Chapter 4
Water Quality

4.1 Environmental Setting

4.1.1 Introduction and Sources of Information

This chapter describes the physical and chemical environment of the Napa River Unit with respect to marsh sediments and water quality in the salt ponds and surrounding surface water bodies (Napa River and San Pablo Bay). Information on the existing conditions is derived from extensive water quality monitoring conducted by the USGS; UCD historical data records for the Napa River and San Pablo Bay; and recent sediment and water quality sampling conducted specifically for the project by Hydroscience Engineers. This chapter also describes the results of a hydrodynamic and water quality model developed for the restoration project by PWA.

Data regarding the quality of water currently discharged from the SVCSD, NSD, and CAC WWTPs (i.e., the Project Component of the Water Delivery Option discussed in Section 4.2.7) were provided by WWTP staff.

4.1.2 Regulatory Setting

Several state and federal agencies have regulatory authority or responsibility over project-related activities that affect water quality. Table 4-1 below summarizes project-related activities, the environmental resources potentially affected by each activity, and the government agency with regulatory authority over the activity.

Table 4-1. Summary of Regulatory Setting for Water Quality

Project-Related Activity	Regulatory Authority
Construction activities that could adversely affect water quality	RWQCB–NPDES stormwater permit (CWA Section 402); CWA Section 401 water quality certification
Operations of controlled levee breaches and/or physical structures (e.g., pumps, weirs, siphons) to facilitate flushing and dilution of salt ponds	RWQCB–NPDES individual permit and/or WDRs (Porter-Cologne Act and Basin Plan) for waste discharge to waters of the state; CWA Section 401 water quality certification

RWQCB = Regional Water Quality Control Board
NPDES = National Pollutant Discharge Elimination System
WDRs = waste discharge requirements
CWA = Clean Water Act
Basin Plan = *Water Quality Control Plan, San Francisco Bay Region*

4.1.2.1 Regional Water Quality Control Board Authority

The RWQCBs have primary authority for implementing provisions of the federal CWA and California's Porter-Cologne Water Quality Control Act. These statutes establish the process for developing and implementing planning, permitting, and enforcement authority for waste discharges to land and water. The *Water Quality Control Plan, San Francisco Bay Region* (Basin Plan) establishes beneficial uses for surface and groundwater resources and sets regulatory water quality objectives that are designed to protect those beneficial uses (San Francisco Bay RWQCB 1995). Under the current Basin Plan, designated beneficial uses of the San Francisco Bay area's surface waters include municipal and domestic supply; agricultural supply; industrial service supply; groundwater recharge; contact and noncontact recreation; warm freshwater fish habitat; cold freshwater fish habitat; wildlife habitat; migration of aquatic organisms; and spawning, reproduction, and/or early development of fish. Beneficial uses of San Francisco Bay area groundwater include municipal and domestic supply, agricultural supply, and industrial service supply.

The Basin Plan establishes numeric and narrative surface and groundwater water quality objectives designed to protect designated beneficial uses of surface water and groundwater resources. Other applicable water quality criteria include the California Toxics Rule (CTR), which establishes numeric criteria for aquatic life and human health protection for approximately 130 priority trace metal and organic constituents. Numeric water quality objectives include specific concentration-based values that may be imposed on the effluent or at the edge of an allowable mixing zone within the receiving water. Numeric Basin Plan and CTR criteria differ depending on the salinity content.

The Basin Plan defines fresh water, saltwater, and estuarine waters as follows: Fresh water has a salinity of less than 5 ppt more than 75% of the time; saltwater has a salinity of more than 5 ppt more than 75% of the time; and estuarine water has a salinity that is between that of fresh water and saltwater. In general, the lower of the saltwater or fresh water quality criteria apply to estuarine conditions.

The San Francisco Bay RWQCB applies estuarine water quality criteria to San Pablo Bay and the Napa River. Narrative criteria provide general guidance to avoid adverse water quality impacts for constituents including salinity, sediment (i.e., total suspended solids [TSS]), tastes and odors, sulfides, toxicity, and bioaccumulation. Numeric criteria included in the Basin Plan include such parameters as trace metals, dissolved oxygen, turbidity, temperature, pH, bacteriological pathogens, and un-ionized ammonia. Table 4-2 shows selected surface water quality objectives of potential concern for tidal wetland restoration projects and applicable numeric and narrative criteria.

Table 4-2. Surface Water Quality Objectives for Potential Constituents of Concern

Constituent	Units	Water Quality Objective *
Temperature	°F	Controllable water quality factors shall not increase temperature by more than 5°F.
Dissolved oxygen	mg/l	5.0 mg/l. Minimum dissolved oxygen is applicable to tidal waters downstream of Carquinez Bridge. The median dissolved oxygen concentration for any 3 consecutive months shall not be less than 80% of the dissolved oxygen content at saturation.
Salinity	ppt	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.
pH	standard units	6.5 to 8.5. The pH shall not be depressed below 6.5 or raised above 8.5. This range encompasses the pH range usually found in waters within the basin. Controllable water quality factors shall not cause changes of greater than 0.5 unit in normal ambient pH levels.
Turbidity	NTU	Waters shall be free of changes in turbidity that could cause nuisance or adversely affect beneficial uses. Increases of turbidity as a result of waste discharge shall not be greater than 10% in areas where natural turbidity is greater than 50 NTU.
Sediment	mg/l	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.
Sulfide	mg/l	All water shall be free of 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.
Toxicity	NA	All waters shall be maintained free of toxic substances in concentrations that are lethal to or that produce other detrimental responses in aquatic organisms. There shall be no acute toxicity in ambient waters. Acute toxicity is defined as a median of less than 90% survival, or less than 70% survival more than 10% 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.

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Table 4-2. Continued

Constituent	Units	Water Quality Objective [1]
Bioaccumulation	NA	Many pollutants can accumulate on particles or 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.
Arsenic	µg/l	36 ^{S}, 150 ^{F}
Cadmium	µg/l	9.3 ^{S}, 1.1 ^{F}
Chromium, total	µg/l	180 ^{F}
Chromium, hexavalent	µg/l	50 ^{S}, 11 ^{F}
Copper	µg/l	3.1 ^{S}, 9.0 ^{F}
Lead	µg/l	5.6 ^{S}, 2.5 ^{F}
Nickel	µg/l	7.1~~8.2~~ ^{S}, 5.2 ^{F}
Silver [2]	µg/l	1.9 ^{S}, 3.4 ^{F}
Selenium	µg/l	7.1 ^{S}, 5.0 ^{F}
Mercury	µg/l	0.025 ^{S}, 0.025 ^{F}
Zinc	µg/l	81 ^{S}, 23 ^{F}
PCBs, total [3]	µg/l	0.000170 ^{S}, 0.000170 ^{F}

[1] Narrative objectives are used where numeric objectives have not been established. Unless noted otherwise, single numeric values represent the chronic exposure (4-day average) concentration not to be exceeded at a frequency exceeding once every 3 years. Trace metal criteria represent the lower of the Basin Plan objectives or California Toxics Rule (CTR) for saltwater (S) or freshwater (F) conditions.

[2] Criteria applicable to acute exposure concentration only (instantaneous maximum).

[3] CTR human health criteria for consumption of organisms.

Notes:
mg/l = milligrams per liter
µg/l = micrograms per liter
ppt = parts per thousand
NTU = nephelometric turbidity units
NA = not applicable
PCBs = polychlorinated biphenyl compounds

Disposal Option Sediment Screening Criteria

The San Francisco Bay RWQCB also established sediment screening criteria and testing requirements for the beneficial reuse of dredged material (e.g., wetlands creation and upland disposal). The criteria are intended to facilitate the creation, enhancement, and restoration of wetlands in marine and estuarine environments. The criteria were developed in part based on Effects Range–Low (ER-L) and Effects Range–Median (ER-M) criteria originally developed by NOAA (California Department of Water Resources 1995). The ER-L criteria reflect the concentration below which adverse biological effects may be expected to occur less than 10% of the time. ER-M criteria reflect the concentration below which adverse biological effects may be expected to occur less than 50% of the time.

The RWQCB criteria specify the allowable use based on two categories: use for wetland noncover where exposure to the aquatic environment would be limited and wetland cover or levee construction where sediments would be exposed to the water. Table 4-3 shows the applicable criteria for trace metals and organic compounds.

Table 4-3. RWQCB Disposal Option Sediment Screening Criteria

	Criteria	
Constituent	Wetlands Creation Noncover (mg/kg, dry weight)	Wetlands Creation Cover and Levee Restoration (mg/kg, dry weight)
Arsenic	33–85	<33
Cadmium	5–9	<5
Chromium, total	220–300	<220
Copper	90–390	<90
Lead	50–110	<50
Nickel	140–200	<140
Mercury	0.35–1.3	<0.35
Selenium	0.7–1.4	<0.7
Silver	1.0–2.2	<1.0
Zinc	160–270	<160
PAHs, total	4–35	<4
DDT	0.003–0.1	<0.003
PCBs, total	0.05-–0.4	<0.05

Notes: mg/kg = milligrams per kilogram; PAH = polycyclic aromatic hydrocarbon

4.1.2.2 CWA Section 402 and RWQCB Permitting Procedures

Section 402 of the CWA prohibits the discharge of all pollution into surface waters unless permitted under the National Pollutant Discharge Elimination System (NPDES), which is administered by the U.S. Environmental Protection Agency (EPA), or by a state agency with a federally approved control program. In California, Section 402 authority has been delegated to the SWRCB and is administered by RWQCBs.

To ensure conformance with the Basin Plan and the federal CWA, the RWQCB issues WDR and/or NPDES permits to projects that may discharge wastes to land or water. The federal NPDES permit system includes procedures for point-source waste discharges and stormwater discharges. It is anticipated that the San Francisco Bay RWQCB would ~~not~~ impose WDRs on the discharge of bittern and an NPDES point-source discharge permit on the discharge of recycled water although~~proposed project because~~ the project is considered a long-term beneficial water reclamation and wetland restoration project. ~~However, t~~The RWQCB administers the statewide general NPDES stormwater permit for general construction activity that applies to projects that disturb more than 5 acres of land; this permit will most likely be required. The NPDES permit requires filing with the San Francisco Bay RWQCB a public notice of intent (NOI) to discharge stormwater and preparation and implementation of a stormwater pollution prevention plan (SWPPP). The SWPPP must include a site map and description of construction activities and identify BMPs that would be employed to prevent soil erosion and discharge of other construction-related pollutants (e.g., petroleum products, solvents, paints, cement) that could contaminate receiving waters. Monitoring may be required to ensure that BMPs are implemented according to the SWPPP and are effective at controlling discharges of stormwater-related pollutants.

Erosion and sediment delivery to the Napa River would be minimized during project construction. Related efforts would include measures to minimize the potential for sediment to enter the river as well as interim measures to stabilize soil pending establishment of vegetative cover. As part of the SWPPP required for project construction, an erosion and sediment control plan would be prepared and incorporated into project construction plans and specifications. More specifically, for stormwater discharges from construction sites, SWRCB Order 99-08-DWQ authorizes NPDES general permit No. CAS000002, Waste Discharge Requirements for Discharge of Storm Water Runoff Associated with Construction Activity. The San Francisco Bay RWQCB implements the provisions of general permit CAS000002 and may issue an individual NPDES permit and waste discharge requirements for construction activities or projects found ineligible for coverage under the general permit. The selected contractor(s) would be responsible for implementing the erosion and sediment control plan under DFG or Corps supervision, as required by the permitting process of the NPDES.

If a general permit application for either stormwater or groundwater extraction is found ineligible for permitting under the limitations and requirements of a general permit, the San Francisco Bay RWQCB may consider authorizing a single individual permit incorporating provisions applicable to both stormwater and groundwater extraction activities.

4.1.2.3 CWA Section 401—Water Quality Certification

Under CWA Section 401, applicants for a federal license or permit to conduct activities that may result in the discharge of a pollutant into waters of the United States must obtain certification from the state in which the discharge would originate or, if appropriate, from the interstate water pollution control agency with jurisdiction over affected waters at the point where the discharge would originate. Therefore, all projects that have a federal component and may affect state water quality (including projects that require federal agency approval [such as issuance of a Section 404 permit]) must also comply with CWA Section 401. In California, the authority to grant water quality certification has been delegated to the State Water Resources Control Board (SWRCB) and applications for water quality certification under CWA Section 401 are typically processed by the RWQCB with local jurisdiction. Water quality certification requires evaluation of potential impacts in light of water quality standards and CWA Section 404 criteria governing discharge of dredged and fill materials into waters of the United States.

For purposes of this project, DFG and the Corps will obtain certification from the San Francisco Bay RWQCB under Section 401.

4.1.2.4 CWA Section 303(d)—Water Quality Limited Water Bodies

Under CWA Section 303(d), the RWQCB and SWRCB list water bodies as impaired when not in compliance with designated water quality objectives and standards. A total maximum daily load (TMDL) program must be prepared for waters identified by the state as impaired. A TMDL is a quantitative assessment of a problem that affects water quality. The problem can include the presence of a pollutant, such as a heavy metal or a pesticide, or a change in the physical property of the water, such as DO or temperature. A TMDL specifies the allowable load of pollutants from individual sources to ensure compliance with water quality standards. Once the allowable load and existing source loads have been determined, reductions in allowable loads are allocated to individual pollutant sources.

The Napa River is currently identified on the EPA Section 303(d) list for the state as being impaired by nutrients, pathogens, and sedimentation. TMDL programs are planned for these constituents with projected completion by 2005. The identified sources of the contaminants include a full range of agriculture, urban runoff, resource extraction, atmospheric deposition, and natural sources.

Sonoma and Petaluma Creeks are included on the 303(d) list because of high levels of nutrients, pathogens, and sedimentation from agriculture, development, and urban runoff. Both TMDL processes are scheduled for completion in 2005. Novato Creek is on the 303(d) list for diazinon contamination (as are all San Francisco Bay urban creeks) because of urban runoff; the TMDL process is scheduled for completion by 2004.

San Pablo Bay is listed as impaired for several organochlorine pesticides, the organophosphorus pesticide diazinon, dioxin and furan compounds, polychlorinated biphenyl (PCB) compounds, copper, mercury, nickel, and selenium. Development of the TMDL for mercury in the greater San Francisco Bay is currently underway. North San Francisco Bay, including San Pablo Bay, is being evaluated to determine whether impairment by copper is actually a problem. As a result of this effort, San Pablo Bay may eventually be delisted for copper. The TMDLs that will be required for San Pablo Bay are in various states of development and are projected for completion in 2010. A mercury TMDL report has been completed that describes the problem conditions and assessment of sources (San Francisco Bay RWQCB 2000).

4.1.2.5 Section 313

Section 313 of the CWA (33 USC 1323) states:

> …each department, agency, or instrumentality of the executive, legislative, and judicial branches of the federal government having jurisdiction over any property or facility, or engaged in any activity resulting, or which may result, in the discharge or runoff of pollutants…shall be subject to, and comply with, all federal, state, interstate and local requirements, administrative authority, and process and sanctions respecting the control and abatement of water pollution in the same manner, and to the same extent as any nongovernmental entity.

The Corps would comply with Section 313 of the CWA by complying with Sections 404, 401, and 402 of the CWA, California Fish and Game Code Section 1600, and regional and local requirements of the San Francisco Bay RWQCB and SWRCB through the Basin Plan and NPDES permitting. A Corps project does not need a Section 404 permit; instead, the Corps conducts an equivalent evaluation in-house. This Section 404(b)(1) evaluation is described in Appendix B. The Corps would consider and mitigate changes in habitat, salinity, and other water quality parameters through project modification and, if necessary, mitigation. <u>In multiple locations, DFG has determined that the restoration project area is not subject to Section 1600 because it is in a tidal zone. Section 313 of the CWA applies only to federal agencies.</u>

4.1.2.6 Water Recycling Law

Chapter 7 of the California Water Code, also known as the Water Recycling Law, establishes the intent of the legislature to encourage water recycling as a method to increase the ability to meet the growing water needs within California. The law authorized the SWRCB to loan money to local agencies to develop water reclamation facilities and directed the state Department of Health Services (DHS) to create water recycling criteria. In addition, it developed reporting requirements and established permitting procedures for the regional boards in conjunction with DHS.

4.1.2.7 Title 22, California Code of Regulations Criteria for Recycled Water Quality

DHS holds the authority to set criteria for recycled water production and use. Title 22, Division 4 of the California Code of Regulations (CCR) defines these criteria, which pertain to treatment processes, water quality, and reliability. Title 22 establishes minimum water quality criteria requirements for various use categories, including irrigation, wetlands, and industrial uses. Table 4-4 lists the treatment levels required for different uses of reclaimed water that are possible within the north bay region.

Table 4-4. Water Treatment Requirements for Recycled Water Use

Treatment Level	User Categories
Disinfected tertiary treatment	Food crops where recycled water comes into direct contact with edible portions; parks and playgrounds; school yards; and unrestricted access golf courses
Disinfected secondary treatment with coliform not exceeding a most probable number of 23 per 100 milliliters	Restricted access golf courses; pasture for animals producing milk for human consumption; and nonedible vegetation where access is controlled
Undisinfected secondary treatment	Orchards or vineyards where the recycled water does not come into contact with edible portion; and fodder or pasture for animals not producing milk for human consumption

Title 22 also sets forth requirements for separation between areas irrigated with reclaimed water and domestic groundwater wells, with separation distances as follows:

- 50 feet for disinfected tertiary treated water (unless several additional criteria are met),
- 100 feet for disinfected secondary water, and
- 150 feet for undisinfected secondary water.

4.1.2.8 RWQCB Policy on Use of Wastewater to Create, Restore, or Enhance Wetlands

In the north bay, the RWQCB prohibits discharges of municipal wastewater effluent discharges that exceed the applicable water quality standards if the quantity of receiving water does not provide an initial dilution capacity for the effluent of at least 10:1. Resolution 94-086 established objectives and guidance for an exception to this shallow-water-discharge restriction that allows effluent discharges in such situations if the effluent is used to create, restore, and/or enhance wetlands. The policy requires that the wetland restoration project must provide a net environmental benefit and the beneficial uses that are established in the wetland must be fully protected. A management plan must be prepared that describes project objectives, design and engineering considerations, operations and maintenance procedures, and monitoring programs.

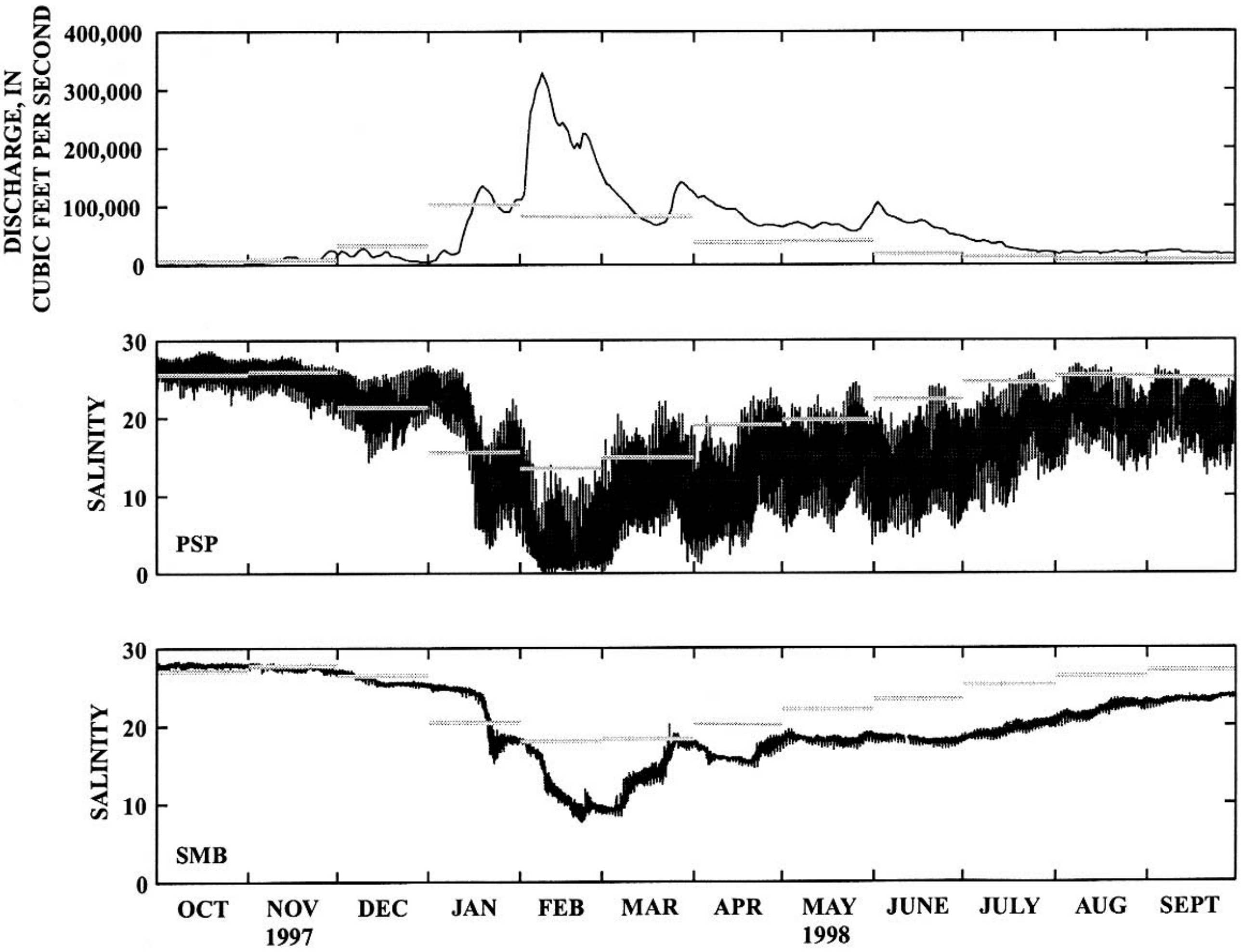
4.1.3 Regional Setting

The hydrologic processes and fate and transport factors for chemical constituents in San Francisco Bay, its tributary rivers, and adjacent estuaries are complex and result in dynamic water quality conditions. Water quality in the Bay-Delta estuary is largely a function of the mixing of ocean water and freshwater inflows from precipitation, the Delta, and other tributary streams. The physical mixing of sediment, nutrients, and salts combine with natural processes of light and heat input and associated primary and secondary production in higher trophic levels in the aquatic ecosystem of the bay. These ecosystem functions have secondary effects on dissolved oxygen, pH, and organic matter production and decay. In addition, the discharge of anthropogenic sources of conventional inorganic contaminants and trace metal and synthetic organic compounds also play a major role in the quality of bay water and sediments. Examples include municipal and industrial wastewater treatment discharges and urban stormwater runoff.

4.1.3.1 Salinity

Salinity in the Bay-Delta estuary reflects a balance between the saline marine influence, freshwater dilution, and the effects of evaporation. Undiluted seawater has an average salinity of about 35 ppt and distilled fresh water is defined as having 0 ppt salinity. Estuarine or brackish water represents salinity that lies between pure freshwater and pure saltwater conditions. Saltwater is considerably more dense than fresh water; therefore, fresh water will float on top of saline water. The density difference between saline and fresh water conditions also influences physical mixing between water layers of varying density. In general, salinity is lower in the northern portion of San Francisco Bay and higher in the southern portion, because San Pablo Bay receives substantially greater freshwater influx from the Delta. Freshwater inflow from the Delta also contributes to a much greater seasonal variation in salinity conditions in the north bay than in the south bay. The salinity in the sloughs of San Pablo Bay varies seasonally. During periods of high flow (particularly the winter rainy season), increased freshwater influx via San Pablo Bay’s creeks decreases the salinity in the sloughs. Slough salinities increase during the summer low-flow period when freshwater influx is reduced.

The USGS and San Francisco Estuary Institute Regional Monitoring Program (RMP) conduct extensive water quality monitoring activities in San Francisco Bay and its freshwater tributaries (San Francisco Estuary Institute 1999, 2000a). The USGS operates a continuous salinity meter at Point San Pablo and has operated several continuous TSS recorders (e.g., Benicia Bridge, Carquinez Bridge, Point San Pablo) in recent years. Figure 4-1 shows a time series of continuous salinity measurements collected at Point San Pablo and the San Mateo Bridge during the 1998 water year in relation to Delta outflow (U.S. Geological Survey 2000c). (Note that this figure shows data from an extremely wet year that is not at all typical.) Analyses indicate that salinity in San Pablo Bay varies over a wide range during the year from nearly fresh water to nearly pure sea water. Salinity also exhibits a distinct variation that correlates with the spring-neap tidal cycle with spring tides having greater energy to force seawater further into the estuary. The spring-neap tidal cycle is generally more pronounced in the north bay.



Source: U.S. Geological Survey 2000.

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Figure 4-1
Time Series of Delta Outflow and Salinity at Point San Pablo and San Mateo Bridge – Water Year 1998

4.1.3.2 Suspended Sediment

Like salinity, suspended sediment concentration is controlled by a balance of factors. Key influences on suspended sediment are loading from inland streams, tidal influences on dilution and mass loading of biotic suspended matter (algae, zooplankton), and resuspension of previously deposited sediments within the bay. Resuspension of sediments within the bay is a function of tidal currents, wind strength and direction (i.e., the strength of wind-driven wave currents), and freshwater inputs. Freshwater influx shows a strong seasonal variation, with a peak during the winter (November–April) rainy season; land-derived sediment loading shows a corresponding peak in the winter. Tidal currents vary on a semimonthly basis from neap tides to spring tides, with the greatest sediment mobility at spring tides.

In general, TSS concentrations are highest in the San Pablo Bay region and at the southern end of San Francisco Bay. TSS concentrations are typically lower in central San Francisco Bay. USGS data show average concentrations of ~80–150 milligrams per liter (mg/l) in San Pablo Bay (Northwest Hydraulic Consultants 2001). High TSS levels in San Pablo Bay are generally associated with sediment input associated with Delta inflows.

Figure 4-2 shows continuous TSS concentration monitoring data at Point San Pablo for the 1998 water year that indicates seasonal conditions are influenced by a combination of Delta inflow and tidal action in San Francisco Bay (U.S. Geological Survey 2001). Figures 4-3 and 4-4 show seasonal variation of TSS data for the 1999 water year at Point San Pablo and within the Mare Island Strait for both mid-depth and near-bottom locations in the water column (U.S. Geological Survey 2001). These plots reflect the wide range of TSS concentrations that can be present as influenced by Delta outflow discharge patterns and tidal action. Measured TSS concentrations range from relatively low values of less than 50 mg/l TSS to very turbid conditions exceeding 1,000 mg/l TSS. Seasonal RMP grab samples also indicate that TSS concentrations are generally elevated in the Napa and Petaluma Rivers compared to San Pablo Bay (San Francisco Estuary Institute 2000a). However, the total sediment transport from the upper watersheds is minimal compared to the quantities of sediment derived from Delta outflow and wind- and wave-driven resuspension of bay sediments. In addition, Warner (2000) identified a complex tidally and salinity driven mechanism that acts to increase TSS transport into Mare Island Strait and the lower Napa River from the Carquinez Strait. Essentially, the earlier timing of flood tides with high TSS levels into Mare Island Strait compared to the Carquinez Strait provides high TSS conditions, and the convergence with lower salinity Napa River outflow creates a standing wave that allows elevated deposition rates. An average suspended sediment concentration of 125 mg/l was assumed to be characteristic of the project area (PWA 2002c), and was used to estimate the rate of habitat development in Pond 3 (closest to Mare Island Strait). A more conservative suspended sediment concentration of 75 mg/l was used to estimate the rate of habitat development in Ponds 4 and 5. This lower suspended sediment concentration accounts for the effect of Pond 3 sediment demand and the greater distance to Mare Island Strait.

4.1.3.3 Priority Trace Metal and Organic Compounds in Water and Sediment

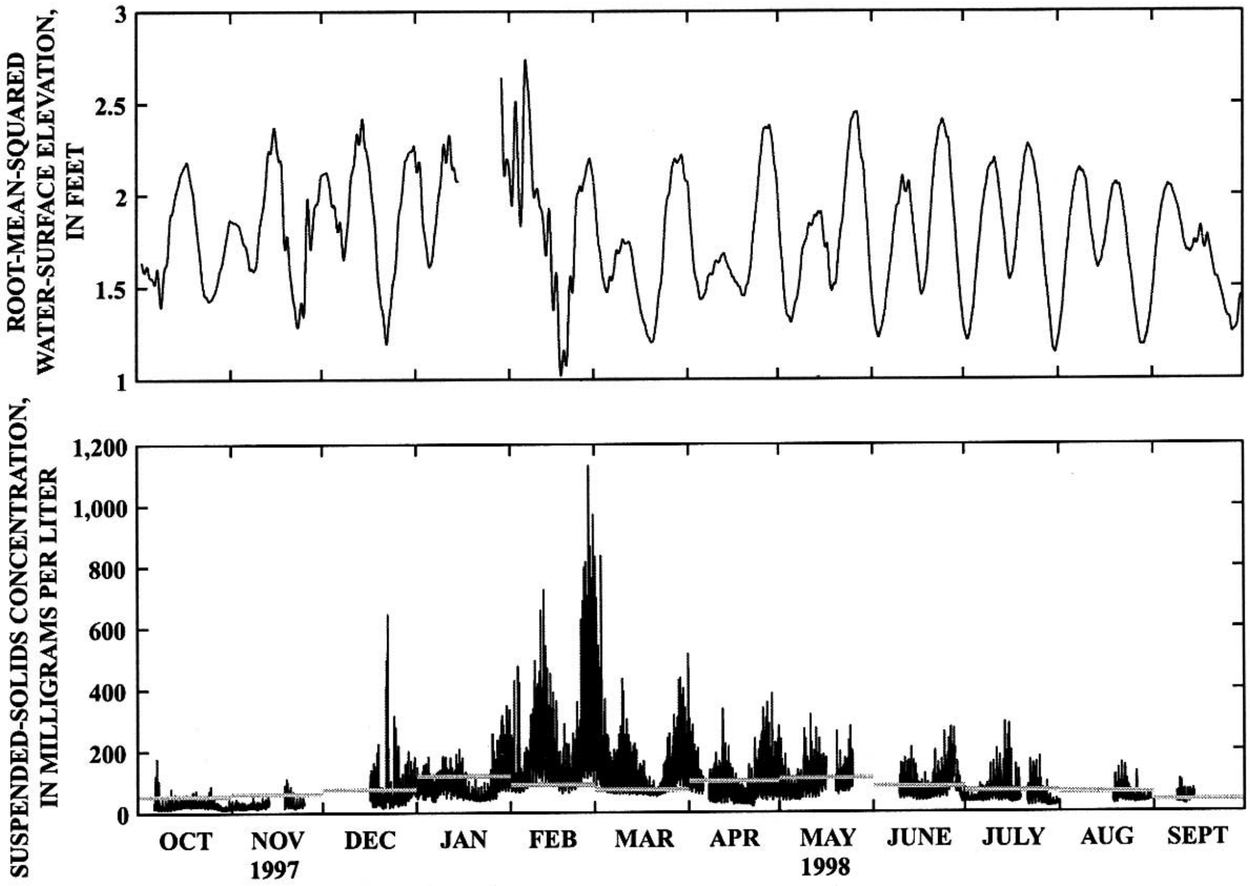
Water

Water and sediment contamination from priority trace metal and synthetic organic compounds in the San Francisco Bay area largely reflects the influence of past and present agricultural and mining activities, industrial uses, and urban development (San Francisco Estuary Institute 1999). Contaminants known to be present in waters and sediments of the Bay-Delta estuary include heavy metals (lead, copper, aluminum, mercury, nickel, vanadium, chromium, silver, zinc), polycyclic aromatic hydrocarbons (PAHs), PCBs, chlorinated hydrocarbon pesticides, and tributyltin (San Francisco Estuary Institute 1999, 2000a, San Francisco Bay RWQCB 1998).

Within the north bay region, constituents of concern that routinely exceed numeric guidance levels, human health guidelines, and/or regulatory concentration criteria in water samples collected for the RMP monitoring program include copper, mercury, and PCBs (San Francisco Estuary Institute 2000a). Table 4-5 shows RMP average concentration values for selected constituents measured during the 1993–1999 period in the Napa River and San Pablo Bay. For the Napa River and San Pablo Bay samples, only copper exceeded applicable criteria on an average basis; however, individual measurements of mercury, copper, nickel, chromium, lead, and zinc exceeded criteria on one or more occasions (San Francisco Estuary Institute 1999). Organic compound concentrations of PCBs and dichlorodiphenyldichloroethelene (DDE) were also measured above water quality guidelines at least once in the Napa River and San Pablo Bay. The sum of 40 PCB congeners was well above the congener-based total-PCB criterion of 170 picograms per liter (pg/l) in all but eight of the RMP sampling locations. While the concentrations of PCBs have dropped since the 1970s, the RMP monitoring data have shown no clear trends in recent years. Measured exceedances of metals and organic compounds occurred less frequently in other north bay sampling locations (i.e., Davis Point, Pinole Point).

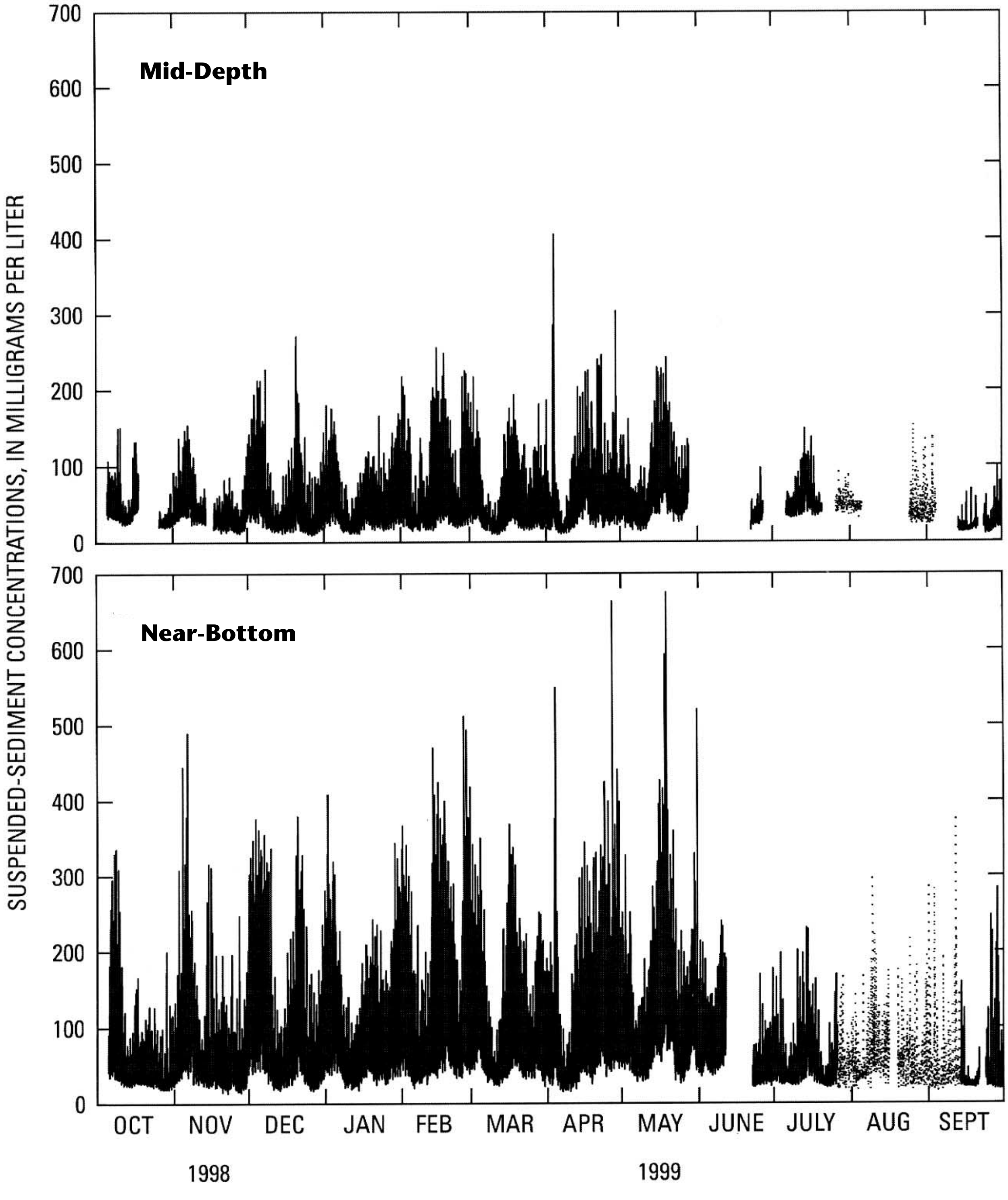
The sources and magnitude of contaminant loading to San Francisco Bay have been recently characterized as consisting primarily of the following categories: Central Valley via Delta inflows, local runoff of rivers and stormwater runoff, point-source discharges to the bay from municipal and industrial facilities, atmospheric deposition, and dredged material disposal (San Francisco Estuary Institute 2000b). Overall, the report indicated that TSS and contaminant influxes from the Delta comprise a large majority of the total loading in San Francisco Bay. Atmospheric deposition and dredged material disposal represent relatively small contributions.

The relative magnitude of contaminant loading from local watershed sources and point-source discharges depends on the particular chemical constituent in question. For example, point-source discharges comprise the majority of inorganic nutrient (nitrogen [N] and phosphorus [P]) loading to San Francisco



Source: U.S. Geological Survey 2000.

Figure 4-2
Time Series of Total Suspended Solids and Tidal Elevation at Point San Pablo – Water Year 1998



Source: U.S. Geological Survey 2001.

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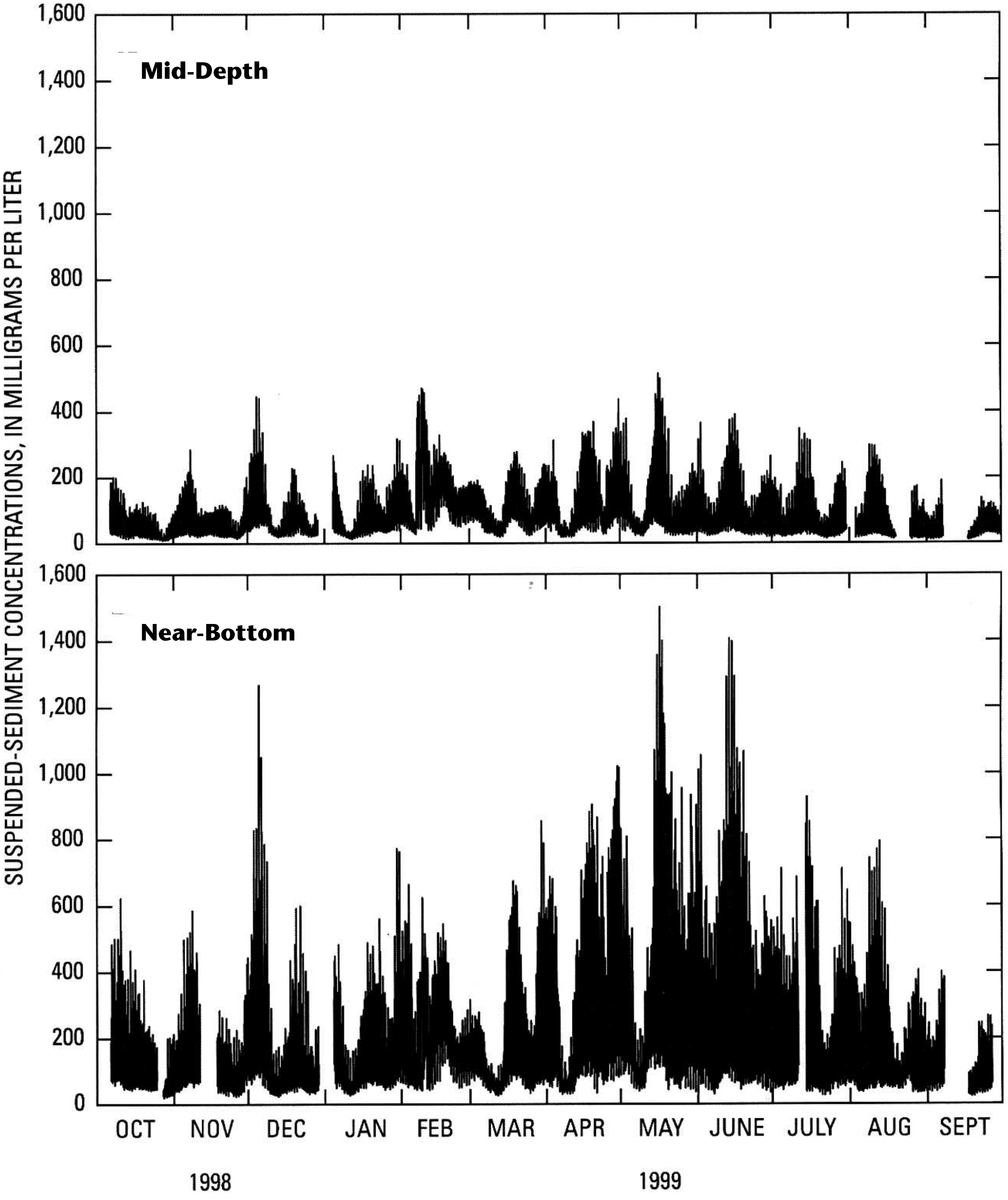
Figure 4-3
Time Series of Mid-Depth and Near-Bottom Total Suspended Solids at Point San Pablo – Water Year 1999



Source: U.S. Geological Survey 2001.

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Figure 4-4
Time Series of Mid-Depth and Near-Bottom Total Suspended Solids at Mare Island Causeway – Water Year 1999

Bay, whereas trace metals inputs are primarily associated with local watershed sources. Relative source contributions of organic compounds have not been determined. Within the category of local watershed runoff, the Napa River, Petaluma River, and Sonoma Creek watersheds were found to contribute a relatively high percentage of the total San Francisco Bay area load of selected trace metals (cadmium, chromium, copper, lead, nickel, and zinc) compared to other watersheds.

Table 4-5. Water Contaminant Levels of the Napa River, San Pablo Bay and the Salt Ponds Project Area[1]

Location[2]	Salinity (tds)	As (µg/l)	Cr (µg/l)	Cu (µg/l)	Pb (µg/l)	Hg (µg/l)	Ni (µg/l)	Zn (µg/l)	Total PCBs (µg/l)[3]
Napa River	—	2.8	12.0	5.9	2.0	0.021	10.2	13.0	0.000558
San Pablo Bay	—	2.6	11.5	5.5	2.0	0.024	9.3	8.6	0.000758
Pond 1	40,050	19.5	<10	31	10	<0.1	<10	13	<MRL
Pond 1A	163,950	12.0	<10	53	<2	<0.1	<10	47	<MRL
Pond 2	38,425	10.5	<10	34	<2	<0.1	11	26	<MRL
Pond 2A	21,850	<6	<10	20	<2	<0.1	<10	<20	<MRL
Pond 3	66,475	ND	ND	53	ND	ND	ND	59	<MRL
Pond 4	37,500~~323,000~~	~~<30~~2.53	~~<500~~0.65	~~287~~1.51	~~<100~~1.05	~~<0.5~~0.00626	~~<500~~8.7	~~725~~2.82	<MRL
Pond 5	~~323,667~~	~~87.0~~	~~<100~~	~~253~~	~~<20~~	~~<0.1~~	~~<100~~	~~1027~~	<MRL
Pond 6	92,100	<24	28.7	<40	<8	<0.1	<40	75	<MRL
Pond 6A	57,533	<24	<40	<40	<8	<0.1	<40	<80	<MRL
Pond 7	396,000~~353,500~~	~~125~~9.2	~~<100~~50.3	~~1519~~4.34	~~<20~~2.81	~~<1.0~~0.02	90	~~3380~~560	<MRL
Pond 7A	47,800~~96,400~~	~~<60~~3.75	~~<100~~48.4	~~65~~0.79	~~<20~~0.20	<0.~~5~~01	~~<100~~7.80	~~<200~~3.51	<MRL
Pond 8	21,400~~293,667~~	~~<300~~0.81	~~<500~~23.9	~~373~~1.34	~~<100~~0.31	<0.~~5~~01	~~<500~~4.40	~~1840~~2.31	<MRL
WQC		36	209	3.2	20.4	0.029	7.2	61.3	

- No Data

[1] Average of measurements at each salt pond in total dissolved solids (tds); measurements can vary substantially during the year depending on the pond depth and amount of rainwater present in a pond.

[2] Sources: Napa River and San Pablo Bay values calculated from San Francisco Estuary Institute data (URL:/ www.sfei.org/rmp/data.htm); salt pond data from Hydroscience 2002, updated based on October 1, 2003, sampling and precipitation-based sample evaluation method. Pond 5 is assumed to be the same as Pond 4 because of the connectivity of the pond waters.

[3] Total PCBs concentration data from salt ponds were all below method reporting limit (MRL), which varied from 0.5 to 2.5 µg/l.

Sediment

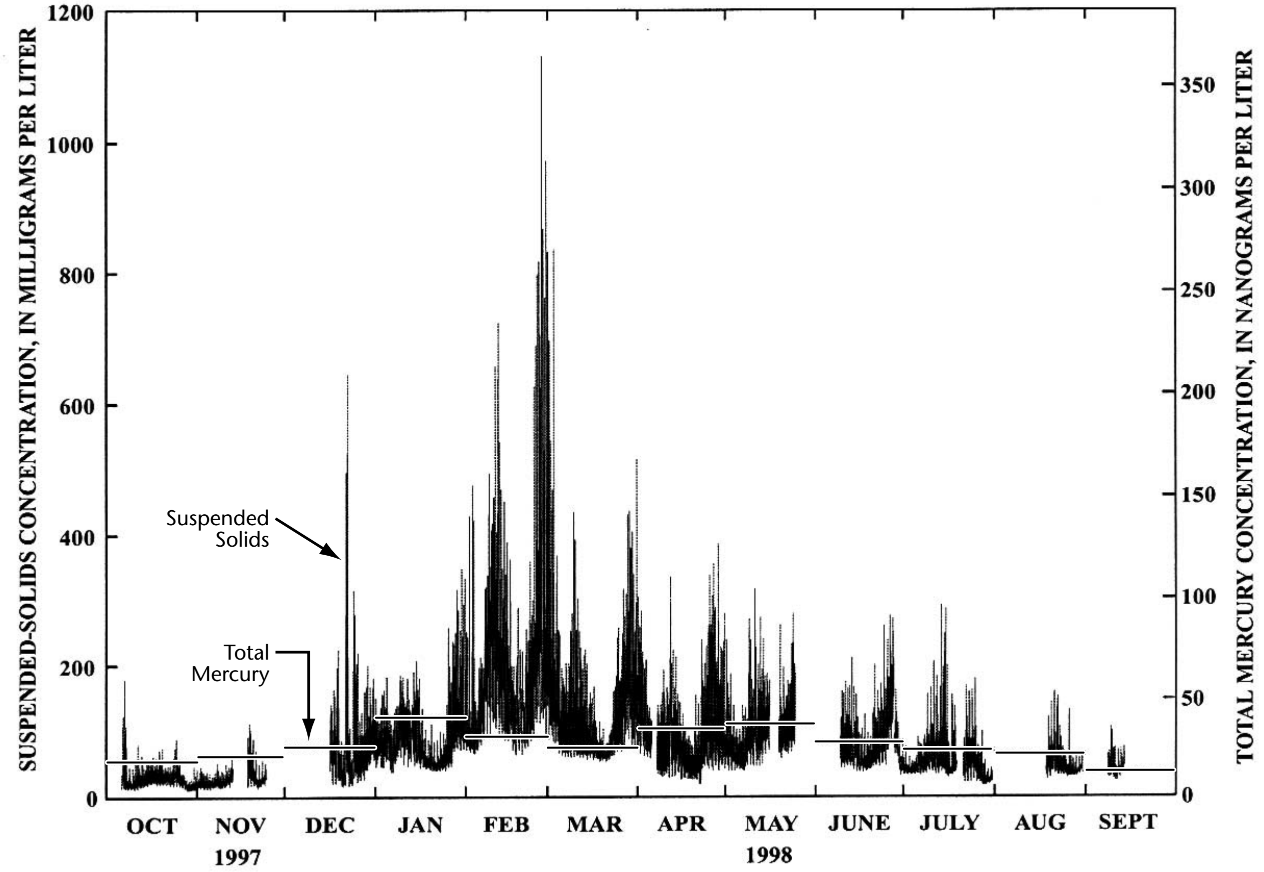
RMP monitoring data for 1993–1999 average sediment constituent concentrations in the Napa River and San Pablo Bay are shown in Table 4-6. The data indicate that both water bodies exceed one or more guidance criteria (refer to table 4-3) for arsenic, chromium, copper, mercury, nickel, and total dichlorodiphenyltrichloroethane isomers (DDTs) (San Francisco Estuary Institute 1999, 2000a). RMP data for the Napa River indicate that mercury, PCBs, total DDTs, arsenic, copper, and chromium exceeded sediment guidelines in more than 90% of the samples collected from 1993 to 1999 (San Francisco Estuary Institute 2000a). San Pablo Bay sediment also exceeds criteria for total PAHs. The former Mare Island Naval Shipyard is also a potential point source of TBT, a highly toxic endocrine-disrupting chemical used as an antifoulant in ship paints. Sediment toxicity tests have also frequently been positive for Napa River samples; Davis Point samples have tested positive for sediment toxicity much less frequently.

Mercury Dynamics in an Estuary

Mercury contamination is widespread in sediments and waters of the San Francisco Bay area (San Francisco Estuary Institute 2000a, San Francisco Bay RWQCB 2000). Mercury is a constituent of particular concern to wetland restoration projects because of its ability to convert to the methylated form of the metal, which is relatively more mobile in the aquatic environment than other forms. Long-term RMP monitoring data for total mercury in water and sediment has consistently shown elevated concentrations, primarily in the north and south bay areas and river tributaries. There is also a strong correlation between total mercury and suspended sediment transport in the water (U.S. Geological Survey 2000c). Figure 4-5 shows the continuous TSS data and calculated mercury concentrations that would be expected at Point San Pablo, based on their known correlation relationship.

Elevated mercury levels are in large part a legacy of the California gold mining era, when mercury was used in the gold refining process. Mines such as south San Francisco Bay's New Almaden Mine, which operated for many years in the upper Guadalupe River watershed extracting the mercury ore cinnabar, are known to be a source of mercury in the bay system. Over time, leaching of mine tailings and overland transport of mercury-bearing sediments have resulted in the downstream accumulation of mercury in the watershed. Mercury is also delivered to the San Pablo Bay system via the Delta.

In aquatic environments, most mercury is chemically bound to suspended particles of soil or sediment; a smaller fraction is bound to dissolved organic carbon. Sediment-bound mercury may be available to aquatic organisms and is thus a pollutant of concern; the potential for adverse environmental effects from sediment-bound mercury depends primarily on transport and depositional characteristics (e.g., particle size) and on the physical and chemical properties of the sediment.



Source: U.S. Geological Survey 2000.

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Figure 4-5
Time Series of Mid-Depth Total Suspended Solids and Calculated Total Mercury Concentration at Point San Pablo – Water Year 1998

Table 4-6. Sediment Contaminant Levels of the Napa River, San Pablo Bay, and the Salt Ponds Project Area[1]

Location[2]	As (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	Ni (mg/kg)	Se (mg/kg)	Zn (mg/kg)	Total PCBs (µg/kg)[3]	Total PAHs (µg/kg)[4]	Total DDTs (µg/kg)[5]
Napa River	12.9	109	61.3	25.9	0.330	104	0.55	144	5.92	1279	5.46
San Pablo Bay	14.1	92.4	49.3	21.3	0.330	84.6	0.43	118	4.02	4274	4.07
Pond 1	12.6	109	60.2	31.7	0.335	107	1.4	126	<MRL	- -	1.88
Pond 1A	14.0	87	45.0	29.6	0.180	77.6	1.4	82	<MRL	<MRL	<MRL
Pond 2	15.3	95	37.7	19.8	0.115	84.6	0.98	84	<MRL	<MRL	<MRL
Pond 2A	24.8	98	74.8	35.7	0.290	116	3.4	142	<MRL	<MRL	4.28
Pond 3	18.1	74	40.8	25.2	0.258	65.1	3.2	79	<MRL	<MRL	1.30
Pond 4	5.78	22	10.1	10.4	0.048	28.8	0.98	25	<MRL	<MRL	2.45
Pond 5	18.7	63	39.2	28.6	0.110	64.4	2.1	71	<MRL	<MRL	7.04
Pond 6	9.85	46	18.2	15.8	0.062	51.4	1.1	49	<MRL	<MRL	2.09
Pond 6A	11.5	58	29.0	21.7	0.170	67.0	1.5	61	<MRL	<MRL	<MRL
Pond 7	10.4	38	12.9	8.50	0.027	29.6	1.2	343	<MRL	- -	<MRL
Pond 7A	15.2	59	27.0	15.6	0.069	90.0	1.1	66	<MRL	<MRL	6.22
Pond 8	8.3	45	18.3	6.30	0.067	30.9	1.3	32	<MRL	<MRL	<MRL

[1] Average of measurements at each salt pond.

[2] Sources: Napa River and San Pablo Bay values calculated from San Francisco Estuary Institute data (URL:/ www.sfei.org/rmp/data.htm), salt pond data from Hydroscience 2002.

[3] Total PCBs concentration data from salt ponds were all below the method reporting limit (MRL), which varied from 3.9 to 56 µg/kg.

[4] Total PAHs data from majority of salt ponds were below the MRL, which varied considerably. The symbol (--) indicates individual PAH isomers (fluoranthene and/or pyrene) were detected in single samples from ponds 1 and 7; however, a total PAHs value is not available.

[5] Total DDTs data from salt ponds were below the MRL, which varied from 1.68 to 24.5 µg/kg.

Additionally, sediment-bound mercury may be converted through both biotic and abiotic processes to its more bioavailable methylated form. Factors conducive to methylation of mercury include low-flow or stagnant waters, hypoxic or anoxic conditions in the water or sediment column, low pH (pH<6), and high concentrations of dissolved carbon. Most of these factors are in turn affected by biological processes such as metabolism, growth, and decay; for example, mercury methylation has been linked to the activity of sulfate-reducing bacteria in the shallow anoxic sediment column.

Aquatic plants, fish, and wildlife readily adsorb methyl mercury. It can then accumulate in their tissues, creating contaminated food sources (plant or animal tissues) that transfer through the food web (Santa Clara Valley Water District and U.S. Army Corps of Engineers 2001). It is a mutagen, teratogen, and carcinogen, and has embryotoxicological, cytochemical, and histopathological effects. In aquatic organisms, concentrations of 0.1–200 µg/l have been shown to produce adverse effects; toxicity increases with age of the organism, exposure time, temperature, lowered salinities, and the presence of other metals.

4.1.3.4 Treatment Plant Discharge

WWTPs are monitored as point sources of pollution, and most plants in the north bay region are converting to tertiary treatment to meet increasingly stringent discharge permit requirements. The WWTPs in the north bay region discharge recycled water to area waterways only during the wet season. The SVCSD WWTP discharges to Schell Slough, the NSD WWTP discharges to the Napa River 14 miles upstream from the confluence with San Pablo Bay (downstream of Carquinez Strait), and the CAC WWTP discharges into ~~the~~ North Slough and adjacent constructed wetlands.

Table 4-7 shows effluent data from selected north bay WWTPs that may consider participating in the restoration of the Napa River Unit. In general, the WWTPs produce effluent that has moderate inorganic mineral content with low suspended solids and turbidity relative to the natural background conditions in the Napa River and San Pablo Bay. The pH values are neutral, and along with ammonia and whole effluent toxicity test data, the effluent usually is in compliance with regulatory permit limits.

High analytical detection limits used for some of the trace metals preclude comparisons with applicable Basin Plan water quality objectives (refer to Table 4-2). However, NSD and City of Petaluma effluent discharges generally contain low levels of copper and mercury, which are listed on the 303(d) list as substances responsible for the impairment of San Pablo Bay. Novato SD and LGVSD discharges have elevated copper and mercury concentrations. These substances are considered in the NPDES permits issued by the San Francisco Bay RWQCB, although the allowable discharge levels could change when the TMDL process is complete. The City of Petaluma and LGVSD WWTP data also indicate that zinc concentrations are periodically elevated relative to Basin Plan water quality objectives.

4.1.4 Project Setting

The project area of interest with regard to water quality issues is primarily defined as the salt ponds, adjacent sloughs, immediately adjacent Napa River area, and northern San Pablo Bay. Salinities of water in the salt ponds undergoing evaporative concentration are significantly higher than those in nearby San Francisco Bay waters. The processes that affect the transport of sediment, salts, and other water quality constituents in adjacent waterways are complex and driven by asymmetric tidal systems to the east and west of the pond system producing a barotropic convergence zone within the slough system. In addition, the transport process is strongly affected by the baroclinic convergence zone created by the phase difference between the two deep tidal channels, Mare Island and the Carquinez Strait. This complex process is a function of density differences between waters of variable salinity and tidal action and is related to the timing of salinity pulses in the Napa River, San Pablo Bay, and Mare Island Strait/Carquinez Strait junction.

The amount of data regarding chemical constituents in the nearby receiving waters, pond waters, and pond sediments is limited. Two baseline studies of inorganic constituents and the variation that occurs in the ponds have been conducted in recent years (Takekawa et al. 2000, Warner et al. 1999). The Coastal Conservancy contracted with Hydroscience Engineers (2002) and PWA to collect water and sediment grab samples in September 2001 in all of the ponds and in the high salinity ponds in October 2003 (Frontier Geoscience 2003); the data are described below and are shown in Tables 4-5, 4-6, and 4-8.

4.1.4.1 Salinity in Pond Water

The salinity patterns in the salt ponds have been extensively described in Chapter 2, “Site Description and Options.” Table 4-8 also shows the average total dissolved solids (TDS) and chloride concentrations in pond water based on grab samples (Hydroscience Engineers 2002). Salinity levels in the salt ponds depend on inflows to the ponds and water management procedures implemented currently by DFG, baroclinic influences, evaporation, precipitation, and runoff.

Salinity records indicate a general trend of increasing salinity in the sloughs toward the southwest of the project area as the influence of the Napa River declines and the influence of San Pablo Bay increases. This trend is reinforced seasonally as Napa River flows decline in summer. Another general trend may be caused by the influence of waters discharging from the Delta through the Carquinez Strait, which produces an increasing salinity gradient toward the west of the project area as the fresh water moves into San Pablo Bay.

Salinity in the Napa River varies daily because of diurnal tidal influence from San Pablo Bay and seasonally as a result of changes in freshwater runoff. Daily fluctuations are on the order of 5 ppt; seasonal variations are on the order of 20 ppt (from completely fresh water during high spring runoff to heavy seawater

Table 4-7. Summary of Representative Effluent Constituent Concentrations in Wastewater Treatment Plants

Constituent	Napa (year 2000)			Petaluma (year 2000)			Novato (year 1999)			Las Gallinas (year 2000)			Sonoma (year 2001)		
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min.	Max.	Avg.
Temperature (C)	12.4	22.3	17.0	ND	ND	ND	14	26	20	16	19	17	18.5	22.7	20.9
BOD (mg/l)	8	22	14.6	14.3	25	18.4	3	41	8	5.5	11.3	8.3	<5	9.5	5.5
TSS (mg/l)	10	22	16	2.4	64.6	44.5	2	19	6	8.6	32	14.4	2.1	6.4	3.7
pH	6.9	7.9	7.6	7.31	7.62	7.46	7.0	8.3	7.6	6.9	7.5	7.2	6.5	6.9	6.6
Ammonia (mg/l)	ND	ND	ND	1.6	15	9.1	0.9	6.6	2.9	0.1	2.8	1.2	0.25	0.47	0.33
Turbidity (NTU)	0.9	11.1	4.9	12.7	43.7	26.9	2	24	10	ND	ND	ND	1.3	3.0	2.2
Toxicity, % survival	25	100	88	95	100	99	ND	ND	ND	97	100	ND	84	100	96
Chlorophyll (µg/l)	ND	ND	ND	143	300	221	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic (µg/l)	<2	<2667	<270	<2	3	2.08	<2	3	ND	<2	<2	<2	<2	<2	<2
Cadmium (µg/l)	<0.2	<0.2	<0.2	<2	<2	<2	<0.2	<0.2	ND	<1	<2	<2	<1	<1	<1
Chromium, total (µg/l)	<1	<2	<1	<1	4	1.5	<2	12.8	ND	<1	1.5	<1.2	<2	<2	<2
Copper (µg/l)	0	<15	<4	<2	3.5	2.38	7	15	ND	7	13	9.7	7.1	10.8	8.9
Cyanide	<3	<3	<3	<3	6	4.3	<3	<3	ND	<3	7	<4	<6	<6	<6
Lead (µg/l)	<2	<2	<2	<2	<2	<2	<2	3	ND	<2	<2	<2	<2	<2	<2
Mercury (µg/l)	<0.00005	<.007	<.00173	0.00421	0.0103	0.0063	0.02	0.10	ND	0.024	0.050	0.034	0.0034	0.0076	0.0053
Nickel (µg/l)	<2.2	<3	<3	<3	27	6.69	<5	17	ND	<3	5	3.9	3	3	3
Selenium (µg/l)	<1	<20	<2	<1	<1	<1	<1	<1	ND	<1	1	<1	<5	<5	<5
Silver (µg/l)	<0	<0	<0	<0.5	<0.5	<0.5	0.8	1.6	ND	<0.5	1.1	0.9	<2	<2	<2
Zinc (µg/l)	<4	<34	<20	<20	40	23.1	23	38	ND	60	110	85	49.75	68.83	58.83
Phenols (µg/l)	<5	<20	<8	ND	ND	ND	<5	5	ND	<5	10	7	ND	ND	ND
PAHs	<5	<20	<8	<0.3	<0.3	<0.3	<MRL	<MRL	ND	<MRL	<MRL	<MRL	ND	ND	ND

Notes:

BOD = biological oxygen demand
TSS = total suspended solids
µg/l = micrograms per liter
mg/l = milligrams per liter
MRL = method reporting limit
ND = no data available
NTU = nephelometric turbidity units
PAH = polycyclic aromatic hydrocarbon

No data available from CAC WWTP at this time.

Table 4-8. Average Concentrations of Conventional and Trace Metal Constituents in the Salt Pond Water Samples

Parameter (units)	Pond 1	Pond 1A	Pond 2	Pond 2A	Pond 3	Pond 4	Pond 5	Pond 6	Pond 6A	Pond 7	Pond 7A	Pond 8
Ammonia (mg/l N)	0.25	0.32	0.25	0.40	0.23	3.38	3.63	0.32	0.24	39.5	0.34	128
Nitrate (mg/l N)	0.7	0.6	0.5	0.3	2.0	6.0	6.2	3.4	1.2	6.4	2.0	1.0
TKN (mg/l N)	2.8	4.2	4.4	1.3	12.4	55.2	59.9	7.0	5.4	111	12.2	130
pH	8.4	9.1	8.9	7.9	8.3	7.7	7.6	8.4	8.8	5.0	8.6	3.3
BOD (mg/l)	4.9	26.7	11.5	1.5	28.7	15.9	4.1	8.7	8.8	44.6	48.4	29.3
Turbidity (NTU)	9.5	23.6	29.2	7.2	59.4	92.0	83.2	12.2	19.6	145	46.5	36.3
TSS (mg/l)	62	47	ND	ND	168	444	533	31	53	354	84	102
TDS (mg/l)	40,050	164,000	38,430	21,850	66,480	323,000	323,700	92,100	57,530	353,500	96,400	293,700
Chloride (mg/l)	22,900	33,600	22,250	12,000	38,900	174,500	173,700	54,200	32,200	226,000	53,300	150,700

Notes:
N = Nitrogen
TKN = total Kjeldahl nitrogen
BOD = biochemical oxygen demand
NTU = nephelometric turbidity units
TSS = total suspended solids
TDS = total dissolved solids
ND = none detected
Source: Hydroscience 2002

influences during the dry season). Salinity in San Pablo Bay in the vicinity of the salt ponds may vary by as much as 10 ppt seasonally, with the salinity level in a small near-shore area having the potential to become freshwater (0 ppt) during heavy rainfall periods.

4.1.4.2 Temperature, Dissolved Oxygen, and pH

Water temperature is an important physical parameter that affects the metabolic rate of aquatic organisms, tolerance of aquatic organisms to other environmental stressors, and other physical and chemical water quality processes. The solubility of dissolved oxygen (DO) in water is a direct function of water temperature, with maximum possible DO values being lower at higher water temperatures. The most extensive information for conventional constituents of concern in the salt ponds comes from recent data collected with continuous monitoring equipment for temperature, DO, pH, and turbidity (Takekawa et al. 2000). The maximum recorded temperature in the salt ponds was 30ºC in August and the minimum was 7ºC in February. DO concentrations were generally lowest in Ponds 4 and 7; however, DO in these ponds ranged from a relatively low value of 0.6 mg/l to as much as 7.0 mg/l, which can still sustain aquatic life. Average DO concentrations were slightly higher in Ponds 2, 2A, and 3. The highest overall DO concentration conditions were recorded in Pond 1 and ranged from 7 to 12 mg/l. Seasonal patterns in the DO concentrations were evident with generally lower values in the summer and higher values in the winter.

The pH values (a measure of acidity) generally vary considerably among the ponds and are generally within the Basin Plan objectives of 6.5 to 8.5 (refer to Table 4-8). Extremely low pH values were previously measured in Pond 8 (2.9–3.2), indicating strongly acidic conditions. However, conditions in Pond 8 typically exhibited a seasonal pattern with higher levels of approximately pH 5 when more water was~~is~~ present and have returned to normal following the operation of the two new water intakes. Low pH values also occurred in Pond 7 (4.4–5.1). Seasonally, pH values were generally lower from September through November and higher in the early spring, when more water is present.

4.1.4.3 Nutrients, Suspended Sediment, and Turbidity in Pond Water

Ammonia, nitrate, and total Kjeldahl nitrogen values measured in 2001 (Table 4-8) indicate that Ponds 4, 5, 7, and 8 have the highest concentrations of these plant nutrients. Nitrogen and phosphorus are primary nutrients necessary for growth of algae and aquatic vascular plants. However, there are no monitoring data for the existing rates of algae or plant growth in the ponds.

Takekawa et al. (2000) found turbidity to be highest in Pond 1, ranging from 200 to 800 NTU. Turbidity is known to be associated with wind and wave agitation that results in the resuspension of precipitated salts from the sediment surface. Turbidity varied widely in Ponds 2, 2A, 3, 4, and 7 from 20 to 250 NTU.

Turbidity was relatively constant in Pond 2A, from 50 to 110 NTU. The 2001 data shown in Table 4-5 indicate that Ponds 4, 5, and 7 had the highest turbidity and TSS values due to low water levels and high salinity at the time of sampling. TSS concentrations in the typical tributary sloughs to San Pablo Bay and the Napa River generally decrease with increasing distance from San Pablo Bay, ranging from 41 mg/l to 386 mg/l (Warner et al. 1999).

4.1.4.4 Trace Metals and Organic Compounds in Pond Water

The 2001 and 2003 sample results shown in Table 4-5 represent the most complete characterization of trace metal and organic compound concentrations in the ponds. In the Coastal Conservancy's and DFG's restoration efforts in the South San Francisco Bay, it became apparent that there were inaccuracies in the laboratory analysis of aqueous metals samples due to elevated levels of salinity. Therefore, a new sampling and metal evaluation procedure was proposed for Pond 4, 7, 7A, and 8 in the project area. Aqueous samples were collected on October 1, 2003 and transmitted under Chain-of-Custody to Frontier Geosciences where they underwent precipitation-based metals analysis. The new analysis indicated that metals in Pond 4, 7A, and 8 were measured to be below the applicable water quality control (WQC) limits except nickel in Pond 4 and 7A; nickel was detected at a level near the WQC (8.7 ug/L for Pond 4 and 7.8 for Pond 7A). The most stringent objective in the Basin Plan is 7.1 ug/L as total recoverable nickel. Pond 7 exceeded WQC limits for copper, nickel, and zinc. ~~It should be noted that single samples where detection did not occur (i.e., cadmium, lead, mercury, nickel, and silver) cannot be compared with Basin Plan and CTR water quality criteria because the laboratory detection limits were higher than the criteria. In addition, the effect of evaporative concentration on contaminant concentrations has not been evaluated. Evaporative concentration and associated lower volumes of water in the ponds during dry conditions may increase the concentrations of soluble constituents. When the ponds contain more water input from rainfall, the concentrations may be lower as a result of increased available dilution capacity. However, e~~Each pond had at least one calculated average concentration of arsenic, copper, lead, nickel, selenium, silver, or zinc that exceeded applicable criteria. ~~With the exception of Ponds 6 and 6A, copper concentrations exceeded criteria in all of the ponds. Zinc was also elevated in all ponds except 1/1A, 2/2A, 6A, and 7A. Overall, Pond 7 had exceedances of the criteria for the most constituents including copper, nickel, selenium, silver, and zinc.~~ All other ponds only exceeded criteria for one or two metals. In general, pond water concentrations of arsenic, copper, and zinc were substantially higher than comparable values in the Napa River or San Pablo Bay.

Evaporative concentration and associated lower volumes of water in the ponds during dry conditions may increase the concentrations of soluble constituents. When the ponds contain more water input from rainfall, the concentrations of soluble constituents may be lower as a result of increased available dilution capacity. For example, the water levels in the ponds were low on October 1, 2003, and the average depth of the water in Pond 4 on this date was 1.4 feet. The samples collected in October 2003 are likely to contain higher concentrations of dissolved constituents than samples collected in late winter/early spring, when the breach discharge is proposed. The average depth at the time of the breach discharge is anticipated to be at or near the maximum depth the pond can accommodate, which is 4.5 feet. The source of the additional water expected in Pond 4 at the time of the breach discharge will be primarily rainfall, which is expected to contribute no additional nickel to the pond.

It is expected that the volume of water impounded in Pond 4 at the time of the breach discharge will be at least three times the volume of water present on October 1, 2003. Therefore, conservatively assuming that the volume of impounded water at the time of the breach is twice the volume impounded on October 1, 2003, the concentration of nickel in Pond 4 at the time of the proposed breach discharge would be expected to be approximately one half of 8.7 µg/L (or approximately 4.4 µg/L).

4.1.4.5 Toxicity of Pond 7 Bittern and Brine Mixtures

Chronic aquatic toxicity test~~e~~s (7-day) were conducted in 2002 (Pacific EcoRisk 2002) using *Americamysis bahia* (mysid), which was the most sensitive species in previous testing on Pond 7 samples conducted in 199~~0~~3. The 2002 toxicity test results were summarized and compared to available literature information regarding potential toxicity mechanisms in highly saline brines (Gaia Consulting 2002). Pond 7 bittern and Pond 8 hypersaline brine samples were collected on May 14, 2002 for the study. Four mixtures with the following bittern and brine ratios were created: 100% bittern/0% brine, 70% bittern/30% brine, 40% bittern/60% brine, and 10% bittern/90% brine. Each of the four test mixtures were diluted to test concentrations of 0.25%, 0.5%, 1%, 2.5%, 5% and 10% with saline dilution water having 20 ppt salinity. Toxicity tests were evaluated for both survival and growth endpoints. The bittern used had a salinity of 310 ppt.

Results from the toxicity tests with the four different mixtures showed that mysid survival rates exceeded 80% for all four of the test mixtures up to and including the 5% dilution test; survival for all of these tests were not significantly less than the laboratory control. Survival was 0% at the 10% dilution in all four test mixtures except the 10% bittern/90% brine mixture which had significantly lower survival than the laboratory control. Mysid biomass was also not significantly less than the control for dilutions up to and including 5%, except for Mixture 1 which contained 100% Bittern. For Mixture 1, the biomass was significantly less than the control at the 5% dilution.

Gaia Consulting (2002) reached two primary conclusions regarding the test results: 1) diluting the bittern with hypersaline brine does not appear to significantly increase the rate at which bittern could be discharged, and 2) the apparent toxicity of bittern in this study is lower than that found in prior studies, suggesting that higher discharge rates may be acceptable. These results differ from the previous bittern testing performed for the Napa Ponds in 199~~0~~3 which showed that only dilutions of 1% to 1.5% bittern had a mean survival rate that was not significantly lower than the control treatment. During previous studies, complete mortality was noted at a 5% bittern solution. The precise salinity of the bittern used in these previous studies is not known, however, it is likely that the concentration was considerably higher (between 390 and 450 g/kg) than the recent testing because the bittern samples were collected shortly after salt production ceased. Because a variety of organisms were previously tested in 199~~0~~3, and more tests were conducted, the prior testing effort still provides the baseline for bittern discharge criteria. Gaia Consulting concluded that additional testing is required to confirm the findings of the 199~~0~~3 investigation and determine whether increased discharge rates for the bittern are possible.

The estimated time for Pond 7 bittern removal has decreased substantially since the release of the Draft EIR/EIS. According to studies conducted prior to the Draft EIR/EIS and Draft Feasibility Report, bittern removal and salinity reduction would take approximately 30 years with recycled water, and approximately 50 years using exclusively Napa River and Napa Slough inputs (“neighboring waters”). The new analysis estimates that it would take approximately 8–10 years using neighboring waters, and a slightly shorter period of time using additional recycled water. The change in estimated time results from using a mass-based rather than a flow-based discharged restriction.

Based on toxicity studies, the regulatory agencies have indicated that bittern discharge from Pond 7 must be limited to 1% of the total flow from the Upper Ponds. While this restriction implies a certain mass removal (based on the Year 1 initial bittern concentration and flow), in earlier iterations of the Corps’s Draft Feasibility Report, this flow-based discharge restriction was assumed to apply throughout the life of the project. This flow-based approach resulted in very long time periods before bittern would be reduced sufficiently to create habitat value in Pond 7. Bittern removal using a flow-based discharge restriction requires a long time because as the bittern concentration in the pond drops, less and less bittern is removed each year.

Assuming that a constant mass of bittern (under a mass-based discharge restriction) can be removed each year means that the allowable flow discharged from Pond 7 can increase as the concentration of bittern in the pond decreases, resulting in a shorter restoration period than previously expected.

4.1.4.6 Constituents in Pond Sediments

The sediment samples collected in 2001 represent the only data set for characterization of conventional (Table 4-9) and trace metal and organic compound concentrations (Table 4-6) in the pond sediments. The pond sediments have relatively uniform percent solids composition ranging from 36% to 58% solids, indicating a moderate organic matter content (refer to Table 4-9). The organic nitrogen content is considerable and phosphorus content is relatively low. Analysis for chloride indicates that all of the ponds have elevated salt content within the sediment structures.

Five sediment surface grab samples were collected and analyzed for total salinity content from Pond 7 (2 samples in March 2002 and 3 samples in May 2002) and

Table 4-9. Average Concentrations of Conventional Constituents in the Salt Pond Sediment Samples

Parameter (units)	Pond 1	Pond 1A	Pond 2	Pond 2A	Pond 3	Pond 4	Pond 5	Pond 6	Pond 6A	Pond 7	Pond 7A	Pond 8
~~Inorganic constituents and trace metals~~												
pH	7.70	8.25	7.70	6.95	8.13	7.73	7.85	7.87	7.47	6.87	7.30	5.97
Total phosphorus (mg/kg)	124	114	87.8	340	242	182	205	150	257	64.0	183	57.3
Chloride (mg/kg)	21,300	53,300	22,100	20,100	43,200	308,000	176,500	129,300	54,870	219,300	83,100	170,300
Organic nitrogen (mg/kg)	1,855	3,140	2,012	3,165	2,278	2,845	5,430	3,270	4,798	2,003	4,797	1,393
Total solids (%)	43.4	35.8	46.4	37.3	48.2	48.5	45.3	39.8	41.6	58.9	44.6	57.6
Sodium (mg/kg)	17,600	34,800	17,800	15,100	28,800	172,500	73,450	70,850	33,700	73,200	49,400	54,700
Potassium (mg/kg)	5,965	6,780	6,060	5,225	5,880	4,803	6,815	5,648	5,293	9,757	5,697	12,000

Notes:
mg/kg = milligrams per kilogram; µg/kg = micrograms per kilogram.
Source: Hydroscience 2002

three sediment samples were collected from Pond 8 in May 2002 (Gaia Consulting 2002). The sediment cores were generally about 7 to 12 inches long and consisted of dark brown silty sand. There was a salt crust approximately ¼-inch thick on the sediment surface of both ponds. Replicate pond brine samples were collected from the ponds at the same time as the sediment samples. Sediment salinity was determined by repeatedly extracting the samples with water to remove all soluble compounds. The data indicate that the salt content of the near surface sediment contains a lower mass of the total pond salt content than brine overlying the sediment. Sediment salinities ranged from 67 g/kg to 99 g/kg for Pond 7, and from 64 g/kg to 110 g/kg for Pond 8. Brine salinities at Pond 7 were 300 g/kg and 310 g/kg for April 19 and May 14, respectively. Salinities at Pond 8 were 140 g/kg and 190 g/kg on May 1 and May 14, respectively.

Pond sediment concentrations of specific trace metals and organic compounds compared closely with values measured in the Napa River and San Pablo Bay with differences generally being less than 50% of each other. There are no long-term geochemical cycling data available with which to evaluate the factors associated with the differences. Average selenium concentration values in the ponds are consistently higher than the respective Napa River and San Pablo Bay values. Concentrations of the majority of constituents in Ponds 4, 5, 6, 6A, 7, 7A, and 8 all appear to be slightly lower than concentrations in the Napa River or San Pablo Bay. Concentrations of constituents in Ponds 1 through 3 are similar or slightly higher than in the Napa River or San Pablo Bay. The detection limits for total PCBs, PAHs, and DDTs used for the pond samples were elevated relative to the criteria, so comparisons with the historical Napa River and San Pablo Bay data are only possible where detections occurred.

Analyses indicate the majority of pond sediments have relatively elevated selenium and total DDT content relative to the San Francisco Bay RWQCB sediment screening criteria for wetland noncover applications. Average concentrations of selenium exceeded the wetland noncover screening criteria in Ponds 2A, 3, 5, and 6A and single sediment sample values from Ponds 1, 1A, and 7A also exceeded the criteria, indicating that these sediments exceed criteria for use in wetland environments. The average concentration of zinc measured in Pond 7 also exceeded the wetland noncover screening criterion. The number of individual organic compounds detected and their measured concentrations were relatively low, with the exception of total DDT compounds. Average concentrations of total DDT did not exceed wetland noncover criteria. However, average DDT values did exceed the wetland cover criteria in Ponds 2A, 5, and 7A indicating that these sediments would be classified as being suitable only for wetland noncover uses. The average DDT values also exceeded the ER-L criteria in all ponds where detections occurred (Ponds 1, 2A, 4, 5, 6, and 7A) with the exception of Pond 3. However, DDT concentrations at the Napa River and San Pablo Bay sites also exceeded the wetland cover and ER-L criteria for DDT and indicate a regional presence of these compounds in the sediments. There were no pond average concentrations of mercury exceeding the either wetland use criteria; however, single sediment samples in Ponds 1 and 3 exceeded the wetland cover criteria. Average mercury values also exceeded the ER-L criteria in Ponds 1, 1A, 2A, 3, and 6A. Average arsenic values exceeded the ER-L