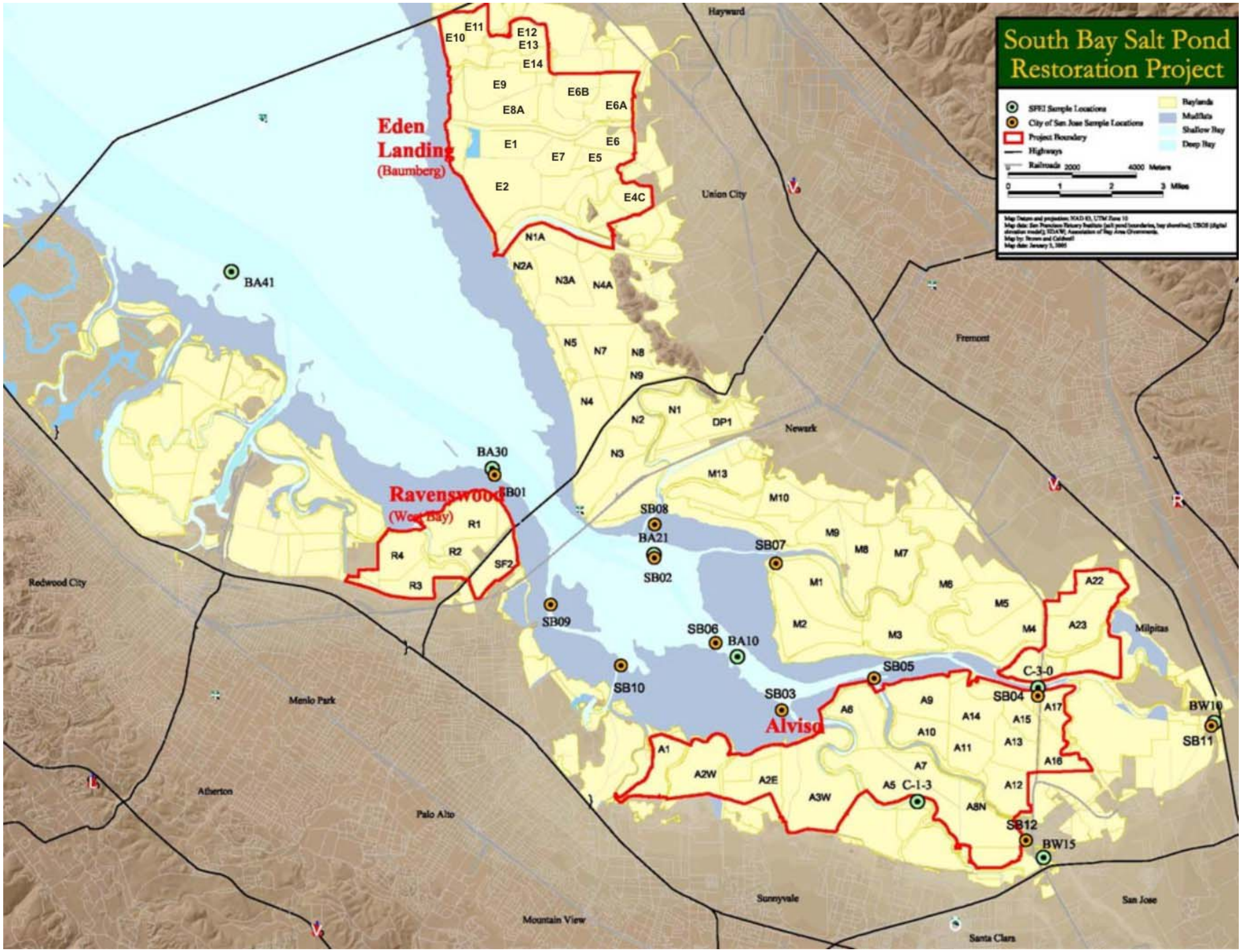


Figure 3.4-1 South San Francisco Bay Sample Stations

Table 3.4-1 Regional Setting Monitoring Programs

REGIONAL MONITORING PROGRAM PARTICIPANTS
Alameda Countywide Clean Water Program
City of Palo Alto
City of San Jose/Santa Clara
City of San Mateo
Santa Clara Valley Urban Runoff Pollution Prevention Program
City of Sunnyvale
South Bayside System Authority
INDIVIDUAL MONITORING PROGRAMS
City of Mountain View, Shoreline Small Boat Lake – NPDES Self-Monitoring Program
FMC Corporation, Phosphorus Chemicals Division – NPDES Self-Monitoring Program
US Department of Energy, Stanford Linear Accelerator Center – NPDES Self-Monitoring Program
International Business Machines – NPDES Self-Monitoring Program
Kaiser Sand and Gravel – NPDES Self-Monitoring Program
Livermore-Amador Valley Water Management Agency, San Lorenzo Creek Intermittent Wet Weather Discharge – NPDES Self-Monitoring Program
NOAA National Status and Trends Mussel Watch Program
RMC Lonestar, Eliot Plant – NPDES Self-Monitoring Program
RMC Lonestar, Sunol Plant – NPDES Self-Monitoring Program
AFFILLIATED LOCAL MONITORING PROGRAMS
SFEI / USGS / SCVWD South Baylands Mercury Project
Alviso Slough Restoration Project
US Geological Survey – Water Resources Division
SFEI Lower Guadalupe River PCB / Mercury Monitoring Project

MeHg is produced in aquatic ecosystems via the methylation of inorganic mercury by microorganisms (Benoit and others 2003). The rate of methylation is a complex function of an array of variables including: mercury levels, mercury speciation, microbial activity, sulfate levels, salinity, DO, oxidation reduction potential, organic carbon, turbidity, solar radiation, and vegetation type. While the interaction of these variables is not fully understood, wetlands are known to be significant sites of microbial methylation (Marvin DiPasquale and others 2003) and potentially important sources of MeHg to aquatic food webs (Wiener and others 2003).

RMP Sediment Results. The Water and Sediment Quality Existing Conditions Report presents a summary of the THg and MeHg concentrations detected in RMP sediment samples (Brown and Caldwell and others 2005). In general, THg was detected at concentrations similar to the RWQCB ambient value of 0.43 milligram per kilogram (mg/kg). Of the 126 samples collected, 16 contained concentrations greater than ambient conditions and five contained concentrations greater than the mercury ER-M (0.71 mg/kg). The mercury ER-L (0.15 mg/kg) is less than the ambient value. The maximum THg concentration detected was 1.08 mg/kg, and the average concentration was 0.32 mg/kg.

Two of the RMP mercury sampling events also included analysis of MeHg. These 16 samples reported a maximum detected MeHg concentration of 3.73 micrograms per kilogram (μg/kg) and an average MeHg concentration of 0.94 μg/kg. Neither a RWQCB ambient MeHg concentration objective nor a respective NOAA ER-L/ER-M has been established for MeHg.

In addition, 2003 RMP data were released in May 2005 in the RMP 2003 Annual Monitoring Results report. Mercury levels in sediments were below the ambient value (0.43 mg/kg) and most were above the ER-L (0.15 mg/kg). MeHg levels in the South Bay ranged from approximately 0.3 to 0.75 μg/kg with a mean of approximately 0.5 μg/kg. MeHg levels in the far South Bay ranged from approximately 0.5 to 0.75 μg/kg with a mean of approximately 0.6 μg/kg.

Mercury in urban wet-weather flows can be from contaminated sites or deposited from the atmosphere. A Bay-wide urban storm drain sediment sampling program was conducted in 2000 and 2001 for the Joint Stormwater Agency Project (Kinnetic Laboratories 2001; Kinnetic Laboratories 2002). Forty-five of the storm drain sediment sampling sites were located in Santa Clara County, representing industrial, open, residential/commercial, and mixed land uses. In 2000, the range of total mercury concentrations in the Santa Clara County sites sampled was 0.1 to 4.26 mg/kg dry; the range for the 2001 sites was 0.02 to 3.04 mg/kg dry. Based on statistical analyses, the highest total mercury concentrations were found in three sites in Marin County, three sites in San Mateo County, and one site in Santa Clara County. Median concentrations of mercury in urban sites were three times greater than non-urban sites. Methylmercury was measured in the sediment only in the 2000 study. Methylmercury in the Santa Clara County samples ranged from 0.00007 to 0.00249 mg/kg and was not substantially different among the Bay regions (Tetra Tech Inc. 2004). Other possible local sources of mercury include urban runoff and emissions from landfills, such as the Guadalupe Landfill, located in the Guadalupe River watershed. Mercury can also come from soils with high mercury levels in historic mining areas, non-cemented mine waste deposits, and in contaminated soils on former industrial sites. The fate of this mercury is not known (Tetra Tech Inc. 2004). Atmospheric deposition of mercury is another potential source that is conveyed into receiving waters by stormwater runoff (Clean Estuary Partnership 2006).

SCVWD Sediment Results. SCVWD collected sediment samples in a proposed wetland area adjacent to Pond A8 in January and June of 2005. Samples were collected at depths of 1.5 and 3.5 ft each month. Average total mercury concentrations at 1.5 ft were 0.664 mg/kg in January and 0.8 mg/kg in June. Average total mercury concentrations at 3.5 ft were 0.483 mg/kg in January and 0.668 mg/kg in June. All four averages exceed the ER-L for mercury of 0.15 mg/kg. The June sample collected at 1.5 ft exceeds the ER-M for total mercury of 0.71 mg/kg (Earth Tech 2006).

Surface Water Results. Several locations along the Guadalupe River system were sampled in October 2000 by USGS under dry and wet conditions (Thomas and others 2002). The data from these events are summarized in Table 3.4-2. The applicable water quality objective for surface water is 51 ng/L. Six out of 14 samples exceeded the water quality objective. The highest total mercury at the USGS gauge (139 ng/L) was associated with the highest observed flow.

Table 3.4-2 Dry and Wet-Weather Water Samples for Mercury

SAMPLING SITES	DRY CONDITIONS (OCTOBER 2000) TOTAL HG, NG/L	WET CONDITIONS (OCTOBER 26–27, 2000) TOTAL HG, NG/L
Guadalupe River		
above Alviso Slough	86	59, 99
at Orchard Lane	19	NA
at USGS Gauging Station	26	139, 30, 18
at Almaden Expressway	55	83
Below Guadalupe Reservoir	NA	44
Los Gatos Creek	3	3, 29
Source: Thomas and others 2002.		

Annual minimum and maximum mercury loads to the far South Bay and South Bay were reported by RWQCB in a report to the USEPA dated June 30, 2000. Table 3.4-3 summarizes these data.

Table 3.4-3 Annual Mercury Loads to South Bay

	MINIMUM AVERAGE ANNUAL MERCURY LOAD (KG)	MAXIMUM AVERAGE ANNUAL MERCURY LOAD (KG)
far South Bay		
Fremont Bayside	0.7	3.0
Coyote Creek	3.2	12.7
Guadalupe River	7.4	73.9
Palo Alto	2.4	9.7
Subtotal	**14**	**99**
South Bay		
East Bay Cities	2.8	11.2
Alameda Creek	4.8	19.3
San Mateo – Bayside	1.9	7.7
Subtotal	**10**	**38**

SFEI has been collecting additional mercury storm water data in the Guadalupe River since 2002. Data from water years 2003 and 2004 are currently available. The water year is defined as October 1 to September 30 and is identified by the end year. In 2003, THg ranged from 0.18 to 18.67 µg/L, with a flow weighted mean concentration of 2.19 µg/L. In 2004 THg ranged from 0.01 to 1.42 µg/L, with a flow weighted mean of 0.33 µg/L (McKee and others 2006). Nearly all results exceed the far South Bay water quality objective of 0.051 µg/L. Total mercury loads were calculated at 116 ± 37 kilograms per year (kg/yr) in 2003 and 14.8 ± 4.7 kg/yr in 2004.

Surface water dissolved and total mercury were also reported for the South Bay and far South Bay in the RMP 2003 Annual Monitoring Results report. The dissolved mercury concentration in the South Bay was typically between 0.001 and 0.002 µg/L, and the far South Bay concentrations were slightly lower, although still approximately 0.001 µg/L. Dissolved mercury concentrations were not compared to any criteria in the RMP report. THg concentrations in both the South Bay and far South Bay were generally below water quality objectives, although one sample (out of 11 samples) in the far South Bay exceeded the far South Bay objective of 0.051 µg/L for THg.

Data also were available from the City of San Jose which summarized mercury concentrations in the effluent from the San Jose/Santa Clara Water Pollution Control Plant (WPCP). This plant discharges its effluent into Artesian Slough, which connects to Coyote Creek in the Alviso pond complex. Mercury levels in the plant's final effluent were relatively low: 2.2 ng/L THg, 0.029 ng/L MeHg, and 1.53 ng/L filtered mercury.

Polychlorinated Biphenyls (PCBs)

PCBs are a class of organic chemicals that do not break down quickly in the natural environment and therefore are considered to be highly persistent in nature. PCBs have been found to pose bioaccumulation risks.

RMP Sediment Results. The Water and Sediment Quality Existing Conditions Report presents a summary of the PCB concentrations detected in the RMP sediment samples (Brown and Caldwell and others 2005). The ambient and ER-L/ER-M concentrations are for total PCBs, which is the sum of a SFEI established list of PCBs. In general, PCBs were detected at concentrations similar to the RWQCB ambient value of 21.6 µg/kg. Of the 92 sampling events that included the SFEI PCB list, 35 events reported concentrations greater than ambient conditions, 30 reported concentrations greater than the ER-L (22.7 µg/kg), and 2 reported concentrations greater than the ER-M (180 µg/kg). The maximum SFEI PCB sum detected was 312 µg/kg, with an average sum of 28.2 µg/kg.

Clean Estuary Partnership Results. The Clean Estuary Partnership funded a series of reports that analyzed existing monitoring data and provided new analyses from sediment core samples collected near storm water inputs. The analysis of existing monitoring data reviewed and combined several historic data sets with RMP data to quantify the horizontal gradients of PCB concentrations in Bay sediments (Hardin 2005). Offshore samples have a mean concentration of 18 µg/kg; nearshore samples, closer to stormwater inputs of PCBs, have a mean concentration of 28 µg/kg. The composite samples prepared from sediment cores near storm drains that have known historic PCB releases upstream have average PCB concentrations ranging from 22 µg/kg to 376 µg/kg (Applied Marine Sciences 2004). The highest concentration observed in the cores collected by the Clean Estuary Partnership was 1,037 µg/kg, from a core in the Moffett Channel. A conceptual model explaining the significance of these PCB distributions to PCB concentrations in the food web and long-term management of PCBs in the Bay was developed by the Clean Estuary Partnership (Davis and others 2006).

Surface Water Results. Total PCB and dissolved PCB data for surface water were available from the SFEI. Data for total PCBs were compared to the water quality objective of 30 ng/L for protection of aquatic life and its uses. Available PCB data never exceeded the water quality objective. These data can be found in the Water and Sediment Quality Existing Conditions Report, presented in (Brown and Caldwell and others 2005).

SFEI also analyzed samples from storm water in the Guadalupe River for PCBs. Data were collected in water years 2003 and 2004. In 2003 total PCB concentrations ranged from 3.4 to 90 ng/L, and had a flow weighted mean concentration of 55 ng/L. In 2004 total PCBs ranged from 0.7 to 66 ng/L, and had a flow weighted mean of 26 ng/L. Concentrations in the storm water sometimes exceed the far South Bay water quality objective of 0.051 µg/L. In 2004 PCB loads were estimated at 0.56 to 126 ng/day with a total seasonal load of 0.70 kg (McKee and others 2006)

In addition, PCB data were reported in the RMP 2003 Annual Monitoring Results report. The RMP report compared total PCB concentrations to the CTR Human Health Criterion of 0.17 ng/L. All of the concentrations in the South Bay and far South Bay exceeded this criterion. Data never exceeded the aquatic life criteria of 30 ng/L. Concentrations were typically in the 0.5 to 1.5 ng/L range.

A recent paper was published by SFEI discussing atmospheric deposition of PCBs. PCBs in the water can also be transferred to the atmosphere. The study concluded that more PCBs were transferred from the water to the atmosphere, than were deposited from the atmosphere. Therefore the Estuary is a source of PCBs to the atmosphere, and atmospheric deposition does not appear to be a significant source of PCBs in the Estuary. This study was conducted from June to November 1999, and it is unknown whether the same results would be found during the winter months (Tsai and others 2005).

RMP PCB Bivalve Tissue Results. SFEI analyzes bivalve tissues for PCBs and other organic contaminants as part of the Regional Monitoring Program. Mussels were transplanted to two South Bay and one far South Bay station for 90 to 100 days during the dry season. At the far South Bay station at Coyote Creek, PCBs in the tissues were 141 ppb. Both the Dumbarton Bridge and Redwood Creek sample results were 212 ppb. All three results exceed the non-regulatory screening value of 140 ppb. The screening values were developed by Brodberg (1999) and are used by the Office of Environmental Health Hazard Assessment in screening shellfish and finfish for human consumption advisories. SFEI also calculates accumulation factors for the organic contaminants by dividing the final result by the pre-deployment tissue concentration. Accumulation factors for PCBs at the three stations ranged from 37 to 56 (Tsai and others 2005).

Other Organic Constituents of Concern

The primary organic constituents analyzed in the RMP include polynuclear aromatic hydrocarbons (PAHs) and organochlorine pesticides. Both organochlorine pesticides, which includes chlordanes and DDTs, and some PAHs are known to be environmentally persistent and pose a concern for bioaccumulation. Polybrominated diphenyl ethers (PBDEs) are flame-retardant compounds that have recently been detected in fish. Summaries of results for PAHs, pesticides, PBDEs, and petroleum hydrocarbons are presented below.

RMP PAH Sediment Results. The Water and Sediment Quality Existing Conditions Report presents a summary of the various PAH concentrations detected in the RMP sediment samples (Brown and Caldwell and others 2005). In general, all 25 PAHs analyzed were detected at concentrations similar to or below their respective ambient value. No PAHs were detected at concentrations greater than ER-Ms. Of the 114 RMP sampling events, eight contained total PAH sums greater than the ambient sum concentrations

(3,390 µg/kg) and three contained sums greater than the ER-L (4,022 µg/kg). The total PAH ER-M is 44,792 µg/kg. The maximum SFEI PAH sum reported was 7,632 mg/kg, and the average concentration sum was 1,813 µg/kg. Data for 2003 RMP sampling were released in the RMP 2003 Annual Monitoring Results report in May 2005. All PAH concentrations reported in 2003 were below the ER-L and most were below the ambient value.

PAH Surface Water Results. Total PAH and dissolved PAH data for surface water were obtained from the SFEI. Data for total PAHs were compared to the water quality objective of 15.0 µg/L. None of the data analyzed exceeded the water quality objective. The Water and Sediment Quality Existing Conditions Report summarizes the data (Brown and Caldwell and others 2005).

A paper by SFEI in 2004 offered further interpretation of these results (Ross and Oros 2004). The paper suggests that storm water runoff in the far South Bay is the main source for PAHs in that area. Concentrations in the far South Bay appeared to be higher in the dry season, while concentrations in the South Bay appeared to be higher in the wet season. PAH concentrations were higher in these two areas than in other parts of the San Francisco Estuary. Data from a San Jose station decreased over the nine years of sampling, which may be the result of improvements in local water quality management.

In addition, PAH data were reported in the RMP 2003 Annual Monitoring Results report. Dissolved PAHs in the South Bay and far South Bay were typically in the range of 0.008 to 0.016 µg/L. Total PAH concentrations were typically 0.03 to 0.125 µg/L and did not exceed the water quality objective of 15 µg/L. The RMP report also compared the data to CTR Human Health criteria for ten individual PAHs, none of which exceeded the criteria.

The study by SFEI regarding atmospheric deposition also evaluated PAHs. This study found that during the study period (June through November) more PAHs were deposited from the atmosphere than were transferred from the water back to the atmosphere. The study found that atmospheric sources of PAHs may be a significant source of PAHs in the Estuary (Tsai and others 2005). The estimated amount of PAHs deposited from the atmosphere to the Estuary each month was estimated to be 75 kg.

RMP PAH Bivalve Tissue Results. SFEI analyzes PAH concentrations in bivalve tissues as part of the RMP. The 2002 and 2003 PAH results are not available due to an ongoing review of the data and analytical procedures (SFEI 2005). The 2001 results were 700.7 ppb at Coyote Creek, 245.6 ppb at Dumbarton Bridge, and 161.8 ppb at Redwood Creek. The accumulation factors ranged from approximately 5 to 10. There is no screening value for PAHs (SFEI 2003).

RMP Pesticide Sediment Results. The Water and Sediment Quality Existing Conditions Report presents a summary of the organochlorine pesticide concentrations detected in the RMP sediment samples (Brown and Caldwell and others 2005). Limited regulatory thresholds are available for these constituents. The RWQCB has established four ambient concentrations, and no ER-Ls/ER-Ms were identified. For a few pesticides, the RWQCB refers to the Threshold Effects Level (TEL) and the Probable Effects Level (PEL), established by the Florida Department of Environmental Protection (FDEP). TELs are analogous to ER-Ls, and PELs are analogous to ER-Ms.

The analytical results obtained for the four pesticides with ambient concentration criteria (aldrin, dieldrin, endrin and hexachlorobenzene), indicate concentrations generally similar to or below the respective ambient concentration. TELs and PELs have also been established for dieldrin. Of the 114 RMP sampling events, 14 contained samples with dieldrin concentrations greater than its TEL and one contained a sample with dieldrin at a concentration greater than its PEL.

The RWQCB, in coordination with SFEI, has also established ambient concentration sums for two major classes of organochlorine pesticides, chlordanes and DDTs. Of the 80 sampling events for which chlordane sums were reported, 53 contained samples with concentrations greater than the ambient value (1.1 μg/kg), 33 with concentrations greater than the TEL (2.26 μg/kg), and 18 with concentrations greater than the PEL (4.79 μg/kg). The maximum chlordane sum reported was 19.7 μg/kg, with an average concentration of 3.23 μg/kg. Of the 113 sampling events for which DDT sums were reported, 44 contained samples with concentrations greater than the ambient value (7.0 μg/kg), 99 with concentrations greater than the TEL (1.58 μg/kg), and 3 with concentrations greater than the PEL (46.1 μg/kg). The maximum DDT sum reported was 127 μg/kg, with an average concentration of 10.4 μg/kg.

SCVWD Pesticide Sediment Results. SCVWD collected sediment samples in an area adjacent to Pond A8 in January and June of 2005. In January samples were collected at depths of 1.5 and 3.5 ft and analyzed for chlordane, DDD, DDE, DDT, and dieldrin. In June only chlordane was analyzed and only at the 1.5 ft depth (Earth Tech 2006). Average chlordane concentrations exceeded the PEL in all three samples. Dieldrin concentrations exceeded the PEL at both depths. DDT concentrations exceeded the PEL at 1.5 ft and the TEL at 3.5 ft.

Pesticide Surface Water Results. Total and dissolved pesticide data for surface water were available from SFEI. Twenty-eight individual compounds were reported, in addition to sums for total chlordanes, DDTs, and HCHs. Values for total chlordanes ranged from 0.005 ng/L to 5.28 ng/L. Values for total DDTs ranged from 0.068 ng/L to 10.42 ng/L. Values for total HCHs ranged from 0.026 ng/L to 7.51 ng/L. In general, most of the total chlordanes and total DDTs were below water quality objectives, with some exceedances. The Water and Sediment Quality Existing Conditions Report summarizes the data (Brown and Caldwell and others 2005).

Samples collected by SFEI from storm water in the Guadalupe River were also analyzed for DDT, chlordane, and dieldrin in water years 2003 and 2004. In 2003, total DDT concentrations ranged from 1.7 to 71 ng/L and had a flow weighted mean of 45 ng/L. In 2004 total DDT ranged from 0.6 to 55 ng/L and had a flow weighted mean of 28 ng/L (McKee and others 2006). All of these concentrations exceed the water quality objective of 0.59 ng/L DDT. Concentrations of total chlordanes varied from 1.6 to 64 ng/L in 2003, with a flow weighted mean of 40 ng/L. In 2004 total chlordanes ranged from 0.6 to 53 ng/L with a flow weighted mean of 25 ng/L. Nearly all of these concentrations exceed the water quality objective for chlordanes of 2.2 ng/L. Dieldrin concentrations varied from 0.3 to 6.0 ng/L in 2003 and had a flow weighted mean of 3.8 ng/L. In 2004 dieldrin concentrations ranged from 0.2 to 3.8 ng/L and averaged 2.0 ng/L. Estimated seasonal loads of pesticides in 2004 were 0.7 kg total DDT, 0.55 kg total chlordane, and 0.054 kg dieldrin.

Pesticide Bivalve Tissue Results. SFEI analyzed bivalve tissues for pesticides as part of the RMP. Samples from the Coyote Creek, Dumbarton Bridge and Redwood Creek stations were analyzed for dieldrin, chlordanes and DDTs. Dieldrin concentrations were 7.8 ppb at Coyote Creek and 8.53 and 8.51 ppb at Dumbarton Bridge and Redwood Creek, respectively. These values do not exceed the non-regulatory screening value of 14 ppb. Chlordanes results were 4.39 ppb at Coyote Creek, 14.3 ppb at Dumbarton Bridge and 8.96 ppb at Redwood Creek, these values are also below the applicable screening value of 210 ppb. DDTs were also below the 700 ppb screening value at 25 to 32 ppb. Accumulation factors ranged from 1.2 to 7. Endrin, gamma-HCH, heptachlor epoxide and hexachlorobenzene were not detected at any site (SFEI 2005).

PBDE Surface Water Results. Total and dissolved PBDE data for surface water were obtained from SFEI. Values for total PBDEs ranged from 0.04 ng/L to 0.51 ng/L. The Water and Sediment Quality Existing Conditions Report) summarizes the data [see Table A-12 in (Brown and Caldwell and others 2005)]. PBDEs are not a regulated chemical, therefore there is no applicable water quality objective. The highest concentrations were found in the far South Bay, which receives 26 percent of the wastewater treatment plant effluents in the Estuary (Oros and others 2005). Based on a study conducted at the Regional Water Quality Control Plant in Palo Alto, levels of PBDEs in plant effluent suggest that wastewater treatment plant discharges may be a significant source of PBDEs to the Estuary.

PBDE Sediment Results. Sediment PBDE concentrations were published in a paper by SFEI in 2005 (Oros and others 2005). Sediment concentrations in the South Bay ranged from below detection to 211.8 ppb. Sediment concentrations in the far South Bay ranged from below detection to 21.2 ppb. The maximum concentration in the South Bay was the maximum concentration found in the San Francisco Estuary from this data set.

PBDE Bivalve Tissue Results. PBDEs have been shown to persist in the environment and biomagnify (Oros and others 2005). In the above referenced SFEI report, tissue concentrations in bivalves (oysters, mussels, clams) was reported for one sample in the far South Bay and two samples in the South Bay. The tissue concentration found in the far South Bay sample was 23 ppb. The concentrations found in the South Bay were 40 and 20 ppb. The 2002 tissue concentrations were higher than the 2001 tissue concentrations in two of the three sampling locations.

SFEI also conducts bivalve tissue sampling as part of the RMP. In 2003, PBDE concentrations in bivalves were 31 ppb in the far South Bay and 23 and 39 ppb in the South Bay. Accumulation factors ranged from 19 to 24 (SFEI 2005).

Petroleum Hydrocarbon Surface Water Results. A small amount of petroleum hydrocarbon data were available for the regional setting. These are summarized in the Water and Sediment Quality Existing Conditions Report (Brown and Caldwell and others 2005). Analyses for gasoline were non-detect, and diesel measurements ranged from .011 to .024 mg/L. Diesel levels are well below the evaluation criterion of 200 mg/L.

Petroleum Hydrocarbon Sediment Results. SCVWD collected sediment samples from an area adjacent to Pond A8 in January and June of 2005. Samples were analyzed for total recoverable petroleum hydrocarbons (Earth Tech 2006). Samples collected in January averaged 465 mg/kg at 1.5 ft depth and 242 mg/kg at 3.5 ft depth. Samples collected in June were considerably lower averaging 1.5 mg/kg at 1.5 ft depth and 0.59 mg/kg at 3.5 ft depth.

Other Metals of Concern

Metals are a class of persistent inorganic chemicals. Metals are present in the environment due to both natural conditions and anthropogenic influences. Depending on the chemical nature of the metal, ecological risks could result from concentrations elevated above toxic thresholds or bioaccumulation levels.

RMP Sediment Results. The Water and Sediment Quality Existing Conditions Report presents a summary of the concentrations detected for the metals other than mercury (aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, silver, selenium, and zinc) included in the RMP sediment sampling (Brown and Caldwell and others 2005). The average metal concentration for each respective metal was below the ambient value. Nickel was the only metal detected above an ER-M. However, the nickel ER-M (51.6 mg/kg) is substantially less than the ambient concentration (112 mg/kg). For all but two metals, lead and silver, the ambient concentration is greater than the ER-L. Ambient concentrations and ER-Ls/ER-Ms have not been established for aluminum, iron, and manganese, while only an ambient concentration was presented for selenium.

In addition, RMP data for 2003 were released in the RMP 2003 Annual Monitoring Results report in May 2005. The mean arsenic value in sediments for the South Bay and far South Bay was below the ER-L of 8.2 mg/kg, however both had occurrences of higher concentrations that exceeded the ER-L. Concentrations of cadmium, lead, and silver never exceeded their respective ER-L. Mean copper concentrations in sediments were below the ER-L (34 mg/kg) in the South Bay but above the ER-L in the far South Bay. However, both areas had samples that exceeded the ER-L. Nickel concentrations were consistently above the ER-L (20.9 mg/kg) and the ER-M (51.6 mg/kg), but were not above the ambient concentration of 112 mg/kg. The RMP compared selenium concentrations to the ambient concentration of 0.64 mg/kg. None of the selenium values exceeded the ambient level. The typical range of zinc concentrations was below the ER-L of 150 mg/kg, however there was at least one exceedance in the far South Bay.

SCVWD Sediment Results. SCVWD sampled sediments in an area adjacent to Pond A8 in January and June of 2005 (Earth Tech 2006). Samples were collected at 1.5 and 3.5 ft depths and analyzed for arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, nickel, vanadium, and zinc in addition to the mercury analyses already discussed. Average concentrations at each depth were calculated and compared to the SQOs. Lead results exceeded the ER-M at 1.5 ft in June and exceeded the ER-L at both depths in January and at 3.5 ft in June. Nickel results exceeded the ER-M of 51.6 mg/kg in all four samples but never exceeded the ambient concentration of 112 mg/kg. Average zinc concentrations at 3.5 ft exceeded the ER-L in January and the ER-M in June.

RMP Surface Water Results. Surface water metals results were reported in the RMP 2003 Annual Monitoring Results report. Dissolved and total concentrations in the South Bay and far South Bay were reported to be below applicable water quality thresholds for arsenic, cadmium, nickel, selenium, silver, and zinc. Dissolved lead concentrations did not exceed the threshold, however one of 11 samples analyzed for total lead in the far South Bay exceeded a calculated non-regulatory freshwater effects threshold of 3.2 µg/L. No lead samples in the South Bay had exceedances. Dissolved copper and total copper both had exceedances at the same location in the South Bay. The threshold for dissolved copper is 3.1 µg/L and the threshold for total copper[1] is 3.7 µg/L. In the far South Bay, the thresholds for both dissolved and total copper are higher (6.9 µg/L and 13.02 µg/L respectively) and subsequently did not have exceedances.

City of San Jose Copper and Nickel Surface Water Results. Surface water data for copper and nickel were available from the City of San Jose. Figure 3.4-1 shows sample locations. Dissolved copper values typically ranged from 1.5 µg/L to 4.5 µg/L. The copper water quality objectives for the far South Bay, are 6.9 µg/L continuous and 10.8 µg/L maximum. Dissolved copper data did not exceed these values. Dissolved nickel values typically ranged from 2 to 8 µg/L, with some higher values. Nickel water quality objectives for the far South Bay, are 11.9 µg/L continuous and 62.4 µg/L maximum. Dissolved nickel concentrations did not exceed these values. The Water and Sediment Quality Existing Conditions Report summarizes the data (Brown and Caldwell and others 2005).

SFEI Lower Guadalupe River Storm Water Results. SFEI and USGS performed surface water monitoring on the Guadalupe River at the USGS gauge at US 101. Samples were collected and analyzed for trace metals during water years 2003 and 2004; results ranges and flow weighted means are presented in Table 3.4-4 (SFEI 2005).

Table 3.4-4 Metals Concentrations at Guadalupe River Gauge Site

METAL	2003		2004	
	RANGE (µG/L)	MEAN (µG/L)	RANGE (µG/L)	MEAN (µG/L)
Arsenic	1.4 – 4.2	2.0	1.1 – 3.8	2.0
Cadmium	0.05 – 0.7	0.21	0.03 – 0.72	0.20
Chromium	2.1 – 9.8	14.7	0.8 – 66	13.9
Copper	6.1 – 52	15.5	2.7 – 59	14.8
Lead	1.5 – 52	11.8	0.2 – 51	11.0
Nickel	3.7 – 189	28.3	1.8 – 133	26.7
Silver	0.03 – 0.27	0.06	0.02 – 0.23	0.06
Zinc	9.4 – 193	65.4	4.6 – 265	62.0

Copper concentrations generally exceed the water quality objectives for the far South Bay of 6.9 µg/L continuous and 10.8 µg/L maximum. Lead concentrations generally exceed the continuous water quality objective of 8.1 µg/L. Nickel concentrations frequently exceed the water quality objectives of 11.9 µg/L continuous and 62.4 µg/L maximum. Some high values of zinc exceed both the continuous and maximum water quality objectives of 81 µg/L and 90 µg/L, respectively.

[1] The calculated non-regulatory saltwater effects threshold.

Dissolved Oxygen

DO measurements for the South Bay were obtained from the City of San Jose. Figure 3.4-2 shows these DO concentrations from November 2002 through October 2003 and the Water and Sediment Quality Existing Conditions Report presents a table of these data (Brown and Caldwell and others 2005). Samples were taken at 12 sites in the South Bay and locations are shown in Figure 3.4-1. DO levels were primarily between 4 mg/L and 12 mg/L, with a minimum of 3 mg/L and a maximum of 15.3 mg/L. For tidal waters downstream of the Carquinez Bridge, the water quality objective is 5.0 mg/L. In sloughs and lagoons, DO regularly fluctuates on a daily cycle. The DO levels observed for both the regional and Project Setting were generally above water quality objectives, however in warm months with high biological productivity, early morning in-pond DO is often below the water quality objectives.

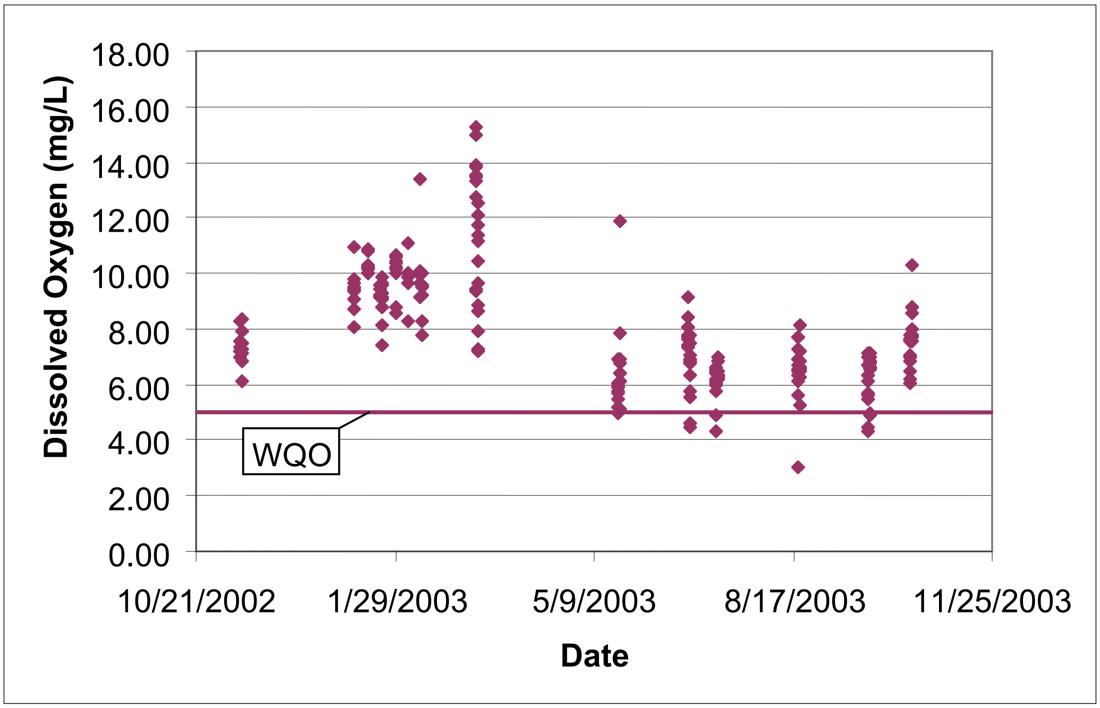


Figure 3.4-2 Dissolved Oxygen Concentrations – Surface Water

In addition, DO is monitored in the receiving waters of pond discharges as part of a self-monitoring program. These 2005 data are available on the SBSP Restoration Project website (www.southbayrestoration.org) (SBSP Restoration Project 2005). DO levels in the receiving waters of the Alviso pond complex in 2005 range from 2.13 mg/L to 9.16 mg/L, with an average level of 5.24 mg/L. DO levels in Eden Landing receiving waters for 2005 range from 2.66 mg/L to 11.75 mg/L, with an average concentration of 6.52 mg/L. In addition, data are given for Newark Slough which is between Eden Landing and Alviso. DO levels in Newark Slough ranged from 3.57 mg/L to 7.68 mg/L with an average level of 5.62 mg/L.

Salinity, Temperature, and pH

Salinity, temperature, and pH data for receiving waters of pond discharges are reported by the self-monitoring program and are available on the SBSP Restoration Project website (www.southbayrestoration.org) (SBSP Restoration Project 2005). Salinity measurements in receiving waters in the Alviso pond complex ranged from 0 ppt to 41 ppt, but averaged around 10 or 11 ppt. Salinity measurements in the receiving waters of the Eden Landing pond complex ranged from 0 ppt to 31 ppt and averaged 17 to 18 ppt. Salinity values for Newark Slough ranged from 22 ppt to 34 ppt. Average salinity in Newark Slough was 24 to 25 ppt. The average temperature in these receiving waters was 20 to 23º C. The lowest and highest temperatures occurred in Eden Landing (12ºC and 29ºC). pH levels were relatively consistent throughout the receiving waters, with an average pH between 7.8 and 8. The lowest pH (6.9) occurred in the Alviso pond complex, while the highest pH (9.1) occurred in the receiving waters of the Eden Landing pond complex.

Salinity data for the South Bay and far South Bay were also summarized in the RMP 2003 Annual Monitoring Results report. Salinity in the South Bay was reported to typically range from approximately 29 to 30 psu (practical salinity units) while salinity in the far South Bay (south of the Dumbarton Bridge) was slightly lower at approximately 26 to 29 psu. Measurements of psu are approximately equal to measurements of ppt.

USGS reported sediment salinity results from Alviso, Mallard, Mud, and Guadalupe sloughs in their 2005 Short-term data needs report. Samples were collected at three points in each slough: upper, adjacent to the ponds and at the mouth. Salinities ranged from 0.5 to 8.4 ppt Na and increased downstream (Takekawa and others 2005).

Organic Carbon

Organic carbon data in sediments and surface water were reported in the RMP 2003 Annual Monitoring Results report. Total organic carbon (TOC) in the far South Bay sediments was typically just above one percent, while TOC in the South Bay typically ranged from one percent to three percent. Dissolved organic carbon (DOC) in the water typically ranged from approximately 3,500 to 4,500 µg/L in the far South Bay and from just below 2,000 to 2,750 µg/L in the South Bay.

USGS analyzed sediments from Alviso, Mallard, Mud and Guadalupe sloughs for organic carbon in April 2004. TOC ranged from 1.00 to 4.06 percent and averaged 1.42 percent. Slough sediments were mainly silty clay loam and had higher sand and silt content than pond sediments (Takekawa and others 2005).

SFEI Lower Guadalupe River Storm Water Results. SFEI analyzed storm water from Guadalupe River for organic carbon in water years 2003 and 2004. DOC concentrations ranged from 0.9 to 18.3 mg/L and were similar between years (McKee and others 2005). The flow weighted average DOC concentration was 5.3 mg/L in 2003 and 5.9 mg/L in 2004. Particulate organic carbon (POC) concentrations ranged from 0.1 to 4.3 mg/L. The flow weighted average POC concentration was 2.3 mg/L in 2003 and 1.0 mg/L in 2004. The POC percentage ranged from 0.02 to 12.22 percent and systematically decreased with increasing suspended sediment concentration. Loads for DOC were estimated at approximately 280,000

± 50,000 kg/yr (mean ± standard error) in 2003 and 270,000 ± 50,000 kg/yr (mean ± s.e.) in 2004. POC loads were estimated at approximately 120,000 ± 23,000 kg/yr (mean ± s.e.) in 2003 and 44,000 ± 8,000 kg/yr (mean ± s.e.) in 2004.

Sediment Toxicity and Bivalve Tissue Concentrations. The RMP 2003 Annual Monitoring Results report also summarized some sediment toxicity data and tissue concentrations of several constituents in bivalve tissues.

Some of the analyzed sediments in the South Bay and far South Bay were found to be toxic. Based on the RMP report, six samples out of approximately 10 total samples were found to be toxic to one of the tested species (amphipods and mussel larvae). Toxicity tests are performed by exposing the amphipods or mussel larvae to the sediment sample for a standard period of time. The percent of organisms surviving at the end of the test is compared to those which were in a control sample (exposed to clean sediment).

The tissue concentration data in this sampling were obtained by analyzing mussels (bivalves). In addition to concentration data, accumulation factors were calculated and reported. One location in the far South Bay and two locations in the South Bay were sampled. Data were compared to California Screening Values for comparison purposes only (non-regulatory). Screening values are: 14 ppb for dieldrin, 210 ppb for total chlordanes, 700 ppb for total DDTs, and 140 ppb for total PCBs. There is no screening value for PBDEs. Tissue concentration of PCBs exceeded the screening value in all three samples. Accumulation factors were also high for PCBs. DDTs, chlordanes, and dieldrins were below the screening value. PBDE tissue concentrations ranged from 23 to 39 ng/g. Mussel tissues were analyzed for several other constituents (endrin, gamma-HCH, heptachlor epoxide, and hexachlorobenzene) but were not found to be present in detectable amounts.

Significance of Water and Sediment Quality Data Summarized for the Regional Setting. The data summarized so far present a general picture of water and sediment quality in the Regional Setting. Bioaccumulative pollutants such as mercury, PCBs, PBDEs, and legacy organochlorine pesticides are a general concern in San Francisco Bay because concentrations in fish exceed risk assessment screening levels. Mercury sources include the watershed legacy of the New Almaden mines, airborne deposition, conveyance of atmospheric loads via urban stormwater, and relatively small loads from municipal treatment plants. PCBs and organochlorine pesticides are found in Bay sediments and urban stormwater as a result of legacy usage. PBDEs are an emerging class of pollutant recently detected in fish. The Project Area is in the interface between the urban and watershed sources of these pollutants and the Bay.

This initial characterization of regional conditions summarized pre-project baseline conditions as a basis for discussing and evaluating Project impacts. It is important to recognize that pre-project conditions include exceedance of risk assessment thresholds of some bioaccumulative pollutants in fish. In contrast, the Bay is in full attainment of water quality objectives for metals and DO in the water column.

Project Setting

The Project Setting spans approximately 15,100 acres of the former Cargill Inc. (Cargill) ponds. The SBSP Restoration Project has divided these former salt ponds into the following three system complexes:

the Alviso pond complex, which comprises approximately 8,000 acres located on the southern tip of the South Bay; the Ravenswood pond complex, approximately 1,600 acres located on the west shore of South San Francisco Bay; and the Eden Landing pond complex, which comprises approximately 5,500 acres located on the east shore of the South Bay.

Sediment and water sampling activities have been conducted within each pond complex and adjacent streams and sloughs by both private and public entities, with the majority of the sampling occurring within the Alviso pond complex. The environmental setting presented below is based on data obtained from the following:

- USFWS Site Assessment – conducted in 2002 by Thomas Maurer and Terrence L. Adelsbach;
- South Bay Salt Ponds Initial Stewardship Plan – conducted in 2003 by Lisa Stallings of Life Science! Inc., Keith Miles of USGS, and Frontier Geosciences;
- SCVWD Pond A8 Assessment – conducted in 2004 by Light, Air and Space Construction (LA&S);
- Draft Final Conceptual Model Report Guadalupe River Watershed Mercury TMDL Project – prepared by Tetra Tech, Inc., July 2004;
- Progress Report for Mercury in Sediments – conducted in 2003, 2004, and 2005 by USGS and in part by Lisa Stallings of Life Science! Inc.;
- 2004 Self Monitoring Reports – submitted annually to the California Regional Water Quality Control Board (RWQCB);
- 2005 Self Monitoring Data – available on the SBSP Restoration Project website (www.southbayrestoration.org); and
- 2003 USGS Short-term Data Needs Report – sampling conducted in 2003 by USGS.

As with the regional setting, the principal contaminant of concern related to proposed restoration components, tidal wetlands and managed ponds, is mercury and its methylated form, MeHg. Therefore, the sampling activities conducted within the pond systems primarily focused on mercury and other metals. In addition, the preliminary results of the ISP sampling indicated that organic chemicals were either not detectable or were detected at concentrations similar to or below the respective ambient conditions. The Water and Sediment Quality Existing Conditions Report contains summaries of the metal data produced by the above investigations (Brown and Caldwell and others 2005). The ISP tables summarizing the available preliminary organic chemical data are included in the Existing Conditions Report.

Mercury

Mercury sediment sampling was included in each of the sampling activities listed above. These sampling results are presented below. Note that this is simply a summary of the site-specific data available for mercury at the time of this analysis. A more detailed assessment of mercury cycling is presented in Appendix K, the Mercury Technical Memorandum.

USFWS Site Assessment Sediment Results. In July 2002, USFWS sampled sediment cores collected from Ponds A1, AB1, A5, A9, A10, and A16 within the Alviso pond complex. The sediment samples represented the upper 10 to 15 centimeters (cm) of surface sediment. THg concentrations detected in these samples ranged from 0.2 to 1.2 parts per million (ppm), with an average concentration of 0.5 ppm; 1 ppm = 1 mg/kg. The mean total mercury concentrations for each pond in ascending order are: Pond A1, 0.31 ppm; Pond A5, 0.37 ppm; Pond A9, 0.48 ppm; Pond A16, 0.53 ppm; Pond AB1, 0.56 ppm; and Pond A10, 0.92 ppm. Eleven out of the 18 samples collected contained mercury above the ambient value (0.43 ppm), and four samples contained mercury above the ER-M (0.71 ppm). These analytical results are summarized in the Water and Sediment Quality Existing Conditions Report (Brown and Caldwell and others 2005).

ISP-Frontier Geoscience Sediment Results. In 2003, Frontier Geosciences collected sediment samples from 16 salt ponds within the three pond systems: Alviso pond complex, A2E, A3N, A7, A8, A10, A11, A12, A13, A14, A16; Eden Landing pond complex, E2, E6A, E11, E12[2]; and Ravenswood pond complex, R2 and R4. Pond A8 specifically may have elevated levels of mercury due to periodic flooding and sediment deposition from the Guadalupe River roughly once every ten years (Stallings 2004). The sediment cores collected represent two depth ranges, from the surface to five cm deep (surface samples) and from 15 to 20 cm deep (subsurface samples

The ISP-Frontier Geosciences study mercury results are summarized in the Water and Sediment Quality Existing Conditions Report (PWA and others 2005) and averages are shown on Figures 3.4-3 and 3.4-4. For comparison purposes, Figures 3.4-3 and 3.4-4 include the current ambient level of THg in sediments in San Francisco Bay of 0.43 ppm. The average MeHg results are shown on Figures 3.4-5 and 3.4-6. These figures are based on preliminary data compiled by Ms. Lisa Stallings (Life Science!) and Dr. Keith Miles (USGS), who are performing a more comprehensive evaluation of the data. These figures represent the average concentration for each pond. The error bars represent one standard deviation, and while estimated from a relatively small data set, the size of the error bars are a rough indicator of the spatial variation of mercury concentrations within a given pond. Due to statistical limitations, error bars are not included for ponds where $n < 3$.

THg. The ISP-Frontier Geosciences data indicated that sediments within the Eden Landing and Ravenswood pond complexes have average mercury concentrations ranging from 0.05 to 0.15 ppm, which are below the ambient mercury level (0.43 ppm). They are also below both the mercury ER-L and ER-M of 0.15 and 0.71 ppm, respectively. Most ponds in these areas have slightly higher levels of mercury in the subsurface sediments except for Pond E11, which appears to have substantially higher mercury concentrations in surface sediments (0.16 ppm surface versus 0.05 ppm subsurface). Error bars for all ponds are fairly small indicating little spatial variability in mercury levels within the ponds.

[2] Earlier reports refer to ponds in the Eden Landing Complex as B2, B6A, B11, and B12, from the name "Baumberg Ponds." To be consistent with current maps, the E2, E6A, E11, and E12 nomenclature is used in this report.

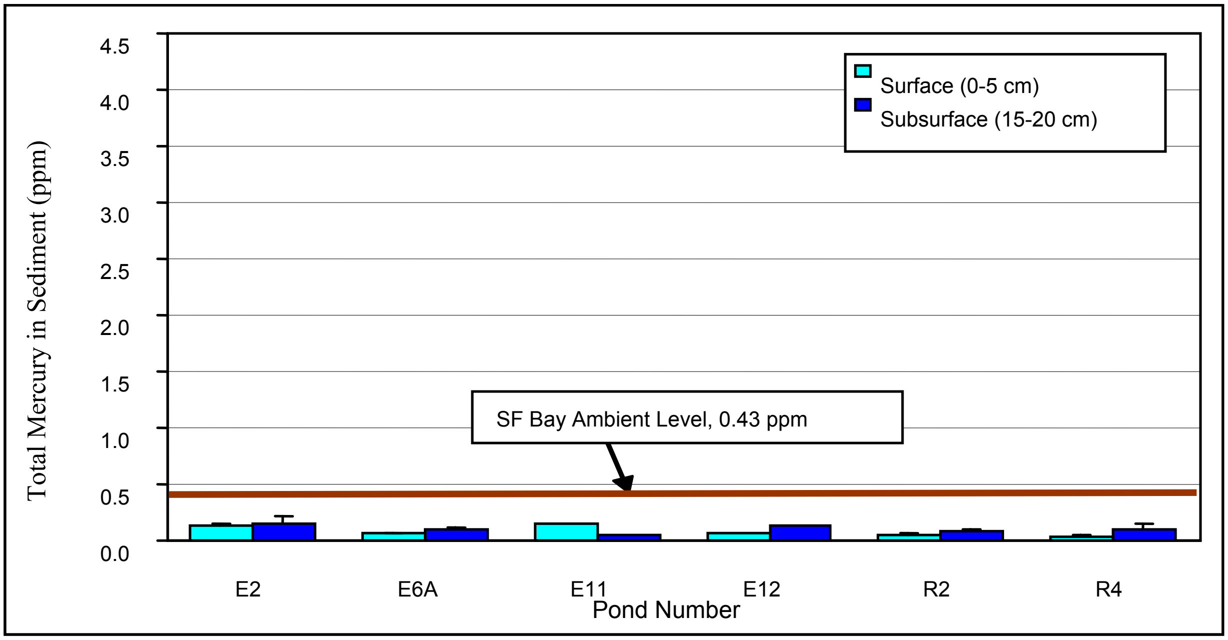


Figure 3.4-3 THg in Eden Landing (B) and Ravenswood (R) Ponds

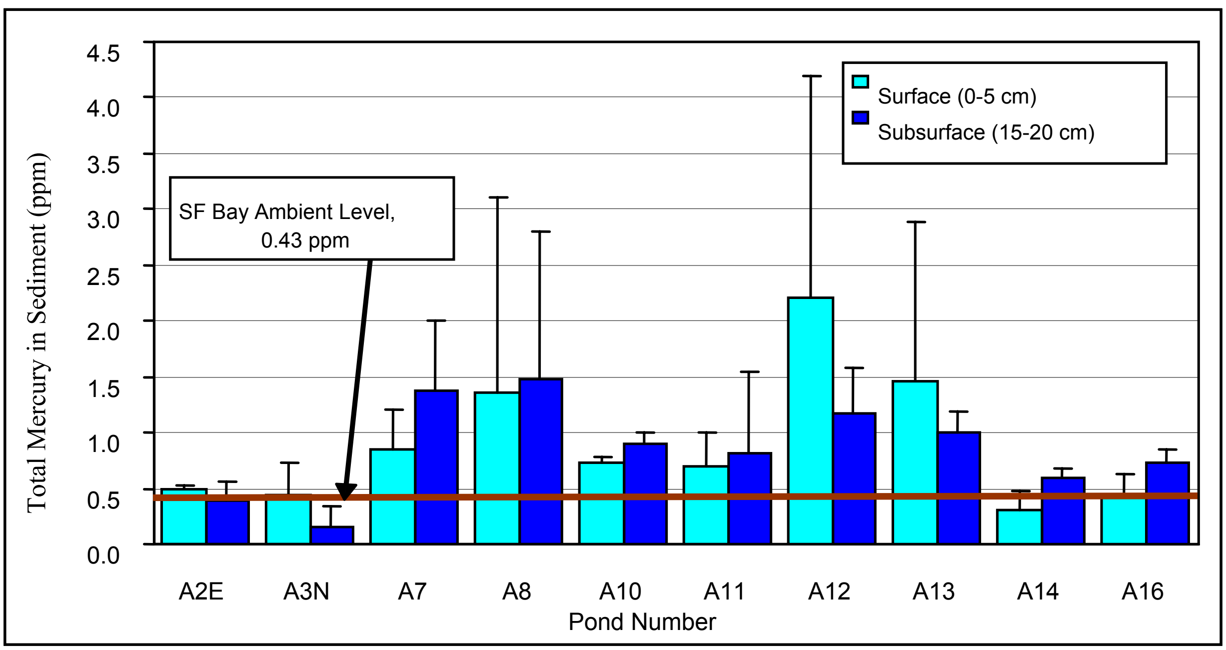


Figure 3.4-4 THg in Alviso Ponds

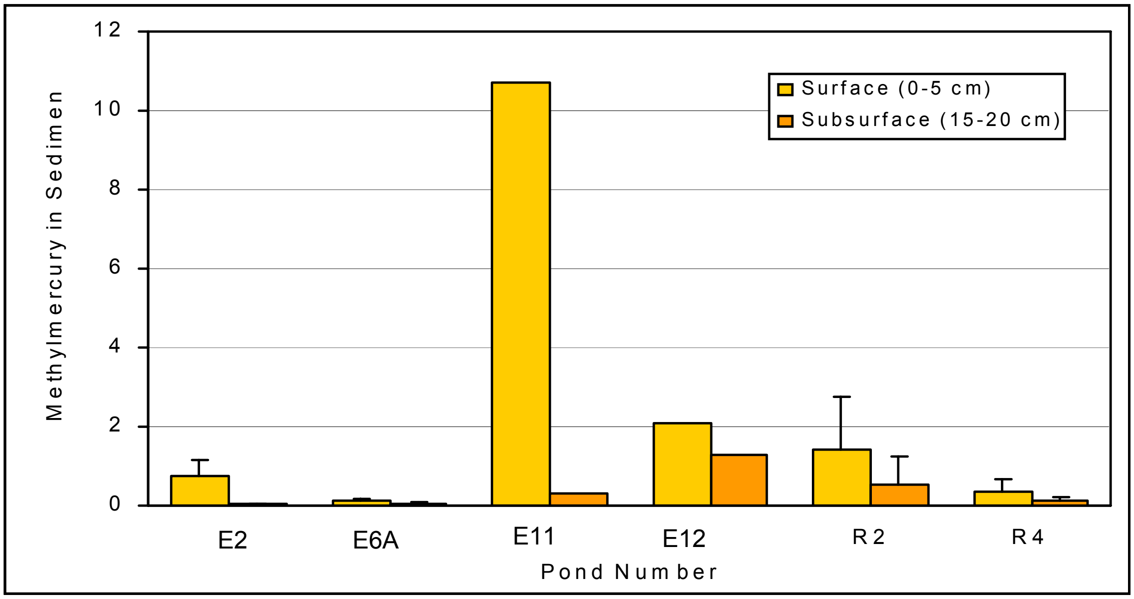


Figure 3.4-5 MeHg Eden Landing (B) and Ravenswood (R) Ponds

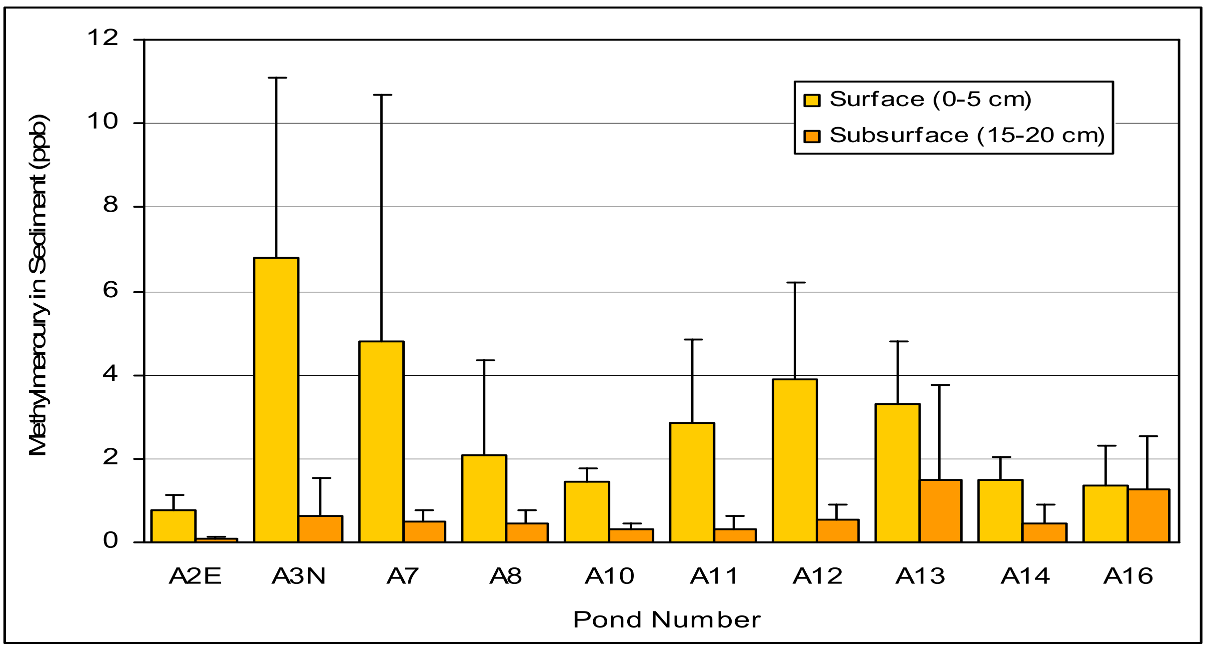


Figure 3.4-6 MeHg in Alviso Ponds

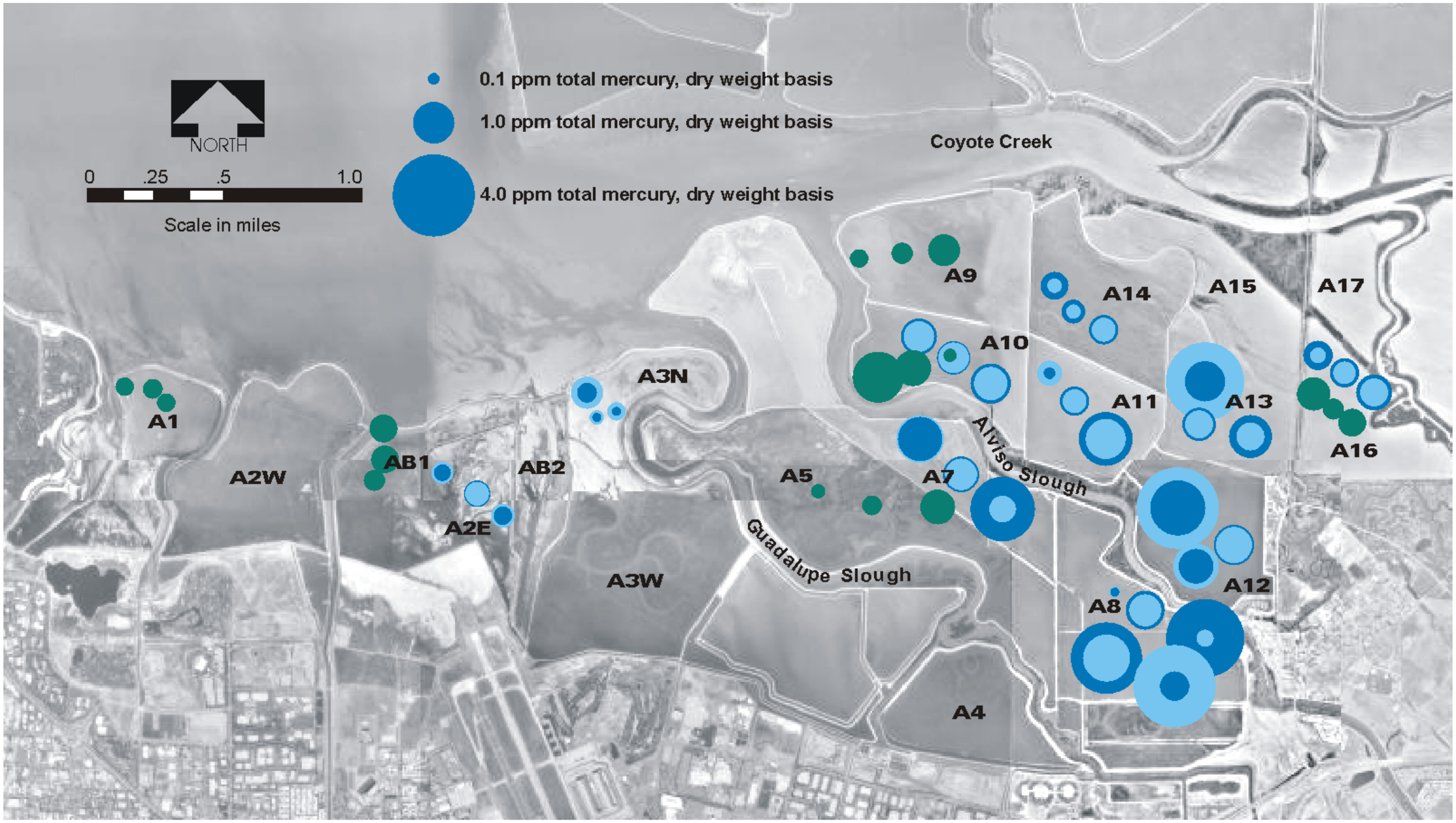
In contrast to the Eden Landing and Ravenswood pond complexes, the ISP-Frontier Geoscience data indicate that sediments from the Alviso ponds are generally elevated above the ambient mercury level. There is no obvious trend with respect to mercury in the surface samples versus the subsurface samples. The highest mercury concentrations, as well as the highest level of spatial variability within the ponds, are in Ponds A7, A8, A12, and A13. While the graphs represent average concentrations, peak concentrations of mercury in individual samples were 3.2 and 4.4 ppm in Pond A8, 4.5 ppm in Pond A12, and 3.1 ppm in Pond A13. Ponds that are under the influence of the Alviso Slough, the discharge point for the Guadalupe River, appear to have elevated mercury levels in sediment that are on average two to five times the ambient level.

Aside from Ponds A2E, A3N, and A14, all ponds had sediment samples that exceeded the ER-M screening guideline of 0.71 ppm. However, since THg and MeHg levels in sediment do not correlate with each other (see MeHg sub-section below), and since MeHg levels are a better indicator of the potential to contaminate biota, the elevated THg levels in some Alviso Ponds are not necessarily a concern from the standpoint of mercury levels in organisms. The elevated mercury levels do not vary considerably from other South Bay sediments. Previous studies in the South Bay report sediment mercury concentrations in the lower Guadalupe River ranging from 1 to 10 ppm, with a median of 2.5 ppm, and in the Alviso Slough ranging up to 1.1 ppm, with a median of 0.8 ppm (Maurer and Adelsbach 2002).

MeHg. Sediments from the Eden Landing and Ravenswood pond complexes generally have average MeHg concentrations below 2 ppb, with the notable exception in Pond E11, which has MeHg concentrations in surface sediment of 10.7 ppb; 1 ppb = 1 μg/kg. Average MeHg levels in the Alviso Ponds range from 0.8 to 6.8 ppb in surface sediment and from 0.1 to 1.5 ppb in subsurface sediment. In all but one sample, methlymercury levels are higher in the biologically active surface sediment compared to the subsurface sediment, which is indicative of the biological origins of MeHg. The highest average MeHg concentrations in surface sediment, as well as the highest level of spatial variability within the ponds, are in Ponds A3N, A7, A11, A12, and A13. While the figures represent averages, peak concentrations of MeHg in individual surface sediment samples were 11.6 ppb in Pond A7, 10.9 and 10.5 ppb in Pond E11, 6.1 ppb in Pond A8, and 6.0 ppb in Pond A12.

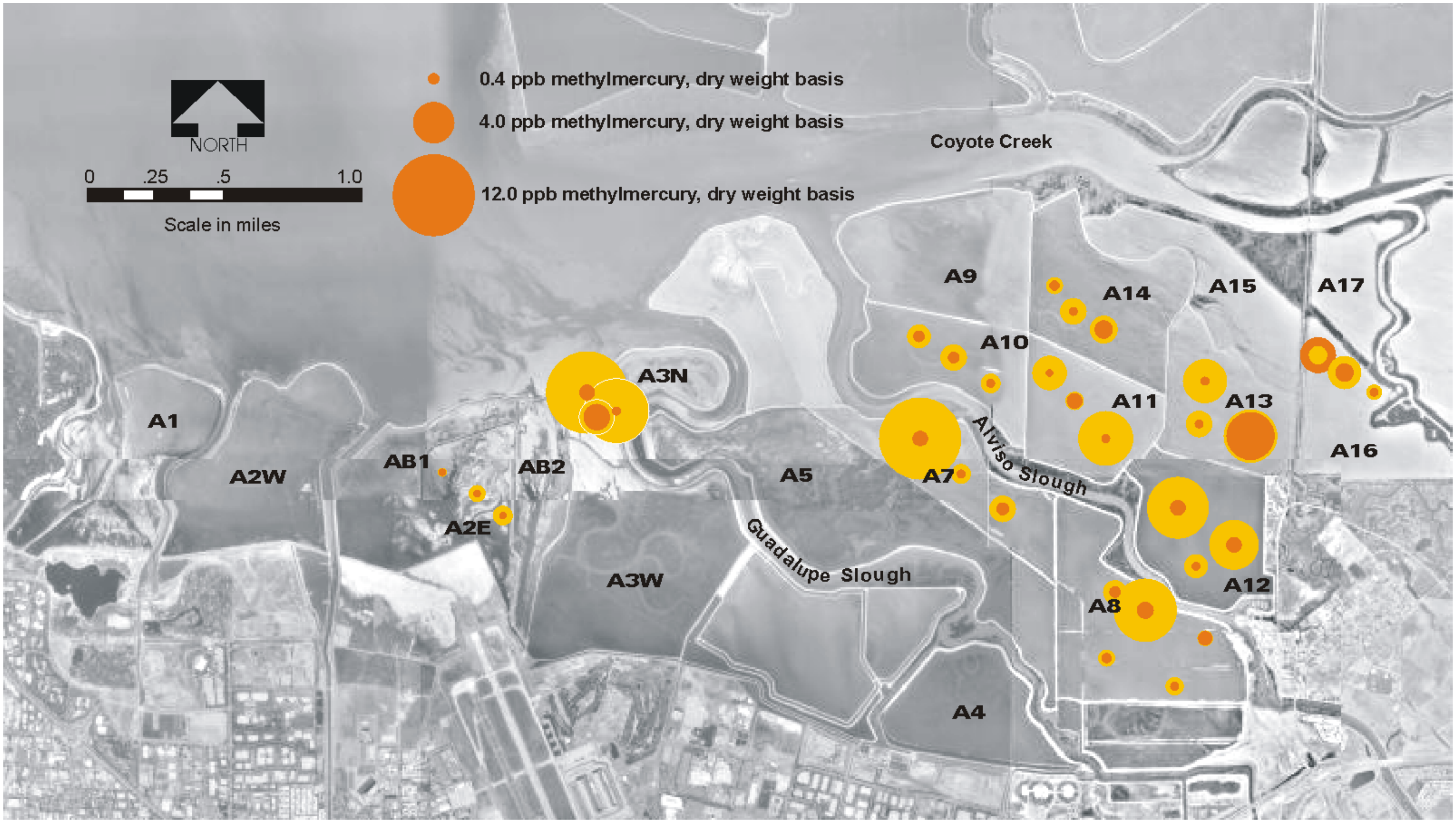
Based on the dataset presented here, there is little correlation between THg and MeHg, thus THg in sediment does not appear to be a key factor controlling sediment MeHg. This lack of correlation is typically the case for moderately contaminated areas (Henry and others 1993) and points to the fact that other environmental factors control mercury methylation.

Spatial Distribution of Mercury in Alviso Ponds. Figures 3.4-7 and 3.4-8 show the spatial distribution of mercury and MeHg in sediments in the Alviso Ponds collected for the ISP-Frontier Geosciences investigation. Figure 3.4-7 also includes data from the USFWS Site Assessment (Maurer and Adelsbach 2002). Note that the ISP data points in the figures do not correspond exactly with the sample location within each pond. As can be seen from the figure, there is a clear spatial pattern with the highest mercury sediment concentrations (Ponds A7, A8, A12, and A13) located adjacent to Alviso Slough, the current



Surface sediment samples (0 to 5 cm) collected during 2003 ISP monitoring. Location of circle does not correspond to location of sample.
Subsurface sediment samples (15 to 20 cm) collected during 2003 ISP monitoring. Location of circle does not correspond to location of sample.
Sediment sediment samples (0 to ~10 cm) reported by Maurer and Adlesbach (2002). Location of circle corresponds to location of sample.
Figure modified from Maurer and Adlesbach (2002)

Figure 3.4-7 Spatial Pattern of Sediment THg in Alviso Ponds



Surface sediment samples (0 to 5 cm) collected during 2003 ISP monitoring. Location of circle does not correspond to location of sample.

Subsurface sediment samples (15 to 20 cm) collected during 2003 ISP monitoring. Location of circle does not correspond to location of sample.

Figure 3.4-8 Spatial Pattern of Sediment MeHg in Alviso Ponds

discharge point for the Guadalupe River. Note that mercury concentrations reported in the USFWS Site Assessment and the ISP-USGS/Life Science! sampling for Ponds A10 and A16 are relatively similar in magnitude, an observation that supports the validity of the ISP-Frontier Geosciences data.

As shown in Figure 3.4-8, elevated MeHg concentrations occur in surface samples from Ponds A3N and A7, and moderate concentrations occur in Ponds A8, A11, A12, and A13. Ponds A2E, A10, and A14 consistently have low concentrations of MeHg (< 1 ppb). Some ponds, such as A7 and A8, exhibit high spatial variability. Surface sediments contain higher levels of MeHg than subsurface samples, and there is little correlation between mercury and MeHg levels in sediment. Because there are striking spatial differences in MeHg concentrations in sediments between some ponds, further study of environmental conditions in the ponds during MeHg sampling may indicate what environmental parameters control or enhance mercury methylation. Note that Figures 3.4-7 and 3.4-8 do not include the Ravenswood or Eden Landing ponds complexes, nor Pond E11, which also has elevated levels of MeHg in surface sediment (10.9 and 10.5 ppb). It should be noted that this is a preliminary assessment based on a small number of samples (1–3) per pond.

ISP-USGS/LifeScience! Sediment Results. USGS and Life Science! collected sediment samples from 19 ponds within the three pond complexes. The Water and Sediment Quality Existing Conditions Report presents a summary of the analytical results, including mercury (Brown and Caldwell and others 2005). The mercury concentrations and trends reported for this sampling activity were similar to those reported for the ISP-Frontier Geosciences study, and therefore, no additional discussion is presented. Further information regarding these results can be found in the ISP (USFWS and CDFG 2003).

SCVWD Pond A8 Assessment Results. The SCVWD collected sediment samples from Pond A8 and Pond A8S, a small pond to the south of Pond A8, and analyzed the samples for THg, MeHg, sulfate, pH, and total organic carbon. Samples consisted of the upper six inches of pond sediments. Mercury results are summarized in the Water and Sediment Quality Existing Conditions Report (Light Air and Space Construction (LA&S) 2004). THg ranged from non-detect (0.02 ppm) to 1.7 ppm in Pond A8 and from non-detect (0.02 ppm) to 0.72 ppm in Pond A8S. MeHg ranged from 0.02 to 12.1 ppb in Pond A8 and from 0.045 to 0.76 ppb in Pond A8S. (Note that there is no clear correlation between THg and MeHg concentrations in the sediments. THg levels observed in Pond A8 in the SCVWD study appear to be less than half the levels observed in the ISP-Frontier Geoscience study). This may be an artifact of high spatial variability within the pond. MeHg concentrations reported in Pond A8 in the two studies were comparable averaging around 1 to 2 ppb and generally ranging from 0.1 to 2 ppb. Peak MeHg concentrations ranged from 6 to 12 ppb.

Progress Reports for Mercury. Additional data for THg and MeHg concentrations in the sediments was available from two Progress Reports for Mercury in Sediments dated January and May of 2005 (Miles and others 2005a; Miles and others 2005b). The analytical data, data analyses, and sample locations are available in these reports. Data were taken from all three pond complexes: Ravenswood, Eden Landing, and Alviso. The most recent report summarizes data from 2003, 2004, and 2005. In Alviso, data from three ponds (A12, A13, A8) exceeded the US EPA criteria for contaminated sediments (1.0 mg/kg), and four additional ponds (A7, A10, A11, A2W) exceeded the ER-M of 0.71 mg/kg. Ponds in the Alviso pond complex consistently exceeded the ER-L (0.15 mg/kg), except for Pond A21. There were no ponds in Eden Landing that exceeded the US EPA criteria or the ER-M, and there were only two occurrences of an ER-L exceedance. THg data from the Ravenswood ponds were below all three of these regulatory criteria. The study found that the THg data did not differ substantially by season. Samples for MeHg were generally lower in Eden Landing and Ravenswood than in Alviso. The average MeHg concentrations were 1.7 ng/g for Eden Landing and 2.6 ng/g for Alviso. The average MeHg concentration in Ravenswood was 0.510 ng/g in surface sediments and 0.164 ng/g in sediment 15 to 20 cm deep. Although some variations were seen over different seasons, the study concluded that MeHg levels did not differ substantially across the seasons. Data analyses performed as part of the study showed that the amount of MeHg making up the total amount of THg ranged from 0.2 percent to 6.9 percent in Eden Landing and 0.03 percent to 1.5 percent in Alviso. The percentage of MeHg was not calculated for Ravenswood.

Based on the findings presented, mercury is of great concern but is not a “fatal flaw” for the SBSP Restoration Project. If it were a “fatal flaw”, restoration should not proceed at all. While the science of mercury cycling is still under development, it is likely that ongoing and future studies of mercury cycling in the San Francisco Bay-Delta will provide managers with the information needed to design and manage the restoration to minimize the impacts of mercury on biota, while obtaining important habitat benefits for wildlife. In addition, using effective adaptive management decisions as presented in the Mercury Technical Memorandum should mitigate production and bioaccumulation of MeHg.

Surface Water Results. A preliminary estimate of movement of mercury in the Guadalupe River watershed was conducted as part of the Guadalupe River TMDL Project (Tetra Tech Inc. 2004). The watershed was divided into five groups of water bodies including the Guadalupe River from St. Johns Street to Alviso Slough (Project Reach). Estimates of both total and MeHg concentrations were determined for a typical mid-summer day and a large storm event in the winter. For the Project Reach, the mid-summer day THg concentration is estimated at 26.2 ng/L. This is just slightly higher than the threshold of 25 ng/L. Mid-summer methylmercury data were not available. Detailed data were not available for wet-season flows (Tetra Tech Inc. 2004), but estimates were made using flow data following a large storm, and wet-season mercury data from Thomas, and others (2002). Because the average flows during this storm were very high, the estimated sediment load is also estimated to be high: 28,000 tons per day total load, including 1,700 ton/day of bed load. The bed load refers to the material that is transported along the bottom of the river, as opposed to sediments that are suspended in the water. At this sediment transport rate, assuming a mercury concentration of 0.8 mg/kg (Thomas and others 2002), the calculated mercury load during high flow periods is estimated to be 24,000 g/day, of which 1,400 g/day is transported by bed load. A storm of this magnitude occurs at a frequency of one such storm every five years in the Guadalupe watershed and the mercury load estimate is biased high (Tetra Tech Inc. 2004). Nevertheless, this calculation underscores the point that loads transported during high flow events can dwarf loads estimated for the dry season.

Daily suspended sediment and bed load transported by the river were also calculated using historical daily USGS streamflow data available from 1950 to 2001. Making similar assumptions as above, the estimated bed load of mercury ranges from 300 g/year to 66,000 g/year, while the estimated suspended sediment load of mercury ranges from 1,600 to 890,000 g/year. Winter flows appear to deliver practically the entire total mercury load transported downstream into the SBSP Restoration Project Area.

Mercury surface water data were also obtained from the 2004 Self-Monitoring Reports (CDFG 2005; USFWS 2005). The THg water quality objective[3] of 25 ng/L was exceeded one time in Eden Landing pond E10 at a concentration of 27.6 ng/L. There were no mercury exceedances in the Alviso pond complex.

Other Metals of Concern

Sediment Results. Four of the five investigations referenced in the Project Setting included sediment sample analysis for additional metals. The USFWS study also analyzed aluminum, arsenic, boron, barium, cadmium, chromium, copper, iron, lead, magnesium, manganese, molybdenum, nickel, selenium, strontium, vanadium and zinc. The ISP-Frontier Geosciences analyzed additionally for arsenic, selenium, nickel, and cadmium. The ISP-USGS/LifeScience! analyzed additionally for arsenic, cadmium, chromium, copper, lead, nickel, selenium, silver, and zinc. Arsenic and selenium data for the Alviso pond complex was reported in the Progress Report for Mercury in Sediments report (Miles and others 2005b).

The analytical metal results for the first three studies are summarized in the Water and Sediment Quality Existing Conditions Report [see Tables A-6, A-7 and A-8, respectively, in (Brown and Caldwell and others 2005)]. In general, the average metal concentrations detected in the Project Setting were similar to their respective ambient value. The spatial distribution of the metals within each pond system was varied. Only nickel was detected at concentrations greater than an ER-M, however, the nickel ER-M is less than one-half the ambient nickel concentration. The metal concentrations detected in the Alviso pond complex sediment samples were also found to be within the general range of ambient concentrations found in the surrounding area, including the Guadalupe River (USFWS and CDFG 2003).

Surface Water Results. Total recoverable and dissolved metals were also reported for surface water in the ISP-Frontier Geosciences report. Samples were analyzed for arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc. These analytical metal results are summarized in the Water and Sediment Quality Existing Conditions Report [see Tables A-15 and A-16 in (Brown and Caldwell and others 2005)]. In general, metal concentrations were relatively low. However, dissolved nickel consistently exceeded the water quality objective. Dissolved arsenic also exceeded the water quality objective in one out of 11 ponds (A18). Total recoverable mercury exceeded water quality objectives in three out of 11 ponds (Figure 3.4-9). There were no other water quality objective exceedances for metals in the Project Setting.

[3] The original report cited has units of µg/L, not ng/L. This was determined to be a typographical error after discussion with the report authors.

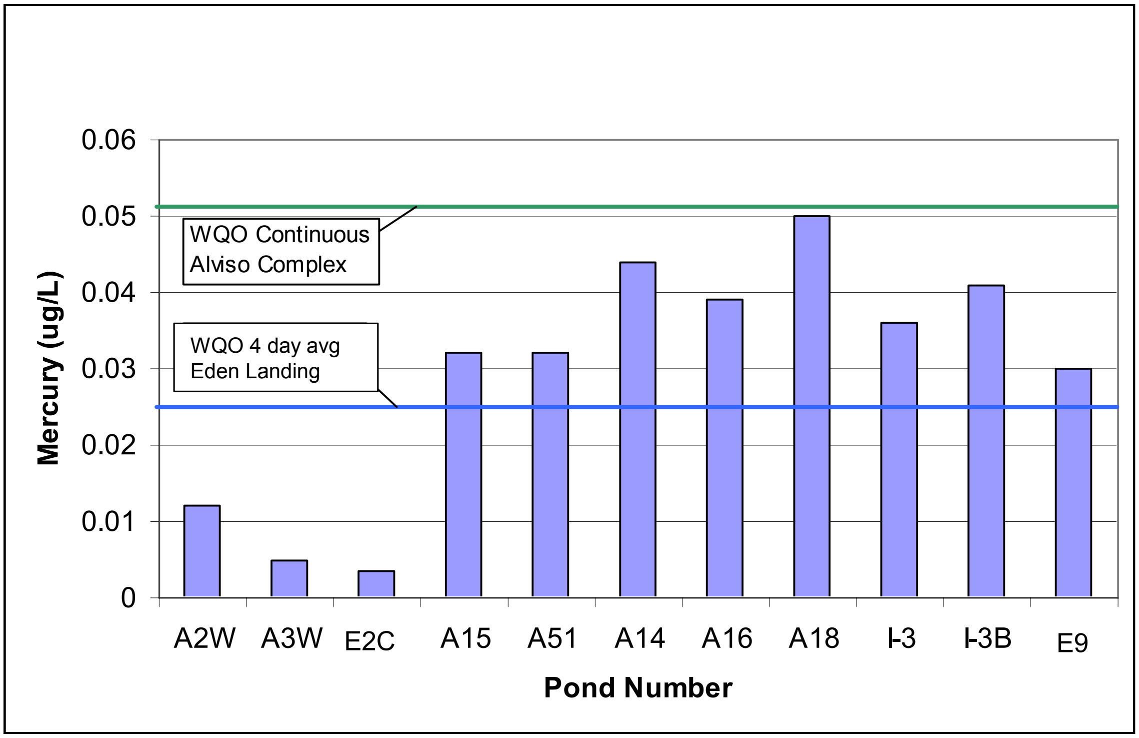


Figure 3.4-9 Total Mercury Concentrations – Site Setting

Metals data were also obtained from the 2004 Self-Monitoring Reports (CDFG 2005; USFWS 2005). Samples were monitored for chromium, nickel, copper, zinc, arsenic, selenium, silver, cadmium, mercury, and lead. Exceedances of water quality objectives were reported at Eden Landing for the following metals and the sample concentration is given in parentheses: chromium (27.00 µg/L), copper (14.00 µg/L), and lead (27.60 µg/L). Discharges analyzed for metals at Alviso were reported to meet all water quality objectives.

Dissolved Oxygen

A study in September 2003 monitored DO levels in five ponds (Ponds E2 and E4 in the Eden Landing pond complex, and Ponds A3W, A2E, and A13 in the Alviso pond complex). DO levels vary throughout the day due to varying rates of algal photosynthesis and respiration. The applicable water quality objective for this area is typically 5.0 mg/L, although if the waters are nontidal and designated as cold water habitat, the water quality objective is 7.0 mg/L. Samples were taken in the mid-afternoon (DO levels typically highest), at dusk (DO levels begin decreasing), and at dawn (DO typically lowest). As expected, dawn samples were lowest, with 7 out of 16 Alviso samples and 13 out of 20 Eden Landing samples showing DO levels below 5 mg/L.

DO data also were obtained from the 2004 Self-Monitoring Reports (CDFG 2005; USFWS 2005). DO levels for self monitoring are required to be above 5 mg/L at all times. DO level requirements were not met at Eden Landing in Pond E2 30 percent of the days and in Pond E10 approximately 53 percent of the days. DO levels were also consistently below 5 mg/L at the Alviso ponds. DO levels showed a strong daily pattern of being higher during mid-day and lower near dawn in both Eden Landing and Alviso.

The 2005 self-monitoring data are also available on the SBSP Restoration Project website (www.southbayrestoration.org) for Alviso ponds A2W, A3W, A7, A14, A16 (SBSP Restoration Project 2005). Average DO levels range by pond from 4.24 mg/L in Pond A7 to 6.65 mg/L in Pond A16. DO levels have reached as high as 19.2 mg/L (Pond A16) and dropped as low as 0 or 1 mg/L in every pond.

USGS measured DO in 53 ponds as part of their monthly point sampling. Data are available from August 2003 to March 2006. Results ranged from 0.09 to 26.11 mg/L. It is not clear what time of day the measurements were made and no obvious trends were reported (Miles and others 2004)

Salinity, Temperature, pH

USGS measured salinity, temperature, and pH at 53 ponds during monthly point sampling from August 2003 to March 2006. Ranges were similar at each pond complex with the lowest being 4.14 ppt at Alviso and the highest being 456 ppt at both Alviso and Ravenswood. Temperatures ranged from 5.36 to 36.83 degrees Celsius and pH ranged from 5.90 to 11.85. Temperatures followed a seasonal signal with the highest values in the summer. Salinities were influenced primarily by rainfall during the wet season and evaporation and water transfers during the dry season. Highest salinities were typically seen during the late summer and fall. (Miles and others 2004)

Additional salinity data from the 53 ponds were collected by USGS during benthic grab sampling from March to June 2003 and March to April 2004. Salinity in Alviso ponds ranged from 27 to 252 ppt and averaged 93 ppt. Salinity in Eden Landing ponds ranged from 41 to 175 ppt and averaged 79 ppt. Ravenswood pond salinities ranged from 92 to 327 ppt and averaged 272 ppt

Salinity, temperature, and pH data are also available through the 2004 Self-Monitoring Reports (CDFG 2005; USFWS 2005). Salinity in discharged waters is required to be less than 44 ppt, and temperature is not allowed to exceed receiving water temperatures by more than 20ºF. In Eden Landing, there were no reported salinity or temperature exceedances during 2004. Salinity at Alviso Pond A7 was initially high when the pond was first opened to the Bay, but eventually fell to below 35 ppt. Overall salinities in Alviso ponds are now below 44 ppt. There were no reported temperature exceedances at Alviso during 2004. Eden Landing pH levels were generally within the required range (6.5 to 8.5) although after initial start up operations Pond E2 showed a pH of 8.6 for approximately two weeks. In Alviso, pH levels were generally above the 8.5 limit.

The 2005 self-monitoring data are also available on the SBSP Restoration Project website (www.southbayrestoration.org) for Alviso Ponds A2W, A3W, A7, A14, A16 (SBSP Restoration Project 2005). Salinity measurements ranged from 3.94 ppt to 70.74 ppt, but averaged from 12.99 ppt in Pond A3W to 42.36 ppt in Pond A14. These data show that temperature in the ponds for 2005 has averaged between 19º and 22º C, with a minimum of 12º C and a maximum of 31º C. Average pH levels have consistently been just above the 8.5 requirement in most ponds. The minimum pH detected has been 7.63, and pH has reached a maximum of 9.88.

Nutrients and Chlorophyll-a

Chlorophyll-a (chl-a) is an indicator of the phytoplankton levels in surface water. USGS sampled ponds in all three complexes for chl-a from April to June 2003 (Miles and others 2004). In Alviso ponds, chl-a ranged from 0 to 380 mg/m^3 and averaged 137 mg/m^3. Chl-a in Eden Landing and Ravenswood ponds was lower, ranging from 0 to 187 mg/m^3 and averaging 24 mg/m^3 at Eden Landing and ranging from 0 to 65 mg/m3 with an average of 16 mg/m^3 at Ravenswood.

USGS results for nutrients include nitrogen as nitrate and ammonium, and total and soluble phosphorus. Nitrogen results were generally low and comparable to unpolluted surface lake water. However, low nitrogen concentrations may simply reflect rapid uptake by algae, meaning that a pool of nitrogen is available. As noted above, nutrients are generally not the limiting factor controlling the timing and magnitude of algal blooms in San Francisco Bay.

Dioxin and Furans

Analytical data for dioxins and furans are only available for surface water. Therefore, dioxin and furan data in sediment are not discussed.

A limited amount of data for dioxins and furans was reported in the ISP and is summarized in the Water and Sediment Quality Existing Conditions Report (Brown and Caldwell and others 2005). Values ranged from 0.023 pg/L in the Alviso pond complex to 1.34 pg/L in Eden Landing. Water quality objectives for dioxins and furans are based on a 10^{-6} risk for human health for consumption. The applicable water quality objective for consumption of organisms is 0.014 pg/L. The available data exceed the water quality objective.

Benthic Community

USGS conducted benthic grab sampling in the ponds in March and June 2003 (Brown and Caldwell and others 2005). Fifty-eight different taxonomic groups of macroinvertebrates were identified, most at the family and genus levels. The most abundant group was Crustacea with seventeen different taxa found, followed by Annelida with twelve different genera. Annelids were mainly found in ponds with salinity less than 60 ppt. Five species of bivalves and nine insect families were also identified.

Ponds with lower salinity were greater in species richness. The data indicate a positive correlation between insect taxa and salinity and between brine shrimp and salinity. Negative correlations are indicated between other crustaceans and annelids with salinity.

Significance of Water and Sediment Quality Data Summarized for the Project Setting. The data summarized above present a general picture of water and sediment quality in the Project Setting. As with the Regional Setting, the most significant water quality issue of concern is bioaccumulation of pollutants such as mercury, PCBs, PBDEs, and legacy organochlorine pesticides. Exceedance of water quality objectives for other metals is generally not an issue under baseline conditions. In contrast to the regional setting, low DO is already known to be a concern in some ponds under baseline (ISP) conditions.

Adaptive management strategies for managing issues of concern, including mercury bioaccumulation and DO, are discussed under the relevant impacts below.

3.4.2 Physical Setting – Groundwater Quality

Methodology

This section characterizes the existing physical setting of the South San Francisco Bay with respect to groundwater hydrology and quality conditions. The physical setting is described at both the regional and Phase 1 Project levels, including the geology, groundwater hydrology, water usage, groundwater management, and groundwater quality, including salinity intrusion issues.

This section summarizes the groundwater hydrology and quality of the SBSP Restoration Project. Portions of the Santa Clara Valley are included in the Project Area, which are part of the San Francisco Bay Hydrologic Region (California Department of Water Resources [DWR] 2003). The SBSP Restoration Project Area includes portions of the following four groundwater subbasins of the Santa Clara Valley Groundwater Basin (DWR# 2-9, as shown in Figure 3.4-10):

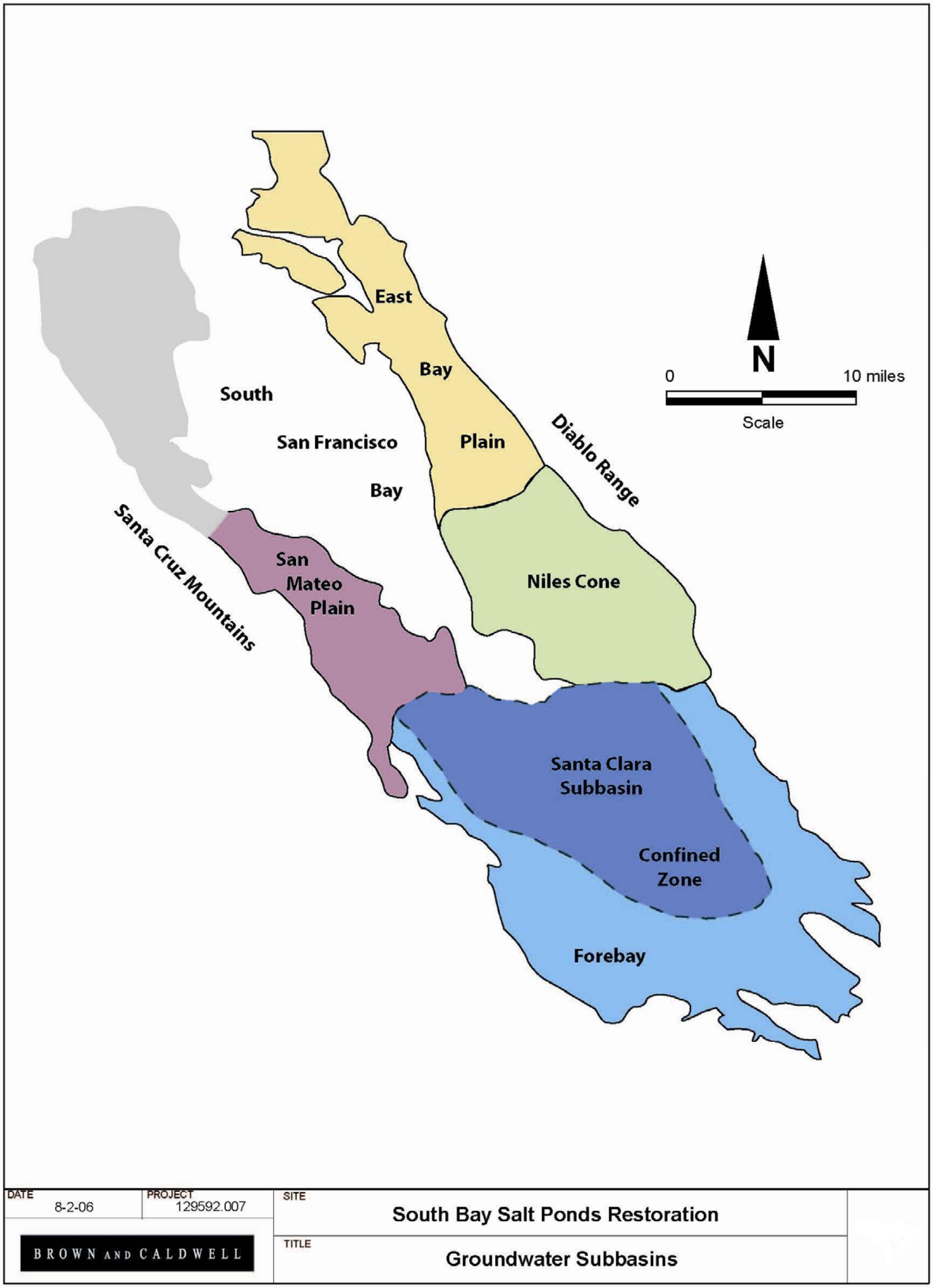
- Santa Clara (# 2-9.02);
- San Mateo Plain (# 2-9.03);
- Niles Cone (# 2-9.01); and
- East Bay Plain (# 2-9.04).

The Alviso pond complex is primarily within the Santa Clara Subbasin, but the northeastern portion is part of the Niles Cone Subbasin (Coyote Creek is the boundary). The Ravenswood pond complex is located within the San Mateo Plain Subbasin. The Eden Landing pond complex straddles Old Alameda Creek, which forms the boundary between the Niles Cone and East Bay Plain Subbasins.

Five main factors ultimately control whether the likelihood of an increased potential for saltwater intrusion would actually occur as a result of the Project and are thus discussed in the regional and Project Settings below:

- **Geology** – controls the permeability of the sediments and thus the rate of surface water infiltration and groundwater flow in the subsurface;
- **Groundwater hydrology** – primarily reflected in water levels, which control the relative hydraulic heads between surface water and groundwater (and between groundwater at different locations or depths) and thus the direction of flow;
- **Groundwater quality** – primarily salinity, since concentration contrasts between two water bodies are required for an impact to occur from flow;

Figure 3.4-10 Groundwater Subbasins



Note: Different colors signify distinct sub-basins denoted in figure text

- **Artificial pathways** – Man-made conduits for preferential flow (primarily created through dredging or improperly constructed or abandoned wells) that short-circuit natural geologic barriers; and
- **Groundwater management** – groundwater data collection, evaluation, and actions to preserve and protect a basin's groundwater resource (both quantity and quality).

All five of the above factors are summarized in this section to provide the basis for the environmental impacts analysis below. More detailed analysis and illustrative examples are included in Appendix L, the Groundwater Analysis Report.

Regional Setting

Geology

The San Francisco Bay Area is located at the boundary between the Pacific and North American plates, two large crustal plates that are separated by the north-northwest trending San Andreas Fault (and related sub-parallel faults including the Hayward and Calaveras faults). The north-northwest-trending faults largely define the boundaries between the uplifted bedrock mountain ranges and the down-dropped Southern San Francisco Bay within the sediment-filled Santa Clara Valley Basin.

Geologic units are classified according to geologic time periods. The most recent time period is the Quaternary Period which covers from 1.8 million years ago to present. The Quaternary Period is subdivided into the Pleistocene Epoch (1.8 million years ago to 11,000 years ago) and the Holocene Epoch (11,000 years ago to present). The Pleistocene includes a number of world-wide glacial (relatively cold) periods of low sea level stands, when sea level was typically two to three hundred ft below present. During these glacial periods the shoreline was tens of miles west of the Golden Gate, and non-marine deposition predominated in the region. The two most recent and significant interglacial (relatively warm) periods with high sea level stands when estuarine (bay) muds have been deposited in San Francisco Bay are the Sangamon (70,000 to 130,000 years ago) and the Holocene (less than 11,000 years ago) (Atwater and others 1977).

Southern San Francisco Bay is a north-northwest trending subsiding basin that has been filled primarily with Quaternary alluvium (stream and alluvial fan) deposits eroded from the surrounding uplifted mountains and some eolian (wind blown) sand deposits. The alluvium consists primarily of sediments eroded from the surrounding topographic upland highs, namely the Santa Cruz Mountains to the west and Diablo Range to the east. These alluvial sediments were transported and deposited by streams and alluvial fans and include a mixture of sands, gravels, silts, and clays with highly variable permeability (a measure of the material's ability to transmit water). The coarser alluvial deposits of sand and gravel form the region's important water supply aquifers (materials that have sufficient permeability to store and transmit significant quantities of water to wells). The discontinuous alluvial clays and silt horizons form local horizons that impede vertical groundwater flow and together create a regional low permeability zone (known as an aquitard, a unit that impedes the vertical flow of groundwater and confines the deeper water supply aquifers).

The youngest Holocene Bay muds underlie almost all of the original Bay (Atwater and others 1977; Helley and others 1979), including the SBSP Restoration Project Area. The Holocene Bay muds are as much as 30 to 50 ft thick beneath the Bay. The older Pleistocene Sangamon Bay muds have a similar thickness, but their extent is not as well defined as that of the Holocene Bay muds. The Sangamon Bay muds were also deposited at or near sea level, but have since subsided to approximate depths of 100 to 150 ft below sea level (due to the natural ongoing subsidence of the basin since the Sangamon interglacial period). The two Bay mud units are separated by Pleistocene alluvium, and both units thin and pinch out (terminate) near the historical edge of the bay where they interfinger with the coarser alluvial deposits. The fine-grained Bay muds have very low permeability and where sufficiently thick generally form an effective natural barrier to significant vertical groundwater flow (known as aquicludes, a unit that prevents the flow of groundwater).

Due to the nature of the salt ponds and the conditions that were there prior to their existence, virtually all of the salt ponds and much of the SBSP Restoration Project Area is underlain by Holocene Bay mud. The Holocene Bay mud is relatively impermeable to both infiltration and groundwater flow. The thickness (and depth to the contact with underlying alluvium) of Holocene Bay mud along Alviso Slough and up into the Guadalupe River ranges from approximately 5 ft to 25 ft below mean sea level (msl). Some Holocene levee deposits and alluvium overlie parts of these areas. The depth of Bay mud along Coyote Creek ranges between approximately 2 and 22 ft below sea level. Young alluvium overlies the Bay mud in the upper reaches of Coyote Creek. Bay mud depths around the edges of the Alviso ponds range from surface level to as deep as approximately 22 ft below msl. The extent of the Bay muds ends close to the edge of the Alviso ponds, and in some areas Holocene alluvium underlies Alviso ponds (Tudor Engineering Company 1973). The other areas of the SBSP Restoration Project exhibit similar Bay mud distribution and thicknesses.

The Santa Clara Valley Groundwater Basin contains two primary water-bearing formations: the Santa Clara Formation (Plio-Pleistocene age) and Pleistocene-Holocene Alluvium (DWR 2003). The exposures of the Santa Clara Formation are limited to the upland areas, where the unit is generally composed of coarse-grained and poorly sorted alluvium that overlies the relatively impermeable Mesozoic bedrock of the Diablo and Santa Cruz Mountains. The unit dips 10 to 30 degrees towards the Bay, where it becomes nearly flat-lying. The Santa Clara Formation (and the overlying Quaternary alluvium) generally contains increasing amounts of fine-grained sediments (silts and clays) toward the Bay and becomes indistinguishable from the overlying alluvium. Together, the sedimentary units are on the order of 1000 to as much as 2000 ft thick beneath the central part of the basin (DWR 2003).

Local land elevations, particularly in the South Bay, have subsided from their original elevations prior to historical development, primarily due to the historical extraction of significant amounts of groundwater. Land subsidence due to the over-extraction of groundwater is well documented in numerous basins (Freeze and Cherry 1979) and in the South Bay is primarily due to agricultural pumping in the early part of the 1900s. Land adjacent to the Bay in Santa Clara Valley was reported to have subsided 2 to 8 ft from 1912 to 1967 (Helley and others 1979), and up to 13 ft locally (Groundwater Committee of the California Regional Water Quality Control Board San Francisco Bay Region and others 2003). Subsidence was virtually halted by 1971 when groundwater pumping decreased with surface water importation from the

State Water Project. As a result, groundwater levels in the region have since recovered (Helley and others 1979). Due to current awareness and management of this problem, water level declines below historical lows and further land subsidence are not expected in the future.

Groundwater Hydrology

Santa Clara and the San Mateo Plain Subbasins. Upland areas (known as the forebay of the basin) serve as recharge areas for the Santa Clara Valley Basin, where precipitation infiltrates into the soil and percolates to the groundwater table, before flowing downgradient towards the natural discharge points at the margins of and beneath the bay. Under natural conditions before historical development, precipitation and recharge in upland areas and discharge in surface springs and beneath the Bay was sufficient to prevent the infiltration of surface water from the Bay (DWR 2003). It is when these natural conditions were altered (primarily by increased groundwater extraction) that historical saltwater intrusion occurred.

Groundwater in the Santa Clara Valley Basin currently flows towards the Bay (keeping salinity intrusion from occurring), as indicated by recent groundwater level measurements (DWR 2003; Fio and Leighton 1995) and groundwater modeling results (SCVWD 2005; WRIME 2005). Groundwater flow towards the Bay is also confirmed by the fact that contaminated groundwater plumes in the South Bay (most of which are west of US 101) move towards the Bay (Groundwater Committee of the California Regional Water Quality Control Board San Francisco Bay Region and others 2003). Groundwater flow in the area would be expected to continue to flow towards the Bay in the future unless there was a significant change in groundwater pumping (which will be addressed in the impacts section). Groundwater flow towards the Bay indicates that there is currently no saltwater intrusion under the baseline conditions for this analysis.

The deep aquifers beneath most of the Santa Clara Valley are separated from the Bay and shallow ground aquifer (above approximately 100 ft deep) by a combination of the Bay mud aquicludes and the alluvial aquitards that together act as a natural confining layer. This confining layer, which is shown in Figure 3.4-10, occupies the northern portion of the Santa Clara Subbasin (at an average depth of 100 to 200 ft) and extends northward beneath the Bay and along its margins on both the east and west sides. Unless absent or compromised, this confining layer provides protection from infiltration of salt water or contaminated groundwater into the deeper water supply aquifers.

Groundwater levels for wells within or near the Alviso pond complex were reviewed using data from the SCVWD groundwater database and published reports. The data indicate that after groundwater levels declined to as much as 100 ft below msl in the 1960s, the declines were arrested by the delivery of imported State Water Project surface water to the SCVWD. Recent data indicate that shallow wells (those screened above approx. 100 ft below msl) in and near the salt ponds have water levels at or near sea level, as would be expected for an aquifer in hydraulic communication with the Bay).

Artesian conditions have been restored to the deeper aquifer. Deeper wells near the Bay screened below the regional confining layer (generally below 200 ft msl) indicate that water levels have generally recovered to water levels (pressure heads) above sea level. Although the District does not measure pressure heads and many monitoring wells are screened in multiple aquifer zones, groundwater modeling data indicate that heads are now 40 to 50 ft above sea level in the SBSP Restoration Project Area, restoring the aquifer to artesian conditions and creating flowing artesian wells. The District's 2003 groundwater elevation index was approximately 19 ft below the maximum historic level (in 1916) and 213 ft above the minimum groundwater level for the period since (SCVWD 2005). This strong upward vertical gradient is a testament to successful groundwater management, and generally precludes salinity intrusion under current conditions.

Groundwater levels are not available for other wells in the Ravenswood pond complex of the San Mateo Subbasin, since there are no municipal water purveyors east of US 101 that pump groundwater and thus have water level monitoring programs. Neither the Menlo Park Municipal Water District (MPWD) nor East Palo Alto County Waterworks District, which border the Project Area to the west, has wells or monitoring programs. Small wellfields of the Palo Alto Park Mutual (5 wells) and O'Connor Tract Mutual (2 wells) water districts are present near US 101, and a few domestic and irrigation wells are present between US 101 and the SBSP Restoration Project Area (Groundwater Committee of the California Regional Water Quality Control Board San Francisco Bay Region and others 2003). Regional water level data do indicate that the horizontal groundwater gradient is eastward toward the Bay (Fio and Leighton 1995), but pumping in some areas west of US 101 has drawn water levels below msl, indicating a downward vertical gradient and the potential for salinity intrusion.

Niles Cone and the East Bay Plain Subbasins. An exception to the general Bay-ward direction in groundwater flow is present in the Niles Cone area where ACWD extracts saline groundwater from the Centerville/Fremont Aquifer as part of its aquifer reclamation project. Groundwater extraction in the Newark area creates a cone of depression (an area of inward sloping groundwater levels) in the Centerville/Fremont Aquifer, but this area is east of the impermeable bedrock of the Coyote Hills and south of the Alameda Creek Flood Control Channel (ACFCC) (and thus outside the SBSP Restoration Project Area).

The shallow aquifer (above approximately 100 ft below msl, and known as the Newark Aquifer in the Niles Cone area) is generally considered to be in communication with the Bay. This is documented by a review of groundwater monitoring data from SCVWD and ACWD that shows water levels to be very stable (not fluctuating substantially seasonally from pumping as is typical of deeper wells). According to DWR, interconnections between the Bay and Newark Aquifer in the Niles Cone area may exist due to dredging of the shipping channel in the Dumbarton Bridge area (See discussion in Appendix L, the Groundwater Analysis Report). ACWD and SCVWD groundwater monitoring data that indicate high salinity in shallow wells also support the existing hydraulic interconnection between the Bay and shallow groundwater. In the Alviso pond complex, SCVWD monitoring data confirm a similar interconnection. The relatively thin Holocene Bay muds at the margins of the Bay therefore do not currently isolate the shallow aquifer in the area between the current outboard and inboard salt pond levees.

However, the Sangamon Bay mud and fine-grained alluvial deposits do generally create differences in hydraulic heads that are evidence of hydraulic separation. Upland of the inboard levees and within the regional setting (below the 100-year flood plain), the fine-grained alluvial deposits alone cause confinement of groundwater (Atwater and others 1977; Helley and others 1979) and a measure of protection for the water supply aquifers (the water-bearing zones).

Alameda County Water District (ACWD) groundwater monitoring data indicate that levels in the Centerville/ Fremont aquifers (between roughly 200 and 350 ft below ground surface (bgs) have recovered from levels of as much as 100 ft bgs in the early 1960s to within 20 ft above or below sea level. However, a downward vertical gradient (from shallow wells to deeper wells) is generally present in clustered wells (ACWD 2006) While the groundwater levels fluctuate seasonally, there is also a general trend over the last 50 years of increasing groundwater elevations. This is consistent with the regional trend that groundwater levels have increased during the later half of the 1900s due to more awareness of the problems created by over-pumping groundwater, and the resulting measures taken to address subsidence and salinity intrusion (discussed below under groundwater management).

To summarize, the groundwater hydrology of the SBSP Restoration Project Area indicates shallow aquifers in communication with the Bay, and deeper aquifers that are generally isolated from shallow aquifers. A possible exception to this is present in the vicinity of Coyote Creek, where the confining layer over the deep aquifer is leaky. Groundwater levels have been historically depleted by overpumping, but recently (within the past 40 years) restored by regional groundwater management actions. Today, flow is generally bayward and, in the Santa Clara Subbasin, generally artesian, providing a measure of protection from salinity intrusion as long as current groundwater levels are maintained.

There is no guarantee that the generally successful groundwater management that has characterized the last 40 years will be as successful in the future as water demands increase, water supplies become increasingly scarce and expensive, infrastructure (such as the large surface water importation projects) ages and is subject to earthquakes, terrorism, or other interruptions, or as the frequency and severity of droughts increases with global climate change. The possibility of greatly increased groundwater pumping in the basin is something that is beyond the control of the project. This analysis finds it unlikely to occur given the current knowledge of the factors affecting saltwater intrusion, the risks of saltwater intrusion and land subsidence, and the current awareness level of local water boards, utilities, and the public. Both ACWD and SCVWD can and will no doubt continue if not increase surface water deliveries, artificial recharge, conservation, recycling, and other activities to the degree possible. However, neither have the regulatory authority to curtail pumping by the various municipal water agencies and private pumpers in the basin, and the potential for future overdraft conditions therefore cannot be ruled out.

Groundwater Quality

According to DWR (2003), groundwater type in the Santa Clara Valley Basin is generally of a bicarbonate type, with sodium or calcium being the principal ions. Although often hard, it is of good to excellent mineral composition and suitable for most uses. All drinking water standards are met at public supply wells without the use of treatment. Some areas of elevated nitrate concentrations occur in the southern portion of the basin, and a number of groundwater contaminant plumes (primarily fuels and chlorinated solvents) are present locally. According to SCVWD and RWQCB data (Groundwater Committee of the California Regional Water Quality Control Board San Francisco Bay Region and others 2003) the plumes are generally at least a mile from the salt ponds. Typical concentrations of inorganic constituents and summaries of organic contaminant detections are included in Appendix L, the Groundwater Analysis Report.

Salinity in the South Bay waters is typically 30 to 32 ppt, with salinities near oceanic levels (33 ppt) since the Bay receives very little fresh water inflow (USFWS and CDFG 2003). Historical salinity concentrations in the salt ponds varied considerably, ranging from as low as the Bay to brines with salinity concentrations several times that of the Bay.

Saltwater intrusion is characterized by the movement of saline water into a freshwater aquifer. Under natural conditions, coastal aquifers typically discharge to the ocean, keeping salinity at bay. However, the development of groundwater resources can reduce or even reverse this seaward flow, causing seawater to enter and penetrate inland aquifers. With high groundwater demands in the South Bay after World War II and continuing subsidence, saltwater intrusion conditions encompassed a substantial area. Saltwater intrusion degrades aquifers and renders them virtually unusable, and is difficult and costly to reverse. (SCVWD 1980).

High concentrations of salinity (TDS) cause drinking water to taste salty and can make it unusable for other beneficial uses as well. California DHS has established a secondary drinking water standard known as a maximum contaminant level, or MCL, for TDS of 500 mg/L (recommended) to 1,000 mg/L (maximum). Concentrations of 1500 mg/L may be permissible on a short-term basis. Typical TDS concentrations in the primary water supply aquifers of the Santa Clara Valley (SCV) are below the recommended MCL, but concentrations in the upper aquifer zones are higher. Two wells in the principal aquifer and three in the upper aquifer exceeded the standard in 2003 in the SCV Subbasin (SCVWD 2005). It should be noted that almost all of the monitoring points are located well south of the SBSP Restoration Project Area.

Groundwater monitoring data in the Alviso pond complex from SCVWD's Salinity Intrusion Monitoring Program also indicates elevated salinity levels in shallow wells (screened above 100 ft below msl) within and near the salt ponds. Only one functioning monitoring well cluster (one or more co-located monitoring wells screened at different depths) is located within the salt ponds themselves on Alviso Slough near the boundary between ponds A7 and A8 (wells L001, L002, and L003). The most recent data (June 20, 2006) indicate very low chloride concentrations in the two screened below 250 ft msl, but the shallow aquifer zone has a chloride concentration of 19,500 mg/L (roughly equivalent to a TDS of 40 ppt). The data demonstrate that the shallow aquifer is already impacted by salinity from the salt ponds and/or Bay.

The Saltwater Intrusion Investigation by the SCVWD (1980) indicated the maximum areal extent of saltwater intrusion (as indicated by chloride concentrations above 100 ppm) by the mid-1970s was as far southeast as the intersection of US 101 and I-880. The salinity intrusion was apparently driven by the movement of saline waters from the Bay up the Guadalupe River and Coyote Creek, during high tides and low stream flow as documented through surface water sampling. Salinity intrusion from the waterways was exacerbated by subsidence and dredging. The Holocene Bay muds were shown to be leaky and allow for downward migration of salinity into the upper aquifer zone. High salinity was also present in the lower aquifer zone beneath the San Jose along the Guadalupe River and in the Palo Alto area (SCVWD 1980). Recent SCVWD data indicate that salinity remains elevated in the upper aquifer as much as five to six miles inland (southeast) of the salt ponds along the Guadalupe River and Coyote Creek (SCVWD 2005).

The shallow Newark Aquifer in the Eden Landing pond complex has high salinity due to its hydraulic connection with the Bay and the historical salt ponds. Although monitoring data are not available for most of the salt pond area, ACWD monitors salinity in eleven shallow wells located near the eastern edge of the salt ponds between State Route (SR) 92 and the ACFCC. The data indicate fall 2005 salinities (measured as total dissolved solids, or TDS) in the range of 10 to 132 ppt. Historically, pumping impacts in the Niles Cone area have resulted in significant cross-communication between the shallow (Newark), intermediate (Centerville-Fremont), and deeper aquifer (350 to 600 ft bgs) as documented in older reports on saltwater intrusion in the area (Luhdorff & Scalmanini Consulting Engineers 2003).Current data indicate that salinities up to 3.9 ppt are present beneath the City of Newark, but salinity in the Eden Landing pond complex in the Centerville/Fremont Aquifer is generally excellent (below .5 ppt salinity). An area of elevated salinity (up to .97 ppt in the Centerville/Fremont Aquifer and 3.2 ppt in the Deep Aquifer in fall 2005) is present just south of SR 92 in the general vicinity of ponds E12 and 13 (ACWD 2006). The origin of this anomaly is unknown, but CDFG has coordinated with Cargill to ensure that wells in the area have been properly identified and abandoned. ACWD is continuing to monitor the anomaly. Two remaining abandoned wells are suspected in this area but have not yet been located. If abandoned wells are located during restoration or other future activities within ACWD boundaries, a well destruction work plan will be prepared in consultation with ACWD to ensure adherence to ACWD specifications.

Groundwater quality data are generally lacking in the SBSP Restoration Project Area in the San Mateo Subbasin (including the Ravenswood pond complex). There is no groundwater management agency in the San Mateo Subbasin and hence no groundwater monitoring. Salinity intrusion was a historic problem in the basin in the mid-1900s, and most municipal wellfields were abandoned with the delivery of imported surface water. The City of East Palo Alto borders the Ravenswood pond complex on the south and relies on surface water. It has one emergency well mid-way between US 101 and the salt ponds at Bay Road and Gloria Way but it is used only for nonpotable water due to poor water quality (presumably due to elevated salinity). The City of Menlo Park on the west side of the Ravenswood pond complex has no groundwater wells. Groundwater conditions similar to those in and adjacent to the other pond complexes can be assumed, with elevated salinity in the shallow aquifer zone.

Artificial Pathways. The confining layers beneath the Bay, salt ponds and adjacent land normally provide a significant barrier to vertical flow of saline waters downward to the groundwater aquifers as described above. Natural pathways exist in the form of windows and thin zones (through which seepage can occur) in the confining aquitards, and saline water may also spill over the edges of aquitards. Fault zones can act as conduits for flow in some circumstances, but are more typically barriers to horizontal flow as appears to be the case in the SCV (USGS 2004). However, a number of anthropogenic causes can short-circuit aquitards, creating pathways for vertical movement of saline waters. The two significant artificial pathways are dredging and the drilling of wells.

Dredging has historically been conducted to deepen and maintain shipping channels in the Bay and to enlarge stream channels to improve flood protection. Both have been hypothesized to have contributed to thinning or eliminating aquitards in the SCV basin (DWR 1967; SCVWD 1980).

The second common artificial pathway is improperly constructed, degraded, or improperly abandoned wells. It is not uncommon for water supply wells to be constructed in multiple aquifer zones (to maximize yields). In such cases the well may serve as vertical conduit for flow between aquifers. If water quality is poor in one aquifer, it may thus contaminate an aquifer with good water quality. ACWD, SCVWD, and the San Mateo County require drilling permits for well construction (as well as repairs, reconstruction, or abandonment) to prevent the installation of new improperly constructed wells.

Degraded wells may also lead to saltwater intrusion. Wells are constructed of both solid casing (in zones that do not yield water to the well) and screened or perforated sections (that are open to the aquifer to allow water to flow into the well). Even if solid casing is used across a shallow aquifer with poor water quality, the solid casing designed to prevent the flow of poor quality water into the well may degrade over time. Saltwater is particularly corrosive to steel well casings, leading to degradation and the potential for the casing to fail and poor quality water to enter the well and migrate to an aquifer with good quality water.

Improperly abandoned wells are also a common conduit for vertical migration of saline waters. Both ACWD and SCVWD have standards for the proper abandonment (decommissioning) of wells that are no longer used in order to protect groundwater supplies and prevent potential physical hazards. The typical procedure in the north SCV Subbasin (classified as Zone W-2 by SCVWD and covered by Ordinance 90-1) is to fill the well with grout, as well as to perforate the well casing and place a seal at a clay layer at about 150 ft bgs (to eliminate the potential for cross-contamination). Unfortunately, records are often incomplete and some wells are in fact not properly abandoned (and in fact are sometimes forgotten).

In a coordinated effort between ACWD, Cargill Salt, DFG, and USFWS, recent progress has been made on locating and destroying abandoned wells within the SBSP Restoration Project Area. ACWD provided extensive detail regarding the current status of abandoned wells within overlapping ACWD boundaries and the SBSP Restoration Project Area in draft EIS/EIR comments (Shaver 2007). ACWD identified a total of 74 abandoned wells within the overlapping area, and had located 48 and destroyed 43 of them as of May 1, 2007.

Groundwater Management. In California, multiple entities are responsible for groundwater management, which is defined as the planned and coordinated monitoring, operation, and administration of a groundwater basin. Unlike the system of appropriative rights for surface water rights administered by the State Water Resources Control Board (SWRCB), percolating groundwater has never been regulated by the state. However, if local groundwater management needs cannot be directly resolved at the local agency level, additional actions such as enactment of local government ordinances, passage of laws by the state legislature, or decisions by the courts may be necessary. The state's role is primarily to provide technical and financial assistance to local agencies for their groundwater management efforts (DWR 2003).

Groundwater management in the Santa Clara Valley has been conducted at the local level. Alameda and San Mateo Counties have not enacted groundwater management ordinances; however, Santa Clara County currently has two groundwater ordinances in place. In addition, there has not been a court adjudication of groundwater rights in the basin (DWR 2003)

Local water agencies manage groundwater under the authority of the California Water Code and other applicable state statutes. One approach for groundwater management by local agencies is development of local Groundwater Management Plans (GMPs), which were originally formalized under AB3030 (water code section 10750 et seq.). As of January 1, 2003, amendments to the Water Code Section resulting from the passage of SB1938 require and recommend additional GMP components. The SCVWD adopted a GMP in July 2001 (SCVWD 2001), with the goal of ensuring that groundwater resources are sustained and protected.

The District has also developed an Integrated Water Resources Plan (SCVWD 1997), and every five years completes an Urban Water Management Plan (UWMP) (SCVWD 2005) that reports and projects water usage (including groundwater).

Historical overdraft (defined as long-term pumping that exceeds recharge) that resulted in historical land subsidence and salinity intrusion has led to extensive investigations by the California DWR (1973, 1975, 1981) and local groundwater management by both SCVWD and ACWD, which are overarching water management agencies that maintain aggressive groundwater programs and have conducted numerous comprehensive groundwater studies. Within the regional Project Setting, the SCVWD manages the entire Santa Clara Subbasin, while ACWD manages those portions of the East Bay Plain and Niles Cone Subbasins that cover the regional Project area. There is no equivalent overarching groundwater management agency in the San Mateo Plain Subbasin, in part because the groundwater resource is much more limited and is not a significant source of supply for municipalities.

Groundwater overdraft and land subsidence led to the formation of the SCVWD in the late 1920s. SCVWD continues to serve as a water resource management agency to Santa Clara County in its entirety. SCVWD operates and manages 10 surface reservoirs and associated creeks and recharge facilities, three groundwater subbasins, three water treatment plants, imported Central Valley Project and State Water Project water, and recycled water (SCVWD 2005b).

SCVWD is responsible for groundwater management in Santa Clara County. The District was created by an act of the California legislature; the Santa Clara Valley Water District Act (California Water Code Appendix, Chapter 60) outlines the District's authority to manage groundwater. The District has passed several ordinances related to groundwater management: Ordinance 90-1 (which regulates the classification, construction and destruction of wells and deep excavations) and Ordinance 89-1 (which provides for the regulation of groundwater extraction under certain conditions).

The primary mission of the SCVWD's groundwater program is ensuring the sustainability and protection of groundwater resources. To achieve this mission, SCVWD implements numerous groundwater management activities, including: in-stream recharge (controlled and uncontrolled), off-stream recharge (percolation ponds and abandoned gravel pits), periodic water balances, direct injection recharge facilities, water use efficiency programs, operational storage capacity estimations, and subsidence and groundwater flow modeling.

Groundwater monitoring by SCVWD occurs to ensure that groundwater quality, levels, and extractions are within acceptable ranges and that land is not further subsiding (SCVWD 2001). SCVWD monitors groundwater levels in 168 wells on a monthly basis and in 108 wells on a quarterly basis, as well as miscellaneous water quality in 10 wells and Title 22 water quality in 234 wells. Various groundwater quality programs are managed by SCVWD, including nitrate management, saltwater intrusion prevention, well construction and destruction, wellhead protection, leaking underground storage tank oversight, toxics cleanup, land use and development, and public outreach and education programs (SCVWD 2001)The SCVWD has recently participated in a cooperative investigation of the SCV Subbasin with USGS, which included the updating and revision of the District's numerical groundwater flow model to support effective groundwater management (USGS 2004; SCVWD 2005).

Formed in 1914, ACWD manages groundwater under the County Water District Act and additional powers were granted to ACWD for groundwater management under Chapter 1942 of the Statutes of 1961 called the Replenishment Assessment Act of Alameda County Water District. ACWD's Amended Groundwater Management Policy (ACWD Policy) was adopted by the Board of Directors on March 22, 2001 (ACWD 2001). The ACWD Policy ensures that the Niles Cone Groundwater Basin is protected and managed effectively to provide reliable and high quality multi-purpose water supplies. To safeguard against saltwater intrusion, ACWD sustains groundwater elevations above sea level in the Niles Cone upper aquifer (the Newark Aquifer), which is hydraulically connected to San Francisco Bay. In drought periods, ACWD may lower the Newark Aquifer groundwater table within the inland area to elevations lower than sea level (with a minimum elevation of 5 ft below mean sea level). ACWD recharges the groundwater system through percolation ponds, which account for the primary recharge source, while other recharge also occurs through rainfall and applied water (ACWD 2005). ACWD monitors groundwater levels in 350 wells annually and 32 weekly as well as groundwater quality in 120 wells annually (in addition to DHS Title 22 requirements for 9 to 12 wells) (DWR 2003).

There is no groundwater management agency in the San Mateo Subbasin (including the Ravenswood pond complex of San Mateo County) although there are two private water agencies (California Water Service Company and Burlingame Water Services) and the following public water agencies:

- Belmont CWD;
- City of Millbrae;
- City of Palo Alto;
- City of San Bruno WSA;
- East Palo Alto Water County Waterworks;
- Estero MID;
- Menlo Park WD; and
- County of San Mateo Health Services Division.

Protection of the groundwater resource falls primarily to the County of San Mateo Health Services Division, and a permit is required for soil borings, well installations, and well destruction, all of which must conform to California Well Standards.

As a result of groundwater management activities by ACWD and others, estimated groundwater pumping in the South East Bay Plain has declined from levels of roughly 10,000 ac-ft/year in the late 1960s to approximately 3,200 ac-ft/year in the year 2000. Pumping in the Niles Cone Subbasin declined over the same period from roughly 42,000 ac-ft/year to 31,000 (including about 6,500 ac-ft/year for aquifer reclamation of historical salinity intrusion (Water Resources & Information Management Engineering Inc 2005).

Recent studies by ACWD include a joint study with East Bay Municipal Water District (EBMUD) of the relationships between the South East Bay Plain and the Niles Cone Groundwater Basin. The study results concluded that the two Subbasins are hydraulically interconnected (Luhdorff & Scalmanini Consulting Engineers 2003). As part of the project, the Niles Cone and South East Bay Plain Integrated Groundwater and Surface water Model (NEBIGSM) was developed to simulate the relationship of the two Subbasins and Niles Cone Subbasin surface and groundwater interactions. The NEBIGSM provides the agencies with a useful tool for evaluating groundwater hydrology, surface and groundwater interactions, and water quality (Water Resources & Information Management Engineering Inc 2005).

Groundwater pumping in the Santa Clara Valley Subbasin has decreased from roughly 165,000 ac-ft/year in the early to mid-1980s, with an abrupt decline in the drought year 1989 as a result of a District appeal for conservation and increased surface water deliveries. Groundwater extraction averaged 108,000 ac-ft/year through the 1990s, and has remained at similar levels since, with the most recently available data indicating a total of 97,000 ac-ft/year in 2003. In 2002, groundwater production consisted of approx 104,000 ac-ft/year of municipal and industrial pumping and 700 ac-ft/year agricultural pumping. Estimated artificial recharge by the District was 72,000 ac-ft/year and natural recharge from rainfall and other sources was 20,000 to 22,000 ac-ft/year in 2002 (SCVWD 2005a).

Groundwater pumping in the San Mateo Subbasin has not been quantified (DWR 2003). Based on the preponderance of surface water use by the municipal and private water agencies in the region, annual groundwater production is judged to be minimal (no more than a couple thousand ac-ft/year) in the general vicinity of the Ravenswood pond complex (primarily for irrigation).

Project Setting

The Project Setting refers to salt ponds that are proposed as restoration areas in Phase 1 of the SBSP Restoration Project. These ponds include the following:

- Eden Landing: Ponds E8A, E8X and E9, and E12 and E13;
- Alviso: Ponds A6, A8, and A16; and
- Ravenswood: Pond SF2.

Due to the nature of the current salt ponds and the conditions that were there prior to their existence, most if not all of the SBSP Restoration Project Area is underlain by one or two layers of Bay mud (an older Pleistocene Sangamon Bay mud deposit and a younger Holocene Bay mud deposit) as well as alluvial silts and clays. These layers are relatively impermeable and separate the Project site from the deeper water supply aquifers below the Bay muds (below approximately 200 ft bgs). Unless compromised, these conditions typically preclude a hydraulic connection between the SBSP Restoration Project Area and the underlying aquifers, providing a natural resistance to saltwater intrusion.

However, the landward extent of the Bay muds is roughly equivalent to the extent of the salt ponds, and the Bay muds thin and pinch out completely in the general area of the landward levees. Water levels and salinity concentrations in the upper aquifer demonstrate the ineffectiveness of the shallow Holocene Bay mud (saltwater has either leaked through or spilled over the landward edge). Fortunately, the alluvial clay and silt aquitards provide a secondary (although not as impermeable) separation between the shallow and lower aquifers.

Two areas have significant exceptions to this general hydrogeologic framework that have bearing on the potential for salinity intrusion where relatively large creeks have deposited relatively coarse-grained alluvial fan deposits that contain relatively less aquitard material. One such site is located just to the east of Alviso, where the alluvium associated with Coyote Creek produces a window in the confining layer where Bay muds and fine-grained alluvium are largely absent and there is thus no confining layer.

The second location is in the Eden Landing pond complex of the Niles Cone Subbasin, where coarse alluvial fan deposits of the relatively large Alameda Creek have similarly created a less complete confining layer than elsewhere in the Basin. These deposits, collectively referred to as the Niles Cone aquifers, contain much less clay and silt than is typical. Well developed in the southern part of the Eden Landing pond complex in the vicinity of the Alameda Creek Flood Control Channel northward to approximately Old Alameda Creek, the section transitions northward to SR 92 to more typical fine-grained confining layers beneath SR 92. The Phase 1 Project ponds are therefore largely over confined aquifers, although Ponds E8A and E9 have less protection and are thus more susceptible to saltwater intrusion than most of the SBSP Restoration Project Area.

There are currently some unused wells in the Eden Landing pond complex which have not been properly abandoned. Alameda County, in accordance with an agreement with Cargill, is in the process of locating and properly abandoning these wells. According to the agreement, this process must be complete prior to any restoration efforts. This activity will help to avoid increased potential for groundwater contamination via surface water infiltration through the improperly abandoned wells (ACWD 2004).

Improperly abandoned wells may also be present in the Ravenswood and Alviso pond complexes. Historical wells located in the Ravenswood pond complex were not immediately sealed after abandonment, and the eventual method (effectiveness) of sealing was questioned by the SCVWD (1980). ACWD stated that five abandoned wells within the Alameda County portion of the Alviso complex were located and that an additional abandoned well is suspected (Shaver 2007). Additional ACWD field work is required to determine if the additional well exists, and access to the wells will be maintained by the Project proponents to allow for ACWD well destruction activities prior to restoration actions.

3.4.3 Regulatory Setting

Regulatory Authorities and Enabling Legislation

Federal and state agencies are authorized to ensure adequate surface water, sediment, and groundwater quality with respect to potential restoration impacts. The agencies, their enabling legislation, and their roles in establishing and implementing policies that should be considered in the evaluation of potential impacts to water quality are described below.

The United States Environmental Protection Agency (USEPA) carries out the mandates set forth in federal Clean Water Act. The Clean Water Act requires that Waters of the United States be protected by adopting and implementing a program of Water Quality Standards. Water quality standards consist of defined beneficial uses of water and numeric or narrative criteria[4] to protect those beneficial uses.

The USEPA is authorized to delegate its authority to state agencies. In situations where a state fails to carry out the mandates of the Clean Water Act (CWA) by enacting policies and regulations, the USEPA is authorized to promulgate federal regulations that the state must abide by. This federal-state relationship is the basis for USEPA's promulgation of the California Toxics Rule (CTR) in 2000, which established numeric criteria for toxic pollutants. USEPA's promulgation authority is relevant to this analysis because of their lead role in revision of the CTR selenium criteria. This is discussed below under "emerging water quality standards programs."

In California, the State Water Resources Control Board (SWRCB) is the lead agency with delegated authority to implement the CWA. The SWRCB's authority is enabled by California's Porter-Cologne Water Quality Control Act (Porter-Cologne). The SWRCB is responsible for implementing statewide water quality standards programs. One such program relevant to this analysis, development and adoption of sediment quality objectives, is discussed below under "emerging water quality standards programs."

The SWRCB has delegated many duties enabled by Porter-Cologne to nine Regional Water Quality Control Boards (RWQCBs) that are defined by distinct hydrologic regions. The entire Project Area is within the jurisdiction of the San Francisco Bay Regional Water Quality Control Board (RWQCB). The RWQCB is responsible for developing water quality standards that are adopted in the Water Quality Control Plan for San Francisco Bay (the 2004 Basin Plan), following scientific and public review procedures set forth in Porter-Cologne sections 13240–13245. The Basin Plan lists beneficial uses of water and water quality objectives to protect those beneficial uses, which are described below under "Existing Water Quality Standards Programs."

The Basin Plan also includes a plan of implementation that guides the RWQCB in carrying out its duties. Those duties include:

[4] In California, water quality criteria are referred to as water quality objectives. The distinction between objectives and criteria is important, as Federal criteria are viewed as guidelines to be considered, whereas state-adopted objectives have force of law. Because of the enforceability of state-adopted water quality objectives, the scientific, public, and legal review process is much more lengthy than for federal promulgation.

1) Issuing National Pollutant Discharge Elimination System (NPDES) permits as authorized by CWA section 402 to regulate discharges to navigable waters of the United States and their tributaries;

2) Issuing state Waste Discharge Requirements (WDRs) as authorized by Porter-Cologne Sections 13260–13274 to regulate discharges to land and other discharges not requiring federal NPDES permits;

3) Issuing water quality certifications as authorized by CWA section 401 to projects with a Federal Component that may affect water quality, such as dredging and filling activities that require a CWA section 404 certification from the United States Army Corps of Engineers;

4) Issuing conditioned waivers of WDRs as authorized by Porter-Cologne 13269 for discharges and other activities that are note considered to threaten the beneficial uses of waters;

5) Requiring monitoring data from permitted dischargers as Authorized by Porter-Cologne Sections 13267 and 13225-c; and

6) Conducting enforcement as authorized by Porter-Cologne Sections 13300–13365 against parties who fail to apply for necessary permits or comply with existing permits and requirements.

The RWQCB also participates in many regional collaborative programs to monitor water quality and implement projects to protect and improve water quality. Examples of such collaborations include the San Francisco Bay Regional Monitoring Program (RMP), the San Francisco Bay Area Wetlands Regional Monitoring Program (WRMP), the San Francisco Bay Clean Estuary Partnership (CEP), and the SWRCB Surface Waters Ambient Monitoring Program (SWAMP). The RWQCB is also responsible for administering water quality related state grant programs, such as the Costa Machado Act (a.k.a. Proposition 13). While these programs are outside of the core regulatory duties of the RWQCB, they are important resources for the monitoring and adaptive management phase of this Project.

There are two publicly owned water districts responsible for groundwater resources. ACWD has an interest in groundwater in Project Areas to the north (Eden Landing and portions of Alviso). SCVWD has an interest in the Project Area to the south (Alviso). Both of these agencies carry out their missions by operating groundwater recharge facilities, conducting monitoring at guard wells, ensuring that unused wells are properly abandoned, and encouraging water conservation by municipalities in their service areas.

In addition to protecting water supplies, the SCVWD is also charged with flood protection and stream stewardship. The SCVWD flood protection mission is discussed in more detail in Section 3.3, Hydrology and Flood Management. The SCVWD stream stewardship mission is carried out through all of its operations, including the Clean Safe Creeks and Natural Flood Protection Program. This program is funded through a 15-year voter approved benefits assessment that sunsets in 2016. The program is designed to protect property from flooding, ensure that streams and creeks are kept clean, protect and enhance the ecosystem function of streams, and provide open spaces, parks, and trails along streams and creeks in the Santa Clara Valley. Implementation of program elements would improve the quality of fresh water upstream of the SBSP Restoration Project Area.

The responsibility for protection of stormwater quality is assigned to the countywide stormwater programs in the SBSP Restoration Project Area. The Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) is a multi-agency program representing 14 municipal government co-permittees and the SCVWD. The Alameda Countywide Clean Water Program (ACCWP) represents 15 municipal government co-permittees, as well as the Alameda County Flood Control and Water Conservation District and the Zone 7 Water Agency. Both of these stormwater programs implement Stormwater Quality Management Plans (SQMPs) with regulatory oversight from the RWQCB. The SQMPs describe a coordinated program of monitoring, watershed assessment, inspections, illicit discharge control, construction controls, municipal maintenance, and public education.

Three publicly owned treatment works (POTWs) discharge highly treated water to shallow waters in the southern area of the regional setting. In the vicinity of the Alviso pond complex, the San Jose/Santa Clara Pollution Control Plant discharges to Artesian Slough. The Sunnyvale WPCP discharges to Moffett Channel, which discharges to Guadalupe Slough. The Palo Alto Regional Water Quality Control Plant discharges to a mudflat to the south of the Ravenswood pond complex. All three of those plants produce water treated to a sufficient quality to allow water recycling for irrigation and other uses. In the northern area of the regional setting, the East Bay Dischargers Authority operates a deep water outfall in San Francisco Bay that discharges secondary treated effluent from four different municipal treatment plants. In addition, the Union Sanitary District operates a treatment wetland to the north of the Eden Landing pond complex. All of these municipal dischargers operate under NPDES permits issued and enforced by the RWQCB. While there are no industrial dischargers in the Regional setting, there are numerous ongoing cleanup operations in the region that extract groundwater, remove pollutants (primarily fuels and organic solvents), and discharge the treated groundwater under coverage by the NPDES general permit for groundwater discharge administered by the RWQCB. Periodic spills of toxic materials (*e.g.*, brines, chemicals) are subject to enforcement by the RWQCB.

The California Department of Toxics Substances Control (DTSC) regulates hazardous wastes. It derives its authority from Title 22 of the California Code of Regulations. Any areas known to have hazardous wastes in need of remediation near the Project would be listed in the DTSC Envirostar database (http://www.envirostor.dtsc.ca.gov/public/).

Existing Water Quality Standards Programs

The existing Water Quality Standards Program implemented by the RWQCB is defined in the Basin Plan. The Basin Plan lists numerous beneficial uses of water that apply in the Project and regional setting. The most relevant beneficial uses include:

- Industrial service supply;
- Groundwater recharge;
- Contact and non-contact recreation;

- Freshwater fish habitat;
- Wildlife habitat;
- Migration of aquatic organisms;
- Spawning, reproduction, and/or early development of fish;
- Commercial Fisheries;
- Estuarine Habitat;
- Navigation;
- Preservation of rare and endangered species;
- Water contact recreation;
- Water non-contact recreation; and
- Shellfish harvesting.

Designated groundwater beneficial uses include municipal and domestic supply, agricultural supply, and industrial service supply.

To protect these beneficial uses, the Basin Plan lists both narrative and numeric water quality objectives for surface and groundwater. Narrative objectives provide general guidance to avoid adverse water quality impacts. Narrative objectives relevant to this analysis include salinity, sediment (*i.e.*, total suspended solids [TSS]), sulfides, toxicity, biostimulatory substances, bioaccumulation, and population and community ecology. Those narrative objectives are listed in Table 3.4-5.

Numeric water quality criteria included in the Basin Plan establish objectives for trace metals, DO, turbidity, temperature, pH, bacteriological pathogens, and un-ionized ammonia. In addition to the Basin Plan, the California Toxics Rule (CTR) establishes another set of relevant water quality objectives for aquatic life and human health protection for approximately 130 priority trace metal and organic constituents. Wherever two objectives differ between the CTR and the Basin Plan, the more stringent objective applies. Numeric water quality objectives are summarized in Tables 3.4-6 to 3.4-8.

Applicable objectives are affected by both geography and salinity. Numeric and narrative objectives from the Basin Plan and most CTR numeric objectives apply to Bay waters north of the Dumbarton Bridge. In contrast, Bay waters south of the Dumbarton Bridge are exempted from Basin Plan numeric objectives, although Bay narrative objectives and CTR numeric objectives still apply. The Basin Plan and the CTR also establish different numeric objectives for freshwater and saltwater. Freshwater is defined as having salinity < 1 ppt more than 95 percent of the time, whereas saltwater is defined as having salinity >10 ppt more than 95 percent of the time. Conditions between these two endpoints define estuarine waters, in which case the more stringent (lower) of either the freshwater or saltwater objectives apply.

Table 3.4-5 Basin Plan Narrative Water Quality Objectives Relevant to this Analysis

OBJECTIVE	NARRATIVE
Salinity	Controllable water quality factors shall not increase the total dissolved solids or salinity of waters of the state so as to adversely affect beneficial uses, particularly fish migration and estuarine habitat.
Sediment	The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses. Controllable water quality factors shall not cause a detrimental increase in the concentrations of toxic pollutants in sediments or aquatic life.
Sulfides	All water shall be free from dissolved sulfide concentrations above natural background levels. Sulfide occurs in Bay muds as a result of bacterial action on organic matter in an anaerobic environment. Concentrations of only a few hundredths of a milligram per liter can cause a noticeable odor or be toxic to aquatic life. Violation of the sulfide objective will reflect violation of DO objectives as sulfides cannot exist to a significant degree in an oxygenated environment.
Toxicity	All waters shall be maintained free of toxic substances in concentrations that are lethal to or that produce other detrimental responses in aquatic organisms. Detrimental responses include, but are not limited to, decreased growth rate and decreased reproductive success of resident or indicator species. There shall be no acute toxicity in ambient waters. Acute toxicity is defined as a median of less than 90 percent survival, or less than 70 percent survival, 10 percent of the time, of test organisms in a 96-hour static or continuous flow test. There shall be no chronic toxicity in ambient waters. Chronic toxicity is a detrimental biological effect on growth rate, reproduction, fertilization success, larval development, population abundance, community composition, or any other relevant measure of the health of an organism, population, or community. Chronic toxicity generally results from exposures to pollutants exceeding 96 hours. However, chronic toxicity may also be detected through short-term exposure of critical life stages of organisms. As a minimum, compliance will be evaluated using the bioassay requirements contained in Chapter 4 [of the Basin Plan]. The health and life history characteristics of aquatic organisms in waters affected by controllable water quality factors shall not differ substantially from those for the same waters in areas unaffected by controllable water quality factors.
Floatables	Waters shall not contain floating material, including solids, liquids, foams, and scum, in concentrations that cause nuisance or adversely affect beneficial uses.
Settleable solids	Waters shall not contain substances in concentrations that result in the deposition of material that cause nuisance or adversely affect beneficial uses.
Oil and Grease	Waters shall not contain oils, greases, waxes, or other materials in concentrations that result in a visible film or coating on the surface of the water or on objects in the water, that cause nuisance, or that otherwise adversely affect beneficial uses.
Biostimulatory Substances	Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses. Changes in chlorophyll-a and associated phytoplankton communities follow complex dynamics that are sometimes associated with a discharge of biostimulatory substances. Irregular and extreme levels of chlorophyll a or phytoplankton blooms may indicate exceedance of this objective and require investigation.

Table 3.4-5 Basin Plan Narrative Water Quality Objectives Relevant to this Analysis (Continued)

<table>
<tr><th>OBJECTIVE</th><th>NARRATIVE</th></tr>
<tr><td>Bioaccumulation</td><td>Many pollutants can accumulate on particles, in sediment, or bioaccumulate in fish and other aquatic organisms. Controllable water quality factors shall not cause a detrimental increase in concentrations of toxic substances found in bottom sediments or aquatic life. Effects on aquatic organisms, wildlife, and human health will be considered.</td></tr>
<tr><td>Population and Community Ecology</td><td>All waters shall be maintained free of toxic substances in concentrations that are lethal to or that produce significant alterations in population or community ecology or receiving water biota. In addition, the health and life history characteristics of aquatic organisms in waters affected by controllable water quality factors shall not differ substantially from those for the same waters in areas unaffected by controllable water quality factors.</td></tr>
<tr><td>Dissolved Oxygen</td><td>For all tidal waters, the following objectives shall apply:
In the Bay:
<table>
<tr><td>Downstream of Carquinez Bridge</td><td>5.0 mg/L minimum</td></tr>
<tr><td>Upstream of Carquinez Bridge</td><td>7.0 mg/L minimum</td></tr>
</table>
For nontidal waters, the following objectives shall apply:
Waters designated as:
<table>
<tr><td>Cold water habitat</td><td>7.0 mg/L minimum</td></tr>
<tr><td>Warm water habitat</td><td>5.0 mg/L minimum</td></tr>
</table>
The median DO concentration for any three consecutive months shall not be less than 80 percent of the DO content at saturation.
DO is a general index of the state of the health of receiving waters. Although minimum concentrations of 5 mg/L and 7 mg/L are frequently used as objectives to protect fish life, higher concentrations are generally desirable to protect sensitive aquatic forms. In areas unaffected by waste discharges, a level of about 85 percent of oxygen saturation exists. A three-month median objective of 80 percent of oxygen saturation allows for some degradation from this level, but still requires a consistently high oxygen content in the receiving water.</td></tr>
</table>

Table 3.4-6 Basin Plan Surface Water Metals Criteria (µg/L)

	WATER QUALITY OBJECTIVE SOUTH OF DUMBARTON BRIDGE		WATER QUALITY OBJECTIVE NORTH OF DUMBARTON BRIDGE	
	CONTINUOUS (4-DAY AVERAGE)	MAXIMUM (1-HOUR AVERAGE)	CONTINUOUS (4-DAY AVERAGE)	MAXIMUM (1-HOUR AVERAGE)
Arsenic	36	69	36	69
Cadmium	9.3	42	9.3	43
Chromium	50	1100	50	1100
Copper	6.9[7]	10.8[7]	3.1	4.8
Lead	8.1	210	8.1	210
Nickel	11.9[7]	62.4[7]	8.2[2]	74[2]
Selenium[6] (total recoverable)	5	20	5	20
Silver	–	1.9	–	1.9
Zinc	81	90	81	90

Table 3.4-7 Other Basin Plan Surface Water Criteria

	EVALUATION CRITERIA
Mercury	0.025[1] / 0.051[2] µg/L, but see Table 3.4-8 below
PCBs	30 ng/L[3]
PAH	15.0 µg/L[1,5]
PBDE	not regulated
DO	5 mg/L[1]
Dioxins and Furans	0.014 pg/L[6]
TPH – Diesel	200 mg/L[4]
Pesticides:	
Chlordanes	2.2 ng/L[2]
DDTs	0.59 ng/L[2]

Notes:
1 CRWQCB, SF Bay Region, Water Quality Control Plan, San Francisco Bay Basin Electronic Basin Plan, September 13, 2005. Surface waters greater than 10 ppt salinity.
2 40 CFR Part 131.38 (California Toxics Rule or CTR), May 18, 2000.
3 CRWQCB, SF Bay Region, PCBs in San Francisco Bay, Total Maximum Daily Load Project Report.
4 US EPA Multi-Sector Permit Benchmark Values.
5 The water quality objective for PAHs is based on a 24-hr average.
6 National Recommended Water Quality Criteria – Correction, USEPA, April 1999.
7 CRWQCB, SF Bay Region, Water Quality Control Plan Amendment, San Francisco Bay Basin.

Notes on Criteria:
Mercury = 0.051 µg/L is for waters south of the Dumbarton Bridge (California Toxics Rule).
0.025 µg/L is for waters north of the Dumbarton Bridge (Basin Plan)
PCBs = Value for protection of aquatic life and uses
Dioxins and Furans = water quality objective value for human health for consumption of organisms, 10^{-6} risk.
DO = water quality objective value for tidal waters downstream of Carquinez Bridge.
Pesticides = Several water quality criteria available. These are protection of human health for organism consumption, which are more conservative.
PAH = water quality objective value for 24hr averaged level, salinity over 10 ppt.

Table 3.4-8 Current and Proposed Numeric Water Quality Objectives for Mercury

CURRENT TOTAL MERCURY WATER QUALITY OBJECTIVES IN SAN FRANCISCO BAY		
LOCATION	**WATER QUALITY OBJECTIVE FOR TOTAL MERCURY**	**SOURCE**
North of Dumbarton Bridge	0.025 µg/L 4-day average in water	Basin Plan
	2.1 µg/L 1-hour average in water	Basin Plan
South of Dumbarton Bridge	0.051 µg/L 30-day average in water	CTR
PROPOSED TOTAL MERCURY WATER QUALITY OBJECTIVES (ADOPTED BY RWQCB, PENDING ACTION BY SWRCB & USEPA)		
LOCATION	**WATER QUALITY OBJECTIVE FOR TOTAL MERCURY**	**SOURCE**
All of San Francisco Bay	2.1 µg/L 1-hour average in water	Basin Plan
	0.2 mg/kg in larger fish which humans consume	Basin Plan
	0.03 mg/kg in smaller fish which wildlife consumes	Basin Plan
South of Dumbarton Bridge	0.051 µg/L 30-day average in water	South of the Dumbarton, this CTR objective applies in addition to the three Basin Plan objectives.
Note: Both the current and proposed Basin Plan objectives listed above are applicable in marine waters – those in which the salinity is equal to or greater than 10 parts per thousand 95 percent of the time. For waters in which the salinity is between fresh and marine, that is between 1 and 10 parts per thousand, the applicable objectives are the more stringent of the freshwater or marine objectives. For mercury, the marine objectives are more stringent.		

As levees are breached and formerly isolated waters become contiguous with the Bay, the mercury and DO objectives for those Project Areas will be consistent with the beneficial uses of the Bay. For mercury, the approach should be to evaluate impacts based on the long-term prospects for attainment of tissue-based water quality objectives, because that is the direction that water quality standards for mercury and other pollutants are moving. For DO, the approach should be to protect far South Bay's assimilative capacity for BOD from excessive loading, while recognizing the natural occurrence of seasonal dips in DO that are found in near-shore estuarine habitats.

There is guidance for sediment assessment in the Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines (LTMS Guidelines) (RWQCB 2000) which is incorporated by reference in the Basin Plan. The LTMS guidelines define statistically determined San Francisco Bay ambient sediment concentrations and ecological thresholds (Table 3.4-9). The ambient concentrations are establish8ed through previous sampling efforts around "unimpacted" areas of San Francisco Bay. The ecological thresholds defined in the guidelines are the Effects Range-Low (ER-L) and the Effects Range-Median (ER-M) established by the National Oceanic and Atmospheric Administration (NOAA). ER-Ls represent the concentration below which adverse biological effects are unlikely, while ER-Ms represent

Table 3.4-9 LTMS Sediment Guidance

CHEMICAL CONSTITUENT	SAN FRANCISCO ESTUARY SEDIMENT AMBIENT CONCENTRATIONS (MG/KG)	ER-L (MG/KG)	ER-M (MG/KG)
Metals			
Arsenic	15.3	8.2	70
Cadmium	0.33	1.2	9.60
Chromium	112	81	370
Copper	68.1	34	270
Lead	43.2	46.7	218
Mercury	0.43	0.15	0.71
Nickel	112	20.9	51.6
Selenium	0.64		
Silver	0.58	1	3.7
Zinc	158	150	410
Pesticides			
Aldrin	0.0011		
Dieldrin	0.00044	0.000715 [1]	0.0043 [2]
p,p'-DDD		0.00122 [1]	0.00781 [2]
p,p'-DDE		0.00220	0.027
p,p'-DDT		0.00119 [1]	0.00477 [2]
Endrin	0.00078		
Hexachlorobenzene	0.000485		
Sum of Chlordanes (SFEI list)	0.0011	0.00226 [1]	0.00479 [2]
Sum of DDTs (SFEI list)	0.007	0.00158	0.0461
Sum of HCH (SFEI list)	0.00078		
Sum of PCBs (SFEI list)	0.0216	0.0227	0.18
PAHs			
1-Methylnaphthalene	0.0121		
1-Methylphenanthrene	0.0317		
2,3,5-Trimethylnaphthalene	0.0098		
2,6-Dimethylnaphthalene	0.0121		
2-Methylnaphthalene	0.0194	0.07	0.67
2-Methylphenanthrene	0.0266		
Acenaphthene	0.0317	0.016	0.5
Acenaphthylene	0.0266	0.044	0.64
Anthracene	0.088	0.0853	1.1
Benz(a)anthracene	0.244	0.261	1.6
Benzo(a)pyrene	0.412	0.43	1.6
Benzo(b)fluoranthene	0.371		
Benzo(e)pyrene	0.294		
Benzo(g,h,i)perylene	0.310		

Table 3.4-9 LTMS Sediment Guidance (Continued)

CHEMICAL CONSTITUENT	SAN FRANCISCO ESTUARY SEDIMENT AMBIENT CONCENTRATIONS (MG/KG)	ER-L (MG/KG)	ER-M (MG/KG)
Benzo(k)fluoranthene	0.258		
Biphenyl	0.0129		
Chrysene	0.289	0.384	2.8
Dibenz(a,h)anthracene	0.0327	0.0634	0.26
Fluoranthene	0.514	0.6	5.1
Fluorene	0.0253	0.019	0.54
Indenol(1,2,3-c,d)pyrene	0.382		
Naphthalene	0.0558	0.16	2.1
Perylene	0.145		
Phenanthrene	0.237	0.24	1.5
Pyrene	0.665	0.665	2.6
Sum of HPAHs (SFEI list)	3.060	1.7	9.6
Sum of LPAHs (SFEI list)	0.434	0.552	3.16
Sum of PAHs (SFEI list)	3.390	4.022	44.792

Notes:
[1] Threshold Effects Level, as established by the Florida Department of Environmental Protection (FDEP); no ER-L was established.
[2] Probable Effects Level, as established by the FDEP; no ER-M was established.
ER-L = Effects Range-Low, as established by NOAA.
ER-M = Effects Range-Medium, as established by NOAA.

the concentrations above which adverse biological effects are likely. The LTMS guidance is not a set of regulatory objectives.

In general, the RWQCB considers sediment with concentrations less than ambient levels to be acceptable for wetland cover material (the upper three ft), while sediment with concentrations less than ER-Ms are acceptable for wetland foundation material (greater than three ft below current or designed ground surface elevation). For PCBs however, the ER-L is used as a guideline for cover material. For chlordanes and dieldrin, the values used for cover material are 0.0023 mg/kg and 0.00072 mg/kg respectively. For some chemical constituents, the ambient value is greater than the respective ER-L. However, the RWQCB acknowledges that it is not practical to regulate to concentrations “cleaner” than ambient conditions.

Emerging Programs of Water Quality Standards

There are several emerging programs that will result in new, enforceable water quality and sediment quality objectives:

- The San Francisco Bay Mercury Total Maximum Daily Load (TMDL) was approved by the State Water Resources Control Board on July 17, 2007. Approval by the State Office of Administrative Law and the United States Environmental Protection Agency is necessary to complete the formal process for adopting the TMDL Basin Plan amendments, typically within six to twelve months;

- The draft Basin Plan Amendments and supporting documents for the San Francisco Bay PCB TMDL were released for public comment on June 22, 2007. The Board is scheduled to hear testimony on September 12, 2007, and an adoption hearing is scheduled for November 14, 2007. Following Board adoption, approval by the State Water Resources Control Board, the State Office of Administrative Law, and the United States Environmental Protection Agency is necessary to complete the formal process for adopting the TMDL Basin Plan amendments;
- The Bay Protection and Toxic Cleanup Program Legislation of 1989, coupled to a Court Order in 2001, requires the State Water Resources Control Board (SWRCB) to adopt sediment quality objectives;
- The RWQCB has completed technical analysis necessary to adopt site specific objectives for copper and nickel North of the Dumbarton Bridge, and is considering amending the Basin Plan to reflect the new information developed;
- The USEPA is working with an interagency technical team, including the SWRCB, USFWS, NMFS, and USGS, to amend the selenium objective promulgated in the California Toxics Rule; and
- Trash could be listed as an impairing pollutant in many urban creeks, including the Guadalupe River and Coyote Creek during the lifetime of this Project. Measures to reduce trash will likely be implemented through the Municipal Regional Permit for stormwater; if these do not succeed, a trash TMDL is a potential next regulatory step. Pathogens could follow a similar trajectory.

New objectives resulting from these programs should also be considered with respect to evaluation of impacts. Details on these emerging programs (except for the trash and pathogens TMDLs) are provided below.

San Francisco Bay Mercury TMDL

The San Francisco Bay mercury TMDL includes a plan to adopt new water quality objectives for mercury concentrations in fish. Although water quality criteria and objectives are traditionally expressed as mass of pollutant per unit mass of water (*e.g.*, μg/L), the Clean Water Act enables expression of criteria and objectives in alternative units. For bioaccumulative pollutants such as mercury, recent guidance by USEPA requires states to develop numeric criteria or objectives that are based on pollutant concentrations in fish tissue, and then implement the tissue-based criteria or objectives by translating the tissue-based values to water-based and sediment-based metrics. The proposed fish tissue TMDL targets for the Bay mercury TMDL are 0.2 mg/kg for 60 cm striped bass, and 0.03 mg/kg for smaller fish (3–5 cm) that are the prey of wildlife. These objectives are summarized in Table 3.4-8

The SF Bay Mercury TMDL also establishes a monitoring endpoint (a.k.a. “TMDL monitoring target”) for methylmercury concentrations in bird eggs. This monitoring endpoint is <0.5 mg/kg wet weight, which is the lowest observable effect level for impaired hatching success.

The San Francisco Bay Mercury TMDL also defines a numeric TMDL target of 0.2 mg/kg mercury, annual median, in suspended sediment for discharges to the Bay. Once this sediment target is met and Bay sediments have reached equilibrium with these inputs, the average mercury in Bay sediments should be reduced by 50 percent from the current (2006) condition, and the water quality objectives in Table 3.4-8 are expected to be attained.

This does not translate directly to a 0.2 ppm guideline for sediments within or discharged from the SBSP Restoration Project Area. Rather, the evaluation of impacts will need to consider the potential of a Project activity to raise or lower the average concentration of mercury in the Bay near where the activity takes place. In general, this is unlikely, because the ponds are sediment sinks, rather than sediment sources to the Bay.

San Francisco Bay PCBs TMDL

As noted above, this TMDL recently entered the adoption phase, with draft Basin Plan Amendments and supporting documents released on June 22, 2007. The proposed policies will include a sediment concentration goal based on fish tissue concentration target that will be used to determine attainment of beneficial uses. The currently proposed sediment goal is 1 µg/kg PCBs, corresponding to a fish tissue target of 10 µg/kg. Currently, ambient Bay sediments are approximately ten-fold higher than the sediment concentration goal of 1 µg/kg. The impact of Project activities on the concentration of PCBs in ambient Bay sediments will be evaluated with reference to this proposed goal and other environmental indicators of ecological risk as appropriate.

SWRCB Sediment Quality Objectives

The SWRCB is developing Sediment Quality Objectives based on the sediment quality triad approach. Chemical concentrations, bioassays, and benthic community condition are used together to establish the level of a constituent in sediment which provides for the reasonable protection of the beneficial uses of water and prevention of nuisances. The SWRCB also acknowledges the significance of bioaccumulation, but lacks the information or resources to develop detailed numeric sediment quality objectives for bioaccumulation. Rather, the SWRCB is working to adopt narrative sediment quality objectives for bioaccumulation, and establish the process and data needs for deriving bioaccumulation-based SQOs on a regional basis. The SWRCB sediment quality objectives apply only to sub-tidal sediments.

Site Specific Objectives for Copper and Nickel North of the Dumbarton Bridge

The RWQCB has completed technical analyses needed to adopt site-specific objectives for copper and nickel north of the Dumbarton Bridge. The site-specific objective adoption process for those two metals has already been completed South of the Dumbarton Bridge, as reflected by the copper and nickel objectives shown in Table 3.4-6. Should the RWQCB choose to adopt site specific objectives for copper and nickel north of the Dumbarton bridge, the objectives shown in Table 3.4-6 would become less stringent for copper and nickel.

USEPA Revision of the CTR Selenium Objective

The USEPA has “reserved” the CTR criterion for selenium pending consultation with wildlife resources agencies (USFWS and NMFS). These agencies are involved in an interagency technical team focused on revising the selenium water quality objectives for San Francisco Bay and the Sacramento-San Joaquin River Delta. It is expected that the resulting selenium objective will be based on fish-tissue concentrations, similar to mercury, and the plan of implementation will specify procedures to translate tissue-based selenium concentrations to concentrations of the different chemical forms of selenium in water and sediments. The exact timing for completion of this process is unknown. For this analysis, the potential for selenium impacts should rely upon the CTR objective for selenium (5 µg/L), as well as tissue-based numeric endpoints that are derived from the national criterion (United States Environmental Protection Agency 2004) with appropriate conservative assumptions.

3.4.4 Environmental Impacts and Mitigation Measures

Introduction/Overview

To evaluate the potential for impacts, thresholds of significant impacts were developed and are summarized below. The thresholds are primarily based on the state's program of Water Quality Standards, as described in Section 3.4.3. Based on information that is summarized in Sections 3.4.1 and 3.4.2 and the descriptions of the SBSP long-term alternatives and project-level Phase 1 actions, the potential to exceed thresholds of significance for each impact is evaluated and summarized below.

Under each potential impact, the likelihood of occurrence and potential for mitigation is discussed. If there is considerable uncertainty in the likelihood of occurrence, the information needed to reduce the uncertainty is described.

Significance Criteria

Thresholds of significance are used to define indicators of significant environmental impacts. In general, thresholds should be objective, quantitative wherever reasonably possible, and based on existing standards wherever possible. Following those guidelines, the relevant water quality objectives shown in the Section 3.4.3 are most appropriate for this analysis.

Some of the water quality objectives are narrative, rather than numeric. In those situations, translations to numeric endpoints are necessary using the best available science. In some cases (*e.g.*, PCBs, selenium), the translation from the narrative relies upon technical summaries completed as part of emerging regulatory programs. In other cases (*e.g.*, salinity, floatables, settleable solids) the translation from the narrative objective relies upon best professional judgment.

Some potential impacts have been identified as "staircase issues" (see Table 2-3 in Chapter 2, Description of Alternatives). This means that in order to ensure that thresholds of significance are not exceeded, triggers for adaptive management actions are established that are well below the thresholds of significance. This analysis describes conceptually how triggers would be developed, but leaves the site-specific development of the triggers to the Adaptive Management Plan. For water quality impacts, the staircase issues are: 1) changes in algal composition leading to nuisance algal blooms; 2) algal blooms leading to low DO; 3) mobilization and transport of mercury-contaminated sediments; and 4) mercury methylation and bioaccumulation.

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.

Threshold for Changes in Algal Abundance and Composition

Project activities that lead to unacceptable increases in algal abundance would be deemed to have significant impacts at the regional setting and at the Project Setting if the RWQCB narrative water quality objective for biostimulatory substances is violated:

> Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses. Changes in chlorophyll a and associated phytoplankton communities follow complex dynamics that are sometimes associated with a discharge of biostimulatory substances. Irregular and extreme levels of chlorophyll a or phytoplankton blooms may indicate exceedance of this objective and require investigation.

Note that in the case of San Francisco Bay, where nutrients are not limiting for algal growth, the biostimulatory substance could be sunlight, in which case the Project activity that could potentially promote aquatic growth is localized reduction in suspended load outside a breached levee due to a net loss of suspended load inside the accreting marsh area. Concerns over nuisance algal blooms apply to both free-floating phytoplankton and attached macrophytes.

The narrative objective for biostimulatory substances is divided into three parts:

1) Irregular or extreme levels of chlorophyll-a;
2) Phytoplankton blooms; and
3) Low DO.

In both the regional and the Project Setting, the key indicator that a threshold of significant impact has been exceeded is if algal growths cause nuisance or adversely affect beneficial uses.

A key difference between the regional setting and the Project Setting is the baseline with respect to nuisance and protection of beneficial uses. In the regional setting, baseline levels of chloryphyll-a and the expected seasonal variations are well known because of the monitoring programs described in Section 3.4.1. Likewise, DO levels in the regional setting have consistently met the Basin Plan water quality objective of 5 mg/L since installation of advanced sewage treatment in the 1970s and 1980s. In contrast, the Bay fringe areas (ponds, tidal marshes, and sloughs) that make up much of the Project Setting are known to have higher algal productivity and lower DO compared to the open Bay. High productivity and lower DO are common to ponds, wetlands, and sloughs, and do not necessarily indicate degraded or impaired habitat.

Project activities that lead to unacceptable increases in algal composition would be deemed to have significant impacts at the regional setting and at the Project Setting if the RWQCB narrative water quality objective for population and community ecology is violated:

> All waters shall be maintained free of toxic substances in concentrations that are lethal to or that produce significant alterations in population or community ecology or receiving water biota. In addition, the health and life history characteristics of aquatic organisms in waters affected by controllable water quality factors shall not differ substantially from those for the same waters in areas unaffected by controllable water quality factors.

The narrative objective is helpful because it recognizes the interactive effect of toxicants on changes in community structure. For example, some species of algae (*e.g*., diatoms) are more resistant to free ionic copper than others (*e.g*., blue-green algae), which can exert a significant effect on algal community structure. Establishing the narrative objective as a threshold ensures that adaptive management actions would address the interactive effects of biostimulation and other controllable water quality factors that can alter algal composition. As with the narrative objective for biostimulation, the baselines for algal community structure would be different in the regional and Project Settings.

The complexity of defining thresholds and baselines for algal abundance and composition is one reason this is being handled as a staircase issue. The narrative objectives cited above are sufficient as thresholds for the purposes of this analysis. Some recommended triggers for adaptive management are discussed below, under the evaluation of impacts and possible mitigation measures.

Threshold for Localized, Seasonal Low DO Levels

The threshold for low DO levels is established by the Basin Plan Water quality objective for DO (See Table 3.4-5). In the regional setting, this corresponds to 5 mg/L DO or greater for tidal waters, although the objective acknowledges that attaining 80 percent oxygen saturation as a three month median is satisfactory for protection of beneficial uses. Low DO can cause mortality in aquatic and benthic organisms (SBSP Impact 3.4-2, below), increased mercury methylation rates (SBSP Impact 3.4-4, below), and increased rates of disease such as avian botulism (SBSP Impact 3.6-22, below).

In the Project Setting, the threshold would vary depending on the habitat type. For open, fully tidal waters of the Project Setting, the threshold is the same as for the regional setting – DO greater than 5 mg/L or at least 80 percent saturation as a three-month median. But the waters of the Project Setting (*i.e.*, the managed ponds) that are subject to muted or constrained tidal action function differently since they are managed primarily for wildlife habitat (avian species use).

Therefore, for this analysis, low DO alone is not considered a threshold for managed ponds in the Project Setting. Rather, the threshold for significant impacts should be low DO and at least one of the following negative impacts of low DO:

1) Mortality of aquatic or benthic organisms;
2) Odors that cause nuisance;

3) Degraded habitat; or
4) Unacceptably high methylmercury production rates (see discussion of methylmercury impacts below).

This impact is also considered a staircase issue. In order to avoid exceeding thresholds of significant impact, the Adaptive Management Plan would define triggers and associated adaptive management actions to prevent impacts from occurring. Some suggested triggers are discussed in the impact analysis below.

Mobilization and Transport of Mercury-Contaminated Sediments

In the regional setting, the threshold for significant impacts for total mercury concentrations in sediments is established by the proposed Bay mercury TMDL. That TMDL includes a proposed target for mercury in suspended sediments of 0.2 ppm, computed as the annual median of RMP monitoring results. It is important to recognize that the Bay is currently over this target, which is in part why a TMDL for mercury will be implemented. Project activities that release sediments to the Bay with a median mercury concentration exceeding this target value would be deemed to have significant impacts.

The threshold for impacts to the Project Setting for total mercury in sediments is based on the median effects range for mercury, from the LTMS guidelines for the beneficial re-use of dredged and sediments, 0.7 mg/kg (See Table 3.4-7 in the regulatory setting). Project activities that would result in sediments within the SBSP Restoration Project Area that exceed this guideline would be deemed to have significant impacts. In addition, the narrative water quality objective for bioaccumulation should be considered to be a threshold for significant impacts:

> Many pollutants can accumulate on particles, in sediment, or bioaccumulate in fish and other aquatic organisms. Controllable water quality factors shall not cause a detrimental increase in concentrations of toxic substances found in bottom sediments or aquatic life. Effects on aquatic organisms, wildlife, and human health will be considered.

Establishing this narrative objective as a threshold of significant impact clarifies that the main concern over mercury, both in the regional and in the Project Setting, is over methylmercury, because methylmercury is the primary mercury form that bioaccumulates. Low dissolved oxygen is known to increase the risk of methylmercury production. Therefore, more sensitive thresholds for mercury concentrations in sediment may need to be considered for areas prone to low dissolved oxygen, in order to stay below the threshold defined by the narrative objective for bioaccumulation. Because of the complexity of biogeochemical processes affecting the conversion of mercury to methylmercury and its accumulation in the food chain, the impacts of mercury mobilization and transport and increased methylmercury production and bioaccumulation are defined as staircase issues to be addressed by the Adaptive Management Plan. The impacts section provides a conceptual level discussion of triggers for adaptive management actions that would avoid significant impacts.

Increased Methylmercury Production and Bioaccumulation

The Project would have significant impacts to both the regional setting and the Project Setting if Project actions resulted in water quality conditions that caused exceedance of tissue-based mercury water quality objectives proposed in the San Francisco Bay mercury TMDL, as summarized in Table 3.4-8. In addition to the water quality objectives listed in Table 3.4-8 above, the Bay Mercury TMDL proposes a bird egg monitoring target that is considered a threshold of significant impact. The bird egg monitoring target is < 0.5 mg mercury per kg bird egg (fresh wet weight), applied to the endangered least tern. This is the lowest observable effect level for reproductive impairment. The Project would have significant impacts if activities lead to exceedance of this numeric threshold.

Although the proposed water quality objectives have not yet been adopted through the RWQCB's formal administrative process, they are enforceable because of the narrative objective for bioaccumulation cited in the Regulatory Setting:

> Many pollutants can accumulate on particles, in sediment, or bioaccumulate in fish and other aquatic organisms. Controllable water quality factors shall not cause a detrimental increase in concentrations of toxic substances found in bottom sediments or aquatic life. Effects on aquatic organisms, wildlife, and human health will be considered.

Methylmercury bioaccumulation is identified as a staircase issue. The Adaptive Management Plan would be framed to avoid exceedance of thresholds by developing triggers for adaptive management actions. Triggers should be based on methylmercury concentrations in water and sediments, net methylmercury production rates, and mercury concentrations in sentinel species. This is described in greater detail in Appendix H, the Nutrients and Contaminants Analysis Report (NCAR). Site-specific food web modeling, verification of models through monitoring, and other tools would be developed as part of the Adaptive Management Plan to establish numeric trigger levels.

Mobilization and Transport of Other Contaminants

For all other contaminants, the thresholds for significant impacts are the Water Quality Objectives for San Francisco Bay. Project activities that would cause an exceedance of these water quality objectives are deemed to have significant impacts.

For pollutants of concern in sediments, the threshold for significant impacts is based on the LTMS Sediment Guidelines (Table 3.4-7). A Project activity would be considered to have significant impacts if it causes an increase of constituent concentrations above ambient conditions or above the median effects range (ER-M). As noted in Section 3.4.1, some metals, such as nickel, have concentrations that are naturally higher than the ER-M. In contrast, PCBs and other pollutants may soon receive guidelines more stringent than LTMS guidelines as a result of emerging programs like TMDLs and the Bay Protection Toxic Cleanup Program (BPTCP).

As noted in the regulatory setting, the BPTCP legislation also requires the adoption of sediment quality objectives. This policy development is expected to be completed by the end of 2010. The guidelines will likely delineate a "sediment quality triad" approach that considers chemistry, toxicity, and indices of biological integrity. An approach for developing bioaccumulation-based site specific objectives will also be described. While these are new statewide implementation plans, the narrative objectives for bioaccumulation and for toxicity in the Basin Plan currently serve as underlying standards. Translation to numeric thresholds would be expected to occur when specific plans to attain water quality standards, such as the PCB TDML, are developed and implemented.

Groundwater Quality

The threshold for an impact to groundwater quality is a substantial increase in the potential for salinity intrusion from the Bay into deep potable aquifers. This would be indicated by a Project-related increase in salinity or TDS at monitoring wells protecting water supplies that exceeded the narrative objective for salinity, the numeric objective for TDS, or violated the states anti-degradation policy by unreasonably degrading the quality of high-quality water. The water quality objective for TDS in municipal water supplies is 500 mg/L.

Program Level Evaluation

SBSP Long-Term Alternatives

***SBSP Impact 3.4-1:* Changes in algal abundance and composition, which could in turn degrade water quality by lowering DO and/or promoting the growth of nuisance species.**

Eutrophication, the process where water bodies receive excess nutrients that stimulate excessive plant growth, is a potential concern in both the regional setting (the Bay) and the Project Setting (managed ponds and restored tidal wetlands). There are two conceptual models for eutrophication responses in waterbodies (Cloern 2001). The first is based on a body of knowledge that was built on lake ecosystems. In the lake eutrophication conceptual model, algal growth responds directly to nutrient inputs. In contrast, the conceptual model for coastal eutrophication that has evolved over the past three decades emphasizes both direct and indirect factors that lead to changes in algal abundance and composition. These factors include water transparency, distribution and abundance of larger plants, nutrient ratios and their effect on algal assemblages, chemical transformations in sediment, the life cycle of bottom dwelling and free swimming invertebrates, and responses to toxic pollutants and other stressors. All of these factors can interact to modulate or amplify a coastal ecosystems response to biostimulatory changes. It is important to recognize that from the Project Setting, *i.e.,* managed ponds and tidal marshes within the three SBSP Restoration Project pond complexes, to the regional setting in South San Francisco Bay, the conceptual model for algal dynamics are different.

The reason for concern over changes to algal communities is the potential to impair the beneficial uses of water in the SBSP Restoration Project Area and in the Bay. Examples of changes to algal abundance and composition that cause nuisances and harm in aquatic ecosystems include:

1) Red tides caused by dinoflagellates;

2) Paralytic shellfish poisoning caused by domoic acid produced by diatoms; and

3) Mats of blue-green algae that are unsightly, cause odors, and lead to depressed DO when they decay.

The potential for changes in algal abundance and composition depends on a number of factors. The main direct factors to consider for evaluating impacts due to Project activities are:

1) *Limiting nutrient availability*. Addition of limiting nutrients stimulates algal growth in the classical lake-based conceptual model, with other attenuating factors at work in the conceptual model for coastal eutrophication.

2) *Hydraulic residence time*. Within a managed pond or tidal marsh, the growth of free-floating algal is balanced by removal due to flushing.

3) *Composition of zooplankton grazers.* The amount of grazing organisms present and their food preference exerts a direct effect on algal community structure.

4) *Concentrations of biologically available metals that are toxic to algae.* Different species of algae have different tolerances for metal toxins, such as copper. Metal toxicity is regulated by the amount of metal available for uptake by algae.

5) *Water transparency*. Increased water transparency can stimulate plankton growth where light is the limiting factor, rather than nutrients. While this appears to be the case in the Bay (Cloern 1999), the limiting factor within the SBSP Restoration Project Area is not known.

These direct factors should be evaluated for changes in both the Project Setting (restored tidal wetlands and managed ponds) and the regional setting (South San Francisco Bay).

Each of these direct factors is dependent on a number of indirect factors. The limiting nutrient can change, depending on seasonal changes in nutrient concentrations and shifts in the algal community composition. Nutrient concentrations are affected by both external sources and internal cycling at the sediment-water interface. Hydraulic residence time is a design feature, but can change as water depths drop due to accretion. Water transparency decreases as suspended sediment increases, so wind shelter that creates quiescent areas can lead to increased light penetration inside the SBSP Restoration Project Area. Accretional areas that trap sediments within the Project Area can cause decreased turbidity outside the Project Area, adjacent to breached levees. Light penetration can be decreased by increased water depth and algal blooms, especially macrophytic algae. The composition of zooplankton grazer populations responds to changes both in the available food and the intensity of predation from higher organisms. The amount of biologically available metals, such as copper, present in the water column can shift in response to not only changes in metal concentration but also the amount of complexing agents present (dissolved organic matter) that reduces metal availability for uptake by algae. The intricacy of interactive effects between direct and indirect factors makes prediction of the exact response of Project alternatives very difficult, which is why this impact would have to be managed adaptively.

Alternative A No Action. As water management is discontinued some ponds would become seasonal and others would maintain flow via gravity control structures. Seasonal ponds fill and dry through rainfall and evaporation. Uncontrolled levee breaches are likely under Alternative A as levees are not improved. These breaches would likely result in sudden flows of pond water to the Bay, potentially releasing algae and BOD.

The effect of these outcomes on the direct factors affecting algal community structure is uncertain, but a few general statements can be made. Reduction of water management would likely lead to longer hydraulic residence times in remaining ponds, potentially causing stagnant waters and nuisance algal blooms. The effect on nutrient availability within the ponds is unknown. Seasonal ponds would be unlikely to have an effect on the Bay as long as they remain hydraulically isolated.

Unintentional breaching of levees would cause sudden flows of pond water into the Bay. The discharged water from many ponds would be rich in algae, ammonia nitrogen, and phosphorous, as evidenced by preliminary assessments of USGS (see Section 3.4.1, Physical Setting). The loss of suspended sediment to settling within the breached pond area can potentially increase water transparency outside the pond, likely stimulating algal growth outside the breach. The combined loss of transparency and inoculation with new algal communities could lead to perturbations in the algal communities, but those impacts would be minimal compared to Alternatives B and C.

Alterations of the composition of zooplankton grazer populations that results from unintended levee breaching and reduced water management is uncertain. It is unlikely that these occurrences would change concentrations of biologically available trace metals such as copper in the Bay, but it may change the concentration and chemical form of metals in the remaining ponds. The impact of this on algal community structure is unknown.

Under Alternative A, there would be neither monitoring of triggers nor any commitment to take adaptive management actions in the event that significant impacts occur.

Alternative A Level of Significance: Potentially Significant

Alternative B Managed Pond Emphasis. Under Alternative B, some levees would be breached to restore ponds to fully tidal and muted tidal habitats, while other levees would be strengthened and maintained. Salt production has ceased, so water management in remaining ponds would establish salinities varying from brackish (one to two ppt), to saline (two to 30 ppt) to hypersaline (30 to 50 ppt). Tidal habitats would import or accrete sediment, causing water depths to decrease and decreasing turbidity outside the levee breaches.

Within the Project Setting, decreased depths in managed ponds could stimulate algal growth by increasing temperature and decreasing light limitation. Retaining some wind-sheltering levee structures to encourage sediment accretion would further increase light penetration. Changes to nutrient cycling in sediments, zooplankton composition, and the concentration of biologically available trace metals are impossible to predict.

In the regional setting (the Bay), the principal factor that could lead to an impact is the decrease in suspended sediments that results from developing accretional tidal habitat. Preliminary results from USGS predict an approximate 10 percent decrease in turbidity (U.S. Geological Survey, Unpublished Data 2005). This could lead to changes in the timing and magnitude of algal blooms, but the overall ecosystem response is difficult to predict because of complicating factors such as benthic grazing and the ability of different algal species to produce complex agents that reduce metal bioavailability.

Key differences between Alternative B and Alternative A are that levee breaches would be intentional under Alternative B, and Alternative B would implement the SBSP Restoration Project's Adaptive Management Plan that establishes triggers for actions to avoid exceeding thresholds of significant impact to the regional or Project Settings.

Adaptive Management Plan. It is difficult to predict the effects of tidal restoration on exceedance of the threshold criteria for significant impacts due to changes in algal abundance and composition. Therefore, monitoring and adaptive management are critical components of the SBSP Restoration Project to determine the extent of tidal restoration that can occur in the long term. The Adaptive Management Plan is the mechanism by which the Project would move up the staircase from Alternative B (50/50 mix of tidal / salt pond habitat) towards Alternative C (90 : 10 tidal / pond mix). Effects are monitored in each pond complex, and triggers for adaptive management actions are established that avoid exceeding the significance threshold.

Adaptive Management Triggers. This analysis describes conceptually some meaningful triggers that lead up to exceedance of the threshold. The triggers and actions should consider how specific attributes of the regional and Project Setting amplify or diminish responses to biostimulation and how different biostimulatory factors interact with each other.

To avoid exceeding the threshold for significant impacts due to biostimulation or changes in algal community structure, triggers should be established that address metrics for the following elements of the coastal eutrophication conceptual model (Cloern 2001):

1) **Increases in biostimulatory substances.** Monitoring biostimulatory substances, such as nitrogen and phosphorous, is an important front line trigger for adaptive management. It should be recognized that determining the limiting nutrient(s) for biostimulation can be complex, varying in time and space and changing as ecosystems change. It should also be recognized that available sunlight may be the limiting factor, so monitoring simple parameters such as turbidity and Secchi depth would help identify potential water quality changes that could lead to ecosystem changes. This is an important indicator in both the regional setting (the Bay) and the Project Setting (managed ponds and restored tidal habitat). The National Science Panel recommended that this is a lower priority compared to monitoring algae and chlorophyll-a.

2) **Algal biomass and primary production**. Biomass is typically characterized by chlorophyll-a concentrations. Primary production is measured by carbon fixation rates. Both of these measures are key indicators of how much algae is present and how fast it grows, which is a direct indicator of response to biostimulation. This is an important indicator in both the regional setting (the Bay)

and the Project Setting (managed ponds and restored tidal habitat). The National Science Panel recommended that monitoring to detect nuisance algal blooms is an extremely high priority. The panel emphasized that monitoring should address whether nuisance algae are accumulating in ponds and whether nuisance algae are being transferred to the Bay as far north as the San Mateo Bridge. The panel also recommended that existing programs be supplemented by phytoplankton time series analyses at a few critical locations. The panel noted that chlorophyll-a measurement is a critical parameter, whereas nutrient measurement is not.

3) **Responses in sediments to changes in algal abundance.** The habitat quality in bottom sediments may be the most sensitive to excessive algal blooms (Cloern 2001). One useful measure of habitat quality is depth of the oxidation-reduction potential discontinuity, *i.e.*, does DO drop within millimeters or centimeters of the sediment water interface. Accumulation of sulfide in sediment pore waters is another related indicator, as is the breakup of oxide surfaces and associated release of adsorbed constituents such as phosphorous and metals. All of these factors are typically measured using sediment pore water chemistry profiles, core incubations, or direct probing with remote sensing cameras. This indicator is more relevant to the Project Setting than the regional setting.

4) **Responses of other biota to changes in algal abundance.** Another measure of habitat quality would be the amount and types of submerged vascular plants. Shifts from perennial plants to ephemeral macroalgae can cause profound disturbances in the habitat quality for swimming, burrowing, and free-floating aquatic life. Direct measures of altered habitat, such as plant surveys, and indirect measures, such as benthic community indices, would be useful triggers for adaptive management. This indicator is more relevant to the Project Setting.

5) **Early responses to biostimulation.** Shifts in algal community composition can be directly characterized by assessment of the proportions of different species, *e.g*., the relative percentages of diatoms, dinoflagellates, and blue-green algae. Another important indicator is the timing of the annual algal bloom in the Bay. A substantially earlier or later onset and peak of the bloom would be an important early indicator of potentially significant shifts in ecosystem structure. This indicator is more relevant to both the regional setting than the Project Setting.

The foregoing description of triggers has necessarily avoided quantitative statements about trigger levels. However, in these cases monitoring to detect deviations from existing norms or trends would provide a good trigger for action. The discussion of the adaptive management process below explains how these triggers can be used to make decisions about the progression of the Project from the managed pond emphasis bookend (Alternative B) towards the tidal marsh bookend (Alternative C).

Adaptive Management Process. The Project's Adaptive Management Plan would address the uncertainties regarding the relationship between Project activities and exceedance of thresholds for biostimulation and harmful changes in algal species abundance and composition by monitoring indicators defined in the triggers section above and adaptively managing the Project to ensure that adverse effects do not reach a significant level.

If monitoring data show that a trigger has been exceeded, the first reasonable action is to conduct focused studies to characterize the degree of ecological risk. A change in algal composition could signal a healthy evolution of the SBSP Restoration Project Area in question, or a benefit to the regional setting, rather than a threat to water quality. The purpose of monitoring is to verify that changes in algal abundance and community structure, distribution of larger plants, and benthic infaunal populations can be detected. Special studies would determine the ecological significance of such changes when they happen.

Should such changes be found to be adverse, adaptive management measures would address both individual projects and the overall program. At the project level, adaptive management actions could include manipulating hydraulic residence time, altering the depths of managed ponds and tidal marshes, introduction of artificial shade cover, or reverting tidal marsh habitat to managed ponds. At the program level, the finding of significant trigger exceedance that cannot be reversed or arrested through adaptive management would cause the program of restoration to move towards the managed pond emphasis (Alternative B), rather than the tidal habitat emphasis (Alternative C).

The Project's Adaptive Management Plan would address the uncertainties regarding the relationship between Project activities and thresholds for significant impacts to algal abundance and composition by monitoring chlorophyll, growth rates, species composition, benthic habitat quality, benthic invertebrate communities, and sediment DO and redox profiles. The Project would be adaptively managed using monitoring to ensure that adverse effects do not reach a significant level.

Alternative B Level of Significance: Less than Significant

Alternative C Tidal Habitat Emphasis. Restoration of tidal habitat would require sediment deposition or import from tidal slack water to raise pond bottom elevations to MHHW elevation. Tidal flood currents would bring slough water into the breached ponds where suspended sediments would settle out from the slack water prior to the ebb phase. The sediment flow to the tidal marsh would decrease suspended sediment supply in the surrounding sloughs and Bay, potentially resulting in decreased turbidity and increased algal abundance. This assumes that the local tributaries have insufficient suspended sediment loads to compensate for loss to tidal marshes.

In Alternative C, all of the same Adaptive Management approaches identified for Alternative B would be utilized to avoid significant adverse impacts.

Alternative C Level of Significance: Less than Significant

SBSP Impact 3.4-2: **Potential to cause localized, seasonally low DO levels as a result of algal blooms, increased microbial activity, or increased residence time of water.**

Changes in water flow/residence time and increased algal abundance (see SBSP Impact 3.4-1 above) productivity could drive lower DO levels in managed ponds, tidal marsh habitat, and discharges from the Project Setting into the Bay.

DO in the water column is necessary to support respiring organisms. DO is depleted in pond and marsh environments by respiration and chemical and microbial aerobic processes. DO is replenished in the system through photosynthesis and oxygen transfer from the atmosphere, termed reaeration.

Microbial degradation of organic matter in pond and marsh sediments can be a significant oxygen demand in the system. This sediment oxygen demand is dependent on the amount of organic matter available to decay. Death of algae and aquatic organisms contributes to the organic matter supply. Respiration may be a significant oxygen demand if algae and organism populations are large. Algae are net oxygen consumers at night, when wind-driven reaeration is also low. This creates periods of low DO. DO is then replenished during the day when the algae photosynthesize instead of respiring and wind-driven reaeration increases.

Reaeration rates are largely dependent on wind mixing and flow rates. Oxygen is transferred over the surface of the water at a rate dependent on the degree of oxygen saturation of the water. Mixing brings low DO waters to the surface, driving oxygen transfer. Waters flowing slowly through a pond would not be as well mixed as faster moving waters. Stagnant conditions lead to anoxic waters as oxygen demands exceed reaeration.

Environments of varying DO ranges can support different communities. Tidal marshes and ponds designed for shorebird habitat may flourish under lower DO conditions than deeper water communities. For this reason, the DO water quality standard should be thoughtfully applied to areas where DO is expected to be naturally low, such as slow moving or standing water over vegetated areas or mudflats. Fringe areas of the Bay, particularly managed ponds, are expected to experience periodic declines in DO.

Significant impacts as a result of low DO would include depressed species diversity, fish kills and death of other aquatic organisms, and odor problems. Even short periods of depressed DO levels can lead to death of aquatic organisms. Another impact of low DO, discussed under SBSP Impact 3.4-4 below, is increased net methylmercury production. These thresholds for significant impacts need to be avoided in both the Project Setting and the regional setting.

Alternative A No Action. Under Alternative A, water management to maintain levels and flows in the ponds would cease. Ponds at higher elevations would become seasonal; flow in ponds at lower elevations would be maintained by gravity flow control structures. Flow in both the seasonal and year round ponds would not be readily adjustable to maintain DO levels by changing hydraulic residence times. Residence times long enough to lead to low DO conditions are likely. Unplanned levee breaches, expected under Alternative A, would result in sudden flows of low DO water to the sloughs and Bay. Fish kills and low species diversity may result. Alternative A would likely result in the DO threshold being exceeded within the SBSP Restoration Project Area.

Alternative A Level of Significance: Potentially Significant

Alternative B Managed Pond Emphasis. Under Alternative B the salt ponds would be restored to half managed pond and half tidal habitat. Restoration plans for managed ponds would be designed to optimize bird habitat while meeting water quality objectives. Initial experience gained during the ISP shows that changes in water management, and the associated new water control structures, led to algal blooms within the SBSP Restoration Project Area in unbreached ponds. Thus, the initial ISP experiences show that conversion of salt ponds to tidally circulated managed pond habitat does pose risks for low DO and related impacts. Lessons learned from that experience are:

1) It is important to monitor DO and be ready to respond rapidly. The National Science Panel strongly recommended a monitoring approach to detect short-term events;

2) Longer residence times can exacerbate low DO problems; and

3) Some adaptive management actions, *e.g*. aeration prior to discharge, may be necessary to protect beneficial uses.

As more breaches are opened for tidal habitat restoration, BOD discharges can potentially increase, but some ameliorating factors of tidal marsh restoration on depressed DO include:

1) Tidal currents that provide mixing to improve re-aeration, dilute nutrients, and counter productivity;

2) Establishment of large vascular plants that provide oxygen transport to root zones; and

3) Establishment of shallow waters where sediment oxygen demand is effectively countered by re-aeration.

A simple box model, described in the Nutrients and Contaminants Analysis Report, has been created to predict DO concentrations in the ponds. The model helps characterize minimum hydraulic residence times needed to prevent a pond from equilibrating at low DO conditions. It can also be used to explore the effect of re-aeration rates, sediment oxygen demand, and initial algal abundance on the minimum hydraulic residence time needed to avoid low DO. The model as developed is a simple one-box model for optimization of residence time. With additional resources, a more sophisticated multi-box model can be developed and evaluated for parameter sensitivity.

The value of modeling is that it allows managers to make predictions that can be tested through monitoring. The results of monitoring then either validate the model or demonstrate the need for model refinement until the model is shown to reliably forecast system responses. A refined, validated numerical model of DO responses in managed ponds and tidal habitats would help plan projects and features necessary to avoid low DO conditions. The lessons learned during the ISP constitute the first iteration of modeling, monitoring and adaptive management that the SBSP Restoration Project Plan describes.

A key difference between Alternative A and Alternative B is that under Alternative B, monitoring through the Adaptive Management Plan would enable adaptive management actions necessary to avoid exceeding thresholds of significant impact.

Adaptive Management Plan. It is difficult to accurately predict the effects of tidal restoration on exceedance of the threshold criteria for significant impact due to low DO. Therefore, monitoring and adaptive management are critical components of the SBSP Restoration Project to determine the extent of tidal restoration that can occur in the long term. The Adaptive Management Plan is the mechanism by which the Project would move up the staircase from Alternative B (50:50 mix of tidal : managed pond habitat) to Alternative C (90 : 10 tidal : pond mix). Effects are monitored in each pond complex, and triggers for adaptive management actions are established that avoid exceeding the significance threshold.

The initial modeling results and the experience of the ISP show that there is considerable uncertainty regarding the effects of restoration on DO in the Project Setting and resulting discharges to the regional setting. Sediment oxygen demand within a Project Area can change in response to algal blooms and die-offs. As described above in SBSP Impact 3.4-1, factors controlling algal blooms are extremely complex. Therefore, the approach would be to establish triggers for adaptive management actions that avoid exceedance of the threshold for significant impacts.

Adaptive Management Triggers. Once restoration activities commence, ongoing monitoring of early warning indicators would be used to detect water quality changes that could lead to exceedance of the threshold for significant impacts. Key indicators that should be monitored to detect deviations from existing norms or trends include:

1) Algal abundance – the National Science Panel strongly recommended monitoring chlorophyll-a, nuisance algal blooms within ponds, and time-series measurements of phytoplankton in the Bay;
2) Sediment oxygen demand; and
3) Magnitude, duration, and spatial extent of DO sags – the National Science Panel strongly recommended monitoring capable of detecting short-term DO sags in the ponds and in the Bay.

The first indicator is also a trigger for adaptive management for SBSP Impact 3.4-1, and gets to the heart of both impacts (SBSP 3.4-1 and SBSP 3.4-2). Algal blooms are a problem if they create an additional problem, such as low DO in large expanses of water. A trigger to indicate if algal blooms are causing a problem would be increased sediment oxygen demand, the second trigger moving up the staircase towards significant impact. Similar to algal bloom, increased sediment oxygen demand is only a problem if it causes an additional problem. The third trigger, the magnitude, duration and spatial extent of DO sags, is necessary in order to separate normal marsh and wetland function from serious ecosystem impacts. The presence of low DO waters in certain areas of the Project Setting is to be expected as part of a healthy Baylands mosaic. The goal of the Adaptive Management Plan is to ensure that the occurrence of low DO does not lead to significant impacts, such as mortality of aquatic life within the Project Setting, discharge of water that leads to depressed DO in the regional setting, or net production of harmful levels of methylmercury in the Project Setting or discharges of methylmercury to the regional setting.

Adaptive Management Process. The triggers described above would initiate adaptive management actions. The triggers are arranged in the order that the Adaptive Management Plan would move up the staircase. Finding of increased algal abundance would trigger a focused study to determine if this condition is at risk of causing increased sediment oxygen demand. Finding of increased sediment oxygen demand would lead to an investigation of the frequency, magnitude, and duration of depleted DO in the Project and regional setting.

At any point along the staircase of triggers, up to and including assessing the extent of DO depression, adaptive management actions could also be taken to reverse the condition leading to trigger exceedance. Some examples of adaptive management actions include:

1) Decreasing the hydraulic residence time to counter algal growth and increase re-aeration;

2) Altering levee configurations to increase wind-driven re-aeration and/or improve pond circulation;

3) Decreasing water depth to counter sediment oxygen demand; and

4) Installing passive or active re-aeration systems.

If through Adaptive Management Plan implementation it is determined that exceedance of triggers cannot be avoided or reversed through adaptive management actions at individual projects after tidal restoration, than the program endpoint would shift towards the bookend of alternative B (managed pond emphasis) rather than Alternative C (tidal marsh emphasis). On the other hand, if tidal marsh habitat is more easily managed to avoid low DO, this finding would shift the program endpoint towards tidal habitat.

The Project's Adaptive Management Plan would address the uncertainties regarding the relationship between Project activities and thresholds for significant impacts due to low DO by monitoring algal growth rates and abundance, sediment oxygen demand, and the magnitude, frequency and duration of DO depression. The SBSP Restoration Project would be adaptively managed using from the Adaptive Management Plan monitoring to ensure that adverse effects do not reach a significant level.

Alternative B Level of Significance: Less than Significant

Alternative C Tidal Habitat Emphasis. Under Alternative C the majority of the SBSP Restoration Project Area would be restored to tidal habitat. As described above, the effect of more tidal habitat compared to more managed pond habitat on DO levels in the SBSP Restoration Project Area is difficult to predict. However, breaching of ponds resulting in more tidal habitat restoration would result in tidal flushing that would typically increase DO in the Project Setting.

In Alternative C, all of the same Adaptive Management approaches identified for Alternative B would be utilized to avoid significant adverse impacts.

Alternative C Level of Significance: Less than Significant

SBSP Impact 3.4-3: **Potential to mobilize, transport, and deposit mercury-contaminated sediments, leading to exceedance of numeric water quality objectives, TMDL allocations, and sediment quality guidelines for total mercury.**

The potential for mobilization and transport of mercury-contaminated sediments into and out of the Project Area could cause exceedance of numeric water quality objectives, TMDL targets, or sediment quality guidelines. The geography and history of the Bay affects the distribution of mercury-contaminated sediments within and surrounding the Project Area. South San Francisco Bay has been subjected to discharges of mercury-contaminated sediments originating from the historic New Almaden mining district. The mining activities causing these discharges date back to the late 1800s and early 1900s, although the discharges persist as a legacy source in the Guadalupe River watershed. The Guadalupe River Watershed Mercury TMDL is an effort to ensure that land in, around and downstream of New Almaden mines will be cleaned up and restored to beneficial use.

However, a legacy of mercury contamination persists in the form of a north-south mercury concentration gradient in sediments (San Francisco Bay RWQCB 2006). The average concentration of mercury in Bay sediments is 0.4 ppm, and the median concentration of mercury in suspended sediments is 0.3 ppm. This gradually increases to 0.5 to 0.8 ppm in the South Bay, and then sharply increases to one to two ppm in Alviso Slough, especially just after high-flow events. Much of the SBSP Restoration Project Area has been separated from the Bay and from source tributaries, so ponds in the northern pond complexes (Eden Landing and Ravenswood) are known or expected to have mercury concentrations below the Bay ambient condition. In these situations, it is reasonable to forecast that breaching levees would bring sediments within the pond up to bay ambient mercury concentrations in sediments. The impact analysis focuses on whether this moderate increase of mercury concentrations (0.05–0.15 ppm up to 0.4 ppm) in sediments poses a risk of mercury impacts for these pond complexes.

In contrast, ponds in the Alviso pond complex, notably Ponds A8 and A12 along Alviso Slough, have mercury concentrations in sediments up to 4 ppm. The cause of this localized increase is deposition of mercury-laden sediments from the Guadalupe River watershed. In this situation, an impact that needs to be analyzed is whether Project activities would release these mercury-contaminated sediments to the Bay. Movement of mercury-contaminated sediments from the Guadalupe River into the SBSP Restoration Project Area around Alviso already occurs under the ISP. This movement results from high-flow discharges of mercury-enriched sediment that are mobilized in the upper watershed during storms, and tidally mixed with ambient sediments in Alviso Slough and bayward channels.

Re-mobilization of mercury-contaminated sediments into the water column can lead to exceedance of water quality objectives for mercury. This is because there is a direct relationship between the concentration of suspended sediments in the water column, the concentration of mercury on those suspended sediments, and the concentration of total mercury in the water column.

Project activities can impact attainment of water quality objectives by changing the ambient TSS or by changing the mercury concentration of suspended particles. Table 3.4-10 below illustrates how this works. For sediments with the current Baywide ambient concentration of 0.4 mg/kg mercury, moderate TSS levels (*e.g.*, 100–200 mg/L) would cause exceedance of the 0.025 and 0.051 mg/L water quality objectives. The Bay TMDL target for mercury in fine suspended sediments corresponds to a median value of 0.2 mg/kg. This condition is expected to be attained over a long time frame (50 to 100 years). Suspended sediments having 0.2 mg/kg mercury would cause exceedance of water quality objectives at somewhat higher TSS concentrations (200 to 300 mg/L). For relatively clean sediments (*e.g*., 0.1 mg/kg Hg or less), TSS levels up to 500 mg/L or more could still be in attainment of water quality objectives. For context, 50 to 100 mg/L TSS is relatively common throughout the regional and Project Setting, whereas 500 to 1000 mg/L TSS is infrequent.

Table 3.4-10 Relationship Between Total Mercury in the Water Column (THg), Mercury Concentrations in Suspended Particles (PHg), and Total Suspended Solids (TSS)

TOTAL MERCURY IN THE WATER COLUMN	CONDITIONS	
(THG = PHG X TSS / 1000)	PHG (MG/KG)	TSS (MG/L)
0.080	0.4	200
0.040	0.4	100
0.060	0.2	300
0.040	0.2	200
0.050	0.1	500
0.030	0.1	300
Note: Relationship makes simplifying assumption that dissolved mercury concentrations are negligible.		

Project activities can impact attainment of the Bay TMDL target for mercury in sediments, which calls for a 50 percent reduction in the mass of mercury in the actively resuspended layer. This target is implemented by requiring sediment sources to the Bay to be at or below the current ambient condition of 0.4 ppm. Therefore, Project activities which discharge sediments to the Bay having greater than 0.4 ppm have the potential for impacts to the regional setting.

Activities that result in sediments in the SBSP Restoration Project Area having mercury concentrations exceeding the LTMS guideline (0.7 ppm) have the potential to cause impacts to the Project Setting. In this case, because the LTMS guideline is based on an ER-M, the potential impact is toxic effects on benthic communities, not bioaccumulation. The potential for bioaccumulation impacts is discussed separately below (SBSP Impact 3.4-4).

Alternative A No Action. Reducing water management and eventually creating seasonally dried out ponds would not affect sediment exchange into or out of the SBSP Restoration Project Area. Dried out ponds in northerly Project Areas that fill seasonally with rainwater would likely attain numeric water quality objectives for mercury as long as the in-place sediments have relatively low mercury concentrations, which is consistent with the findings of preliminary surveys from the ISP (See Figure 3.4-3). In contrast, dried out ponds in southerly Project Areas may exceed water quality objectives during seasonal rains, assuming the elevated mercury concentrations in sediments found during ISP monitoring of the Alviso pond complex persist. Wetting and drying cycles may potentially enhance methylmercury. Without an adaptive management plan, this is a potentially significant impact.

Uncontrolled / unintentional levee breaching would cause increases in the mercury concentrations of northern pond complexes (Eden Landing and Ravenswood) until they equilibrate with Bay ambient concentrations. This would lead to more frequent exceedance of water quality objectives within the Project Setting, caused both by the increase in mercury concentrations to the Baywide ambient condition and the increase in TSS by greater wind-wave action that results as levees deteriorate.

In contrast, uncontrolled / unintentional levee breaching could release mercury-contaminated sediments from sloughs and areas around the breaches. This would work against the Bay TMDL's objective to reduce the inventory of mercury in Bay sediments by preventing the discharge of sediments at greater than ambient mercury concentrations.

Under Alternative A, there would not be an Adaptive Management Plan in place to determine if these impacts are significant nor any process to take action if they are found to be significant.

With respect to attainment of LTMS guideline (0.7 mg/kg), the Eden Landing and Ravenswood pond complexes are currently in attainment and expected to be in attainment under the no-action alternative. Unintentional breaching would, in a worst case, bring northerly Project Areas into equilibrium with the Baywide ambient condition of 0.4 mg/kg, which is below the LTMS guideline. The Alviso pond complex is currently above this LTMS guideline under the ISP, so this is considered a baseline condition. This is not expected to change under the No Action Alternative.

Alternative A Level of Significance: Potentially Significant

Alternative B Managed Pond Emphasis. The impacts under Alternative B, which aims for a 50/50 mixture of tidal habitat and managed ponds, would be similar to impacts described under the No Action Alternative, but for a few important exceptions. In general, northerly breaches would increase mercury concentrations in the sediments of restored tidal habitats up to Bay ambient conditions. Southerly breaches could release mercury-contaminated sediments from closer to the Guadalupe River watershed source into the SBSP Restoration Project. The key difference compared to Alternative A is that conversion of ponds to tidal habitat under Alternatives B and C would be deliberate, rather than unintentional.

A potential benefit of deliberate rather than unintentional breaching is that levees would be maintained to provide sheltered conditions that encourage evolution from mudflat to marsh habitat. With regard to total mercury concentrations in water, this would have the effect of maintaining lower TSS concentrations in the SBSP Restoration Project Area, which can ameliorate the effect of bringing mercury concentrations in sediments up to Bay ambient conditions.

Adaptive Management Plan. It is difficult to predict the effects of tidal restoration on exceedance of the threshold criteria for significant impact due to mobilization and transport of mercury-contaminated sediments. Therefore, monitoring and adaptive management are critical components of the SBSP Restoration Project to determine the extent of tidal restoration that can occur in the long term. The Adaptive Management Plan is the mechanism by which the Project would move from Alternative B (50/50 mix of tidal/salt pond habitat) to Alternative C (90/10 tidal/pond mix). Effects are monitored in each pond complex, and triggers for adaptive management actions are established that avoid exceeding the significance threshold. In the regional setting, the threshold for significance for mercury-contaminated sediments is the Bay Mercury TMDL's ambient condition of 0.4 mg/kg. In the Project Setting, the thresholds of significance are the Basin Plan's narrative objective for bioaccumulation and the numeric LTMS guideline for mercury in sediments (0.7 ppm).

Adaptive Management Triggers. Once restoration activities commence, ongoing monitoring of water quality conditions would be used to detect changes in the transport of mercury-contaminated sediments into and out of the SBSP Restoration Project Area. Triggers would be established to signal Project impacts that are approaching the threshold of significance.

In the SBSP Restoration Project Area, the applicable objectives for total mercury in water (0.051 µg/L and 0.025 µg/L, depending on location) are reasonable triggers for actions. Exceeding these water quality objectives in a pond after a restoration action is completed would trigger the adaptive management actions described below. In the regional setting, the trigger should be if the average concentration of mercury in sediments discharged from the SBSP Restoration Project Area is 0.2 ppm or more, and this was not already occurring under baseline conditions.

Adaptive Management Process. If restoration activities trigger exceedance of water column objectives for mercury in the SBSP Restoration Project Area, the first step would be to determine if this poses a risk to mercury bioaccumulation in the food web. This would be accomplished through focused studies of mercury methylation and bioaccumulation. If monitoring determines that exceedance of the water quality objective is directly related to increased mercury methylation and bioaccumulation, then adaptive management actions to reduce the exceedance would be initiated.

Adaptive management actions to address exceedance of water column mercury objectives should either reduce TSS in the Project Setting, reduce the mercury concentrations of the actively resuspended sediments, or both. For example, adding an upper layer of clean sediment would decrease mercury concentrations in re-suspended sediments. Placing berms within ponds to decrease fetch length would help decrease wind-driven resuspension, thereby decreasing TSS in the Project Setting.

In contrast, if exceedance of the water column mercury objectives is not associated with bioaccumulation impacts, the appropriate adaptive management action would be to implement emerging guidance for tissue-based mercury water quality objective in favor of the less protective water column objective for the pond complex in question. This would have the effect of making the water quality standards implementation for mercury in the SBSP Restoration Project Area consistent with that of the Bay, where water column objectives are expected to soon be replaced with tissue-based objectives.

If restoration activities discharge significant amounts of sediment having greater than 0.2 ppm mercury from the SBSP Restoration Project Area into the regional setting, the first step would be to determine if this has a significant effect on the average mercury concentration in Bay sediments, and whether the discharge causes a localized bioaccumulation effect. The effect on mercury concentrations in Bay sediments can be evaluated by considering the mass of sediment discharged and average concentration of mercury in that sediment, along with the mass of sediment in the impacted receiving waters. Significant impacts on the mass of mercury in the actively resuspended layer of the Bay can be offset by removal of mercury-contaminated sediments from the affected area or nearby areas of the Bay. Bioaccumulation effects can be evaluated using sentinel species monitoring, as described in more detail in the Nutrients and Contaminants Analysis Report (Brown and Caldwell 2006) and in Section 3.4-4.

It should be noted that the discharge of mercury-contaminated sediments to the regional setting would be most likely in the southern portion of the Project, in the Alviso pond complex, because sediments in the Eden Landing and Ravenswood pond complexes are below Bay ambient mercury concentrations. The adaptive management strategy as described is equivalent to a “no net increase” in mercury loads discharged from the SBSP Restoration Project Area, in that monitoring and adaptive management actions are coordinated to ensure that loads from the Guadalupe River watershed and its estuary interface the Bay are reduced over time. This is consistent with the overall goals of both the San Francisco Bay mercury TMDL and the Guadalupe River mercury TMDL, which are the overarching water quality regulatory drivers for mercury in the regional setting.

The Project’s Adaptive Management Plan would comply with emerging regulations and guidance affecting mercury and other contaminant concentrations in sediments. An important anticipated development, which the Adaptive Management Plan would need to address, is the state’s Sediment Quality Objectives program. This program is described in Section 3.4.2.

The Project’s Adaptive Management Plan would address the uncertainties regarding the relationship between Project activities and state water quality regulations based on total mercury loads and concentrations by monitoring loads, concentrations, and bioaccumulation in sentinel species and adaptively managing the Project to ensure that adverse effects do not reach a significant level.

Alternative B Level of Significance: Less than Significant

Alternative C Tidal Habitat Emphasis. Under Alternative C, the potential for impacts would be similar to Alternative B, except that more breaching activity would require more monitoring and, if triggers are exceeded, require more management actions. Since restored tidal marshes are generally sediment traps, moving towards the 90:10 Tidal:Pond endpoint of Alternative C would tend to result in movement of mercury loads from the regional setting into the Project Setting. This would shift the emphasis of the Adaptive Management Plan towards evaluation of net methylmercury production and bioaccumulation.

In Alternative C, all of the same Adaptive Management approaches identified for Alternative B would be utilized to avoid significant adverse impacts.

Alternative C Level of Significance: Less than Significant

SBSP Impact 3.4-4: **Potential increase in net methylmercury production and bioaccumulation in the food web.**

A major concern with mercury pollution in the Bay is the accumulation of methylmercury (MeHg) in biota, particularly at the top of aquatic food webs. Mercury occurs in many forms, but MeHg is the form which poses the highest bioaccumulation risk. MeHg is converted from inorganic mercury (IHg) primarily by the metabolic activity of bacteria, especially sulfate reducing bacteria. Because microbial activity is generally increased in productive wetlands and marshes, restoration of tidal marshes has the potential to increase the net production of MeHg.

It is important to emphasize that the net production of MeHg and the bioaccumulation of MeHg is the impact of interest, as opposed to increased MeHg concentrations. A recent discovery of the CALFED mercury studies is that the Sacramento San Joaquin River Delta (the Delta) is a net MeHg sink, as evidenced by the MeHg mass balance across the Delta and by the lower concentrations of MeHg in organisms within the Delta compared to peripheral tributary rivers (Foe and others 2003). Therefore, it is not certain that restoration of tidal marsh would cause a bioaccumulation impact. Rather, increased net MeHg production and bioaccumulation is a risk that would need to be adaptively managed.

Water quality regulators have been struggling for a number of years to develop standards that are based on MeHg in the food chain, rather than total mercury (THg) in the water column. This analysis of MeHg impacts to the Project and regional setting focuses on MeHg in the food chain. This recognizes the latest science supporting water quality standards and moves the evaluation closer to the actual beneficial uses of interest: protecting bird reproduction and making fish safe for wildlife and people to eat.

The linkage between IHg and MeHg is complex. Clearly, when no IHg is present, no MeHg can be formed. Increased IHg concentrations in sediments are known to drive increased MeHg production when considering order-of-magnitude increases. For example, comparing ambient Bay sediments to mercury-contaminated sediments in the Guadalupe River watershed, the latter sediments typically also have higher MeHg concentrations.

However, for the range of IHg concentrations in sediments found within the Project Setting (from 0.1 to 4 ppm) during the initial ISP monitoring, the concentration of IHg did not have a significant correlation with the concentration of MeHg. SBSP Impact 3.4.2 above deals with water quality impacts, other than bioaccumulation, of IHg and THg in sediments. This impact analysis subsection focuses on bioaccumulation effects, and so considers movement and transport of THg along with other water quality factors that affect net MeHg production and bioaccumulation.

DO is a factor that can affect net MeHg production. Sulfate reducing bacteria that produce MeHg are known to thrive under low oxygen conditions. Low DO also promotes the breakup of oxide surfaces on particles, which can release MeHg into the water column. There are national studies showing the linkage between low DO and elevated MeHg in the water column. Regional studies have showed a similar linkage, and have led to a novel pilot project in the Guadalupe River watershed that attempts to reduce methylmercury in reservoirs by oxygenating bottom waters. SBSP Impact 3.4.1 above describes DO as a staircase water quality issue. One of the important points of that discussion is that low DO does occur in wetland and marsh habitats. If low DO is found to drive elevated net methylmercury production and bioaccumulation, this would be considered a significant impact.

Another key factor that affects net MeHg production is the chemical form of the raw material, IHg. Some forms of IHg are more readily acquired by methylating bacteria than other forms. Formation of neutrally charged soluble sulfide complexes is one mechanism that can enhance mercury availability. The amount of available sulfide, in turn, can be affected by iron redox chemistry, which is strongly affected by the nature of vegetative root matter and sediment characteristics. This sets up complex spatial variation in MeHg production rates, with unique pockets of localized enhanced net MeHg production rates. At least two examples are relevant to MeHg impact analysis for the SBSP Restoration Project: the peak of MeHg production rates at optimal sulfate concentrations, and the variation of MeHg production rates depending on vegetation type.

There appears to be an optimum window of sulfate concentrations that maximizes net MeHg production. Too little sulfate prevents sulfate reducing bacteria from thriving and producing sulfide, too much produces so much sulfide that the availability of IHg is diminished (Benoit and others 1998; Gilmour and others 1992; Gilmour and others 1998). When the sulfide concentration is "just right," MeHg production peaks. This is commonly referred to by mercury scientists as the "Goldilocks effect" of sulfate stimulation. For the SBSP Restoration Project, the Goldilocks effect may be significant to conversion of salt ponds to tidal marsh habitat. Creation of estuarine microzones in the window of sulfate concentrations causing the Goldilocks effect could cause enhanced MeHg production.

Net methylation rates are emphasized because the overall release of MeHg reflects the balance of production and destruction of MeHg. MeHg can be degraded by sunlight and microbial activity. DO and sulfide are examples of water quality factors that affect production of MeHg. In contrast, microbial community composition affects net MeHg production by influencing both production and degradation.

The ecological endpoint that needs to be evaluated is MeHg in the food web. Most of the foregoing discussion has been focused on net MeHg production rates, because net MeHg production is an important factor affecting MeHg bioaccumulation. But the structure of the food web also is an important control on MeHg bioaccumulation.

MeHg bioaccumulation increases at increasing trophic levels and with increasing food web complexity. This is driven by the biomagnification of MeHg. MeHg binds strongly to the sulfur atoms of protein residues. Large organisms eat smaller organisms for their protein, and so retain the associated MeHg. With every step up the food chain, mercury concentrations are found to increase, which is why large predators such as leopard sharks and striped bass have higher mercury concentrations than smaller fish like surf perch. Increasing food web complexity can also increase mercury concentrations at the top of the food web. Adding links to the food web increases the overall biomagnification of MeHg for top level predators. Therefore, Project activities that alter ecosystem structure can have significant impacts on mercury accumulation.

Most of the MeHg biomagnification in the food web occurs in the lower trophic levels (*e.g.*, from direct MeHg uptake by algae to zooplankton). MeHg concentrations in lower organisms can strongly regulate

MeHg concentrations at the top of the food web. Therefore, changes in the community structure of life cycle of lower organisms such as algae and zooplankton can play a significant role in MeHg bioaccumulation. For example, smaller phytoplankton that have not lived as long would tend to have smaller MeHg concentrations per unit mass, simply because they haven't had as much time to accumulate MeHg as larger organisms of the same species. So algal blooms which result in large standing stocks of relatively low-MeHg algae can reduce mercury concentrations at the top of the food web, a phenomenon known as "biodilution." Intense zooplankton grazing pressure which keeps algal communities "young" can also keep the average MeHg concentration per unit mass low, resulting in lower concentrations in top level predators. These ecosystem effects are complex and difficult to predict, which is why MeHg bioaccumulation impacts would need to be adaptively managed.

Alternative A No Action. Reducing water management and eventually drying out ponds would reduce net MeHg production and bioaccumulation within the SBSP Restoration Project Area. Note that this is essentially avoiding MeHg accumulation in the aquatic food web by minimizing the aquatic food web. In places where a food web remains, wetting and drying cycles could lead to enhanced methylation. Since ponds are not directly connected to the Bay, this would be neither a positive nor negative impact to the regional setting in terms of MeHg discharges. As levees degrade over time, unintentional breaching would occur that converts ponds to tidal habitat in an uncontrolled manner. Since the consequent changes to vegetation and ecosystem structure are unpredictable, the effect on net MeHg production and bioaccumulation is also uncertain. Other factors that affect microbial communities and the availability of IHg to methylating bacteria also defy forecasting efforts. There would be no Adaptive Management Plan in place to monitor changes or trigger actions, so the impacts under Alternative A are potentially significant.

Alternative A Level of Significance: Potentially Significant

Alternative B Managed Pond Emphasis. Alternative B aims for a 50/50 mixture of tidal habitat and managed ponds. Actions under this alternative that can influence IHg concentrations in sediments, microbial communities, vegetative cover, sulfate concentrations, DO, and ecosystem structure can all impact MeHg production and bioaccumulation. A brief summary of the kinds of Project actions that impact these factors helps one understand the potential for Project impacts and the rationale underlying the adaptive management strategy.

While introduction of mercury-contaminated sediments due to levee breaching and flood control design may be of concern in the Alviso pond complex, it is important to emphasize that preliminary findings show no relationship between IHg and MeHg in the SBSP Restoration Project Area. This will continue to be investigated, starting with the baseline and follow-up monitoring as part of the South Baylands Mercury Project in and around Pond A8 of the Alviso pond complex, which is known to have mercury-contaminated sediments originating from the Guadalupe River.

Restoration activities that alter landscape morphology and vegetation would inevitably alter the microbial community composition. Whether this alteration is a positive or negative influence on net MeHg production is unknown. Likewise, restoration activities have the potential to cause low DO within the Project Setting due to changes in hydraulic residence times, algal abundance, and other factors. Low DO can enhance net MeHg production. Since the factors affecting DO concentrations are complex, the effect of Alternative B on DO-related increases in net MeHg production are also uncertain.

Conversion of high and medium salinity managed ponds to low salinity managed ponds and tidal marshes has the potential to increase MeHg bioaccumulation. As noted in the Mercury Technical Memorandum (Appendix K), the food webs of medium salinity ponds are simpler than food webs found in low salinity ponds or tidal marsh food webs. Increasing the number of links in the food web tends to increase MeHg bioaccumulation in top level predators. However, foraging patterns would also change as the mosaic of the SBSP Restoration Project Area evolves, so the net effect on the dietary intake of MeHg by foraging birds and other wildlife is uncertain.

Managed ponds can avoid the intermediate salinity and sulfate concentrations that are optimum for MeHg production. In contrast, some tidal marsh areas would be restored by breaching bayward levees, which can introduce freshwater that creates estuarine-type microzones of enhanced net MeHg production. This makes increased net MeHg production a potential impact of some of the levee breaching activities. As noted in the discussion above, the relationship between sulfate concentration and net MeHg production is complex, and so the potential for impacts is uncertain.

Adaptive Management Plan. It is difficult to predict the effects of tidal restoration on exceedance of the threshold criteria for significant impact due to increased net production and methylation of mercury. Therefore, monitoring and adaptive management are critical components of the SBSP Restoration Project to determine the extent of tidal restoration that can occur in the long term. The Adaptive Management Plan is the mechanism by which the Project would move from Alternative B (50/50 mix of tidal / salt pond habitat) to Alternative C (90/10 tidal/pond mix). Effects are monitored in each pond complex, and triggers for adaptive management actions are established that avoid exceeding the significance threshold.

Adaptive Management Triggers. From the above discussion of the factors affecting net MeHg production and bioaccumulation, a conceptual level discussion of adaptive management triggers shows how the adaptive management process would avoid exceeding thresholds of significant impacts. Details are provided in supporting material (Appendix H, the Nutrients and Contaminants Analysis Report; Appendix K, the Mercury Technical Memorandum).

Monitoring sentinel species is the main trigger for adaptive management actions. Adaptive Management Plan monitoring could include methylmercury concentrations in water and sediments, as well as special studies of methylmercury production, degradation, and transport, but management actions should be triggered by changes in food web indicators. Since thresholds are defined by tissue concentrations in predators (bird eggs, larger food fish for people, smaller prey fish for wildlife), the triggers should be concentrations in their prey (small fish, benthic invertebrates, zooplankton and algae. An early implementation action for the Adaptive Management Plan should be to develop a suite of sentinel species and associated desirable mercury concentrations that are based on a food web model.

Adaptive Management Process. Following development of sentinel species and trigger levels, baseline levels in sentinel species would be monitored so that changes in response to Project activities can be detected. It is important to note that San Francisco Bay is already impacted by mercury, so it would be expected that many sentinel species would exceed desirable levels of mercury for a healthy ecosystem under baseline conditions.

Therefore, adaptive management actions should be triggered when sentinel species mercury concentrations increase substantially, regardless of whether they are over or under desirable levels. The goal of the Adaptive Management Plan for mercury is to ensure that over time Project actions help progress towards less mercury in the food chain of both the Project and the regional setting.

To attain that goal, monitoring in the individual pond complexes in the initial phases would make them pilot-scale studies that guide next steps as outlined in the Adaptive Management Plan. The Adaptive Management Plan studies should focus on management questions as outlined in the NCAR and the Mercury Technical Memorandum, including:

- Does tidal marsh habitat produce and/or bioaccumulate more MeHg compared to pond habitat? The National Science Panel recommended monitoring fluxes of MeHg in ponds and tidal marshes and an isotope study of the South Bay food web that relates mercury concentrations to specific food webs. The isotope study will help select appropriate organisms to use as biosentinel species.
- Does tidal marsh habitat release significant amounts of MeHg compared to pond habitat? The National Science Panel recommended monitoring fluxes of methylmercury from ponds and restored tidal marshes to the Bay.
- What are the design, operation, and management features in ponds and tidal marshes that minimize methylmercury production and bioaccumulation? The National Science Panel recommended that studies be conducted that are explanatory. Explanatory studies provide information about what to do when early warning signs of a problem are detected. Recognizing the resource limitations, the Panel further recommended that this be accomplished by leveraging existing programs with a small amount of matching incentive funds.

The South Baylands Mercury Project has been initiated in the Alviso Pond complex that is a tangible example of how this adaptive management process will work. The description of the applied study, excerpted from Chapter 2 of this report, is repeated below to clarify the approach to mercury methylation and bioaccumulation:

> The potential exists to inadvertently increase the risk of mercury (Hg) accumulating in South Bay fish and wildlife through hydrological modification of salt ponds. The concern is that some management actions will favor conversion of Hg into toxic methylmercury (MeHg) and its uptake into local food webs. Ponds within the Alviso Pond complex and Alviso Slough are especially worrisome because they contain more Hg than most other areas of South Bay and are slated for early management actions.
>
> Although Hg concentration data are being collected at various locations within the South Bay, very little is known about the regional and habitat-specific processes governing Hg physical transport, Hg methylation, and bioacccumulation. This applied study will address (a) how much legacy Hg is contained in sediments of different habitats; (b) how readily available is this legacy Hg currently for conversion to toxic MeHg; (c) how effectively and by what specific pathways is MeHg incorporated

into local food webs; and (d) how might various management actions being considered impact the availability of legacy Hg and its incorporation into the food web as MeHg.

Bayland managers need to know how restoration actions may affect the risk of mercury toxicity in wildlife. This risk can be assessed most directly by monitoring Hg in 'biosentinel' wildlife species that represent bayland conditions. Coupling such a monitoring effort to study MeHg production and uptake is essential to understand how the risk of Hg bioaccumulation can be reduced in light of the various management options under consideration. The mercury applied study that has already been initiated and would be continued in Phase 1 will include the following activities during a three-step process:

Step 1 would:

- Develop sentinel species indicators of Hg exposure;
- Map the legacy Hg in Alviso Slough that might be mobilized by Phase 1 action at Pond A8;
- Assess the mercury problem for dominant specific habitat types associated with Pond A8 and Alviso Slough; and
- Establish a baseline for tracking the effects of management actions on the Hg problem into the future.

Step 2 would:

- Expand the survey of the mercury using the sentinel species, sub-habitat designations, and biogeochemical indicators to encompass more of the South Baylands. This will provide a picture of the spatial variability in mercury problem within and between bayland habitats throughout the South Bay.

Step 3 would:

- Initiate focused research to better understand the linkages between Hg contamination in sentinel species and bio-geochemical indicators for specific habitat types in selected areas, based upon the results of Step 2; and
- Help translate the scientific understanding of the Hg problem into habitat designs and management options that minimize the problem.

The Project's Adaptive Management Plan would address the uncertainties regarding the relationship between Project activities and state water quality regulations based on total mercury loads and concentrations by monitoring loads, concentrations, and bioaccumulation in sentinel species and adaptively managing the Project to ensure that adverse effects do not reach a significant level.

Alternative B Level of Significance: Less than Significant

Alternative C Tidal Habitat Emphasis. Under Alternative C, the potential for impacts would be similar to Alternative B, except that more breaching activity would require more monitoring and, if triggers are exceeded, require more management actions. Restored tidal marshes open new connections to the Bay, and the upland areas could generally be expected to have higher net methylation rates compared to the open Bay, consistent with previous findings summarized in Section 3.4.1. So Alternative C would generally be expected to increase MeHg transport to the Bay. The key question is whether the increased transport rate is ecologically significant with respect to mercury accumulation in protein sources for wildlife and people.

In Alternative C, all of the same Adaptive Management approaches identified for Alternative B would be utilized to avoid significant adverse impacts.

Alternative C Level of Significance: Less than Significant

SBSP Impact 3.4-5: **Potential impacts to water quality from other contaminants.**

The proposed alternatives for the SBSP Restoration Project have the potential to affect water and sediment quality with various constituents other than mercury, methylmercury, nutrients, and DO. The primary mechanisms that could impair water and sediment quality by introducing these other contaminants are similar for each proposed alternative and are each summarized below, followed by a discussion of the expected extent of the impact that could occur with each alternative.

Construction-Related Activities. Construction-related activities can lead to transient adverse water quality impacts during or shortly after the period of construction. Construction activities that could affect water and sediment quality include site grading, placement of fill (*i.e.*, site sediments excavated during site preparation or earthwork and reused as fill) in upland areas, dredging of channels, breaching of levees, and construction of water control structures. In addition, flood control would entail construction of new levees or restoration of existing levees. Construction activities could result in short-term increased turbidity due to upland soil disturbances from levee and transition zone construction, and mobilization of channel and pond sediments.

Construction activities would bring equipment and materials not normally present in the SBSP Restoration Project Area onto the site. This increases the possibility of exposure to or release of hazardous materials and waste associated with construction, such as fuels or oils, as a result of accidents, or equipment malfunction or maintenance.

Maintenance Activities. Hazards could result from the routine maintenance activities required for managed ponds and public access facilities, which may include levee repair, dredging, small-scale construction, and general cleaning. Hazardous materials that could lead to water or sediment quality impairments if spilled would primarily include spills and leaks of liquids (fuels and oils) from maintenance vehicles and equipment.

Intrusion of Selenium from Adjacent Aquifers. Waters in Alviso Slough exceed the 5 µg/L CTR surface water quality objective for selenium (Abu-Saba and Ogle 2005). The cause of this is unknown at present, but may be related to the presence of selenium in groundwater found in the Santa Clara Valley in the Guadalupe River and Coyote Creek floodplains (SCVWD 2004, as cited in Abu-Saba and Ogle 2005). Wells within these floodplains have higher selenium concentrations than wells in the surrounding region, though the selenium concentrations in all Santa Clara Valley aquifers are well below the drinking water standard of 50 µg/L. Breaching levees in the Alviso pond complex may introduce water with elevated selenium into the SBSP Restoration Project Area. This is a potentially significant impact. The concern over selenium is its potential to biotransform and bioaccumulate in the food web. Unlike mercury, however, selenium is also a dietary requirement in most organisms. Selenium is also known to detoxify inorganic mercury by formation of mercury selenide precipitates, (NCAR) though it can be a synergist for the developmental effects of methylmercury.

Illegal Discharges and Dumping. State law prohibits littering, and all municipalities in the SBSP Restoration Project Area have anti-littering ordinances. Implementation of state programs, including municipal stormwater permits and possibly TMDLs, will ensure monitoring for trash and trash abatement measures. Adverse water quality impacts may result from illegal discharges and illicit dumping from the general public as a result of increasing public access to the SBSP Restoration Project Area. These discharges or dumping could vary in size and may consist of liquid or solid wastes.

Increased Mobilization and Transport of Particle-Associated Contaminants. Concentrations of particle-associated 'legacy' pollutants, such as PCBs and organochlorine pesticides (*i.e.,* DDT and chlordanes), which were deposited during the times of their historic peak use are often substantially higher in subsurface sediments than surface sediments. Levee breaching and/or failure, scour of undersized channels, and increased tidal mixing could lead to temporary increased turbidity and the mobilization and transport of contaminated surface and subsurface sediments (Connor and others 2004; Davis and others 2006). Turbidity increases and contaminant mobility could lead to deposition of such contaminated sediments in restored areas of biological use. It is expected that the potential for mobilization and transport of contaminated sediments would increase in proportion to the amount of tidal marsh restoration, as these areas of increased tidal action would result in scour of existing tidal sloughs and channels.

Because of the spatial gradients for mercury and other sediment-associated contaminants (*e.g*., PCBs, PAHs, copper, silver) discussed in Section 3.4.1, it is important to recognize that breaching levees would always have the effect of either releasing contaminant loads from the Project Setting into the regional setting, or from the regional setting into the Project Setting, unless sediment contaminant concentrations are identical in ponds and the Bay. Most of the ponds would be expected to have lower concentrations of urban-associated pollutants such as PCBs and copper in their sediments, because they have been largely cut off from Bay sediments during the past 100 years of industrialization and urbanization. Conversion of ponds to tidal habitat generally involves accumulating sediment in the SBSP Restoration Project Area, which makes those most of those activities net losses of particle-associated pollutants from the regional setting to the Project Setting.

Project Areas where extra caution should be exercised are those where sediments may be affected by infrastructural elements known or suspected to contribute to pollutants in sediments. The presence of copper in brake pads is known to increase copper concentrations in particles discharged from stormwater from roadways. A railway in the South Bay was recently demonstrated to be a source of PCB-contaminated sediments(Santa Clara Valley Urban Runoff Pollution Prevention Program 2002). The Moffett Channel, which discharges into Guadalupe Slough via the Northern Channel, is known to be contaminated with PCBs and other pollutants (Regional Water Quality Control Board 2007). Railways are also major sources of creosote, with associated chlorinated phenols and PAHs. A major PG&E gas transmission line runs through Milpitas, and is known to have discharged PCBs to the Coyote Creek watershed in the past (Davis and others 2006). There are also electric transmission lines crossing the SBSP Restoration Project Area, so the potential for discharge of PCBs from transformers needs to be considered.

Unplanned Levee Breaching/Failure. An unplanned levee failure could occur at any time within any of the alternatives, and could result in a decrease in water quality. Unplanned breaching/failure could result in the uncontrolled release of existing brines or other contaminants resulting in an adverse effect on the receiving water. In addition, ponds formerly used in the advanced stages of salt crystallization have a saline crust on the ground surface. This crust would likely dissolve or partially dissolve if exposed to water, possibly resulting in an adverse impact on the receiving water. The relative likelihood of unplanned levee failures is directly related to amount of levee maintenance and construction activities proposed within each alternative. A more robust program of levee maintenance is planned for Alternatives B and C compared to Alternative A. Therefore, the most significant impact under this activity is Alternative A (the no-action alternative).

Surface Water Contamination from Groundwater. Because surface water and groundwater are in at least partial hydraulic communication, shallow groundwater could seep into the ponds or restored tidal habitat or the surrounding sloughs and Bay. Although there are numerous fuel and solvent spills affecting the shallow aquifers in industrialized areas of the South Bay, the plumes are generally at least a mile from the salt ponds with the exception of the Moffett Federal Airfield area. None of the proposed alternatives for the SBSP Restoration Project are expected to substantially affect either horizontal or vertical groundwater gradients (and resulting groundwater flows) in the area, so the Projects would not affect the concentrations or the migration rates or directions of plume migration compared to baseline conditions. Additionally, the water management agencies (primarily SCVWD and ACWD) and the RWQCB (as well as DTSC and the counties) have coordinated programs that together ensure that fuel and solvent spills are identified, contained, and remediated in such a way that neither the ecosystem nor surface water resource is impacted by groundwater contamination. Therefore, the Project would not have any significant impacts due to surface water contamination from groundwater.

Increased Interaction with Urban Runoff. Increased exchange of urban runoff with tidal marshes and managed ponds (via tide gates connected to flood control channels) could transport and/or deposit contaminants, including trash, from urban sources into the restored areas. Urban runoff in the South Bay has been shown to have contaminants such as PAHs, metals (copper and zinc), urban pesticides (diazinon, pyrethroids) and PBDEs (McKee and others 2006). Restored tidal marshes and managed ponds could sequester urban pollutants, thereby reducing overall pollutant loads from urban runoff to the Bay. However, the sequestering of urban pollutants such as mercury in the biologically active restored areas could also render the pollutants more available to biological uptake.

Bacterial Growth in the Restored Areas. Slow-moving, stagnant waters may promote the growth of unwanted bacteria. As the water in the SBSP Restoration Project Area is non-potable, water-quality related impacts analysis focuses on the potential to impact water contact recreation. Water contact would be possible because of kayaking and other recreational activities in the area. Although County Health Departments advise against shellfish harvesting in South San Francisco Bay, there is anecdotal evidence that people may indeed collect shellfish for food in the area. Both of these potential impacts from human exposure to bacteria can be mitigated with appropriate monitoring and communication of the results.

Alternative A No Action. As this alternative would involve no significant deviations from the current operations of the Project Area, the potential for adverse impacts from construction-related activities, maintenance activities (use of hazardous materials), illegal discharges and dumping, changes in bacteria concentrations from wildlife, and groundwater-to-surface water contamination would be very minimal beyond what currently exists. Alternative A would not intentionally increase the interaction of urban runoff into the Project Area and would therefore not have the potential to reduce contaminant loads to the Bay or deposit urban contaminants in areas of biological use. Implementation of Alternative A would likely result in the highest risk of unplanned levee breaching/failures and could therefore result in short-term uncontrolled discharges of existing brines and mobilization of contaminated sediments from channel scour. Other than from unplanned levee failures, it is unlikely implementation of Alternative A would result in the exceedances of any thresholds discussed above at a frequency greater than the baseline condition.

Alternative A Level of Significance: Less than Significant

Alternative B Managed Pond Emphasis. Site grading and construction of water control structures for restored ponds would be necessary for Alternative B, and construction related impacts could occur. Alternative B would be expected to have the highest risk of impacts from maintenance activities because it has the greatest proportion of managed ponds, which require ongoing maintenance. Impacts from illegal discharging and dumping as a result of increased public access would likely be similar between this alternative and Alternative C, as the public access features between both alternatives are largely interchangeable. Alternative B would have a lower potential for unplanned levee breaches/failures than Alternative A because levee maintenance would occur. However, the alternative could result in increased mobilization and transport of contaminated sediment as levees are intentionally breached for tidal marsh restoration and undersized channels are scoured. As with all alternatives, groundwater contamination in the SBSP Restoration Project Area is not expected as a result of this alternative. Impacts from interaction of urban runoff with restored areas could occur as a result of Alternative B as areas near urban inputs are restored to tidal marshes or managed ponds.

SBSP Mitigation Measure 3.4-5a: Stormwater Pollution Prevention Plan.

This mitigates potential impacts due to construction related-activities and maintenance activities. The Project sponsors will obtain authorization from the RWQCB prior to beginning construction. As part of this application, the Project sponsors will prepare a Stormwater Pollution Prevention Plan (SWPPP) and require all construction contractors to implement BMPs identified in the SWPPP for controlling soil erosion and discharges of other construction-related contaminants. Routine monitoring and inspection of BMPs will be conducted to ensure that the quality of stormwater discharges is in compliance with the permit.

BMPs that will appear in the SWPPP include:

- Soil stabilization measures, such as preservation of existing vegetation and use of mulch or temporary plantings to minimize soil disturbance;
- Sediment control measures to prevent disturbed soils from entering waterways;
- Tracking control measures to reduce sediments that leave the construction site on vehicle or equipment tires; and
- Nonstormwater discharge control measures, such as monitoring water quality of dewatering operations and hazardous material delivery, storage, and emergency spill response requirements, and measures by the Project sponsors to ensure that soil-excavation and movement activities are conducted in accordance with standard BMPs regarding excavation and dredging of bay muds as outlined in BCDC's bay dredge guidance documents. These include excavating channels during low tide; using dredge equipment, such as sealing clamshell buckets, designed to minimize escape of the fine grained materials; and testing dredge materials for contaminants.

The contractor will select specific BMPs from each area, with Project sponsor approval, on a site-specific basis. The construction general contractor will ensure that the BMPs are implemented as appropriate throughout the duration of construction and will be responsible for subcontractor compliance with the SWPPP requirements.

Other impacts due to construction-related and maintenance activities can be mitigated by appropriate additions to stormwater pollution prevention plans, including a plan for safe refueling of vehicles and spill containment plans. An appropriate hazardous materials management plan will be developed for any activity that involves handling, transport or removal of hazardous materials.

SBSP Mitigation Measure 3.4-5b: Selenium Management.

This mitigates potential impacts from intrusion of selenium from high-selenium aquifers. As noted in Section 3.4.2, tissue-based selenium standards are currently being developed for the state of California by USEPA as part of updating the California Toxics Rule. Adoption by the state will include a plan and program of implementation. The timeline for this process is uncertain. It will likely take longer than the time to complete this EIS/R process, but is also likely to be completed before the end of the 50 year lifetime of the SBSP Restoration Project. Selenium standards and monitoring requirements will be addressed thorough the RWQCB Waste Discharge Requirements. As long as state policies and regulations are followed in the implementation of emerging selenium objectives, there will be no significant impacts to water quality. Based on experiences in other watersheds, the Project can expect that emerging selenium regulations will require:

- Monitoring chemical forms of selenium in water and sediments;
- Monitoring selenium in the food web; the National Science Panel recommended leveraging of existing monitoring programs to monitor selenium in bivalves in the Bay.
- Development of food web models linking concentrations in water and sediments to concentrations in biota; and
- Development of management plans to avoid harmful selenium bioaccumulation.

SBSP Mitigation Measure 3.4-5c: Actions to Minimize Illegal Discharge and Dumping.

This mitigation addresses illegal discharge and dumping. The likelihood of increasing frequency of illegal discharge and dumping will be minimized with adequate public education and outreach, patrolling of the area, readily accessible and frequently serviced trash and recyclable materials receptacles, and timely clean-up activities. Specifically, the Project will undertake the following activities to ensure that existing programs and practices avoid impacts due to illegal discharge and dumping:

- Gate structures upstream of the Project Area will include a trash capture device that will prevent fouling of marsh and pond complexes;
- Plans for recreational access in the Project Area will include appropriate trash collection receptacles and a plan for ensuring regular collection and servicing; and
- “No Littering” signs will be posted in public access areas.

SBSP Mitigation Measure 3.4-5d: Monitoring Sediments to Follow Existing Guidance and Comply with Emerging Regulations.

This mitigation addresses potential impacts due to mobilization and transport of particle-associated pollutants. The Project will monitor contaminant concentrations in sediments whenever activities will involve moving, transporting, or emplacing soils and sediments or exposing older sediments by dredging and excavation. Existing guidance for the beneficial re-use of sediments establishes numeric screening guidelines for the placement of sediments in direct contact with water or at buried beneath a cover layer. This guidance may be refined by the State’s emerging program of Sediment Quality Objectives. Monitoring data will be used to follow existing guidance and follow emerging regulations for the placement of sediments and other activities that affect mobilization and transport of sediments. This translates to the following specific actions:

- Sediment monitoring data will be used to determine appropriate disposal or beneficial re-use practices for sediments. If sediment monitoring data indicate that tidal scour outside a levee breach could remobilize sediments that are significantly more contaminated than Bay ambient conditions, the Project will consult with the appropriate regulatory agencies regarding other potential required actions.

SBSP Mitigation Measure 3.4-5e: Urban Runoff Management.

This mitigation addresses potential impacts due to increased interaction of urban runoff with the Project Area. The RWQCB has a coordinated program of permitting and enforcement for regulating urban runoff discharge. As long as policies and regulations prohibiting the discharge of constituents causing pollution are carried out, significant impacts from urban runoff will be avoided.

The Project proponents will notify the appropriate Urban Runoff Program of any physical changes (such as breaches) that will introduce urban discharges into the Project Area, and request that the Urban Runoff Program consider those changes when developing annual monitoring plans.

SBSP Mitigation Measure 3.4-5f: Bacteria Monitoring and Risk Communication.

This mitigation addresses for potential impacts due to bacterial growth in restored areas. The SBSP Restoration Project's National Science Panel recommended that monitoring be conducted for avian botulism and bivalve disease and toxicity to humans. Mitigation measures for avian botulism are discussed under SBSP Impact 3.6-22. The Project will consider the need for additional monitoring of shellfish as each phase is implemented. For protection of public health, a program of public outreach and communication will be developed and implemented. The program will include posting of warning signs in multiple languages where monitoring data indicate the need to advise the public of exposure risks from swimming or shellfish consumption.

Alternative B Level of Significance: Less than Significant with Mitigation

Alternative C Tidal Habitat Emphasis. Site grading and construction of water control structures for restored ponds are similar for Alternatives B and C, however construction for tidal restoration is greater in Alternative C. As a result, construction-related impacts would be most likely under Alternative C, although impacts from maintenance would be minimal because managed ponds are only a small portion of the SBSP Restoration Project Area. Potential impacts from increasing public access (illegal dumping) would be similar to Alternative B, as many public access features are similar between the two alternatives. Alternative C would have the highest potential for remobilizing potentially contaminated sediments and increasing turbidity because levee breaching and scour of undersized channels would occur in restored tidal marshes. For intensively managed ponds, construction impacts could be greater than similarly sized construction for tidal restoration. Alternative C would have a lower potential for unplanned levee breaches/failures than Alternative A because many levees would be intentionally breached as part of the tidal marsh restoration. Groundwater contamination in the SBSP Restoration Project Area is not expected as a result of this alternative, as long as groundwater overdraft is avoided and abandoned wells are properly destroyed to eliminate vertical conduits. Alternative C would involve the greatest amount of urban runoff exchange into restored areas as restoration occurs near urban inputs.

Similar to Alternative B, with proper management and oversight, impacts associated with construction activities and increased public access should not result in exceedances of any thresholds of significant impact. Additionally, it is unlikely that the impacts associated with mobilization and transport of contaminated sediment and increased interaction of urban runoff would be of a sufficient magnitude or extent as to cause exceedances of the thresholds identified after mitigation. Mitigation measures 3.4-5a through 3.4-5f also apply to Alternative C.

Alternative C Level of Significance: Less than Significant with Mitigation

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SBSP Impact 3.4-6: **Potential to cause seawater intrusion of regional groundwater sources.**

Five main factors – geology, groundwater hydrology, groundwater quality, artificial pathways, and groundwater management – control groundwater conditions and are thus germane to the evaluation of potential impacts of the SBSP Restoration Project on groundwater hydrology and quality. To determine whether there is a significant increased potential for saltwater intrusion as a result of the SBSP Restoration Project, all of these factors must be considered.

As described in Section 3.4.2, Physical Setting for Groundwater, historic overdraft conditions during the early to mid-1900s that lowered groundwater levels have been reversed over the past forty years. Today, water flows from groundwater basins into the Bay. As long as that condition persists, there is no significant risk of salinity intrusion into drinking water aquifers. If groundwater levels drop due to pumping, drought or other causes, then Project activities that move salt water towards conduits between surface waters, shallow aquifers and deeper drinking water aquifers could contribute to significant impacts to drinking water supplies.

Alternative A No Action. Under the No Action Alternative, the primary risk of a significant impact would be inadvertent levee failures that either inundate improperly abandoned wells, or exposure of levees that protect areas with old improperly abandoned wells (or even existing wells in good condition) to erosion and failure. This would only pose a risk if groundwater levels are below sea level at that time or subsequently. Once inundated, it could be hard to locate old wells.

Allowing ponds to eventually dry out could provide beneficial changes with respect to the potential for salinity intrusion. Removing standing bodies of highly saline water from the Bay margins reduces risk of salinity intrusion to groundwater. Any remaining salt residue on the ground could be swept towards conduits by stormwater in the event of inadvertent inboard levee breaches, so a small risk would remain.

Alternative A Level of Significance: Potentially Significant

Alternative B Managed Pond Emphasis. Similar to the No Action Alternative, the primary risk of salinity intrusion from Project activities comes from the potential to move saline waters towards conduits to deeper aquifers during times of groundwater overdraft. Project activities would not introduce new conduits between surface waters, shallow aquifers, and deeper drinking water aquifers. The depth of excavations for the pond channel modifications are minimal compared to the thicknesses of the aquitards that protect the basin.

The flooding of the ponds would provide beneficial changes in the pond salinity with respect to the potential for salinity intrusion. Salinity in tidally inundated ponds would continue to decline to concentrations comparable to the Bay. An additional benefit of this alternative compared to the No Action Alternative is construction of new flood protection levees. (ACWD will be notified prior to proposed new levee construction so that ACWD can assist in identifying and properly destroying abandoned wells.)

The flooding of the ponds in either Alternative B or C would not cause any significant change in the horizontal or vertical hydraulic gradients. A change of a five ft or less is not likely to be enough to change the direction of either horizontal flow or vertical flow, since groundwater levels generally fluctuate several ft in a normal year anyway. Water levels are currently at or near sea level in the ponds, and if either 50 percent (Alternative B) or 90 percent (Alternative C) become tidally inundated, this would not result in a significant change in groundwater hydrology.

Breaching of levees and tidal inundation of levee areas or low lying ponds poses a potentially significant risk if such actions inundate improperly abandoned wells and groundwater overdraft occurs in the future. Although both ACWD and SCVWD have programs to properly seal old wells, it is uncertain how effective these measures have been, particularly since the salt ponds were not the primary focus.

Stream channel modifications or operational changes also pose a potential risk of salinity intrusion, especially considering that migration of Bay waters up creeks and sloughs was documented as a historical cause of salinity intrusion. As with inundation of improperly abandoned wells, this only poses a risk if there groundwater levels drop due to overpumping, drought or other factors in the future. In contrast to the abandoned wells, increased salinity in the stream channels is an expected outcome of the Project design, rather than a possibility that can be avoided. Specific areas where this poses a potential risk are discussed below, under the project-level analysis.

To summarize, the two significant risks for salinity intrusion in the future are improperly abandoned wells and salinity migration into areas with poorly confined aquifers. The existence of other preferential pathways to the lower water supply aquifers that have not been previously identified cannot be ruled out. Real or potential preferential pathways to lower aquifers only pose a significant risk in the event of falling groundwater levels. Therefore, mitigation measures for this potentially significant impact focus on identifying conduits, ameliorating them where possible, and working to avoid groundwater overdraft.

SBSP Mitigation Measure 3.4-6: USFWS and CDFG (Project proponents) will coordinate with ACWD and SCVWD to ensure that the following activities take place:

- If any abandoned wells are found before or during construction they will be properly destroyed by the Project as per local and State regulations by coordinating such activities with the local water district. If abandoned wells are located during restoration or other future activities within ACWD or SCVWD boundaries, a well destruction work plan will be prepared in consultation with ACWD or SCVWD (as appropriate) to ensure conformance to ACWD or SCVWD specifications. The work plan will include consulting the databases of well locations already provided by ACWD and SCVWD. The Project will properly destroy both improperly abandoned wells and existing wells within the Project Area that are subject to inundation by breaching levees. Well destruction methods will meet local, county and state regulations. The Project proponents will also lend support and cooperation with any well identification and destruction program that may be undertaken as part of the Shoreline Study or other projects;

- The Project proponents will assist ACWD and SCVWD to obtain funding for the development, implementation, analysis and reporting of groundwater levels and groundwater quality adjacent to the Project boundaries. If groundwater monitoring detects seawater intrusion, the Project proponents will participate and assist ACWD and SCVWD in identifying the sources and causes, and in selecting and implementing an appropriate mitigation measure;
- The Project will work to assist ACWD and SCVWD in the development and implementation of communication and outreach strategies that ensure groundwater users are informed on groundwater levels, quality, usage, and the linkage between groundwater overdraft and salinity intrusion. Groundwater data will be shared with groundwater users to the extent allowed by law.

All of these mitigation actions are coordination and communication activities that require voluntary participation of the water agencies. An advantage of Alternatives B and C over the No Action Alternative with respect to SBSP Impact 3.4-6 is that Project activities would motivate regional coordination concerning groundwater protection over the 50-year Project lifetime through these mitigation measures.

Alternative B Level of Significance: Less than Significant with Mitigation

Alternative C Tidal Habitat Emphasis. The issues for Alternative C are similar to Alternative B. The main difference is that as the SBSP Restoration Project moves from a 50/50 tidal/pond ratio towards a 90/10 ratio, the number of certifications involving breaching projects would increase. This could possibly require an accelerated level of effort in implementing the abandoned wells and monitoring programs described in SBSP Mitigation Measure 3.4-6 above.

Implementation of SBSP Mitigation Measure 3.4-6 above would be required to reduce potentially significant impacts.

Alternative C Level of Significance: Less than Significant with Mitigation

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Project-Level Evaluation

Phase 1 Impact 3.4-1: **Changes in algal abundance and composition, which could in turn degrade water quality by lowering DO and/or promoting the growth of nuisance species.**

Changes in algal abundance are a potential result of many of the Phase 1 actions. The magnitude of the impact is not quantifiable without further system characterization and modeling efforts that would be implemented through the Adaptive Management Plan, as described under SBSP Impact 3.4-1. For

Phase 1, on a project by project basis, risk factors in any particular pond complex are waters that are deep, slow, rich in nutrients and chlorophyll, subject to calm wind exposure, and highly transparent. Conversely, the lowest risk waterbodies would likely be shallow, quickly turned over, poor in nutrients and chlorophyll, windy and opaque.

If triggers are exceeded in high-risk waters as a result of high risk factors then adaptive management actions would be implemented that convert high risk factors to low risk factors. Examples of such actions include making water shallower with fill, decreasing hydraulic residence time, or increasing exposure to wind. Phase 1 of the SBSP Restoration Project is another step forward in the Adaptive Management Plan, after implementation of the ISP. Lessons learned on the project scale would inform the design of future projects and the decision to move forward at the program scale. Thus, Adaptive Management Plan implementation would assure avoidance of significant impacts.

Phase 1 No Action

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

With no action under Phase 1, water management would be reduced in individual Project Areas, resulting in longer residence times and likely increased algal blooms. The possibility of inadvertent breaching introduces the risk of transporting algal blooms into the Bay. With no Adaptive Management Plan to monitor for warning signs and respond, this has potentially significant impacts in all Project Areas.

Phase 1 No Action Level of Significance: Potentially 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. Phase 1 actions at the ELER would take place in Ponds E8A, E9, E8X, E12, and E13.

Pond E8A/9/8X. Tidal action would be restored to Ponds E8A, 9, and 8X through 5 levee breaches along nearby creeks. Beds are expected to accrete 1 to 2 ft to MHHW with sediment deposited from the tidal inflow. This sediment deposition may lead to localized low turbidity levels at tides close to MHHW, but is not likely to have a significant impact on algal abundance within the pond. Turbidity levels in the region around the levee breaches may be lowered enough to cause increased algal abundance.

Pond E12/13. Tidal action would be restored to Pond E12/13 with flows managed between cells to maintain varying salinities. The average pond bottom elevation is currently 1.3 ft below MHHW; therefore pond bottom accretion would only potentially have an impact on turbidities within the ponds at high tides. Water depths would range from two inches to one foot with an average depth of less than six inches. If flow and wind driven mixing are not sufficient to maintain turbidities algal abundance may increase.

Alviso. Phase 1 actions at the Alviso Slough pond complex would take place in Ponds A6, A8, and A16.

Pond A6. Tidal action would be restored to Pond A6 through four levee breaches along adjacent sloughs. The current pond bottom elevation is one foot below MTL, through tidal restoration the pond bottom would accrete to MHHW, a total accretion of five ft. Potentially low turbidity could result from the Project design. Increases in algal abundance are possible within the pond and in the surrounding region.

Pond A8. Pond A8 would be restored to muted tidal action by installing an armored notch in the levee along Alviso Slough. Water depths would be maintained at a minimum of one foot. Algal blooms may occur when tidally-driven changes in water level are not sufficient to produce adequate mixing in the pond.

Pond A16. Pond A16 would be reconfigured as a managed pond with influent from A17 which would be muted tidal. Pond A16 would consist of cells with water depths of approximately six inches and a deeper outlet canal. Increased algal abundance is likely as flow and wind driven mixing are low. Algal blooms will likely continue to be a problem in this area that requires monitoring to detect early warning signs of problems, management actions to avoid nuisance algal blooms if early warning signs are detected, and preventative design and operation strategies to avoid problems. Details of monitoring techniques, early warning signs, management actions, and design and operations strategies are provided in a recent technical memorandum (May and Abusaba 2007).

Ravenswood. Pond SF2 would be reconfigured as a year-round managed pond. Water depth would range from approximately two inches to one foot. If flow and wind driven mixing are not sufficient to maintain turbidities algal abundance may increase.

Phase 1 Actions Level of Significance: Less than Significant

Phase 1 Impact 3.4-2: **Potential to cause localized, seasonally low DO levels as a result of algal blooms, increased microbial activity, or decreased residence time of water.**

Changes in DO are a potential result of many of the Phase 1 actions. The magnitude of the impact is not quantifiable without further system characterization and modeling efforts that would be implemented through the Adaptive Management Plan, as described under SBSP Impact 3.4-2 above. Similar to algal blooms, for Phase 1, risk factors in any particular pond complex are waters that are deep, slow, rich in nutrients, organic matter, or chlorophyll, subject to calm wind exposure, and highly transparent. Conversely, the lowest risk waterbodies would likely be shallow, quickly turned over, poor in nutrients, organic carbon and chlorophyll, windy and opaque.

If triggers are exceeded in high-risk waters as a result of high risk factors then adaptive management actions would be implemented that convert high risk factors to low risk factors. Examples of such actions include making water shallower with fill, decreasing hydraulic residence time, increasing exposure to wind, or otherwise increasing the re-aeration rate.

Phase 1 No Action

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

With no action under Phase 1, water management would be reduced in individual Project Areas, resulting in longer residence times and algal blooms that could increase the BOD and COD within ponds. The possibility of inadvertent breaching introduces the risk of discharging COD and BOD loads into the Bay. Without an Adaptive Management Plan to monitor for warning signs and respond, this has potentially significant impacts in all Project Areas.

Phase 1 No Action Level of Significance: Potentially 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. Phase 1 actions at the ELER would take place in Ponds E8A, E9, E8X, E12, and E13.

Pond E8A/9/8X. Tidal action would be restored to Ponds E8A, 9, and 8X through five levee breaches along nearby creeks. Tidal mixing and flushing would aid re-aeration and significant impacts on DO are not expected.

Pond E12/13. Tidal action would be restored to Pond E12/13 with flows managed between cells to maintain varying salinities. Water depths would range from two inches to one foot with an average depth of less than six inches. If flow and wind-driven mixing are not sufficient to maintain turbidities algal abundance may increase. Low wind-driven mixing would also limit reaeration rates. However, the impact to DO is not expected to be significant because of the shallow depth.

Alviso. Phase 1 actions at the Alviso pond complex would take place in Ponds A6, A8, and A16.

Pond A6. Tidal action would be restored to Pond A6 through four levee breaches along adjacent sloughs. Increased algal abundance may result, which could lead to decreased DO.

Pond A8. Pond A8 would be restored to muted tidal action by installing an armored notch in the levee along Alviso Slough. Water depths would be maintained at a minimum of one foot. Algal blooms and low reaeration rates may occur if the tidal cycle increases depth sufficiently to impeded re-aeration.

Pond A16. Pond A16 would be reconfigured as a managed pond with inflow from Pond A17 which would be muted tidal. Pond A16 would consist of cells with water depths of approximately six inches and a deeper outlet canal. This area has already experienced DO problems under the ISP. DO will likely continue to be a problem in this area that requires monitoring to detect early warning signs of problems, management actions to avoid low DO if early warning signs are detected, and preventative design and operation strategies to avoid problems. Details of monitoring techniques, early warning signs, management actions, and design and operations strategies are provided in a recent technical memorandum (May and Abusaba 2007).

Ravenswood. Pond SF2 would be reconfigured as a year-round managed pond. Water depth would range from approximately two inches to one foot. Impacts on DO are not expected to be significant because of the shallow depth.

Phase 1 Actions Level of Significance: Less than Significant

Phase 1 Impact 3.4-3: **Potential to mobilize, transport, and deposit mercury-contaminated sediments, leading to exceedance of numeric water quality objectives, TMDL allocations, or sediment quality guidelines for total mercury.**

Movement of mercury-contaminated sediments is a potential outcome of Phase 1 actions. The magnitude of this impact is not quantifiable without further system characterization and modeling efforts that would be implemented through the Adaptive Management Plan. Location is the primary risk factor for mobilization of mercury-contaminated sediments. As described in Section 3.4.1, mercury concentrations in Bay sediments increase to the south, and sediments in the Alviso pond complex have considerably higher mercury concentrations than Bay sediments (*i.e.*, about two–10 times the ambient Bay condition). Another Project-specific risk factor to look for is introduction of urban stormwater to the SBSP Restoration Project Area, as some urban catchments can convey mercury-polluted sediments.

If triggers are exceeded then adaptive management actions would be implemented that avoid significant impacts. Examples of such actions include monitoring to evaluate the bioaccumulation impact of mercury-contaminated sediments, capping with clean fill, or removing mercury-contaminated sediments.

Phase 1 No Action

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

Under the Phase 1 no-action alternative, the principal risk for mobilization and transport of mercury-contaminated sediments is inadvertent levee breaching. This would mean either impacts to the Project Setting or to the regional setting, depending on geography. The differences are summarized by pond complex below.

Eden Landing. The concentrations of mercury in sediments within the ponds at the Eden Landing Reserve are lower than ambient Bay sediments, as a result of being separated from the Bay for nearly a century. Inadvertent levee failure would bring ambient Bay sediments into the Project Area, raising the average mercury concentration in sediments. Without an Adaptive Management Plan to evaluate the potential for increased bioaccumulation and other impacts that result from this mobilization and transport of mercury contaminated sediments, the impacts to the Project Setting are Potentially Significant.

Alviso. The concentrations of mercury in sediments within the ponds at the Alviso pond complex are higher than ambient Bay sediments, as a result of the historic influence of the New Almaden Mercury Mines near the headwaters of the Guadalupe River. Inadvertent levee failure would bring ambient Bay sediments into the Project Area, lowering the average mercury concentration in sediments within the pond complex. Over time, re-working and tidal mixing would have the net effect of moving mercury-contaminated sediments out of the pond complex and into the Bay. Without an Adaptive Management Plan to evaluate the potential for increased bioaccumulation and other impacts that result from this mobilization and transport of mercury contaminated sediments, the impacts to the regional setting are Potentially Significant.

Ravenswood. The concentrations of mercury in sediments within the ponds at the Ravenswood pond complex are lower than ambient Bay sediments, as a result of being separated from the Bay for nearly a century. Inadvertent levee failure would bring ambient Bay sediments into the Project Area, raising the average mercury concentration in sediments. Without an Adaptive Management Plan to evaluate the potential for increased bioaccumulation and other impacts that result from this mobilization and transport of mercury contaminated sediments, the impacts are Potentially Significant.

Phase 1 No Action Level of Significance: Potentially 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. Mercury concentrations within Phase 1 action locations are less than the Bay ambient concentration. There is a risk that introduction of Bay ambient sediments could increase mercury bioaccumulation within the SBSP Restoration Project Area, but there is not a significant risk to the regional setting. This would be addressed by monitoring through the Adaptive Management Plan to identify whether mercury bioaccumulation occurs. To avoid impacts to the SBSP Restoration Project Area, these Phase 1 action locations would be managed to avoid exceedance of impact thresholds for net methylmercury production and bioaccumulation. The Adaptive Management Plan would include triggers for undesirable levels of mercury in biota, and include monitoring to establish whether adaptive management actions are needed to avoid thresholds of significant impact.

Alviso. Ponds in the Alviso pond complex are known to contain mercury-contaminated sediments from the legacy of the New Almaden mercury mines, upland in the Guadalupe River watershed. So breaching levees introduces the risk of transporting mercury-contaminated sediments from Phase 1 Projects to the Bay. This has the potential to exceed the Bay Mercury TMDL allocation that is based on a target for mercury in suspended sediments.

However, essentially all Alviso projects in Phase 1 would create accretional areas, resulting in a net loss of mercury from the Bay to the SBSP Restoration Project Area. To avoid impacts to the Project Area, these areas should be managed to avoid exceedance of impact thresholds for net methylmercury production and bioaccumulation. The Phase 1 action at Pond A8 contemplates an adjustable notch that would allow for tidal exchange between Alviso Slough and Pond A8. This action could allow accumulation of sediments in Pond A8 that originate more directly from the Guadalupe River watershed. Implementation of the South Baylands Mercury Project takes the first step in the adaptive management process for this geographic area by defining sentinel species and measuring mercury in those species. This Phase 1 action is intended to be one that can be reversed. In other words, the tidal exchange can be cut off if data indicate that methylmercury production and bioaccumulation are being exacerbated by the tidal exchange.

Ravenswood. Mercury concentrations within Phase 1 action locations are less than the Bay ambient concentration. There is a risk that introduction of Bay ambient sediments could increase mercury bioaccumulation within the Project Setting, but not a significant risk to the regional setting. This would be addressed by monitoring through the Adaptive Management Plan to identify whether mercury bioaccumulation occurs. To avoid impacts to the SBSP Restoration Project Area, these areas would be managed to avoid exceedance of impact thresholds for net methylmercury production and bioaccumulation.

Phase 1 Actions Level of Significance: Less than Significant

Phase 1 Impact 3.4-4: **Potential to increase net methylmercury production and bioaccumulation in the food web.**

Project activities have the potential to increase net methylmercury production and bioaccumulation in the food web. The magnitude of the impact is not quantifiable without further system characterization and modeling efforts that would be implemented through the Adaptive Management Plan, as described under SBSP Impact 3.4-4 above.

Factors that add to risk of increased net mercury methylation include mercury contaminated sediments, low DO that promotes methylating bacteria and/or the breakup of oxide surfaces, fresh-brackish salinities and other water quality factors that increase mercury bioavailability to methylating bacteria, and factors that reduce the activity of demethylating bacteria and photodemethylation. Factors that increase risk of bioaccumulation include increased food web complexity, longer-lived prey items, and shifting foraging habits of predators.

If triggers are exceeded then adaptive management actions would be implemented that avoid significant impacts. Examples of such actions include monitoring to identify processes causing increased net methylation, passive or active measures to increase aeration if low DO is a cause, decreasing hydraulic residence time to increase methylmercury removal rates, decreasing water depth to promote photo-degradation of methylmercury, and altering final elevations or other factors that encourage evolution of favorable plant species over unfavorable ones.

Phase 1 No Action

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

Mercury methylation and bioaccumulation are complex processes. The risk factors affecting the potential for impacts include changes in salinity, decreased DO, and shifts in the food web, especially changes in algal populations. All of these are likely to happen under the no action alternative in all Project Areas. Without an Adaptive Management Plan to monitor sentinel species and take actions in response to exceedance of trigger levels the impacts are Potentially Significant.

Phase 1 No Action Level of Significance: Potentially 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. An important factor to note in Phase 1 of the Eden Landing Restoration is the establishment of a range of salinities in Ponds E12 and E13. As discussed in the Adaptive Management Plan, this Phase 1 action would be monitored to assess the effect of salinity on net methylation and bioaccumulation and the results would be used to inform the design of future Project phases.

The presence of gypsum deposits in Pond E8A and the possibility of remediating that gypsum is a potentially important factor because of the release of sulphate. Sulfate has been shown to be a risk factor for mercury methylation, with intermediate concentrations introducing the highest potential for mercury methylation in other natural waters. The approach to remediating the gypsum deposits and subsequent water management choices could result in either an increase or decrease in net mercury methylation within the SBSP Restoration Project Area.

As a restored marsh that is somewhat removed from the mercury-contaminated sediments of the Alviso pond complex, the Pond E8A, E9, and E8X tidal restoration is a good location for the Adaptive Management Plan to evaluate other factors while isolating the variable of highly contaminated sediments.

Alviso. Sediments in the Alviso pond complex are known to be contaminated with mercury from the legacy of the New Almaden mercury mines. This Phase 1 action is where the Adaptive Management Plan should focus on evaluating the risk of mercury-contaminated sediments leading to increased net mercury methylation and bioaccumulation.

Ravenswood. As discussed under Phase 1 Impact 3.4-1 above, the Ravenswood pond complex is expected to have a relatively low risk of depressed DO because of the shallow depth. As discussed under Phase 1 Impact 3.4-2, it is also removed from the mercury-contaminated sediments of the Alviso pond complex. Therefore, this Phase 1 action is a good place for the Adaptive Management Plan to examine the interactive effects of varying salinity and hydraulic residence time on net mercury methylation.

Phase 1 Actions Level of Significance: Less than Significant

Phase 1 Impact 3.4-5: **Potential impacts to water quality from other contaminants.**

Phase 1 No Action

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

Similar to the analysis of Program Alternative A, the Phase 1 No Action would not result in a significant increase over baseline for activities such as construction, recreation and public access, movement of urban stormwater into the Project Area, or other activities that may result in potential impacts from other contaminants. Therefore, the impacts would be less than significant.

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.

Phase 1 actions are expected to result in similar impacts, although to varying degrees, as those program-level impacts previously discussed. Impacts to water and sediment quality due to other contaminants that could occur as a result of specific Phase 1 actions are discussed below by pond complex.

Eden Landing. Phase 1 actions at the ELER would take place in Ponds E8A, E9, and E8X and Ponds E12 and E13.

Ponds E8A/9/8X. Implementation of Phase 1 actions at Eden Landing Ponds E8A/E9/E8X would restore tidal action to the ponds by breaching levees with Old Alameda Creek, North Creek, and Mt. Eden Creek. As previously mentioned, breaching levees and construction of pilot channels may cause scour, short-term erosion, and transport of potentially contaminated sediments. Construction activities may have potential for accidental spills or leaks and transient increases of turbidity; however, proper inspection of equipment and planning can minimize these impacts. Also of potential concern are the impacts associated with increased interaction of the restored area with contaminants transported in Old Alameda Creek, North Creek, and Mt. Eden Creek.

Treatment of the gypsum deposits could mobilize sulfate, but the principal risk due to sulfate is the effect on mercury methylation, as discussed above under Phase 1 Impact 3.4-4.

Ponds E12 and E13. Implementation of Phase 1 actions at Ponds E12 and E 13 would create six cells of varying salinities designed for migratory shorebird foraging. Levees within this Phase 1 action location would be improved, a distribution canal would be constructed, and a culvert would be installed between the discharge mixing basin and Mt. Eden Creek. Construction activities may have potential for accidental spills or leaks and transient increases of turbidity; however, proper inspection of equipment and planning can minimize these impacts.

Implementation of SBSP Mitigation Measures 3.4-5a through 3.4-5f, above, would reduce impacts to less-than-significant levels.

Alviso. Phase 1 actions at the Alviso pond complex would take place in Ponds A6, A8, and A16.

Pond A6. In Phase 1, the levees in Pond A6 would be breached at two locations on Guadalupe Slough and two locations on Alviso Slough to restore tidal inundation. Breaching levees and construction of pilot channels may cause scour, short-term erosion, and transport of potentially contaminated sediments. Also of potential concern is the increased interaction of the restored area with urban runoff conveyed in these sloughs. Although the interaction of urban runoff with the restored area may serve to reduce the overall contaminant loads discharged to the Bay from the urban sources, it may also deposit contaminants in areas of restored habitat. Construction activities may have potential for accidental spills or leaks, however, proper inspection of equipment and planning can minimize these impacts.

Pond A8. Implementation of Phase 1 actions at Pond A8 would involve installation of an armored notch along the perimeter levee that separates Pond A8 and upper Alviso Slough. A pilot channel of approximately 300 ft would also be constructed between the notch and Alviso Slough. Construction of the armored notch and pilot channel may result in water and sediment quality impacts due to construction-related activities and may also cause scour, short-term erosion, and transport of potentially contaminated sediments. Also of potential concern are the impacts associated with increased interaction of the restored area with urban runoff and other contaminants from the Guadalupe River conveyed in Alviso Slough. The restored pond would also serve as flood storage capacity for Alviso Slough, which could further introduce runoff-related contaminants into the SBSP Restoration Project Area.

Pond A16. Reconfiguration of Pond A16 to create islands for nesting birds would involve the use of construction equipment and would therefore have potential for introducing construction-related pollutants. Construction under these situations can typically be well managed to minimize introducing pollutants and this is not viewed as a significant impact. Levee conditions would remain very similar to the existing conditions, therefore impacts associated with transport and/or remobilization of contaminated sediments and interactions with urban runoff would not be expected.

Implementation of SBSP Mitigation Measures 3.4-5a through 3.4-5f, above, would reduce impacts to less-than-significant levels.

Ravenswood. Phase 1 actions at Pond SF2 would reconfigure the pond to create nesting islands for birds and shallow water habitat. Culverts would be installed in the bayfront levee to allow tidal circulation and a low berm would be constructed through the middle of the pond to guide flow. The main impacts with respect to “other contaminants” would be from construction-related activities.

Implementation of SBSP Mitigation Measures 3.4-5a through 3.4-5f, above, would reduce impacts to less-than-significant levels.

Phase 1 Actions Level of Significance: Less than Significant with Mitigation

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Phase 1 Impact 3.4-6: **Potential to cause seawater intrusion of regional groundwater sources.**

Phase 1 No Action

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

Under the Phase 1 no action alternative, the primary risk to groundwater is inadvertent levee failure that moves saline Bay water towards natural or artificial conduits. This poses a threat to drinking water supplies only if groundwater overdraft occurs subsequent to the introduction of saline waters into shallow aquifers. Presently, groundwater is not overdrafted and so groundwater flows into the Bay. Natural and artificial pathways do exist, as evidenced by the salinity anomaly in the vicinity of Pond E12 and E13. Without appropriate mitigation measures associated with the Project, this would result in potentially significant impacts.

Phase 1 No Action Level of Significance: Potentially 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. Preliminary results of PWA's hydrodynamic modeling results for salinity (Appendix J) indicate that salinity would not increase substantially in the Eden Landing pond complex. There is thus judged to be no significant risk of salinity intrusion from stream channel modifications or operational changes in these Phase 1 actions.

> The risk of improperly abandoned wells is as discussed in SBSP Impact 3.4-6. CDFG has performed due diligence in coordination with Cargill to ensure that wells in this Project Area have been properly abandoned. Implementation of SBSP Mitigation Measure 3.4-6, above, would be required, in coordination with ACWD, to prevent groundwater overdraft, thereby reducing potentially significant impacts.

Alviso. Preliminary results of PWA's hydrodynamic modeling results for salinity (Appendix J) indicate that salinity would increase approximately 4 ppt at the southeast edge of the SBSP Restoration Project Area in the Guadalupe River and Coyote Creek at the end of the 50-year modeling period. Salinity increases continue up both water bodies for an unknown distance. The increased salinity concentrations reach at least as far as the area of the unconfined portion of the Santa Clara Valley Subbasin on Coyote Creek in the vicinity of Milpitas.

The risk of improperly abandoned wells is as discussed in SBSP Impact 3.4-6. Implementation of SBSP Mitigation Measure 3.4-6, above, would be required to reduce potentially significant impacts.

Ravenswood. Preliminary results of PWA's hydrodynamic modeling results for salinity (Appendix J) indicate that salinity would not increase substantially in the Ravenswood pond complex. There is thus judged to be no significant risk of salinity intrusion from stream channel modifications or operational changes in these Phase 1 actions.

The risk of improperly abandoned wells is as discussed in SBSP Impact 3.4-6. Implementation of SBSP Mitigation Measure 3.4-6, above, would be required, in coordination with San Mateo County Environmental Health Department to reduce potentially significant impacts.

Phase 1 Actions Level of Significance: Less than Significant with Mitigation