REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

REGIONAL TOXIC HOT SPOT CLEANUP PLAN

Region Description

The Los Angeles Region encompasses all coastal drainages flowing to the Pacific Ocean between Rincon Point (on the coast of western Ventura County) and the eastern Los Angeles County line, as well as the drainages of five coastal islands (Anacapa, San Nicolas, Santa Barbara, Santa Catalina and San Clemente). In addition, the region includes all coastal waters within three miles of the continental and island coastlines.

The enclosed bays, estuaries and coastal waters of the Los Angeles Region subject to the provisions of the Bay Protection and Toxic Cleanup Program are listed in Table 1). The region contains two large deepwater harbors (Los Angeles and Long Beach Harbors) and one smaller deepwater harbor (Port Hueneme). There are small craft marinas within the harbors, as well as tank farms, naval facilities, fish processing plants, boatyards, and container terminals. Several small-craft marinas also occur along the coast (e.g., Marina del Rey, King Harbor, Ventura Harbor); these contain boatyards, other small businesses and dense residential development.

Several large, primarily concrete-lined rivers (e.g., Los Angeles River, San Gabriel River) lead to unlined tidal prisms which are influenced by marine waters. Salinity may be greatly reduced following rains since these rivers drain large urban areas composed of mostly impermeable surfaces. Some of these tidal prisms receive a considerable amount of freshwater throughout the year from publicly-owned treatment plants discharging tertiary-treated effluent. Lagoons are located at the mouths of other rivers draining relatively undeveloped areas (e.g., Mugu Lagoon, Malibu Lagoon, Ventura River Estuary, Santa Clara River estuary). There are also a few isolated coastal brackish water bodies receiving runoff from agricultural or residential areas.

Santa Monica Bay, which includes the Palos Verdes Shelf for the purposes of the Bay Protection and Toxic Cleanup

TABLE 1. LOS ANGELES REGION - WATERBODIES COVERED UNDER BAY PROTECTION AND TOXIC CLEANUP PROGRAM

WATER BODY OR SEGMENT NAME	HYDROLOGIC UNIT	TOTAL AREAL EXTENT
ESTUARIES		
Ormond Beach Wetlands	400.00	20 acres
Ventura River Estuary	402.10	10 acres
Santa Clara River Estuary	403.00	60 acres
Calleguas Creek Tidal Prism	403.11	10 acres
McGrath Lake Estuary	403.11	40 acres
Mugu Lagoon-East & West Arms	403.11	1500 acres
Malibu Lagoon	404.31	29 acres
Colorado Lagoon	405.12	13 acres
Dominguez Channel Tidal Prism	405.12	8 miles
Los Angeles River Tidal Prism/Queensway Bay	405.12	3 miles
Los Cerritos Channel Tidal Prism/Wetland	405.12	5 acres
Sim's Pond	405.12	1 acre
Ballona Wetlands	405.13	150 acres
Venice Canals	405.13	20 acres
San Gabriel River Tidal Prism	405.15	3 miles
ENCLOSED BAYS		
Channel Islands Harbor	403.11	220 acres
Port Hueneme	403.11	121 acres
Ventura Harbor	403.11	423 acres
Alamitos Bay	405.12	285 acres
King Harbor	405.12	90 acres
Long Beach Harbor (Inner)	405.12	840 acres
Long Beach Marina	405.12	100 acres
Los Angeles Harbor (Inner)	405.12	1,260 acres
San Pedro Bay	405.12	10,700 acres
Shoreline Marina	405.12	25 acres
Marina Del Rey Harbor	405.13	354 acres
OPEN BAYS/OCEAN		
Nearshore - Point Mugu to Latigo Point	400.00	11,710 acres
Santa Monica Bay (L.A. County Line to Pt. Fermin)	405.13	256,000 acres
Anacapa Island ASBS	406.10	21,280 acres
San Nicolas Island/Begg Rock ASBS	406.20	102,528 acres
Santa Barbara Island ASBS	406.30	14,000 acres
Santa Catalina Island ASBS	406.40	17,936 acres
San Clemente Island ASBS	406.50	80,512 acres

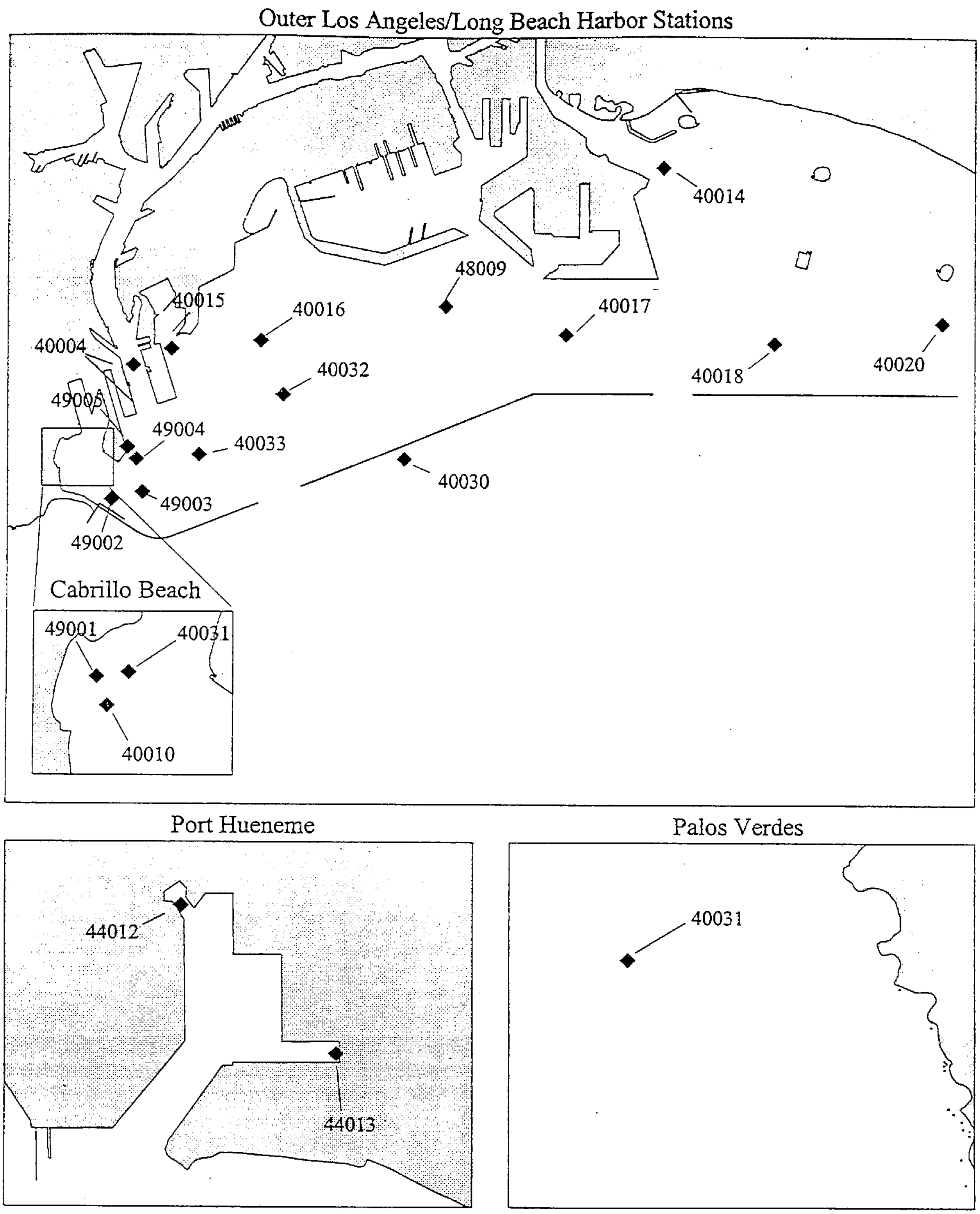
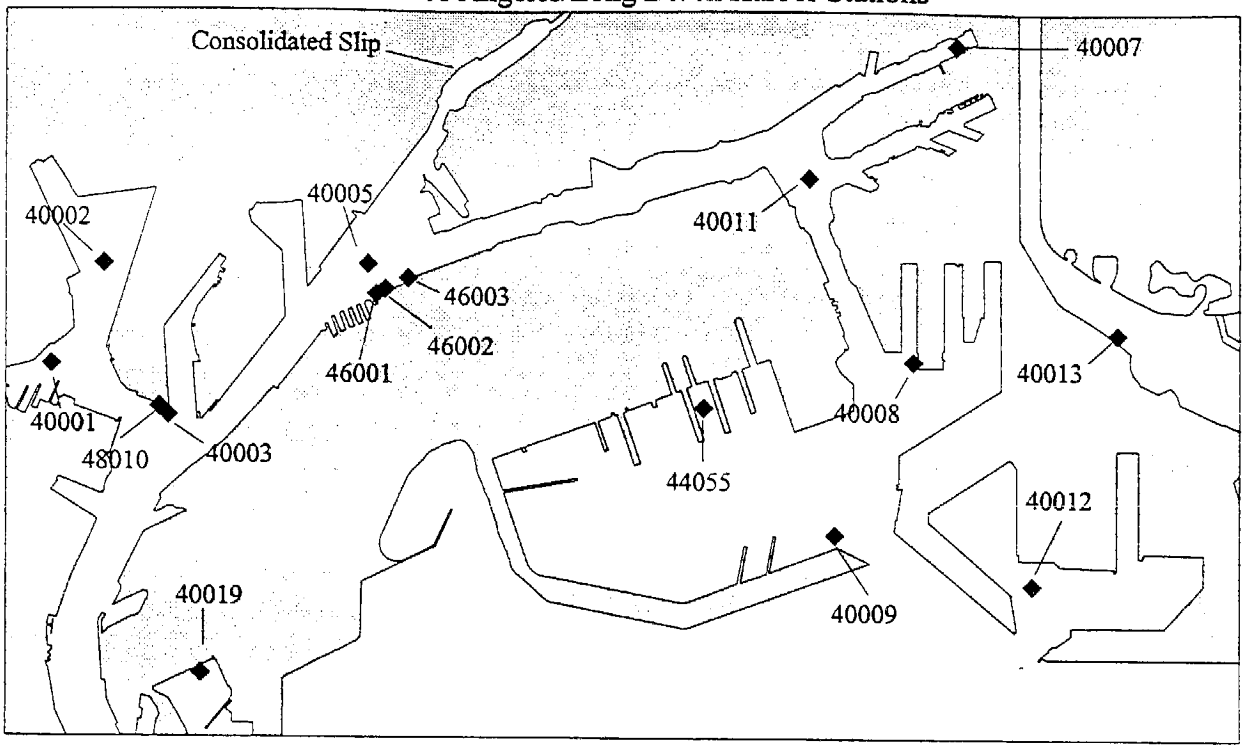


Figure 1: Sampling Stations in outer Los Angeles and Long Beach Harbor, Port Hueneme, and Palos Verdes.

Inner Los Angeles/Long Beach Harbor Stations



Consolidated Slip of Inner Los Angeles Harbor

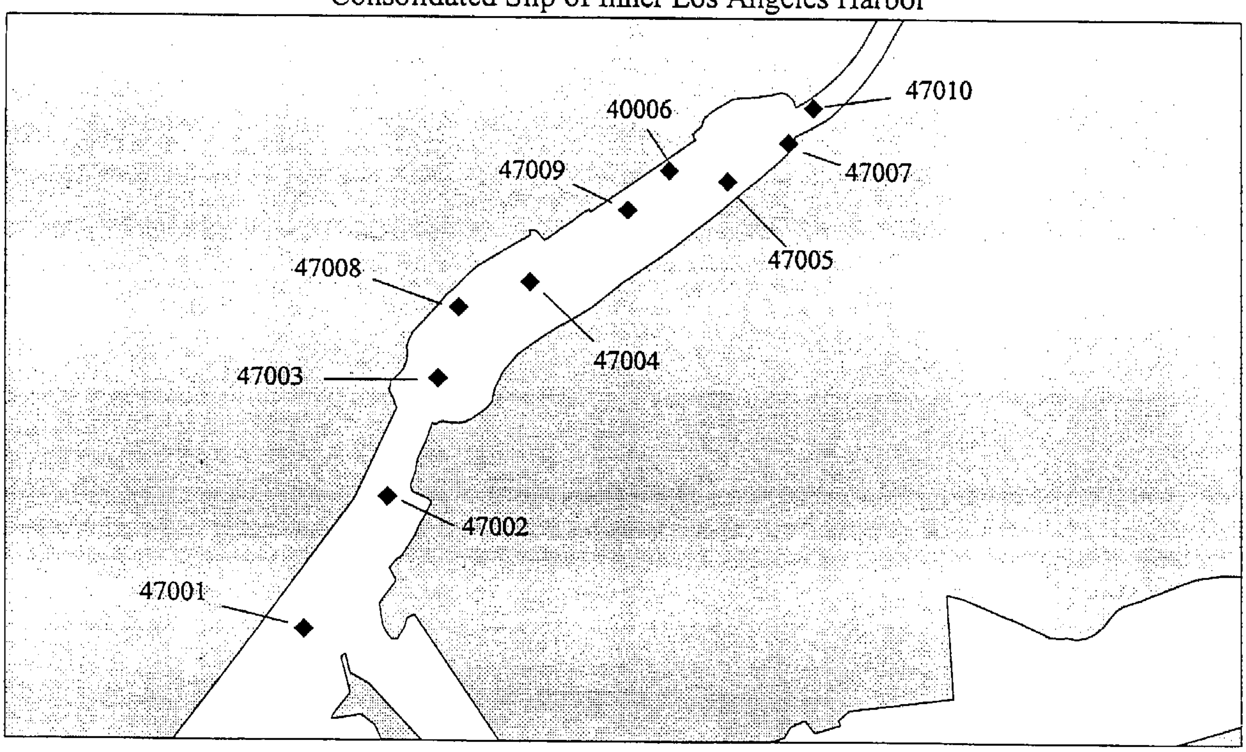


Figure 2: Sampling Stations in Inner Los Angeles and Long Beach Harbor and Consolidated Slip.

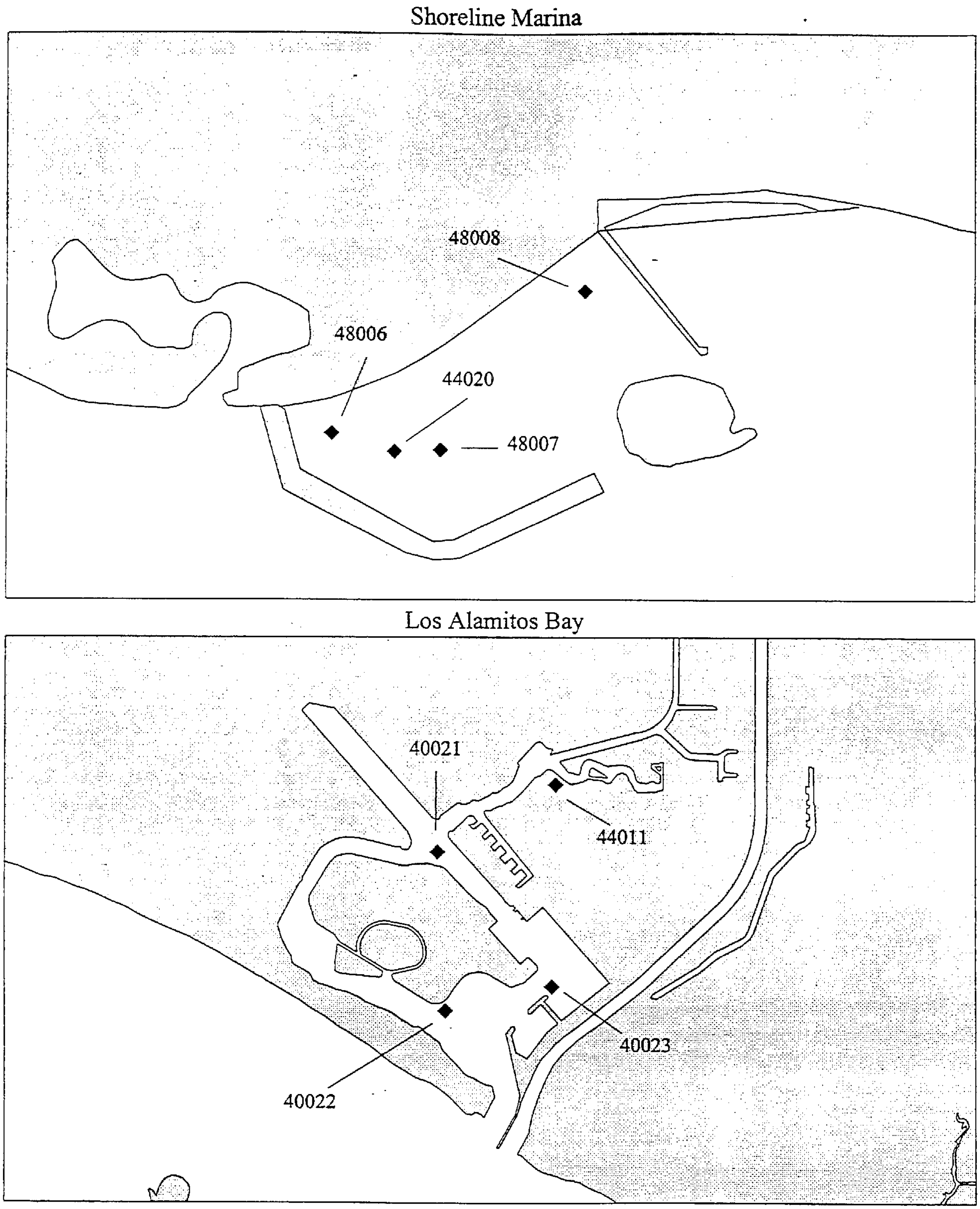


Figure 3: Sampling Stations in Shoreline Marina and Los Alamitos Bay.

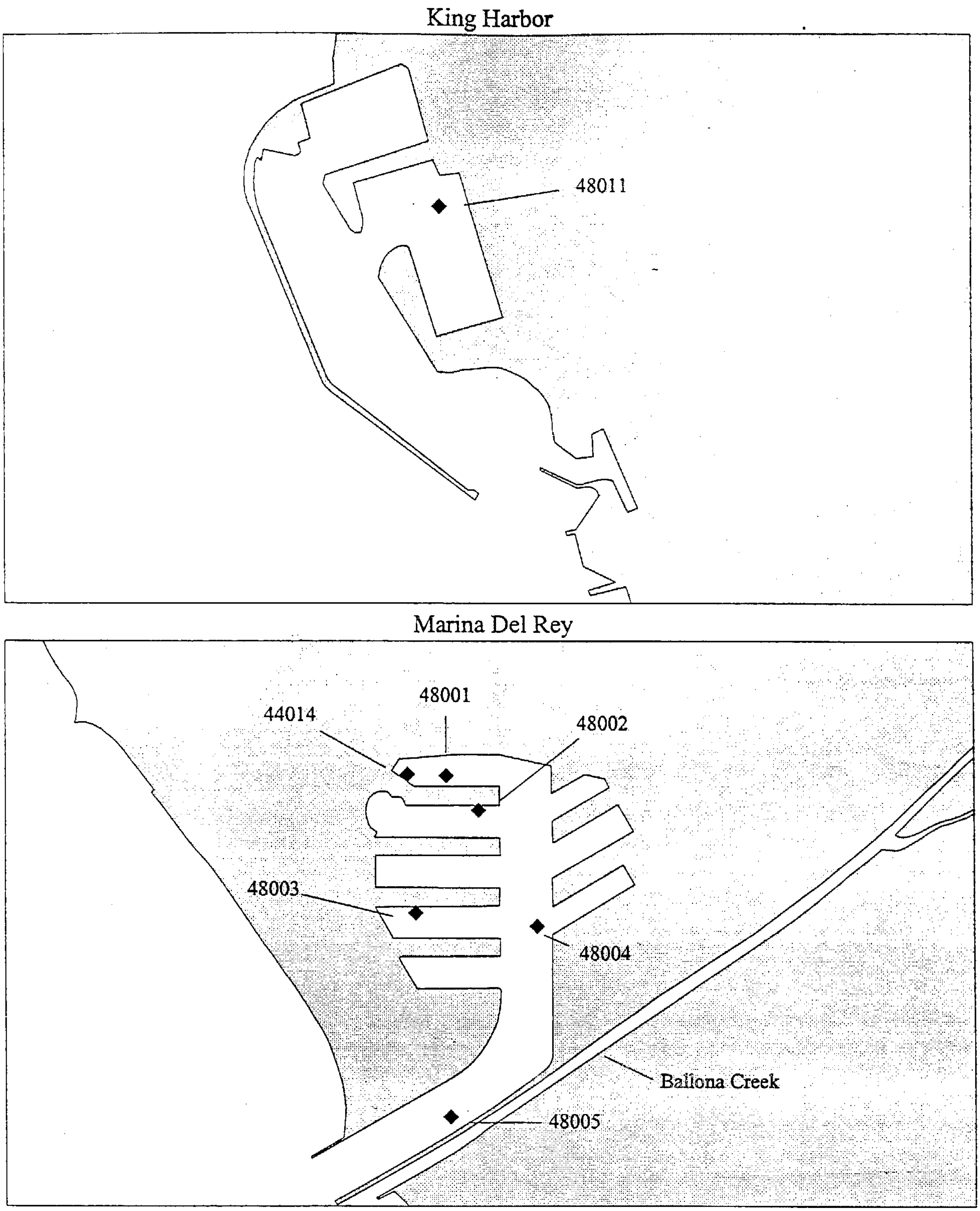


Figure 4: Sampling Stations in King Harbor and Marina del Ray.

Ventura Marina

Channel Islands Harbor

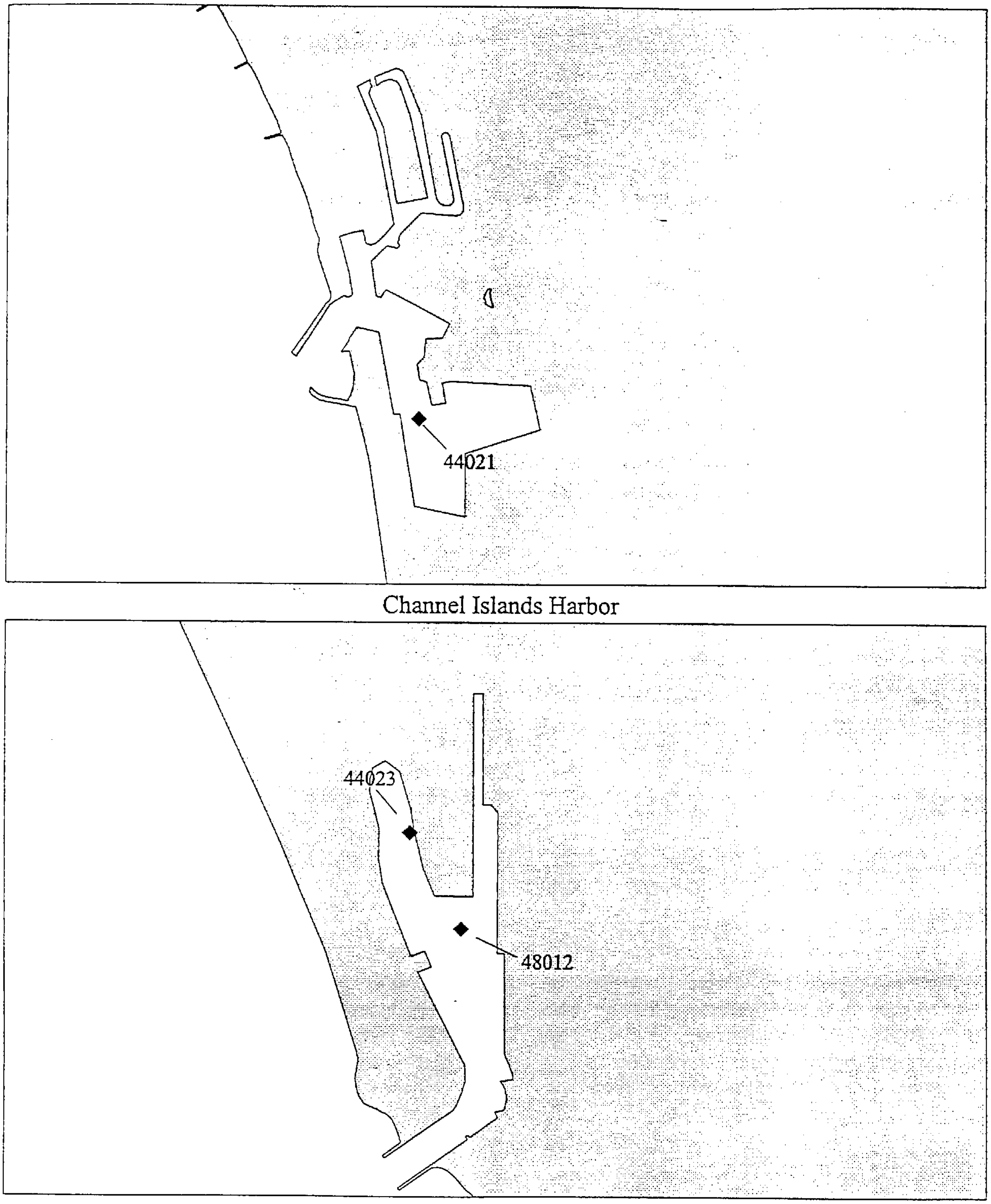


Figure 5: Sampling Stations in Ventura Marina and Channel Islands Harbor.

Mugu Lagoon

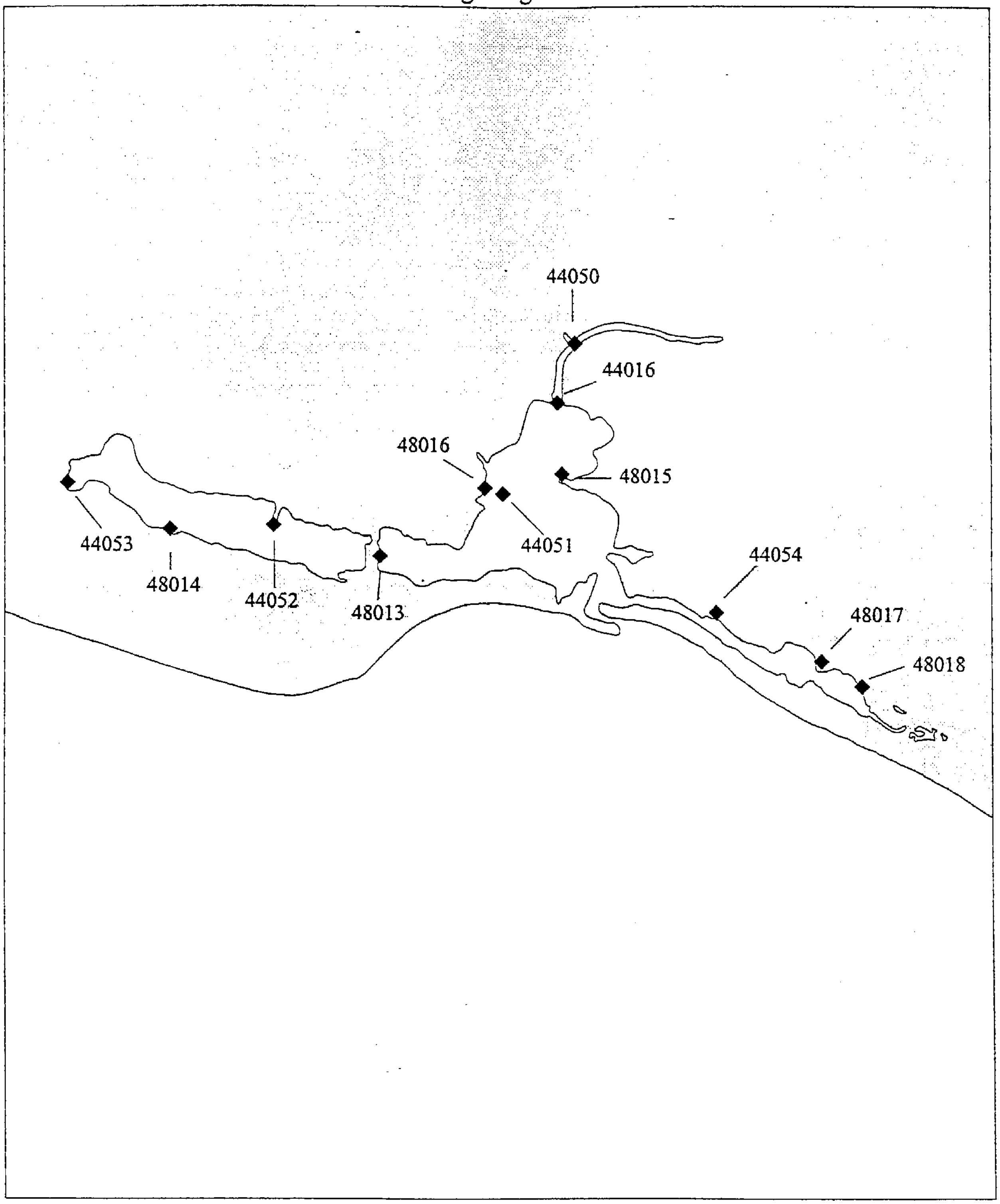


Figure 6: Sampling Stations in Mugu Lagoon.

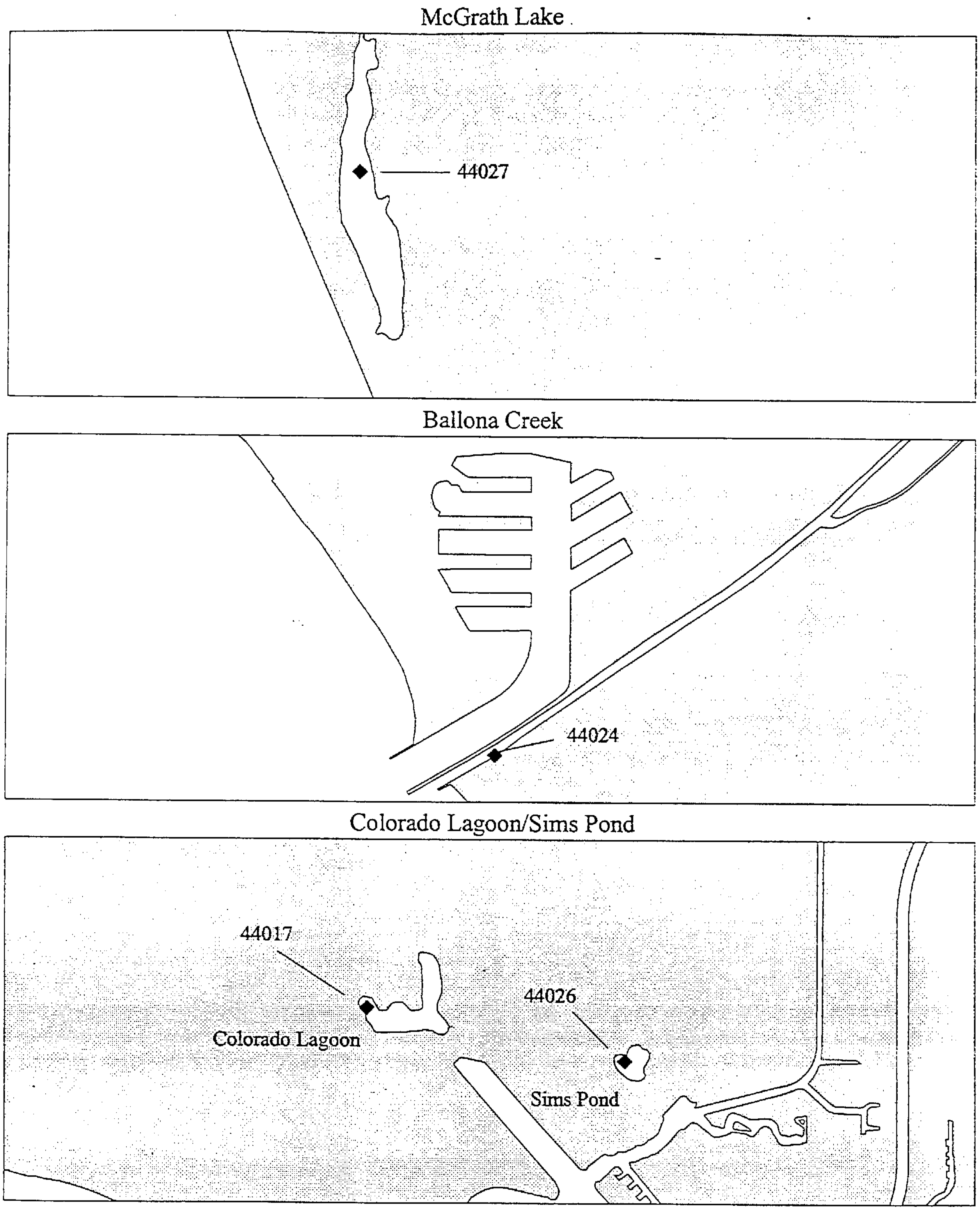


Figure 7: Sampling Stations in McGrath Lake, Ballona Creek and Colorado Lagoon/ Sims Pond.

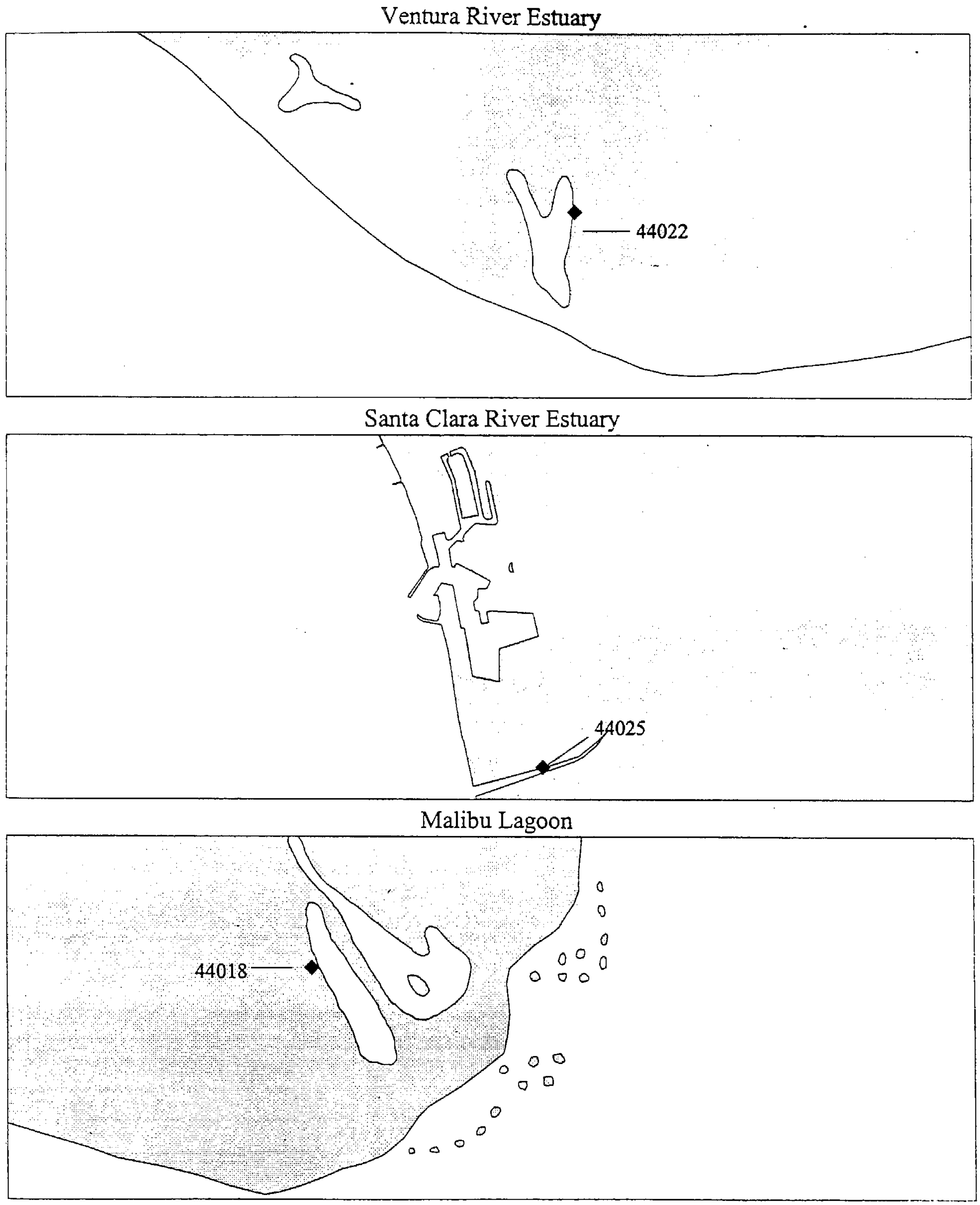


Figure 8: Sampling Stations in Ventura River Estuary, Santa Clara River Estuary and Malibu Lagoon.

Program, dominates a large portion of the open coastal waters in the region. The region's coastal waters also include the areas along the shoreline of Ventura County and the waters surrounding the five offshore islands in the region.

Candidate Toxic Hot Spot List

Water body name	Segment Name	Site Identification	Reason for Listing	Pollutants present at the site	Report reference
Santa Monica Bay	Palos Verdes Shelf	BPTCP 40031.1, 40031.2, 40031.3	Human health advisory; NAS level exceeded for DDT; sediment concentrations + sediment toxicity; degraded benthic community	DDT, PCB	[1], [2], [3], [4]
McGrath Lake		44024.0, 44027.0	sediment concentrations; sediment toxicity	DDT, Chlordane, Dieldrin, Toxaphene, Endosulfan	[5]
Mugu Lagoon/ Calleguas Creek Tidal Prism	Eastern Arm, Main Lagoon, Western Arm/ Tidal Prism	BPTCP 44050.0, 44052.0, 44053.0, 44054.0; 44016.0, 48013.0, 48014.0, 48015.0, 48016.0, 48017.0, 48018.0, SMW 507.8; TSM 403.11.04, 403.12.06	Reproductive impairment; ~~OEHHA~~ EPA level exceeded for Hg; NAS level exceeded for DDT; sediment concentrations + sediment toxicity; degraded benthic community	DDT, PCB, metals, Chlordane, Chlorpyrifos	[4], [5], [6], [7]
Los Angeles Inner Harbor	Dominguez Channel/ Consolidated Slip	BPTCP 40006.1, 40006.2	Human health advisory; NAS level exceeded for DDT; sediment concentrations + sediment toxicity; degraded benthic community	DDT, PCB, PAH, metals (Cd, Cu, Pb, Hg, Zn), dieldrin, chlordane	[2],[4], [8], [9], [10]
Los Angeles Outer Harbor	Cabrillo Pier	BPTCP 40010.1, 40010.2, 40010.3	Human health advisory; NAS level exceeded for DDT; sediment concentrations + sediment toxicity	DDT, PCB, Cu	[2], [4], [10]
Los Angeles River	Estuary	BPTCP 40013.1	Sediment concentrations + sediment toxicity	DDT, PAH, Chlordane	[4]
Ballona Creek	Entrance Channel	BPTCP 44024.0, COE	Sediment concentrations + sediment toxicity	DDT, metals (Zn, Pb), Chlordane, Dieldrin, Chlorpyrifos	[4]

Water body name	Segment Name	Site Identification	Reason for Listing	Pollutants present at the site	Report reference
Marina del Rey		BPTCP 44014.0, 48001.0, 48002.0, 48003.0, 48004.0, 48005.0	Sediment concentrations + sediment toxicity	DDT, PCB, Metals (Cu, Hg, Ni, Pb, Zn), Chlordane	[4]

Reference list

[1] Los Angeles Regional Water Quality Control Board. Santa Monica Bay: State of the Watershed. June, 1997.

[2] California Department of Fish and Game. 1996 California Sport Fishing Regulations.

[3] Santa Monica Bay Restoration Project, Comprehensive Conservation and Management Plan, ~~1996~~ 1994.

[4] Anderson, B. et al. 1998. Sediment chemistry, toxicity and benthic community conditions in selected water bodies of the Los Angeles Region. Final Report to State Water Resources Control Board, Bay Protection and Toxic Cleanup Program Monitoring.

[5] ~~Ledig, D. Preliminary report on the ecology of the light-footed clapper rail at Mugu Lagoon, Ventura Co., California.~~ Los Angeles Regional Water Quality Control Board. Chemical and biological measures of sediment quality in McGrath Lake. February 1999.

[6] Final report to California Department of Fish and Game FG 8555, 1990.

[7] Los Angeles Regional Water Quality Control Board. Calleguas Creek Watershed. June, 1996.

[8] Malins, D.C. et al. Toxic chemicals, including aromatic and chlorinated hydrocarbons and their derivatives, and liver lesions in white croaker (Genyonemus lineatus) from the vicinity of Los Angeles. Environ. Sci. and Tech., August 1987, pp. 765-770.

[9] MEC Analytical Systems, Inc. Biological baseline and ecological evaluation of existing habitats in Los Angeles Harbor and adjacent waters, Vol. II, Final Report. Page 4-74. Sept. 1988. Prepared for Port of Los Angeles, Environmental Management Division.

[10] Cross, J.N. et al. Contaminant concentrations and toxicity of sea-surface microlayer near Los Angeles, California. Mar. Environ. Research: 23 (1987) 307-323.

Ranking Matrix

Water body Name	Site Identification	Human Health Impacts	Aquatic Life Impacts	Water Quality Objectives	Areal Extent	Remediation Potential	Overall Ranking
Santa Monica Bay	Palos Verdes Shelf	High	High	Low	> 10 acres	High	High
McGrath Lake		High	High	Moderate	1 – 10 acres	High	High
Mugu Lagoon	Eastern Arm, Main Lagoon, Western Arm/ Tidal Prism	Moderate	High	Low	> 10 acres	High	High
Los Angeles Inner Harbor	Dominguez Channel/ Consolidated Slip	High	High	Low	1 - 10 acres	High	High
Los Angeles Outer Harbor	Cabrillo Pier	High	Moderate	Low	1 - 10 acres	High	High
Los Angeles River	Estuary	Moderate	Moderate	Low	1-10 acres	High	Moderate
Marina Del Rey	Entrance Channel	Low	Moderate	Low	< 1 acre	High	Moderate
Marina del Rey		Moderate	Moderate	Low	1-10 acres	High	Moderate

High Priority Candidate Toxic Hot Spot Characterization

This section of the cleanup plan contains a characterization of the four high priority candidate toxic hot spots identified (Santa Monica Bay/Palos Verdes Shelf, Mugu Lagoon/Calleguas Creek Tidal Prism, McGrath Lake, Los Angeles Outer Harbor/Cabrillo Pier, Los Angeles Inner Harbor/Dominguez Channel, Consolidated Slip). This section also contains a preliminary assessment of actions to address the problems identified at these sites.

Candidate Toxic Hot Spot	Areal Extent	Estimated Remediation Cost
Palos Verdes Shelf	9 million cubic meters	$13 - 67 million
Mugu Lagoon Calleguas Creek Tidal Prism	725,000 cubic yards 50,000 - 100,000 cubic yards	$72.5 million $1-5 million
McGrath Lake	150,000 - 300,000 cubic yards	$3 – $30 million (up to $300 million for treatment)
Cabrillo Pier	25,000 - 50,000 cubic yards	$0.5 - 50 million
Consolidated Slip	50,000 cubic yards	$1 - 50 million

Three areas were designated as moderate priority candidate toxic hot spots (Los Angeles River Estuary, Marina del Rey Entrance Channel, Marina del Rey), based on lower ratings for human health impacts and aquatic life impacts (refer to ranking matrix). The Cleanup Plan is not required to contain a detailed characterization report and preliminary assessment of remediation actions for "moderate" candidate toxic hot spots. However, these needs would be addressed in the future after remediation plans have been initiated at the high priority sites.

Santa Monica Bay/Palos Verdes Shelf

The contaminated sediments on the Palos Verdes Shelf appear to significantly impact the marine community and may pose a serious risk to individuals who regularly consume fish from the area. Currently, elevated levels of DDT and PCBs are found in the organisms that live in the area of the contaminated sediments, including bottom feeding fish such as white croaker, and water column feeders such as kelp bass. Marine mammals and birds could be affected through the consumption of contaminated fish [Draft Ecological Risk Evaluation Report for the

Palos Verdes Shelf, U.S. Environmental Protection Agency, September 1998].

The ongoing release of these hazardous substances from the sediment into the environment and the resulting accumulation of DDT and PCB in food chain organisms may persist if no action is taken. Commercial fishing and recreational fishing have been affected by the contamination. The State of California has issued a health advisory warning against the consumption of white croaker and kelp bass and closed commercial fishing for white croaker on the Palos Verdes Shelf.

A. Areal Extent of Toxic Hot Spot

In July 1996, the United States Environmental Protection Agency initiated a response action under Superfund site and began an evaluation to address the large deposit of DDT and PCB contaminated sediments on the Palos Verdes Shelf. The contaminated sediment footprint identified as the study area for this evaluation was defined as the boundary for one part-per-million (mg/kg) sediment DDT concentration described by the United States Geological Survey (USGS), covering portions of the continental shelf and continental slope between Point Vicente in the northwest and Point Fermin to the southeast (Figure 9). This entire area is proposed as a candidate know toxic hot spot.

Studies by the USGS in 1992 and 1993 indicated that this layer of contaminated sediments is about two inches to two feet thick and covers an area of more than 15 square miles, with the highest concentrations located in a 3-square mile band near the outfall pipes. The total volume of contaminated sediments on the Palos Verdes Shelf is approximately 9 million cubic meters and covers a surface area of approximately 40 square kilometers, with approximately 70% of this volume present on the continental slope in water depths less than 100 meters. The total mass of p,p'-DDE in the contaminated sediments is estimated to be greater than 67 metric tons.

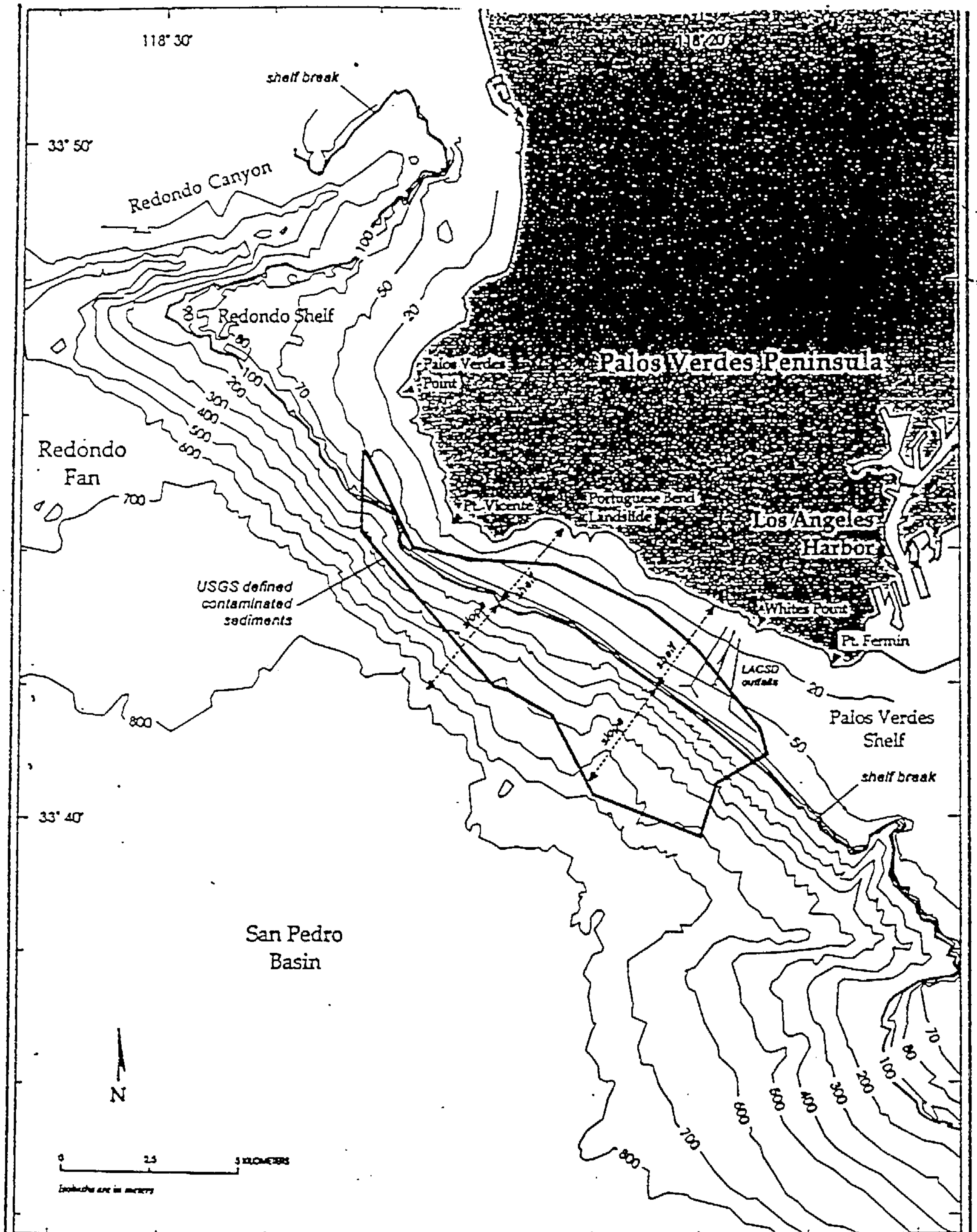


Figure 9: Areal extent of toxic hot spot on the Palos Verdes Shelf.

In addition to the large volume of monitoring data evaluated as part of the Superfund evaluation, limited sampling was conducted as part of the Bay Protection and Toxic Cleanup Program. BPTCP monitoring data showed that on September 10, 1992, sediment concentrations at stations 40031.1, 40031.2 and 40031.3 exceeded the ERM thresholds for Total DDT and Total PCB. Samples collected on August 17-19, 1993, and February 3. 1994, at station 40031.2 (Replicates 1, 2 and 3) also exceeded the ERM thresholds for Total DDT and Total PCB. Amphipod toxicity was recorded with whole sediments at station 40031.2 on February 3, 1994. Porewater toxicity to abalone was recorded at station 40031.2 on September 10, 1992. A degraded benthic community was observed at station 40031.2 on August 17-19, 1993.

Palos Verdes Shelf BPTCP Stations With Sediment Chemistry Concentrations Exceeding ERM Threshold

BPTCP Station	Sampling Date	Total DDT (ppb)	Total PCB (ppb)
40031.1	9/10/92	2729.3	268.7
40031.2	9/10/92	3337.5	271.3
40031.3	9/10/92	2520.7	204.1
40031.2 Rep 1	8/17-19/93	2525.8	259.5
40031.2 Rep 2	8/17-19/93	3569.3	301.4
40031.2 Rep 3	8/17-19/93	2604.6	302.5
40031.2 Rep 1	2/3/94	3344.2	271.3
40031.2 Rep 2	2/3/94	3331.5	312.8
40031.2 Rep 3	2/3/94	2063.9	221.8

B. Sources of Pollutants

From 1947 to 1983, the Montrose Chemical Corporation of California, Inc., manufactured the pesticide dichloro-diphenyl-trichloroethane (DDT) at its plant at 20201 Normandie Avenue in Los Angeles. Wastewater containing significant concentrations of DDT was discharged from the Montrose plant into the sewers, flowed through the Los Angeles County Sanitation Districts' wastewater treatment plant and was discharged to the Pacific Ocean waters on the Palos Verdes Shelf through subsurface outfalls offshore of Whites Point. Montrose's discharge of DDT stopped around 1972, and the plant was shut down and dismantled in 1983.

Polychlorinated biphenyls (PCBs) also were present in the wastewater discharged from the LACSD wastewater treatment plant and are found along with DDT in the effluent-affected deposits on the ocean floor along the Palos Verdes Shelf. Historically, PCB contamination entered the sewer system as the result of discharges from several industrial sources.

Although DDT and PCBs were banned in the early 1970s, release of contaminants from historically deposited sediments continues to be a source of these toxic chemicals. Concentrations of total DDT and p,p'-DDE (the predominant metabolite of DDT) in the surface sediments have remained relatively high since the late 1980s. This suggests that historical deposits are brought to the sea floor surface by a combination of natural physical, chemical or biological processes.

Besides DDT and PCB, there has been little evidence that the concentrations of other toxic organic compounds, such as PAHs and heavy metals (including copper, cadmium, chromium, nickel, silver, zinc and lead), discharged from the LACSD wastewater treatment plant have caused impacts to marine organisms. However, the concentrations of heavy metals in the sediments on the Palos Verdes Shelf are significantly higher than the background levels found in most parts of Santa Monica Bay and other parts of the Southern California Bight.

C. Actions by Regional Board

The Los Angeles Regional Board's Water Quality Assessment identifies the Palos Verdes Shelf as an impaired water body. The aquatic life beneficial use was listed as impaired due to sediment toxicity, tissue bioaccumulation of pollutants (DDT, PCBs, silver, chromium, lead), sediment contamination (DDT, PCBs, cadmium, copper, lead, mercury, nickel, zinc, PAHs, chlordane), and a health advisory warning against consumption of fish (white croaker). The Regional Board believes that the impairment is due to the effects of historical discharges of these pollutants, since the concentrations presently discharged are very low.

The Santa Monica Bay Restoration Project (SMBRP) was formed in 1988 under the National Estuary Program in response to the critical problems facing Santa Monica Bay. The Los Angeles Regional Board has been an active participant in this program. The SMBRP was charged with the responsibility for assessing the Bay's problems, developing solutions and putting them into action. The scientific characterization of the Bay is described in the SMBRP's "State of the Bay, 1993" report and other technical investigations. This report, along with the Project's recommendations for action, comprises the Bay Restoration Plan which was approved in 1995. With over 200 recommended actions (74 identified as priorities), the plan addresses the need for pollution prevention, public health protection, habitat restoration and comprehensive resource management throughout Santa Monica Bay, including the Palos Verdes Shelf area. The Los Angeles Regional Board is the lead agency responsible for implementation of several recommended actions.

The Los Angeles Regional Board has adopted a watershed management approach, which is expected to regulate pollutant loads from point sources through permits that better focus on issues relevant to each watershed. The Regional Board also expects that pollutant loads from nonpoint sources can be better controlled through the participation of the public in the management of their watersheds. During the 1996-97 Fiscal Year, the watershed management approach was used to renew selected NPDES permits within the Santa Monica Bay Watershed. The NPDES permit for the Los Angeles County Sanitation Districts' Joint Water Pollution Control Plant, which discharges a mixture of advanced primary and secondary effluent through an ocean outfall onto the Palos Verdes Shelf, was renewed with appropriate limits, performance goals and mass emission caps to limit the discharge of pollutants of concern.

D. Preliminary Assessment of Remediation Actions

In July 1996, the U.S. Environmental Protection Agency decided to undertake a Superfund response (under the Comprehensive Environmental Response, Compensation and Liability Act) called a removal action to address the contaminated sediment problem on the Palos Verdes Shelf. EPA initiated the preparation of an Engineering Evaluation/Cost Analysis (EE/CA) of possible response actions. The EE/CA will evaluate the need for Superfund action and will use the three broad criteria of effectiveness, implementability and cost to evaluate the alternatives for addressing hazardous substances being released into the environment.

As an initial step in the EE/CA process, EPA has prepared the "Screening Evaluation of Response Actions for Contaminated Sediments on the Palos Verdes Shelf". The Screening Evaluation describes the range of potential cleanup and disposal technologies for contaminated sediments and makes an initial determination about which technologies will be incorporated into the alternatives evaluated in detail in the EE/CA. General response actions which were evaluated included:

-removal (i.e., dredging) and treatment or disposal;
-institutional controls; and
-in situ (or in-place) capping;
-no action.

While sediment removal (i.e., dredging) is technically feasible, it could possibly result in the dispersal of contaminated sediment, thereby increasing short-term risks. Once dredged, the sediment would require disposal, possibly preceded by treatment, which could be both expensive and very difficult to implement. Upland disposal facilities are very limited, and disposal options along the coastline or in the open ocean would likely violate Federal and State environmental laws. For these reasons, EPA has decided not to consider dredging and treatment or disposal options further in the EE/CA.

Institutional control measures, such as warning notices or fishing restrictions, intended to protect human health already have been established for certain coastal areas including the Palos Verdes Shelf by the State of California, although their effectiveness is uncertain. Additional institutional controls could include measures to (1) expand the scope of existing State controls by increasing the area affected; (2) increase the awareness of and effectiveness of existing controls through additional public outreach efforts; and (3) enhance State enforcement of the commercial fishing closure.

In situ, or in-place, capping can be used to prevent or reduce direct human or ecological exposure to contaminants and to prevent migration of contaminants into the water. The cap could reduce or eliminate adverse impacts through (1) physical isolation of the contaminated sediment from the benthic environment, reducing the exposure of organisms to contaminants and limiting the potential for bioaccumulation and movement of contaminants into the food chain; (2) physical stabilization of the contaminated layer to retard resuspension and transport of contaminated sediment; and (3) reducing the flux of dissolved contaminants from the sediments into the water column (e.g., due to waves and currents). Large caps for areas like the Palos Verdes Shelf typically would consist of clean dredged material (i.e., sand or silt) that is placed over the contaminated area using dredge or platform barges. Caps can be constructed to various sizes or thicknesses and may be augmented after initial construction to increase effectiveness. For a large site like the Palos Verdes Shelf, a phased approach to capping would likely be desirable in order to maximize cost-effectiveness. Any cap design would need to consider the engineering characteristics of the cap material and the effluent-affected sediment in order to address potential erosion by currents and waves, mixing of the cap material and underlying sediment by bottom-dwelling organisms or other disturbances.

In situ capping has the potential to isolate the contaminated marine sediments, thereby providing long-term protection for the majority of the mass of contaminants on the Palos Verdes Shelf. Approximately 25% of the mass of contaminants is on the Palos Verdes slope, which is likely to be too steep for capping. Over the short term, capping would have some adverse impact on the existing benthic communities in the capped area, although it is expected that they would rapidly recolonize. If the cap were composed of suitable dredged material generated by local navigation projects (e.g., maintenance dredging), there would be no additional excavation beyond that already required for those projects, and reuse of the material for capping would reduce short-term impacts at traditional disposal sites. Carefully controlled placement of the cap material would minimize the resuspension of contaminated sediment.

In situ caps have been used successfully at numerous sites, although not as deep as the deeper parts of the Palos Verdes Shelf. In general, existing caps have stabilized after initial reworking and consolidation of the contaminated sediment. Capping could be accomplished reasonably quickly, depending on the availability of capping material.

A draft report (September 1998) prepared by the United States Army Corps of Engineers for EPA evaluates "Options for In-Situ Capping of Palos Verdes Shelf Contaminated Sediment". The report considers two options: (1) capping an area of approximately 4.9 square kilometers centered over the area with the highest DDT contamination; (2) capping a secondary area of contamination comprising approximately 2.7 square kilometers located northwest of the first area. Bioturbation, consolidation and cap effectiveness evaluations indicated that a thickness of 15 centimeters would be appropriate for a thin capping approach, designed to isolate contaminated material from shallow burrowing benthic organisms, while a 45 centimeter cap would be adequate for a thick cap design, effectively isolating the contaminated material from benthic organisms. Capping both areas with a thick cap (45 cm) would result in a reduction of potential exposures to contaminants over the total shelf area on the order of 60-70%, while a thin cap (15 cm) over both area reduces the potential exposures on the order of 60%. Capping only the most contaminated area (4.9 square kilometers) with a thin cap would reduce potential exposures on the order of 40%.

E. Cost Estimate to Implement Cleanup Plan

Cost estimates have been developed by the United States Environmental Protection Agency for three capping options (others may be developed):

Option 1 - capping of both areas (4.9 + 2.7 square kilometers) with a thick (45 cm) isolation cap = approximate cost would be $44 million to $67 million.

Option 2 - capping of both areas (4.9 + 2.7 square kilometers) with a thin (15 cm) cap = approximate cost would be $18 million to $30 million.

Option 3 - capping of only the most contaminated area (4.9 square kilometers) with a thin (15 cm) cap approximate cost would be $13 million to $19 million.

Option 1 would require on the order of 7 million cubic meters of capping material for implementation, while options 2 and 3 would require proportionally less material.

F. Estimate of Recoverable Costs from Dischargers

The United States National Oceanographic and Atmospheric Administration (NOAA), via its Natural Resource Damage Assessment, and the United States Environmental Protection Agency (EPA), via Superfund, are attempting to recover financial damages from parties responsible for DDT-related damages to the environment on the Palos Verdes Shelf. EPA estimates that approximately $20-25 million may be recovered from municipalities through settlement agreements. NOAA and EPA are seeking to recover approximately $100 million from Montrose Chemical Corporation, Westinghouse Electric Corporation and other industrial dischargers. All of the recovery estimates are approximations, and the actual amount recovered may change.

G. Two-year Expenditure Schedule

EPA should complete its evaluation of alternatives (including the "no-action" alternative) and issue the EE/CA report during 1999. At the end of the EE/CA process, EPA will solicit public comment on the EE/CA report, including the recommended removal alternative. If EPA decides to move ahead, EPA would issue an Action Memorandum formally selecting the response action.

Option 1 would require approximately 5 years to construct with a single hopper dredge. However, to take advantage of the availability of clean dredged material from the Queensway Bay dredging project for use in the cap, it may be necessary to use three hopper dredges, reducing the time for completion of the project to less than 2 years. Options 2 and 3 would require proportionally less material and less time for completion.

If $20-25 million becomes available from settlement agreements or other means, Options 2 and 3 potentially could be implemented within two years. Although Option 1 could be completed with 2 years with the use of multiple hopper dredges, $20-25 million would only allow completion of approximately one-third to one-half of the capping project, unless additional funds are available.

H. Benefits of Remediation

Capping of the DDT and PCB contamination on the Palos Verdes Shelf would isolate this material from the benthic environment and reduce bioaccumulation and movement of contaminants into the food chain. This would improve the ecological health of the marine environment and could lead to elimination of the health advisory warning against human consumption of fish caught in this area.

I. Environmental Impacts of Remediation

Placement of a cap could release contaminants into the marine environment, but design studies indicate that this should not occur with proper deployment of the capping material. Depending on the nature of the cap material, placement of the cap could destroy or modify the existing benthic community. Placement of the cap could cause damage to the ocean outfall and interfere with its operation. Monitoring will be required to verify the integrity of the final cap and assess environmental impacts from cap placement.

Mugu Lagoon/Calleguas Creek Tidal Prism

Monitoring of Mugu Lagoon and the lower Calleguas Creek watershed has identified the following problems: (1) impaired reproduction in the light-footed clapper rail, a resident endangered species inhabiting the lagoon, due to elevated levels of DDT and PCBs; (2) fish and shellfish tissue levels exceeded National Academy of Sciences guidelines for several pesticides; (3) possible exceedances of U.S. Environmental Protection Agency water quality criteria for the protection of saltwater biota for nickel, copper and zinc at some locations; (4) possible impacts to sediment and water quality, as well as aquatic community health, from operations at the Naval Air Base over many years. Several pesticides whose use has been discontinued still are found at high concentrations in the sediment and biota; (5) excessive sediment loading.

The Point Mugu Naval Air Base is located in the immediate vicinity of Mugu Lagoon. The surrounding Oxnard Plain supports a large variety of agricultural crops. These fields drain into ditches which either enter the lagoon directly or through Calleguas Creek and its tributaries. The lagoon borders on an Area of Special Biological Significance and supports a great diversity of wildlife, including several endangered birds and one endangered plant species. Except for the military base, the Oxnard Plain portion of the watershed is relatively undeveloped.

Calleguas Creek and its major tributaries (Revolon Slough, Conejo Creek, Arroyo Conejo, Arroyo Santa Rosa and Arroyo Simi) drain an area of 343 square miles in southern Ventura County and a small portion of western Los Angeles County. This watershed is about 30 miles long and 14 miles wide.

The Calleguas Creek watershed exhibits some of the most active and severe erosion rates in the country. Although erosion rates are naturally high in this tectonically active area, land use also is a factor in erosion and sedimentation problems. Channelization of Calleguas Creek was initiated by local farmers in Somis and downstream areas beginning about 1884, and around Revolon Slough in 1924. Following complete channelization, eroded sediment generated in the higher reaches of the Calleguas Creek watershed has begun to reach Mugu Lagoon even during minor flood events. At current rates of erosion, it is estimated that the lagoon habitat could be filled with sediment within 50 years.

Urban developments generally are restricted to the city limits of Simi Valley, Moorpark, Thousand Oaks and Camarillo. Although some residential development has occurred along the slopes of the watershed, most upland areas still are open space. Agricultural activities (primarily cultivation of orchard and row crops) are spread out along valleys and on the Oxnard Plain. The U.S. Navy maintains a Naval Air Base on much of the area around Mugu Lagoon.

The main surface water system drains from the mountains and toward the southwest, where it flows through the flat, expansive Oxnard Plain before emptying into the Pacific Ocean through Mugu Lagoon. Mugu Lagoon, situated at the mouth of the Calleguas Creek system, is one of the few remaining salt marshes in southern California along the Pacific Flyway. Threatened and endangered species that are supported by valuable habitats in Mugu Lagoon include the peregrine falcon, least tern, light-footed clapper rail and brown pelican. In addition to providing one of the last remaining habitats on the mainland for harbor seals to pup, Mugu Lagoon is a nursery ground for many marine fish and mammals.

The Eastern Arm of Mugu Lagoon is somewhat removed from the rest of the lagoon and tends to receive water from and drain directly into the lagoon mouth. The arm empties and fills rather quickly, leaving a considerable amount of sand near its western end, but moving towards finer sediments further east. The water tends to be marine in character the majority of the time.

The Main Lagoon and Western Arm are the areas most heavily used by birds (including endangered species). The Western Arm, with its slight gradient and slow water flow, has the most widespread freshwater influence during dry weather, receiving water from several drains. The Main Lagoon is affected primarily by Calleguas Creek, which may carry a considerable amount of fresh water during storms, although this flow generally is funneled into a channel which leads to the lagoon mouth.

A. Areal Extent of Toxic Hot Spot

Sediment contamination clearly exists throughout Mugu Lagoon and within the Calleguas Creek Tidal Prism. Problems appear to be worst in the Western Arm of Mugu Lagoon, particularly near the Rio de Santa Clara, which drains neighboring agricultural lands, and parts of the Eastern Arm. Although sediment contamination problems occur in the Main Lagoon, it appears that the large volume of this water body and good flushing is helping to keep contamination and associated effects at a lower level than might otherwise be expected. It is estimated that approximately 20% of the Western Arm and approximately 10% of the Eastern Arm of Mugu Lagoon contain contaminated sediments. The total volume of contaminated sediments is estimated to be approximately 725,000 cubic yards (based on approximately 150 acres with 3-foot depth of contamination).

Twenty-two miles of Calleguas Creek are listed as impaired due to high sediment concentrations of pesticides and accumulation in fish and shellfish. However, the area with the greatest contamination problem is estimated to cover approximately 3 miles. The total volume of contaminated sediments is estimated to be approximately 50,000 to 100,000 cubic yards.

In samples collected for the Bay Protection and Toxic Cleanup Program on February 6, 1997, sediment concentrations at stations 48013.0, 48014.0, 48015.0, 48016.0, 48017.0 and 48018.0 exceeded the ERM Thresholds for p,p'-DDE and Total DDT. Station 44054.0 also exceeded the p,p'-DDE threshold on June 19, 1996. No sediment chemistry data were collected during sediment toxicity screening surveys conducted on January 12, 1993 and April 14, 1994.

Amphipod toxicity with whole sediment was observed at stations 44016.0, 44050.0, 44051.0, 44052.0, 44053.0 and 44054.0 on January 15, 1993. Amphipod toxicity was observed at stations 44053.0 and 44054.0 on April 18, 1994, and station 48015.0 on

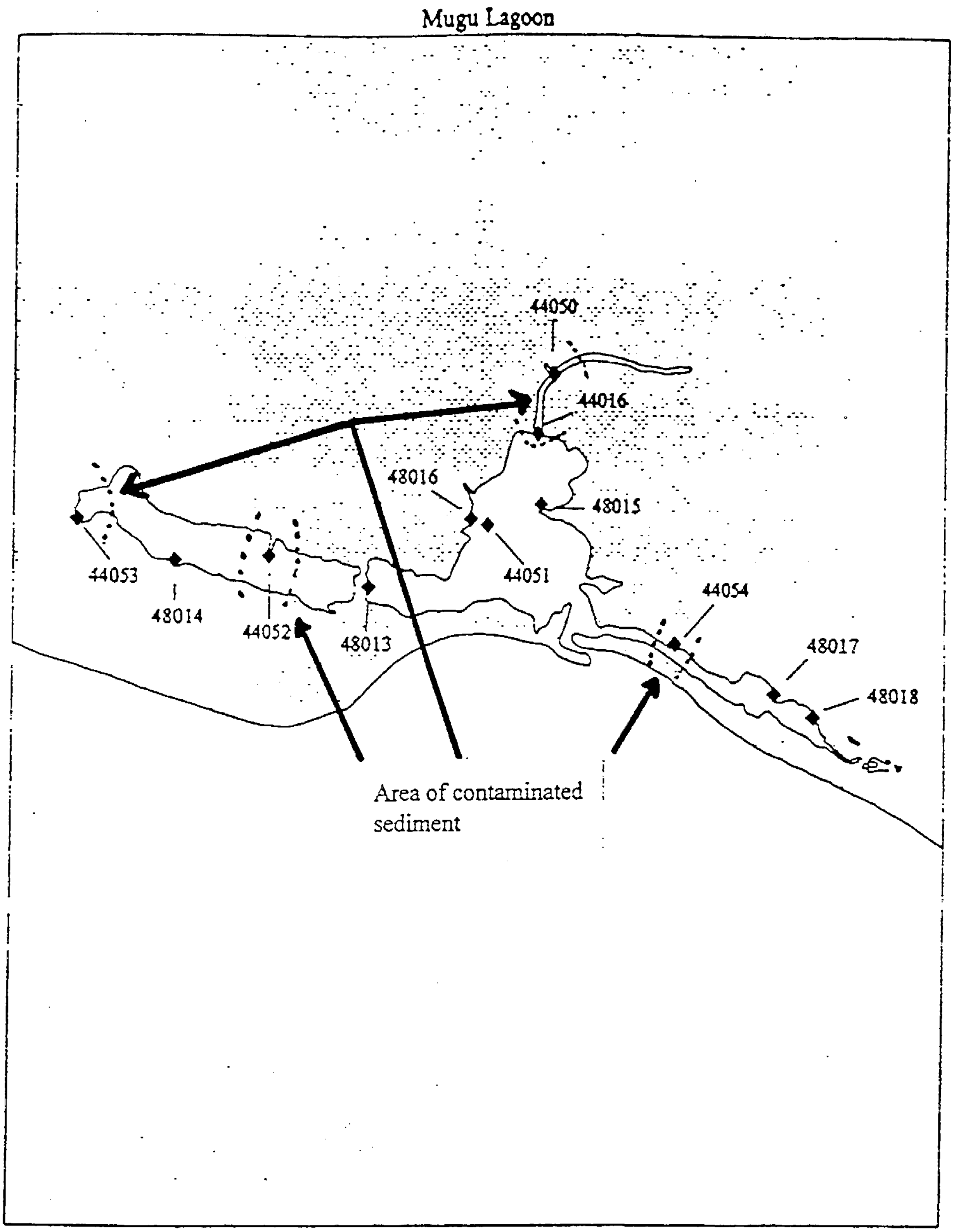


Figure 10: Areal extent of toxic hot spot within Mugu Lagoon/Calleguas Creek Tidal Prism.

February 10, 1997. A degraded benthic community was found at all of the stations analyzed (48013.0, 48014.0, 48015.0, 48016.0, 48017.0 and 48018.0) on February 10, 1997.

Fish were collected from Mugu Lagoon for bioaccumulation analyses. Shiner surfperch exceeded the EPA guidelines for total PCB, but not for total DDT. Topsmelt did not exceed the EPA screening guidelines for total DDT or total PCB.

Mugu Lagoon BPTCP Stations With Sediment Chemistry Concentrations Exceeding ERM Threshold

BPTCP Station	Sampling Date	p,p'- DDE (ppb)	Total DDT (ppb)
44054.0	6/19/96	30.5	
48013.0	2/6/97	44.7	64.7
48014.0	2/6/97	68.1	103.4
48015.0	2/6/97	131.0	255.1
48016.0	2/6/97	112.0	166.7
48017.0	2/6/97	165.0	276.8
48018.0	2/6/97	129.0	232.6

B. Sources of Pollutants

Pesticides are of concern in Mugu Lagoon at the mouth of the Calleguas Creek watershed. The primary source of pesticides probably is agricultural runoff, both during dry weather and wet weather. Water-soluble pesticides currently in use, such as diazinon and chlorpyrifos, may be occurring in sediment porewater at high enough concentrations to be causing observed porewater toxicity. These pesticides are likely involved with observed upstream ambient toxicity. Historical discharges of pesticides, such as DDT, PCBs, toxaphene, chlordane and others, probably has contributed to the existing sediment contamination problem. Erosion from unlined channels in the watershed and from agricultural lands probably contributes to the excessive sediment loading in Mugu Lagoon. Metals may originate from non-point source runoff during dry and wet weather conditions.

The Regional Board has issued 37 permits for discharges of wastewater from point sources into the Calleguas Creek watershed. Of the 22 permitted discharges under the NPDES ~~program~~ permits, 7 are for municipal wastewaters from publicly-owned treatment works, accounting for a combined permitted discharge of 36.7 million gallons per day (98% of the total permitted discharges). Of the remaining NPDES permits, 11 are for discharges of treated groundwater from hydrocarbon or other contamination, and 5 are general permits for discharges of either well development water or ground water from dewatered aquifers at construction sites. In addition, 88 releases of stormwater from major municipalities, certain industrial activities and construction projects are now permitted under the Regional Board's NPDES program for storm water.

Only one landfill, the Simi Valley Landfill, is active in the watershed. Simi Valley Landfill began operating in 1970. Hazardous wastes were accepted until 1983; since that time, only Class III wastes (municipal solid waste) have been discharged at this landfill. Since operations at the landfill predate current regulations for siting waste management units, only a portion of the Simi Valley Landfill is lined in accordance with current regulations. Leaks from unlined portions of the landfill have contaminated ground water in an underlying sandstone aquifer; corrective actions are underway by the operator under the direction of the Regional Board.

C. Actions by Regional Board

The Los Angeles Regional Board's Water Quality Assessment identifies the following problems in Mugu Lagoon: aquatic life beneficial use is impaired based on water column exceedances of criteria for copper, mercury, nickel, and zinc, bird reproductivity affected (DDT), tissue accumulation (arsenic, cadmium, silver; chlordane, DDT, endosulfan, dacthal, toxaphene, PCBs); sediment concentrations (DDT, toxaphene), sediment toxicity and excessive sediment. Fish consumption beneficial use is impaired based on tissue accumulation of DDT, PCBs and toxaphene. For Calleguas Creek (Estuary to Arroyo Los Posas), the Water Quality

Assessment lists the following problems: aquatic life beneficial use is impaired based on water column toxicity, sediment contamination (DDT, toxaphene), tissue bioaccumulation (chlordane, toxaphene, PCBs, DDT, dacthal, endosulfan) and sediment toxicity. Fish consumption beneficial use is impaired based on tissue bioaccumulation (DDT, toxaphene, chlordane).

The first large-scale stakeholder effort in the watershed was Mugu Lagoon Task Force, formed in September 1990. The purpose of the Task Force is to improve communication between agencies with various interests and specific projects in Ventura County that may impact water quality in Mugu Lagoon. All of the members share a common goal - to preserve and enhance Mugu Lagoon. The Task Force currently meets infrequently, since many of its members belong to the Calleguas Creek Watershed Management Committee. Active members of the Mugu Lagoon Task Force include the U.S. Army Corps of Engineers, University of California Cooperative Extension Service Farm Advisor, Ventura County Public Works Agency, Ventura County Planning Department, California Department of Fish and Game, California Coastal Conservancy, U.S. Navy Point Mugu Naval Air Station, Ventura County Resource Conservation District, U.S. Natural Resources Conservation Service and Los Angeles Regional Water Quality Control Board.

The Los Angeles Regional Board's Watershed Management Initiative began in late 1994 with the Calleguas Creek (and Ventura River) watersheds. Through watershed management, the Regional Board expects to regulate pollutant loads from point sources through permits that better focus on issues relevant to each watershed. The Regional Board also expects that pollutant loads from nonpoint sources can be better controlled through the participation of the public in the management of their watersheds.

The Los Angeles Regional Board renewed NPDES permits for discharges within the Calleguas Creek Watershed in June 1996. However, the Regional Board was unable to fully assess cumulative impacts to beneficial uses from all pollutant sources, particularly from nonpoint sources, during the first eighteen months of application of the Watershed Management Initiative. The Regional

Board was able to develop a regional monitoring program for the inland waters of the watershed which is currently being implemented and should provide additional information needed to assess cumulative impacts.

Thanks to the formation of the Calleguas Creek Watershed Management Committee in 1996, stakeholders will have the opportunity to structure and implement measures that will address pollutants from nonpoint sources through the development of a Watershed Management Plan. The Committee intends to hire a facilitator to help prepare a plan to develop a strategy for the preservation, enhancement and management of the watershed's resources, including identification and control of sources of pollution. The Committee has outlined a three-phased plan to accomplish this goal over a 2.5 year period, beginning in January 1998. The Regional Board plans to reassess cumulative impacts to the beneficial uses of waters in the watershed by fiscal year 2002-2003. Using this information, the Regional Board is scheduled to revise NPDES permits by June 2003.

The Regional Board is working with the Naval Air Weapons Station at Point Mugu to develop a cleanup plan for contamination at this Department of Defense site. This effort still is at the stage of characterizing historical sources of pollution and the extent of existing contamination levels. In the near future, decisions will be made concerning possible remediation and restoration activities in and around Mugu Lagoon.

D. Preliminary Assessment of Remediation Actions

Effects-based data has established that Mugu Lagoon sediment is more toxic than sediment from other lagoons in the region. Current agricultural and erosion control practices are likely moving soils heavily polluted with residuals of banned pesticides to drainages and subsequently into Mugu Lagoon.

Under the direction of the California Coastal Conservancy, Ventura County Resource Conservation District and other members of the Mugu Lagoon Task Force, the U.S. Natural Resources Conservation Service completed a report entitled: "Calleguas Creek Watershed

Erosion and Sediment Control Plan for Mugu Lagoon (May 1995)". The primary focus of this study was to address erosion and sedimentation impacts and solutions for the watershed. The U.S. Environmental Protection Agency, State Water Resources Control Board and the Los Angeles Regional Water Quality Control Board recently have granted additional 319(h) funds to implement specific erosion control measures for Grimes Canyon, a critical area targeted for remediation in the plan.

Existing contaminated sediments within Mugu Lagoon and the Calleguas Creek Tidal Prism are unlikely to remediate naturally within a reasonable time frame. Removal of the contaminated sediments (i.e., dredging) or treatment appear to be the most appropriate remediation alternatives, although in situ capping might be the best solution for historical deposits, particularly within the lagoon.

E. Cost Estimate to Implement Cleanup Plan

Given the sensitive nature of Mugu Lagoon as a habitat for endangered species, the most likely remediation alternatives would be no action or in situ treatment. The no action alternative would not have a financial cost, but the contaminated sediment could remain in the environment and continue to cause problems for several more decades. In situ treatment would be very expensive and may pose technical problems for remediation in an estuarine environment. No reliable cost estimate exists at this time for this treatment method, but it would probably exceed $100 per cubic yard. The total cost for remediation of Mugu Lagoon would be at least $72.5 million.

Dredging could be used to remove the contaminated sediments from the Calleguas Creek Tidal Prism. However, identifying a suitable and legal disposal site for contaminated sediments may be difficult. Application of this technique would cost an estimated $1 million to $5 million, based on a cost estimate of $20-100 per cubic yard (disposal costs are likely to be high, so the cost estimate probably would approach or even exceed the upper limit of the cost estimate range).

F. Estimate of Recoverable Costs From Dischargers

Contamination of the Mugu Lagoon sediments probably associated with historical use of the now-banned pesticide DDT. Although the United States Navy could be liable for any remediation activities required as a result of historical discharges of pollutants due to operations at the Naval Air Weapons Station at Point Mugu, there is no evidence that the Navy is responsible for the elevated concentrations of DDT in the sediments. It is unlikely that costs can be recovered from any other dischargers in this watershed.

G. Two-Year Expenditure Schedule

The Regional Board plans to work with the Calleguas Creek Watershed Management Committee, which already has begun development of a watershed management plan, to select the appropriate remediation alternative for Mugu Lagoon and the Calleguas Creek Tidal Prism. In addition, watershed management measures may be required to control sources of contaminants and prevent recontamination of these areas.

During Year One, the focus would be on selection of the appropriate remediation alternative for Mugu Lagoon and Calleguas Creek Tidal Prism. Additional sediment sampling may be required, particularly for Calleguas Creek Tidal Prism, to fully characterize the areal extent of the sediment contamination and prepare a plan for capping, dredging or treatment of the contaminated sediments. This sampling program probably will require approximately $100,000 - $250,000 for implementation. A source for this funding has not been determined.

During Year Two, the focus would be on implementation of the remediation alternative(s) selected for Mugu Lagoon and Calleguas Creek Tidal Prism, as well as watershed management measures to control sources of contamination and prevent recontamination of the existing hot spots. Remediation of the Calleguas Creek Tidal Prism probably could be completed within Year Two, if funding is available. However, remediation of Mugu Lagoon could require additional time, depending upon the alternative selected. A monitoring program will be required to measure the success of the remediation plans that are implemented; although a monitoring program has not yet been designed, the estimated cost would be $50,000 - $100,000 per year, and may be required for at least three to five years following completion of the remediation activities.

H. Benefits of Remediation

Successful remediation of the contamination in Mugu Lagoon and the Calleguas Creek Tidal Prism could eliminate the source of impairment of the beneficial uses of these waters. However, watershed management efforts to control erosion probably would be required to prevent recontamination of the these areas.

I. Environmental Impacts of Remediation

If in-situ treatment is implemented, it could result in short-term impacts to the benthic infaunal community. However, this community would be expected to fully recover within 2-3 years. Any remediation activity within this sensitive watershed, particularly in Mugu Lagoon, potentially could affect endangered species, such as the peregrine falcon, least tern, light-footed clapper rail and brown pelican. Prior to initiating any remediation plan, the Regional Board will consult with the California Department of Fish and Game and the United States Fish and Wildlife Service concerning potential adverse impacts to endangered species.

With proper management of dredging and disposal of dredged material, this activity would not be expected to result in adverse environmental impacts.

Los Angeles/Long Beach Harbors

The Los Angeles and Long Beach Harbors are located in the southeastern portion of the Los Angeles Basin. Along the northern portion of San Pedro Bay, there is a natural embayment formed by a westerly extension of the coastline which contains both harbors, with the Palos Verdes Hills as the dominant onshore feature. Offshore, a generally low topographic ridge is associated with the eastern flank of the Palos Verdes uplift and adjacent Palos Verdes fault zone, and extends northwest across the San Pedro shelf nearly to the breakwater of the Los Angeles Harbor.

The port and harbor areas have been modified over the course of more than one hundred years to include construction of breakwaters, landfills, slips and wharves, along with channelization of drainages, dredging of navigation channels and reclamation of marshland. The inner harbor includes the Main Channel, the East and West Basins, and the East Channel Basin. The outer harbor is the basin area located between Terminal Island and the San Pedro and Middle Breakwaters.
Los Angeles and Long Beach Harbor are considered to be a single oceanographic unit, and share a common breakwater across the mouth of San Pedro Bay. The outer harbor areas reflect the conditions of the coastal marine waters of the Southern California Bight, while the inner harbor areas typically have lower salinities.

In the presence of the strong currents and rocky habitat of the outer harbor, aquatic life communities are similar to those of the nearby coast, while the inner harbor supports biota generally found in bays and estuaries. The inner harbor has a mostly soft bottom character.

The major surface drainages in the area include the Los Angeles River, which flows in a channel and drains parts of the San Fernando Valley, as well as downtown and south Los Angeles, into eastern San Pedro Bay at Long Beach. The Dominguez Channel drains the intensely urbanized area west of the Los Angeles River into the Consolidated Slip of the Los Angeles Inner Harbor, carrying with it mostly urban runoff and non-process industrial waste discharges. A major source of both freshwater and waste in the outer harbor is secondary effluent from the Terminal Island Treatment Plant. Waste discharges to the inner harbor area of Los Angeles Harbor consist of both contact and non-contact industrial cooling wastewater and stormwater runoff. Fuel spills and oil spills from marine vessel traffic or docking facilities also contribute pollutants to the inner harbor.

Los Angeles Outer Harbor/Cabrillo Pier

A. Areal Extent of Toxic Hot Spot

The site's toxic hot spot status is based on several factors, including a fish advisory warning against human consumption of white croaker, which resulted from an OEHHA study released in 1991 which cited elevated DDT and PCB levels in a number of fish species caught in the area. Sediment DDT levels in some BPTCP samples collected from the site were elevated above that found elsewhere in the harbor, while sediment PCB levels were comparable to other sites. Sediment toxicity fluctuated widely. This is a heavily used sustenance and sportfishing pier (Figure 11). It is unclear whether fish caught there are contaminated from DDT found locally or from sources outside of but close to the harbor. It is estimated that 25,000 to 50,000 cubic yards of contaminated sediments exist within the Cabrillo Pier area (based on 1 to 2 foot depth of contaminants).

Based on samples collected for the BPTCP, sediment concentrations exceeded the ERM Threshold for Total DDT at every station (40010.1, 40010.2, 40010.3, 49001.0, 49002.0, 49003.0) on each occasion that sediment chemistry analyses were conducted (August 18, 1992; September 16, 1992; August 19, 1993; May 19, 1994; February 15, 1994; May 13, 1997). Sediment concentrations also exceeded the ERM for copper at station 40010.1 (Replicates 1, 2 and 3) on February 14, 1994. Amphipod toxicity with whole sediments was observed at station 40010.1 on May 28, 1993, and again at stations 40010.1, 40010.2 and 40010.3 on February 14, 1994. A degraded benthic community was observed at station 40010.2 (Replicate 2) on August 17-19, 1993.

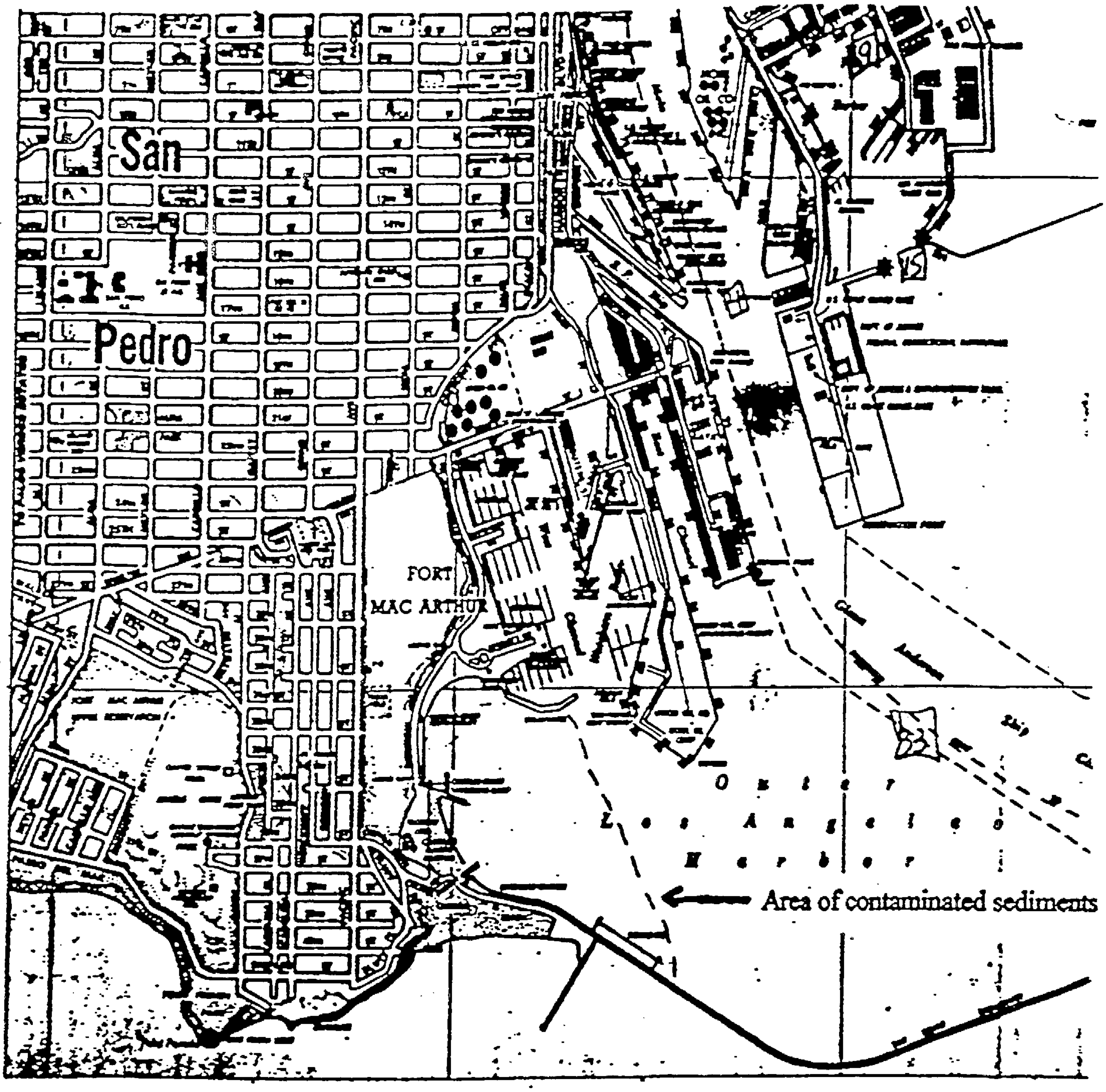


Figure 11. Areal extent of toxic hot spot within Los Angeles Outer Harbor/Cabrillo Pier.

Cabrillo Pier Area BPTCP Stations With Sediment Chemistry Concentrations Exceeding ERM Threshold

BPTCP Station	Sampling Date	Copper (ppm)	Total DDT (ppb)
40010.1	8/18/92		267.5
40010.2	8/18/92		207.3
40010.3	8/18/92		203.7
40010.1	9/16/92		195.6
40010.1	8/19/93		304.8
40010.2	8/19/93		204.6
40010.3	8/19/93		215.0
40010.1 Rep 1	2/15/94	247.0	175.0
40010.1 Rep 2	2/15/94	274.0	186.6
40010.1 Rep 3	2/15/94	273.0	174.4
40010.2 Rep 1	2/15/94		207.2
40010.2 Rep 2	2/15/94		168.8
40010.2 Rep 3	2/15/94		180.4
40010.3 Rep 1	2/15/94		171.6
40010.3 Rep 2	2/15/94		212.0
40010.3 Rep 3	2/15/94		163.2
49001.0	5/13/97		192.9
49002.0	5/13/97		100.0
49003.0	5/13/97		53.5

Fish were collected on May 12, 1997, to assess bioaccumulation of DDT and PCB. Total DDT and total PCB in white croaker muscle tissue samples exceeded EPA screening values at stations 49001.0, 49002.0 and 49003.0. Total PCB in white surfperch muscle tissue also exceeded the EPA screening value at all three stations, although total DDT concentrations fell below the EPA screening value. Clams (Macoma) collected at station 49002.0 also exceeded the EPA screening value for total PCB.

B. Sources of Pollutants

Historical discharges of DDT, PCBs and metals are the probable cause of sediment contamination in the Cabrillo Pier area. Discharge of wastewater effluent from the Terminal Island Treatment Plant is a potential source of pollutants, especially metals. Nonpoint sources of pollutants include spills from ships and industrial facilities, as well as stormwater runoff. Many areas of the port have experienced soil and/or groundwater contamination, which may result in possible transport of pollutants to the harbor's surface waters.

C. Actions by Regional Board

The Los Angeles Regional Board's Water Quality Assessment lists the following problems in the Cabrillo area of Los Angeles Outer Harbor: aquatic life beneficial use is impaired due to tissue accumulation (DDT), sediment toxicity, sediment contamination (PAHs, DDT, zinc, copper, chromium).

The Los Angeles Regional Board has adopted a watershed management approach, which is expected to regulate pollutant loads from point sources through permits that better focus on issues relevant to each watershed. The Regional Board also expects that pollutant loads from nonpoint sources can be better controlled through the participation of the public in the management of their watersheds. During the 2001-02 Fiscal Year, the watershed management approach will be used to renew NPDES permits within the Los Angeles/Long Beach Harbors Watershed. The Los Angeles Regional Board's Site Cleanup Unit has developed cleanup and remediation plans for many contaminated soil and groundwater sites, including refineries and old oil fields. The Regional Board has issued waste discharge requirements for some of the boatyards and stormwater runoff sources within the port.

The Los Angeles Regional Board and the California Coastal Commission began work during fiscal year 1997-98 to prepare a long-term management plan for the dredging and disposal of contaminated sediments in the coastal waters adjacent to Los

Angeles County. The goals of this plan will be to develop unified multi-agency policies for the management of contaminated dredged material, promote multi-user disposal facilities and reuse, to the extent practicable, and support efforts to control contaminants at their source using a watershed management approach.

D. Preliminary Assessment of Remediation Actions

Given the protected nature of the Cabrillo Pier area within the Los Angeles Outer Harbor, in situ capping might be a feasible method for containment of contaminated sediments. Dredging would be a proven method to remove the contaminated sediments, but identification of a suitable and legal disposal site is often a problem. Treatment of contaminated sediments may be feasible, but is likely to be expensive and difficult to accomplish with marine sediments.

E. Cost Estimate to Implement Cleanup Plan

In situ capping would probably be the least expensive remediation option. However, a stable cap must be designed to prevent reexposure of the contaminated sediments. Application of this technique to contain contaminated sediments from the Cabrillo Pier area would cost an estimated \$0.5 million to \$1 million, based on a cost estimate of up to \$20 per cubic yard (this is a rough estimate, since the unit cost could be higher).

Dredging could be used to remove the contaminated sediments from the Cabrillo Pier area. However, identifying a suitable and legal disposal site for a large volume of contaminated sediments can be difficult. Application of this technique would cost an estimated \$0.5 million to \$5 million, based on a cost estimate of \$20-100 per cubic yard (if a disposal site, such as a confined aquatic disposal or land disposal site, is available within or close to the Los Angeles/Long Beach Harbors complex, the cost estimate probably would approach the lower limit of the cost estimate range).

Treatment of the contaminated sediments is likely to be expensive. Application of this technique would cost an estimated \$2.5 million to \$50 million, based on a cost estimate of \$100-\$1,000 per cubic yard (due to limited experience in treating marine sediments, costs are likely to be in the upper part of the cost estimate range).

F. Estimate of Recoverable Costs from Dischargers

In July 1996, the U.S. Environmental Protection Agency decided to undertake a Superfund response (under the Comprehensive Environmental Response, Compensation and Liability Act) to address the contaminated sediment problem on the Palos Verdes Shelf. However, the Los Angeles Harbor area was not included within the scope of the Superfund action. Since it will be difficult or impossible to prove that the contamination of the harbor is due to stormwater runoff from the Montrose Chemical Corporation's historical manufacturing site in Torrance, which appears to be a likely source for this contamination, we do not anticipate recovering any remediation costs from dischargers.

G. Two-year Expenditure Schedule

The Regional Board plans to work with the Los Angeles Basin Contaminated Sediments Task Force to select a remediation alternative and implement the cleanup plan for the Cabrillo Pier hot spot. Additional sediment sampling will be required to better define the areal extent of the sediment contamination, prior to selection of an appropriate remediation alternative. This sampling program could be conducted during Year One, if funding becomes available (estimated cost approximately $250,000 - $500,000). However, the Regional Board would recommend implementing the cleanup of the Consolidated Slip/Dominguez Channel hot spot prior to initiating any remediation activities at the Cabrillo Pier site, since the Consolidated Slip/Dominguez Channel area may represent a source of contamination to the Cabrillo Pier area. A monitoring program would be required upon completion of any remediation activities; it is estimated that monitoring would cost $50,000 to $100,000 per year, and may be required for three to five years.

H. Benefits of Remediation

Remediation of the contamination would eliminate the immediate source of impairment of beneficial uses of the receiving waters.

However, recontamination from other areas of the harbor could occur.

I. Environmental Impacts of Remediation

If capping or dredging is implemented, it could result in short-term impacts to the benthic infaunal community. However, this community would be expected to fully recover within 2-3 years. There is potential for release of contaminants into the marine environment during dredging, but proper management of this operation should minimize this risk. Special management practices would be required for disposal of contaminated sediments to contain the material and prevent releases of contaminants to the environment.

Los Angeles Inner Harbor/Dominguez Channel, Consolidated Slip

A. Areal Extent of Toxic Hot Spot

A reservoir of polluted sediment in Consolidated Slip (moving down from Dominguez Channel) probably is continuing to contaminate a large part of Los Angeles Inner Harbor (Figure 12). It is estimated that approximately 30,000 cubic yards of contaminated sediments exist in Consolidated Slip and approximately 20,000 cubic yards in Dominguez Channel (based on 6 miles of channel contaminated to an average depth of 1 foot).

In limited sampling conducted on July 30, 1992, sediment samples from stations 40006.1 and 40006.2 exceeded ERM thresholds for zinc, total chlordane and total PCB; in addition, station 40006.1 also exceeded the ERM for mercury. Amphipod toxicity with whole sediments, as well as porewater toxicity with the abalone test, were observed at both stations. A degraded benthic community was observed at station 40006.1.

In limited sampling conducted on February 3, 1994, sediment samples from station 40006.1 (Replicates 1, 2 and 3) exceeded ERM thresholds for zinc, total chlordane, total PCB and high molecular weight PAH; in addition, Replicate 3 from this station also exceeded the ERM for mercury. Amphipod toxicity was observed in

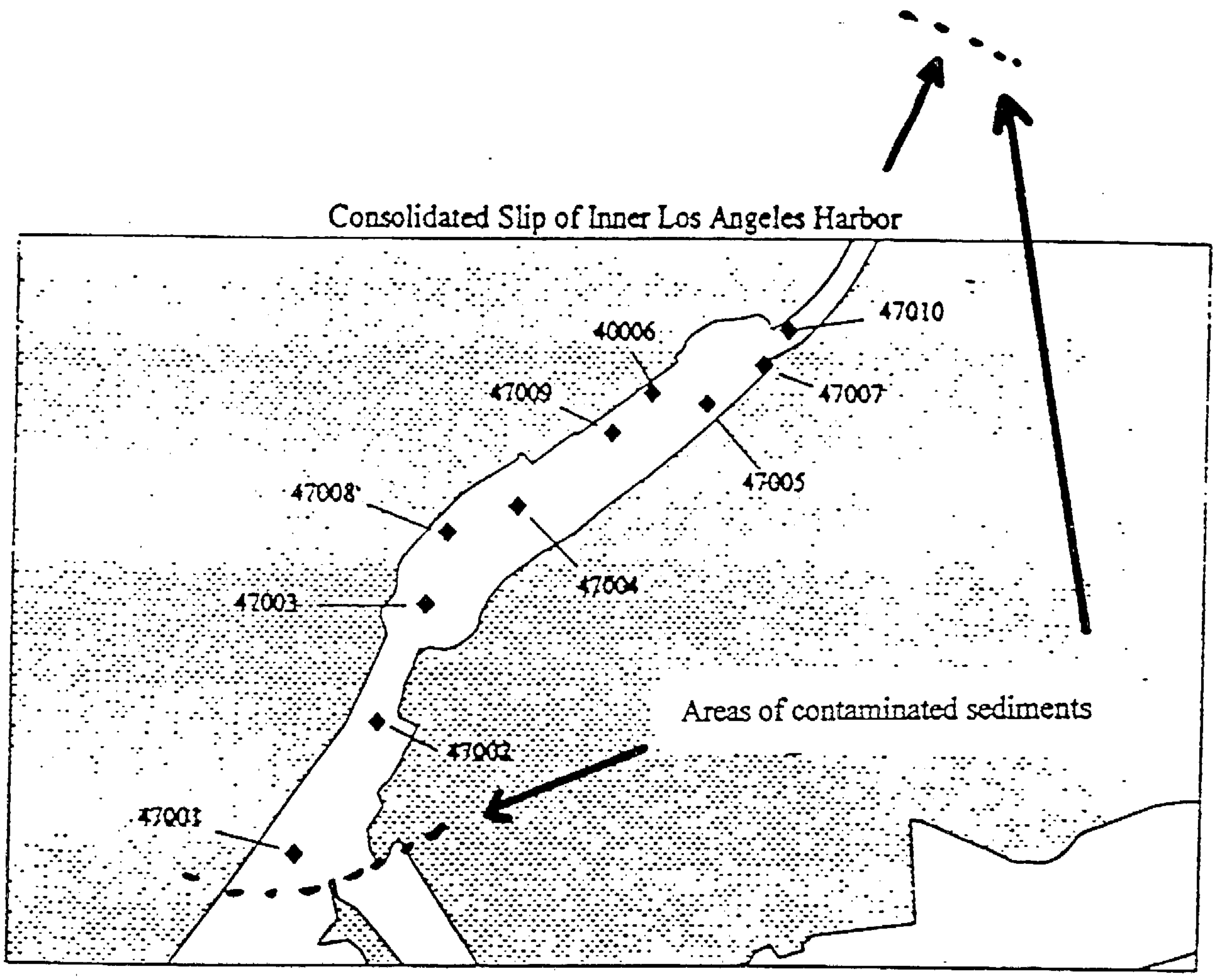


Figure 12. Areal Extent of toxic hot spot within Los Angeles Inner Harbor/Dominguez Channel, Consolidated Slip

Replicates 1 and 2 from station 40006.1. Benthic samples were not analyzed on this occasion.

A more extensive survey was conducted at several stations on July 22, 1996, including the collection of surface samples and subsurface samples. Sediment samples from stations 47001.0, 47002.0, 47003.0, 47004.0, 47005.0, 47010.0, 47007.0, 47008.0 and 47009.0 all exceeded at least one ERM threshold, and sometimes exceeded several, including those for cadmium, copper, lead, mercury, zinc, dieldrin, total PCB, low molecular weight PAH, high molecular weight PAH and total PAH. Amphipod toxicity with whole sediment was observed at stations 47001.0 (surface and depth 2), 47002.0 (surface), 47003.0 (surface and depth 2), 47004.0 (surface and depth 2), 40005.0 (surface and depth 2), 47007.0 (surface), 47008.0, 47009.0 (surface) and 47010.0 (surface). A degraded benthic community was found at stations 47002.0, 47003.0, 47009.0 and 47010.0.

When average ERM Quotient exceeds 1.00, the probability of amphipod toxicity was found to be 71% (Long et al., 1995). When average PEL Quotient exceeds 1.00, probability of significant amphipod toxicity was found to be 56% (McDonald, 1996). Consolidated Slip exceeded both of these effect thresholds at several stations (47004.0, 4006.1, 47002.0, 47009.0, 47003.0, 47008.0, 47001.0, 40006.2, 40007.0). When sediment concentrations were found to exceed 11 or more of the ERM thresholds, 85% of the samples have been found to be significantly toxic to amphipods. When sediment concentrations exceeded 21 or more of the PEL thresholds, 100% of the samples have been found to be significantly toxic to amphipods. One of the Consolidated Slip stations exceeded the ERM threshold (47004.0), but not the PEL threshold.

Consolidated Slip/Dominguez Channel BPTCP Stations With Sediment Chemistry Concentrations Exceeding ERM Threshold

BPTCP Station	Sampling Date	Compound	Concentration
40006.1	7/30/92	Mercury	0.73 ppm
40006.1	7/30/92	Zinc	540 ppm
40006.1	7/30/92	Total Chlordane	50.0 ppb
40006.1	7/30/92	Total PCB	473.8 ppb
40006.2	7/30/92	Zinc	570 ppm
40006.2	7/30/92	Total Chlordane	46.0 ppb
40006.2	7/30/92	Total PCB	534.5 ppb
40006.1 Rep 1	2/3/94	Zinc	463 ppm
40006.1 Rep 1	2/3/94	Total Chlordane	112.8 ppb
40006.1 Rep 1	2/3/94	Total PCB	513.1 ppb
40006.1 Rep 1	2/3/94	HMW PAH	12146 ppb
40006.1 Rep 2	2/3/94	Zinc	606 ppm
40006.1 Rep 2	2/3/94	Total Chlordane	83.6 ppb
40006.1 Rep 2	2/3/94	Total PCB	504.5 ppb
40006.1 Rep 2	2/3/94	HMW PAH	11963 ppb
40006.1 Rep 3	2/3/94	Mercury	0.74 ppm
40006.1 Rep 3	2/3/94	Zinc	616 ppm
40006.1 Rep 3	2/3/94	Total Chlordane	58.1 ppb
40006.1 Rep 3	2/3/94	Total PCB	578.6 ppb
40006.1 Rep 3	2/3/94	HMW PAH	12553 ppb
47001.0 Surface	7/22/96	Total PCB	981.8 ppb
47001.0 Depth 2	7/22/96	Total PCB	646.2 ppb
47002.0 Surface	7/22/96	Total PCB	2118.2 ppb
47002.0 Depth 2	7/22/96	Total PCB	803.3 ppb
47002.0 Depth 2	7/22/96	HMW PAH	10374 ppb
47003.0 Surface	7/22/96	Dieldrin	10.1 ppb
47003.0 Surface	7/22/96	Total PCB	1420.6 ppb
47003.0 Depth 2	7/22/96	Lead	385.0 ppm
47003.0 Depth 2	7/22/96	Mercury	1.57 ppm
47003.0 Depth 2	7/22/96	Zinc	568 ppm
47003.0 Depth 2	7/22/96	Total PCB	893.4 ppb
47004.0 Surface	7/22/96	Zinc	473 ppm
47004.0 Surface	7/22/96	HMW PAH	11721 ppb

47004.0 Depth 2	7/22/96	Mercury	0.78 ppm
47004.0 Depth 2	7/22/96	Zinc	737 ppm
47003.0 Depth 2	7/22/96	Dieldrin	33.3 ppb
47004.0 Depth 2	7/22/96	Total PCB	1341.6 ppb
47004.0 Depth 2	7/22/96	LMW PAH	9679 ppb
47004.0 Depth 2	7/22/96	HMW PAH	16467 ppb
47005.0 Surface	7/22/96	Copper	478 ppm
47005.0 Surface	7/22/96	Lead	460 ppm
47005.0 Surface	7/22/96	Mercury	3.28 ppm
47005.0 Surface	7/22/96	Zinc	447 ppm
47005.0 Surface	7/22/96	Total PCB	1599.9 ppb
47005.0 Depth 2	7/22/96	Copper	1740 ppm
47005.0 Depth 2	7/22/96	Lead	542 ppm
47005.0 Depth 2	7/22/96	Mercury	2.94 ppm
47005.0 Depth 2	7/22/96	Zinc	700 ppm
47005.0 Depth 2	7/22/96	Total PCB	525.8 ppb
47005.0 Depth 3	7/22/96	Lead	1590 ppm
47005.0 Depth 3	7/22/96	Mercury	1.49 ppm
47005.0 Depth 3	7/22/96	Zinc	1010 ppm
47010.0 Surface	7/22/96	Total PCB	361.5 ppb
47007.0 Surface	7/22/96	Total PCB	246.2 ppb
47008.0	7/22/96	Cadmium	14.5 ppm
47008.0	7/22/96	Total PCB	942.4

B. Sources of Pollutants

Historical discharges of DDT, PCBs and metals probably caused much of the existing contamination. Current point source discharges of process water and other waste streams from refineries located along Dominguez Channel may be contributing to the contamination problem. Numerous nonpoint sources, such as spills, vessel discharges, leaching of pollutants from boat anti-fouling paints, and storm drains, also are present in the area.

C. Actions by Regional Board

The Los Angeles Regional Board's Water Quality Assessment lists the following problems in Dominguez Channel: aquatic life beneficial use is impaired due to sediment contamination (chromium, zinc, DDT, PAHs) and benthic community impairment. The Water Quality Assessment identifies the following problems in Consolidated Slip: aquatic life beneficial use is impaired due to tissue accumulation (DDT, chlordane, PCBs, tributyltin, zinc), sediment toxicity, benthic community effects, sediment contamination (PAHs, zinc, chromium, lead, DDT, chlordane, PCBs); fish consumption advisory.

The Los Angeles Regional Board's Site Cleanup Unit has developed cleanup and remediation plans for many contaminated soil and groundwater sites, including refineries and old oil fields. The Regional Board has issued waste discharge requirements for some of the boatyards and stormwater runoff sources within the port.

The Los Angeles Regional Board has adopted a watershed management approach, which is expected to regulate pollutant loads from point sources through permits that better focus on issues relevant to each watershed. The Regional Board also expects that pollutant loads from nonpoint sources can be better controlled through the participation of the public in the management of their watersheds. During the 2001-02 Fiscal Year, the watershed management approach will be used to renew NPDES permits within the Los Angeles/Long Beach Harbors Watershed and the Dominguez Channel Watershed.

The Los Angeles Regional Board and the California Coastal Commission began work during fiscal year 1997-98 to prepare a long-term management plan for the dredging and disposal of contaminated sediments in the coastal waters adjacent to Los Angeles County. The goals of this plan will be to develop unified multi-agency policies for the management of contaminated dredged material, promote multi-user disposal facilities and reuse, to the extent practicable, and support efforts to control contaminants at their source using a watershed management approach.

D. Preliminary Assessment of Remediation Actions

Dredging would be a proven method to remove the contaminated sediments, but identification of a suitable and legal disposal site often can be a problem. Treatment of contaminated sediments may be feasible, but is likely to be expensive and difficult to accomplish with marine sediments. In situ capping is not likely to be chosen as an alternative, due to the high flows that can occur in this area and the potential for reexposure and transport of contaminated material.

E. Cost Estimate to Implement Cleanup Plan

Dredging could be used to remove the contaminated sediments from the Dominguez Channel/Consolidated Slip area. However, identifying a suitable and legal disposal site for a large volume of contaminated sediments can be difficult. Application of this technique would cost an estimated $1 million to $5 million, based on a cost estimate of $20-100 per cubic yard (if a disposal site, such as a confined aquatic disposal or land disposal site, is available within or close to the Los Angeles/Long Beach Harbors complex, the cost estimate probably would approach the lower limit of the cost estimate range).

Treatment of the contaminated sediments is likely to be expensive. Application of this technique would cost an estimated $5 million to $50 million, based on a cost estimate of $100-$1,000 per cubic yard (due to limited experience in treating marine sediments, costs are likely to be in the upper part of the cost estimate range).

F. Estimate of Recoverable Costs from Dischargers

No responsible parties have been identified from which costs could be recovered.

G. Two-year Expenditure Schedule

The Regional Board plans to work with the Los Angeles Basin Contaminated Sediments Task Force to select a remediation alternative and implement the cleanup plan for the Consolidated Slip/Dominguez Channel hot spot. Additional sediment sampling will be required to precisely define the areal extent of the sediment contamination, prior to selection of an appropriate remediation alternative. This sampling program could be conducted during Year One, if funding becomes available (estimated cost approximately $250,000 - $500,000). If dredging is selected as the desired remediation method, the Regional Board will work with the Task Force to identify a suitable disposal alternative (e.g., constructed fill site, confined aquatic disposal site). A monitoring program would be required upon completion of any remediation activities; it is estimated that monitoring would cost $50,000 to $100,000 per year, and may be required for three to five years.

H. Benefits of Remediation

Remediation of the contamination would eliminate the immediate source of impairment of beneficial uses of the receiving waters. However, recontamination of the site from other areas is possible.

I. Environmental Impacts of Remediation

If capping or dredging is implemented, it could result in short-term impacts to the benthic infaunal community. However, this community would be expected to fully recover within 2-3 years. There is potential for release of contaminants into the marine environment during dredging, but proper management of this operation should minimize this risk. Special management practices would be required for disposal of contaminated sediments to contain the material and prevent releases of contaminants to the environment.

McGrath Lake

McGrath Lake is a 40-acre lake within McGrath State Beach Park and is under the stewardship of the California Department of Parks and

Recreation. The area is managed for low intensity uses, such as hiking and nature observation. Adjacent uses include oil-related facilities to the north and a power generating station to the south. Park land and agricultural fields lie to the east. A public beach is located immediately to the west end of the lake.

The lake surface currently measures approximately 3000 feet in length and is approximately 450 feet at its widest point. It is a shallow lake, with an average depth of approximately 2 feet. The southern portion of the lake generally is deeper than the northern portion, with a maximum depth of approximately 5 feet. The lake contains brackish water, with salinities varying from 2.5 to 5 parts per thousand throughout much of the lake, with higher salinities (up to 24 parts per thousand) in some of the deeper areas.

The lake does not have an ocean connection, but waves occasionally overtop the beach berm. Water is pumped from the lake to the ocean throughout most of the year to maintain a lowered lake level and avoid flooding of upstream agricultural fields. In addition, the lake is breached intermittently at the southern edge during the wet season to prevent flooding of nearby agricultural fields.

Water sources to the lake include seawater intrusion from the ocean through the coastal dunes, groundwater seepage, and irrigation and stormwater runoff. McGrath Lake was included on the Los Angeles Regional Water Quality Control Board's 1996 list of 303(d) impaired water bodies due to sediment pollution (elevated pesticides and other contaminants) and sediment toxicity. The lake was impacted in 1993 when a ruptured pipeline released nearly 80,000 gallons of crude oil into an agricultural ditch draining into the lake. However, PAH levels in the sediments are relatively low, suggesting little long-term effect on sediment contamination due to the oil spill.

The lake historically was part of the Santa Clara River Estuary. The backdune coastal lake is unique in Southern California and plays a key role in the avian migratory flyway. It is fronted by a coastal dune which is rare because of the undisturbed natural processes, which allow the dunes to continue to grow and build.

McGrath Lake is an important coastal resource that has been impaired by high levels of trace metals, pesticides, and other organic contaminants. Elevated levels of several chemical contaminants in the lake sediments and the demonstrated toxicity of these sediments appear to have limited productivity within the lake and threatens the health of wildlife, such as birds, associated with the habitats provided by the lake.

A. Areal Extent of Toxic Hot Spot

Sediment contamination appears to exist throughout most of McGrath Lake (Figure 13). To estimate the volume of contaminated sediments present in the lake, we have assumed that the layer of contamination extends down approximately 3 feet (based on core samples collected in 1998); however, the contaminated layer could extend deeper, since the sampling device employed for this study could not penetrate beyond this level. In addition, some of the shallowest areas of the lake were not sampled and could contain contaminated sediments. The total volume of contaminated sediments is estimated to be approximately 150,000 to 300,000 cubic yards.

In samples collected for the Bay Protection and Toxic Cleanup Program on January 13, 1993 and June 19, 1996, sediment concentrations at station 44027.0 exceeded the ERM Thresholds for chlordane, p,p'-DDE, Total DDT, Dieldrin and Total PCB. No sediment chemistry data were collected during the sediment toxicity screening survey conducted on April 13, 1994. Amphipod toxicity with whole sediments was observed at the single station tested on January 13, 1993, but in only one of the three replicate samples collected on April 14, 1994 (testing with Rhepoxynius abronius). No sediment toxicity was observed at the single station tested during the June 19, 1996 sampling period (testing with Eohaustorius estuarius). No benthic infaunal community analyses were performed.

During a sediment characterization investigation of McGrath Lake conducted in October 1998, sediment concentrations at several stations exceeded the ERM Thresholds for chlordane, Total DDT, dieldrin and Total PCB. During this 1998 survey, two stations (S1 and N1) exceeded the ERM Threshold for mercury. Sediment toxicity was observed at nine of the ten stations samples (all but S10) during this study (testing with Eohaustorius estuarius).

Benthic infaunal analyses indicated that McGrath Lake supports an extremely limited benthic community, in terms of number of species present and abundance. Insect larvae (family Chironomidae) were found at most stations, indicating a degraded benthic community.

B. Sources of Pollutants

Historical discharges of DDT and other pesticides, as well as PCBs, probably were responsible for some of the existing contamination. However, although sediment contamination has been found in the deeper layers of core samples collected from the lake, contaminant levels also were extremely high in the surficial sediments (top 2 centimeters), suggesting continuing present-day sources of contamination. Runoff from approximately 1000 acres of agricultural fields enters McGrath Lake and may be the primary source of both historical and current contamination problems. Although PCBs and the pesticides contaminating the lake's sediments have been banned from use for many years, residues may exist in the soil on the agricultural fields, acting as a continuing source of contamination as erosion and stormwater runoff carries material from the fields into the lake.

C. Actions by Regional Board

The Los Angeles Regional Board's Water Quality Assessment lists the following problems in McGrath Lake: aquatic life beneficial use is impaired due to sediment contamination (DDT, chlordane, dieldrin) and sediment toxicity. The Regional Board has adopted a watershed management approach, which is expected to regulate pollutant loads from point and non-point sources through permits that better focus on issues relevant to each watershed. During the 2003-2004 Fiscal Year, the watershed management approach will be used to renew NPDES permits within the Ventura Coastal Watershed.

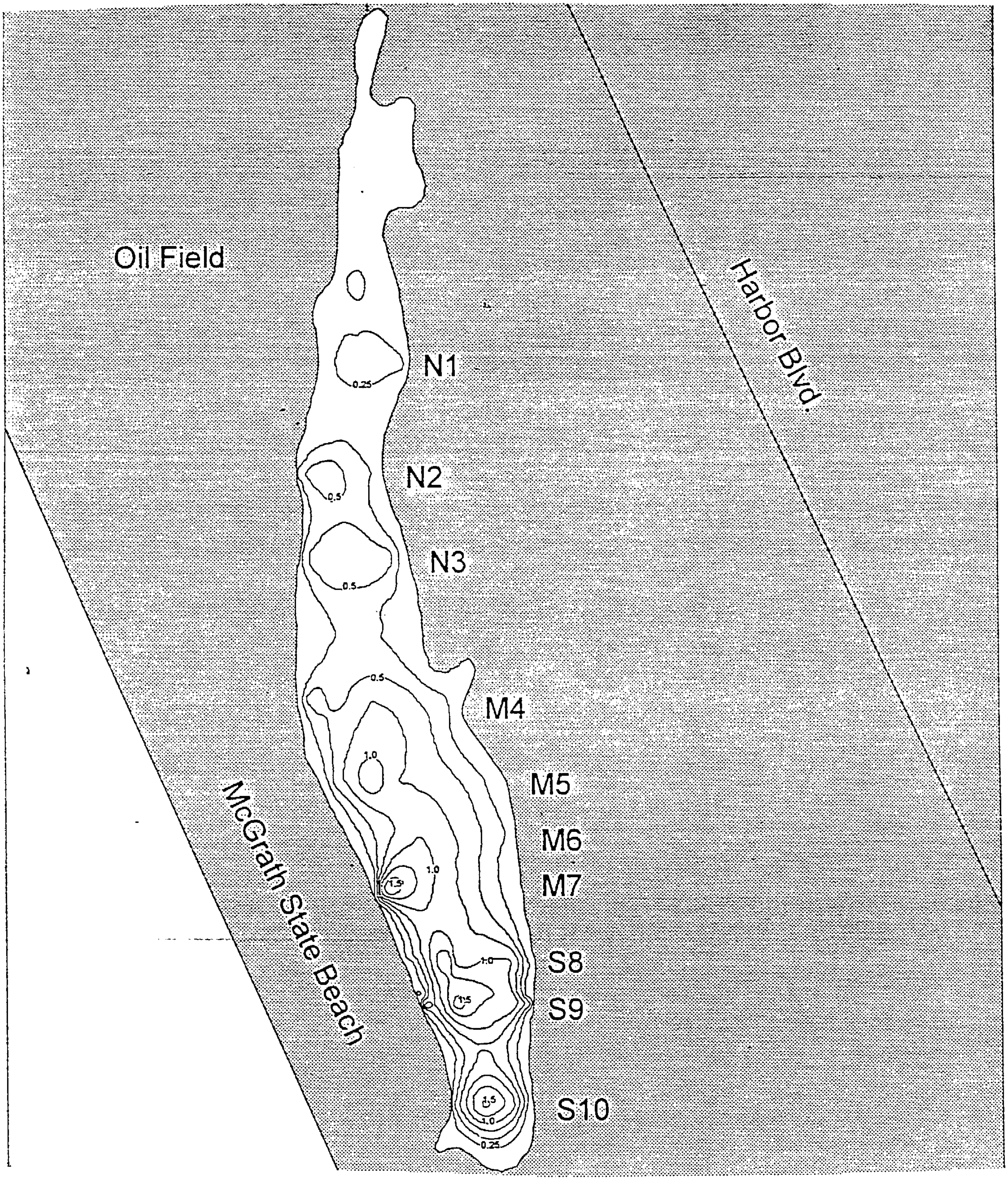


Figure 13. Areal extent of toxic hot spot within McGrath Lake.

McGrath Lake

Stations With Sediment Chemistry Concentrations Exceeding ERM Threshold

Station #	Sampling Date	Compound	Concentration
44027.0	1/13/93	Total Chlordane	150.8 ppb
44027.0	1/13/93	P,p'-DDE	1540 ppb
44027.0	1/13/93	Total DDT	3187 ppb
44027.0	1/13/93	Dieldrin	23.6 ppb
44027.0	6/19/96	Total Chlordane	233.1 ppb
44027.0	6/19/96	P,p'-DDE	1090 ppb
44027.0	6/19/96	Total DDT	1983.1 ppb
44027.0	6/19/96	Dieldrin	16.8 ppb
N1	10/98	Total Chlordane	37-450 ppb
N1	10/98	Total DDT	1464-2943 ppb
N1	10/98	Dieldrin	14.3-17.3 ppb
N1	10/98	Total PCB	298 ppb
N1	10/98	Mercury	1.5 ppm
N2	10/98	Total Chlordane	67-251 ppb
N2	10/98	Total DDT	2312-2758 ppb
N2	10/98	Dieldrin	14.3-26.2 ppb
N2	10/98	Total PCB	200 ppb
N3	10/98	Total Chlordane	67-541 ppb
N3	10/98	Total DDT	1713-2678 ppb
N3	10/98	Dieldrin	8.8-28.0 ppb
N3	10/98	Total PCB	200 ppb
M4	10/98	Total Chlordane	734 ppb
M4	10/98	Total DDT	2414 ppb
M4	10/98	Dieldrin	31.1 ppb
M4	10/98	Total PCB	448 ppb
M5	10/98	Total Chlordane	28-699 ppb
M5	10/98	Total DDT	543-3488 ppb
M5	10/98	Dieldrin	11.7-37.3 ppb
M5	10/98	Total PCB	260 ppb
M6	10/98	Total Chlordane	647 ppb
M6	10/98	Total DDT	2576 ppb
M6	10/98	Dieldrin	35.6 ppb
M6	10/98	Total PCB	243 ppb

M7	10/98	Total Chlordane	61-816 ppb
M7	10/98	Total DDT	994-3412 ppb
M7	10/98	Dieldrin	19.8-26.0 ppb
M7	10/98	Total PCB	185-310 ppb
S8	10/98	Total Chlordane	550 ppb
S8	10/98	Total DDT	2629 ppb
S8	10/98	Dieldrin	26.0 ppb
S8	10/98	Total PCB	227 ppb
S9	10/98	Total Chlordane	10-697 ppb
S9	10/98	Total DDT	150-2808 ppb
S9	10/98	Dieldrin	16.9 ppb
S10	10/98	Total Chlordane	30-486 ppb
S10	10/98	Total DDT	180-1369 ppb
S10	10/98	Dieldrin	14.5 ppb
S10	10/98	Mercury	2.6 ppm

D. Preliminary Assessment of Remediation Actions

Dredging would be a proven method to remove the contaminated sediments, but identification of a suitable and legal disposal site often can be a problem. Treatment of contaminated sediments may be feasible, but is likely to be expensive. In situ capping is not likely to be chosen as an alternative, due to the shallow nature of the lake and the high flows that can occur in this area, which could lead to reexposure and transport of contaminated material.

Source control measures appear necessary to prevent recontamination of the lake sediments. Flows from adjacent agricultural fields, which apparently continue to introduce pesticides and other contaminants into the lake, could be redirected away from the lake or treated to remove the contamination (e.g., settling basins could be used to remove particulates, which may remove much of the contaminant load).

E. Cost Estimate to Implement Cleanup Plan

Dredging could be used to remove the contaminated sediments from McGrath Lake. However, identifying a suitable and legal disposal site for a large volume of contaminated sediments can be difficult. Application of this technique would cost an estimated $3 million to $30 million, based on a cost estimate of $20-100 per cubic yard to remove 150,000 to 300,000 cubic yards of contaminated sediments.

Treatment of the contaminated sediments is likely to be expensive. Application of this technique would cost an estimated $15 million to $300 million, based on a cost estimate of $100-1000 per cubic yard (due to limited experience in treating dredged material, costs are likely to be in the upper part of the cost estimate range).

F. Estimate of Recoverable Costs from Dischargers

No responsible parties have been identified from which costs could be recovered.

G. Two-year Expenditure Schedule

The Regional Board plans to work with the McGrath State Beach Area Trustee Council, which is composed of representatives from the California Department of Fish and Game, California Department of Parks and Recreation and United States Fish and Wildlife Service. The Trustee Council was formed as a condition of settlement with Berry Petroleum following the 1993 oil spill. The Council is working with local stakeholders to develop a plan to remediate and restore the habitat values and maximize beneficial uses of McGrath Lake. The Council plans to address any residual problems related to the oil spill, as well as those caused by other sources (e.g., agricultural runoff).

Additional sediment sampling will be required to precisely define the areal extent and total volume of the sediment contamination problem, prior to selection of an appropriate remediation alternative. This sampling program could be conducted during Year One, if funding becomes available (estimated cost approximately $250,000 - $500,000). Source control measures to eliminate or reduce recontamination of the lake's sediments should be undertaken during Year Two prior to initiation of remediation of the existing sediment contamination. Although no specific funds have been secured for this source control effort, several potential sources are available, such as United States Environmental Protection Agency grants, Wetlands Restoration Program grants, Mitigation Project funds and enforcement action settlements.

H. Benefits of Remediation

Remediation of the sediment contamination and source control measures would eliminate the source of impairment of beneficial uses of the receiving waters of McGrath Lake and adjacent areas.

I. Environmental Impacts of Remediation

If dredging or treatment is implemented as the sediment remediation alternative, it could result in short-term impacts to the benthic infaunal community. However, this community would be expected to fully recover within 2-3 years. Dredging or treatment alternatives could result in short-term disturbances to wildlife in the area (e.g., birds), but proper management of this operation should minimize this risk. Special management practices would be required for disposal of contaminated sediments to contain the dredged material and prevent releases of contaminants to the environment. Long-term benefits associated with habitat improvement should result in a healthier and more productive benthic infaunal community, which would benefit migratory waterfowl and other organisms that utilize the lake for foraging and other activities.

Future Needs

Additional monitoring should be conducted at sites of concern to determine whether such sites meet the criteria for designation as candidate toxic hot spots in the future. Monitoring of candidate toxic hot spots also will be required to determine whether remediation efforts are successful in eliminating the hot spots or whether conditions improve without any directed remediation efforts.

Sites of Concern (Sites that do not qualify as Candidate Toxic Hot Spots)

Water body name	Segment Name	Site Identification	Reason for Listing	Pollutants present at the site	Report reference
Los Angeles Inner Harbor	Inner Fish Harbor	44019.0, 40019.2, 40019.3	sediment concentrations; sediment toxicity	DDT, PCB, metals (Cu, Hg, Zn)	[1]
Los Angeles Inner Harbor	Kaiser International	49004.0	sediment concentrations	DDT, PCB, PAH, Cu, Endosulfan	[1]
Los Angeles Inner Harbor	Hugo Neu Proler	46001.0, 46002.0	sediment concentrations	PCB	[1]
Los Angeles Inner Harbor	Southwest Slip	40001.2, 40001.3	sediment concentrations; sediment toxicity	DDT, PCB, PAH, metals (Hg, Cr), Benz[a]anthracene, Benzo[a]pyrene, Dibenz[a,h] anthracene	[1]
Long Beach Inner Harbor	Cerritos Channel	44011.0	sediment concentrations; sediment toxicity; accumulation in mussel tissue	DDT, PCB, metals, Chlordane, TBT	[1], [2]
Colorado Lagoon		44017.0	sediment concentrations; sediment toxicity; accumulation in mussel and fish tissue	DDT, PCB, metals (Pb, Zn), Chlordane, Dieldrin	[1], [2], [3] DFG
Shoreline Marina		44020.0, 48006.0, 48008.0	sediment concentrations; sediment toxicity	Zn, DDT, PCB, Chlordane, Phenanthrene	[1], [3]
~~McGrath Lake~~		~~44024.0, 44027.0~~	~~sediment concentrations; sediment toxicity~~	~~DDT, Chlordane, Dieldrin, Toxaphene, Endosulfan~~	~~[1]~~

Sites of Concern (Sites that do not qualify as Candidate Toxic Hot Spots)

Water body name	Segment Name	Site Identification	Reason for Listing	Pollutants present at the site	Report reference
Port Hueneme		44012.0, 44013.0	sediment concentrations; sediment toxicity; accumulation in mussel tissue;	DDT, PCB, PAH, metals (Zn, Cr), Benz[a]anthracene; Benzo[a]pyrene; Dibenz[a,h] anthracene	[1], [2]
Long Beach Outer Harbor		44018.1, 44018.2, 44018.3, 44020.1, 44020.2, 44020.3	sediment concentrations; sediment toxicity	DDT, Chlordane	[1]
Long Beach Inner Harbor	West Basin	40009.0, 40009.1, 40009.2, 40009.3	sediment concentrations; sediment toxicity; accumulation in clam tissue	DDT, PCB	[1]
Alamitos Bay		40021.1, 40021.2, 40021.3, 40022.1, 40022.2, 40022.3, 40023.1, 40023.2, 40023.3	sediment concentrations	DDT, Chlordane	[1]
King Harbor		48011.0	sediment concentrations; sediment toxicity	DDT, PCB	[1]
Channel Islands Harbor		44023.0	sediment concentrations; sediment toxicity	DDT, Ag	[1]

Reference list

[1] Anderson, B. et al. 1998. Sediment chemistry, toxicity and benthic community conditions in selected water bodies of the Los Angeles Regi Report to State Water Resources Control Board, Bay Protection and Toxic Cleanup Program Monitoring.

[2] State Mussel Watch Program, Los Angeles Region

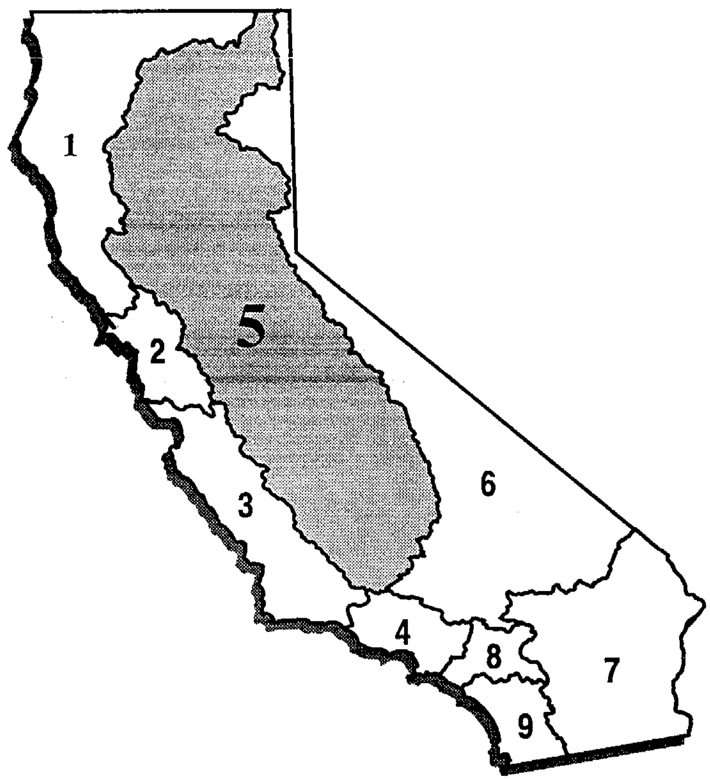
[3] Water Quality Assessment [303(d) List], Los Angeles Region, ~~December 1995~~ August 1996

Several sites have been listed in the table above as "Sites of Concern". These are sites that displayed signs of sediment contamination problems, primarily based upon data collected as part of the Bay Protection and Toxic Cleanup Program, but did not meet the criteria for designation as "Candidate Toxic Hot Spots". Although designation as a "Site of Concern" does not trigger any specific action under the Bay Protection and Toxic Hot Spot Program, these sites have been identified by the Regional Board so that they can be targeted for additional monitoring as funding becomes available.

Several of the Sites of Concern could not be designated as "Candidate Toxic Hot Spots" due to the lack of recurrent toxicity; in some cases, the sites were only sampled on one occasion, while in other cases, toxicity was observed on only one of the sampling events. Inner Fish Harbor, Southwest Slip, Cerritos Channel, Colorado Lagoon, Shoreline Marina, ~~McGrath Lake,~~ Port Hueneme, Long Beach Outer Harbor, West Basin, King Harbor and Channel Islands Harbor all fall into this category.

Hugo Neu Proler, Kaiser International, Alamitos Bay are listed as sites of concern due to sediment contamination, but sediment toxicity was not observed on any occasion.

REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION



REGIONAL TOXIC HOT SPOT
CLEANUP PLAN

Region Description

The Central Valley Region covers the entire area included in the Sacramento and San Joaquin River drainage basins. The two basins cover about one fourth of the total area of the State and include over 30% of the State's irrigable land. The Sacramento and San Joaquin Rivers furnish roughly 50% of the States water supply. Surface water from the two drainages meet and form the Delta which ultimately drains to San Francisco Bay.

The Delta, the area of primary focus for the BPTCP, is a maze of river channels and diked islands covering roughly 1,150 square miles, including 78 square miles of water area. Two major water projects located in the South Delta, the Federal Central Valley Project and the State Water Project, deliver water from the Delta to Southern California, the San Joaquin Valley, Tulare Lake Basin, the San Francisco Bay area, as well as within the Delta boundaries. The legal boundary of the Delta is described in Section 12220 of the Water Code.

Candidate Toxic Hot Spot List

Water body Name	Segment Name	Site Identification	Reason for Listing	Pollutants present at the site	Report reference
Delta Estuary	All	Delta	Aquatic Life	Diazinon	~~7, 8, 10,12, 13, 17~~ 8, 9, 11, 13, 14, 20
Delta Estuary	Various	Morrison Ck, Mosher, 5-Mile, Mormon Sls, & Calaveras R.	Aquatic Life	Diazinon & Chlorpyrifos	~~2, 3, 4~~ 1, 3, 4, 5, 17, 18
Delta Estuary	Various	Ulatis Ck, Paradise Cut, French Camp & Duck Sls	Aquatic Life	Chlorpyrifos	~~5,~~ 6, 7
Delta Estuary	All	Delta	Human Health	Mercury	~~9, 14, 18~~ 10, 15, 21
Delta Estuary	South Delta	San Joaquin River at City of Stockton	Water Quality Objective	Low Dissolved Oxygen	~~1, 11, 19~~ 2, 12, 22
Delta Estuary	Various	Smith Canal, Mosher & 5-Mile Sloughs and Calaveras R.	Water Quality Objective	Low Dissolved Oxygen	~~15~~ 16
Delta Estuary	All	Delta	Human Health	Chlordane, Dieldrin, Total DDT, PCBs, Endosulfan & Toxaphene	~~16~~ 19
Delta Estuary	All	Delta	Aquatic Life	Chlordane, Dieldrin, Lindane, Heptachlor, Total PCBs, PAHs, DDT	~~16~~ 19

References

Chen, C. and W. Tsai, 1997. Evaluation of alternatives to meet the dissolved oxygen objectives of the lower San Joaquin River. Prepared for SWRCB by Systech Engineering Inc. San Ramon, Ca.

Connor, V. 1994. Toxicity and diazinon levels associated with urban storm runoff. Staff memorandum, Central Valley Regional Water Quality Control Board, Sacramento, CA

Connor, V. 1995a. Status of urban storm runoff project. Staff memorandum, Central Valley Regional Water Quality Control Board, Sacramento, CA

Connor, v. 1996. Chlorpyrifos in urban storm runoff. Staff memorandum, Central Valley Regional Water Quality Control Board, Sacramento, CA

Deanovic, L. H. Bailey, T.W. Shed and D. Hinton. 1996. Sacramento-San Joaquin Delta Bioassay monitoring report. 1993-94. First annual report to the Central Valley Regional Water Quality Control Board.

Deanovic, L. H. Bailey, T.W. Shed and D. Hinton. 1998. Sacramento-San Joaquin Delta Bioassay monitoring report. 1994-95. Second annual report to the Central Valley Regional Water Quality Control Board.

Foe, C. and R. Sheipline 1993. Pesticides in surface water from application on orchards and alfalfa during the winter and spring of 1991-92. Staff report, Central Valley Regional Water Quality Control Board, Sacramento, CA

Foe, C. 1995. Insecticide concentrations and invertebrate bioassay mortality in Agricultural return water from the San Joaquin Basin. Staff report, Central Valley Regional Water Quality Control Board, Sacramento, CA

Foe, C. and W. Croyle. 1998. Mercury concentrations and loads from the Sacramento River and Cache Creek to the Sacramento-San Joaquin Delta Estuary. Central Valley Regional Water Quality Control Board staff report. Sacramento Office.

Foe, C., L. Deanovic and D. Hinton 1998. Toxicity Identification Evaluations of Orchard Dormant Spray Storm Runoff. Central Valley Regional Water Quality Control Board Staff Report, Sacramento Office.

Jones and Stokes Associates. 1998. Potential Solutions for Achieving the San Joaquin River Dissolved Oxygen Objective. Report prepared for De Cuir and Somach and the City of Stockton. Jones and Stokes Associates, 2600 V Street, Suite 100, Sacramento, CA 95818.

Kratzer, C. 1977. Transport of diazinon in the San Joaquin River Basin, California. U.S. Geological Survey open file report 97-411. Sacramento 22p.

Kuivila, K and C. Foe. 1995. Concentration, transport and biological impact of dormant spray insecticides in the San Francisco Estuary, California. Env. Toxicol. and Chem. 14:1141-1150

Larry Walker and Associates, 1997. Sacramento River mercury control planning project. Prepared for the Sacramento Regional County Sanitation District.

Larson, K.K. Cortright, V. Connor, P. Young, L. Deanovic and D. Hinton. 1998. Stockton fish kills associated with urban storm runoff: the role of low dissolved oxygen. University of California Report prepared for the Central Valley Regional Water Quality Control Board.

Montoya, B. 1991. An analysis of the toxic water quality impairments in the Sacramento-San Joaquin Delta Estuary. Staff report, Central Valley Regional Water Quality Control Board, Sacramento, CA

Novartis Crop Protection, 1997. An ecological risk assessment of diazinon in the Sacramento and San Joaquin River Basins. Technical report 11/07 Environmental and Public affairs department Greensboro, NC

San Francisco Bay Regional Water Quality Control Board, 1995. Contaminant levels in fish tissue from San Francisco Bay. Staff report prepared jointly by the San Francisco Regional Board, the State Water Resources Control Board, and the Department of Fish and Game.

~~Schantz, R. and C. Chen, 1993. City of Stockton water quality model: Volume I. Model development and calibration. Prepared by Phillip Williams and Associates, San Francisco, CA.~~

1. Bailey, H., L. Deanovic, K. Luhman, T. Shed, and D. Hinton. 1996. Pesticides in Urban stormwater from the Sacramento Valley and the San Francisco Bay Area. Poster presentation In Third annual State of the Estuary Conference. October 10-12 San Francisco, CA. p51.

2. Chen, C. and W. Tsai, 1997. Evaluation of alternatives to meet the dissolved oxygen objectives of the lower San Joaquin River. Prepared for SWRCB by Systech Engineering Inc. San Ramon, Ca.

3. Connor, V. 1994. Toxicity and diazinon levels associated with urban storm runoff. Staff memorandum, Central Valley Regional Water Quality Control Board, Sacramento, CA

4. Connor, V. 1995a. Status of urban storm runoff project. Staff memorandum, Central Valley Regional Water Quality Control Board, Sacramento, CA

5. Connor, v. 1996. Chlorpyrifos in urban storm runoff. Staff memorandum, Central Valley Regional Water Quality Control Board, Sacramento, CA

6. Deanovic, L. H. Bailey, T.W. Shed and D. Hinton. 1996. Sacramento-San Joaquin Delta Bioassay monitoring report. 1993-94. First annual report to the Central Valley Regional Water Quality Control Board.

7. Deanovic, L. H. Bailey, T.W. Shed and D. Hinton. 1998. Sacramento-San Joaquin Delta Bioassay monitoring report. 1994-95. Second annual report to the Central Valley Regional Water Quality Control Board.

8. Foe, C. and R. Sheipline 1993. Pesticides in surface water from application on orchards and alfalfa during the winter and spring of 1991-92. Staff report, Central Valley Regional Water Quality Control Board, Sacramento, CA

9. Foe, C. 1995. Insecticide concentrations and invertebrate bioassay mortality in Agricultural return water from the San Joaquin Basin. Staff report, Central Valley Regional Water Quality Control Board, Sacramento, CA

10. Foe, C. and W. Croyle. 1998. Mercury concentrations and loads from the Sacramento River and Cache Creek to the Sacramento-San Joaquin Delta Estuary. Central Valley Regional Water Quality Control Board staff report. Sacramento Office.

11. Foe, C., L. Deanovic and D. Hinton 1998. Toxicity Identification Evaluations of Orchard Dormant Spray Storm Runoff. Central Valley Regional Water Quality Control Board Staff Report, Sacramento Office.

12. Jones and Stokes Associates. 1998. Potential Solutions for Achieving the San Joaquin River Dissolved Oxygen Objective. Report prepared for De Cuir and Somach and the City of Stockton. Jones and Stokes Associates, 2600 V Street, Suite 100, Sacramento, CA 95818.

13. Kratzer, C. 1977. Transport of diazinon in the San Joaquin River Basin, California. U.S. Geological Survey open file report 97-411. Sacramento 22p.

14. Kuivila, K and C. Foe. 1995. Concentration, transport and biological impact of dormant spray insecticides in the San Francisco Estuary, California. Env. Toxicol. and Chem. 14:1141-1150

15. Larry Walker and Associates, 1997. Sacramento River mercury control planning project. Prepared for the Sacramento Regional County Sanitation District.

16. Larson, K.K. Cortright, V. Connor, P. Young, L.Deanovic and D. Hinton. 1998. Stockton fish kills associated with urban storm runoff: the role of low dissolved oxygen. University of California Report prepared for the Central Valley Regional Water Quality Control Board.

17. Larson, K.K.,V.Connor, L.Deanovic, and D. Hinton. 1998. Sacramento River Watershed project. Toxicity monitoring results:

1997-98. Report prepared for the Sacramento Regional County Sanitation District by the U.C. Davis Aquatic Toxicology Laboratory. Davis, CA.

18. Larson, K.K.,V.Connor, L.Deanovic, and D. Hinton. 1998. Sacramento River Watershed project. Toxicity monitoring results: 1997-98. Report prepared for the Sacramento Regional County Sanitation District by the U.C. Davis Aquatic Toxicology Laboratory. Davis, CA.

19. Montoya, B. 1991. An analysis of the toxic water quality impairments in the Sacramento-San Joaquin Delta Estuary. Staff report. Central Valley Regional Water Quality Control Board, Sacramento, CA

20. Novartis Crop Protection, 1997. An ecological risk assessment of diazinon in the Sacramento and San Joaquin River Basins. Technical report 11/07 Environmental and Public affairs department Greensboro, NC

21. San Francisco Bay Regional Water Quality Control Board, 1995. Contaminant levels in fish tissue from San Francisco Bay. Staff report prepared jointly by the San Francisco Regional Board, the State Water Resources Control Board, and the Department of Fish and Game.

22. Schantz, R. and C. Chen, 1993. City of Stockton water quality model: Volume I. Model development and calibration. Prepared by Phillip Williams and Associates, San Francisco, CA.

Ranking Matrix

Water body Name	Site Identification	Human Health Impacts	Aquatic Life Impacts	Water Quality Objectives	Areal Extent	Remediation Potential	Overall Rank
Delta Estuary	Delta		High		>10 acres	High	High [1]
Delta Estuary	Morrison Ck, Mosher, 5-Mile, Mormon Sls & Calaveras R.		High		>10 acres	High	High [1]
Delta Estuary	Ulatis Ck, Paradise Cut, French Camp & Duck Sls		High		>10 acres	High	High[1]
Delta Estuary	Delta, Cache Creek	High			>10 acres	High	High
Delta Estuary	San Joaquin River @ City of Stockton			High	>10 acres	High	High
Delta Estuary	Smith Canal, Mosher & 5-Mile Sloughs and Calaveras R.		High	Moderate	>10 acres	High	Moderate [2]
Delta Estuary	Delta	Moderate			>10 acres	Moderate	Moderate
Delta Estuary	Delta		Moderate		>10 acres	Moderate	Moderate

1/ No cleanup plan provided as the Regional Board directed staff to seek site specific variance for pesticides.

2/ Sites ranked as moderate because of the lower importance of the water bodies involved.

High Priority Candidate Toxic Hot Spot Characterization

Mercury Clean up Plan

Background

Mercury has been identified in part II of the cleanup plan as responsible for creating a candidate BPTCP hot spot in the Sacramento-San Joaquin Delta Estuary. In January 1998 the Central Valley Regional Water Quality Control Board adopted a revised 303(d) list, ranked mercury impairments in the lower Sacramento River, Cache Creek, Sulfur Creek , Lake Berryessa, Clear Lake and the Sacramento-San Joaquin Delta Estuary as high priority because of elevated concentrations in fish tissue and committed to the development of a load reduction program by the year 2005[1]. The widespread distribution of mercury contamination emphasizes the regional nature of the problem and the need for regional solutions.

Mercury is a potent human neurotoxin with developing fetuses and small children being most at risk. The principal route of human exposure is through consumption of mercury contaminated fish. In 1970 a human health advisory was issued for the Sacramento-San Joaquin Delta Estuary advising pregnant women not to consume striped bass. In 1994 an interim health advisory was issued by the Office of Environmental Health Hazard Assessment (OEHHA) for San Francisco Bay and the Delta recommending no consumption of large striped bass and shark because of elevated mercury and PCB concentrations.

Factors which promote excess mercury in fish tissue are not well understood. To a large extent this is because until very recently there was no methodology to measure mercury at environmental concentrations (part per trillion) in surface water. However, it is generally agreed that mercury biomagnifies in the aquatic food chain with fish in California often having a million times more mercury, on a weight basis, than ambient water. Methyl mercury is the most toxic form of mercury and the primary form

[1]The lower American River, lower Feather River, Harley Gulch, Sacramento Slough, March Creek and Reservoir, San Carlos Creek, James Creek, and Panoche Creeks were also placed on the 303(d) list as impaired because of excess mercury but were given a lower priority for cleanup.

accumulating in the aquatic food chain. Over ninety percent of the mercury in fish tissue is usually in the form of neurotoxic methyl mercury. Conversion of inorganic to organic mercury appears to be controlled primarily by microorganisms, mostly sulfate reducing bacteria in sediment. Important factors in other systems which appear to control the conversion rate of inorganic to organic mercury include temperature, percent organic matter, redox potential, salinity, pH and mercury concentration (Gilmour, 1994). Neither the primary locations of methyl mercury production nor the principal factors controlling methylation are yet known for any location in the Central Valley.

In California mercury was historically mined in the Coast Range both north and south of San Francisco Bay and transported across the Valley for use in placer gold mining in the Sierra Nevadas. Both operations caused widespread mercury sediment contamination in water courses in the Coast Range, Sierra Nevada Mountains, Valley floor, and Sacramento-San Joaquin Delta Estuary.

The limited mercury work undertaken so far in the Central Valley has concentrated on estimating mercury loads to the Estuary and on determining *in situ* mercury bioavailability in valley waterways. A loading study conducted by Larry Walker and Associates (1997) estimated that 640 kg of mercury were exported by the Sacramento watershed to the Estuary between October 1994 and September 1995. Most of the material was contributed during winter high flow periods. Surprisingly, the Feather and American River watersheds, sites of intensive historical placer gold mining activity, only accounted for about 25 percent of the total load. The majority of mercury appeared to originate from the Sacramento watershed above the confluence of the Feather River. The Sacramento Regional Wastewater Treatment Plant, the largest NPDES discharger in the Region, accounted for less than 2 percent of the total load.

In a companion study mercury concentration in aquatic invertebrates and fish in the historic gold mining region of the Sierra Nevada Mountains was evaluated (Slotton *et al.*, 1997a). Concentrations of mercury in aquatic indicator organisms increased in a predictable fashion with increasing trophic feeding level. A clear signature of mine derived mercury was found associated with the most intensively worked river stretches.

Mercury concentrations were lower in non-hydrologically mined reaches of the Feather and American Rivers.

Foothill reservoirs were found to operate as traps for both bioavailable and sediment associated inorganic mercury (Slotton *et al.*, 1997a; Larry Walker and Associates, 1997). Significantly lower levels of mercury were found in aquatic organisms below reservoirs as compared to concentrations both in and above them. Similarly, bulk loads of mercury entering foothill reservoirs were greater than the amount exported. This suggests that foothill reservoirs in placer gold mining districts may act as interceptors of mercury, trapping and preventing downstream transport to the Estuary. This may explain the lower than expected loads measured by Larry Walker and Associates (1997) in the Feather and American Rivers.

Between 1993 and 1995 the Central Valley Regional Board also conducted a bulk mercury loading study to the Estuary from the Sacramento watershed. The study differed from that of Larry Walker and Associates (1997) in that the Regional Board study also included an assessment of loads from the Yolo Bypass during high flows. During flood conditions the Bypass receives overflow from the Sacramento River and significant input from several coastal watersheds.

The Regional Board estimated that the Sacramento Watershed (Sacramento River at Greene's Landing plus Yolo Bypass at Prospect Slough) exported 800 kg of mercury to the Estuary between May 1994 and April 1995 (Foe and Croyle, 1998). Staff found, like Larry Walker and Associates, that most of the mercury was transported into the Estuary during high flow periods. High mercury concentrations in the Yolo Bypass suggested possible local inputs. Follow up studies demonstrated that Cache Creek was exporting about 1,000 kg of mercury during the year. Half of the mercury appeared to be trapped by the Cache Creek Settling Basin at the confluence with the Bypass while the remainder was exported to the Estuary.

In the spring of 1996 a one time benthic invertebrate survey was conducted in the upper Cache Creek basin to determine local mercury bioavailability (Slotton *et al.*, 1997b). All invertebrate tissue samples with mercury concentrations greater than background were associated with known mercury mines or geothermal hot springs. These included Sulfur and Davis Creeks, Harley Gulch, and the discharge from Clear Lake. The highly localized nature of these sites was demonstrated by the lower biotic tissue concentrations in adjacent streams without historic mercury mining activity. Invertebrates collected in the upper mainstem of Cache Creek away from all historic mining activity had tissue concentrations comparable to similar indicator organisms obtained from mainstem Sierra Nevada River gold mining activity that Coast range mercury is at least as bioavailable as that in the Sierras. However, tissue concentrations in Cache Creek decreased downstream suggesting that much of the large bulk loads of mercury observed by the Regional Board might not be very biologically available in the lower watershed.

Limited fish tissue sampling has occurred in Cache Creek. Most sampling has been conducted in the lower watershed between Woodland and the Settling Basin. Mean mercury concentrations in fish of a size eaten by people ranged between 0.2 and 0.4 ppm for benthic predators (channel and white catfish) and between 0.4 and 0.9 ppm composite fillet wet weight for water column predators (squawfish, crappie, small and large mouth bass, Davis, 1998; Slotton *et al.*, 1997b). Concentrations in small fish (2-4 inches) suitable for consumption by wildlife ranged between 0.1 and 0.3 ppm whole body wet weight. Sufficient data have not yet been collected to warrant evaluating the Cache Creek watershed for a possible human health fish consumption advisory.

Estuarine bioavailability of Cache Creek mercury is not known. However, the Creek serves as the major water source for the recently created Yolo Wildlife Refuge. In addition, the CALFED Bay Delta Program is proposing to purchase large areas downstream in the Yolo Bypass and further out in the Estuary for conversion to shallow water wildlife habitat. Follow up studies are needed to ascertain the methylation potential of mercury at such sites and also to compare the methylation potential of mercury from sources in the Coast Range to that from the Sierra Nevada Mountains.

A. Areal Extent

There is a human health advisory in effect in the Delta and in San Francisco Bay because of elevated mercury levels in striped bass and other long lived fish. The entire area of the Delta is therefore considered a hot spot. The Delta is a maze of river channels and diked islands covering roughly 78 square miles of open water and about 1,000 linear miles of channel.

Cache Creek is a 1100 square mile watershed in the Coast Range with about 150 linear miles of mercury impacted waterways. The watershed also contains Clear Lake, the largest natural lake in California at 43,000 acres. A human health advisory has been posted in Clear Lake because of elevated mercury concentrations in fish tissue. The source of the mercury is Sulphur Bank Mine, a U.S. EPA Superfund site.

B. Sources

Four major bulk sources of mercury have been identified for the Sacramento-San Joaquin Delta Estuary. They are: (1) exports from the placer gold mining regions of the Sierra Nevada Mountains, (2) mercury mining in the Coast Range, (3) resuspension of estuarine sediment, and (4) effluent from municipal and industrial discharges to surface water. Not known, but critically important, is the relative methylation potential of mercury from each source once in the estuary. The four sources are briefly reviewed below.

1. Sierra Nevada Mountains It has been estimated that over 3 million kg of mercury were lost in the Sierra Nevada Mountains during the gold rush (Montoya, 1987). All this mercury was initially in an elemental form (quicksilver) and most of it is probably still highly oxidized. Foothill reservoirs appear to trap most of the bioavailable and total mercury entering them. Therefore, only the mercury presently located in water courses below the foothill reservoirs appear available for transport into the estuary, unless major flooding events move large volumes of sediment downstream from behind reservoirs. This needs evaluation.

2. Coast Range Some of the largest historic mercury mines in the world were located in the Coast Range both north and south of San Francisco Bay. Most of the mercury in the Coast Range is as mercuric sulfide (cinnabar) and is probably emanating from abandoned mine portals and deposits around retorts and slag piles, geothermal springs and seeps, and erosion of mercury rich landforms. The Coast Range is drier than the Sierra Nevada Mountains and therefore has fewer reservoirs and permanently flowing waterways. Off site movement of

mercury from the Coast Range appears to occur mostly in the winter after large rainstorms although evidence from Clear Lake indicates it may be occurring year-round. Cache Creek has been identified as a major source of mercury to the Estuary. Sites in the Cache Creek watershed with highly bioavailable loads include runoff from Sulfur Creek, Harley Gulch, Schneider Creek and Clear Lake.

3. Sediment Potentially the largest source of mercury is already present in the Estuary buried in sediment. Mercury from sediment is potentially available through natural fluxing, bioturbation, scour and erosion from wave action, dewatering and beneficial reuse of dredge spoils on levees, and creation of intertidal shallow water habitats by breaking levees and reflooding Delta agricultural land. Potential bioavailability of mercury from each action depends on, among other things, the chemical form of the metal in sediment and environmental conditions in the Estuary which influence biological processes at the time of release to the food chain.

Municipal and Industrial Discharges Undoubtedly, the smallest source of mercury to the Estuary is from permitted municipal and industrial discharges to surface water. Load estimates are only available for the Sacramento Regional Wastewater Treatment Plant, the largest discharger in the Central Valley. The facility was estimated to have discharged 9.9 kg of mercury during water year 1995 (Larry Walker and Associates, 1997). This represents less than 2 percent of the total annual load from the Sacramento Basin. More recent mercury effluent data indicates that the annual mass discharge from the Regional Plant may be as low as 2 kg/yr. This contribution represents less than one percent of the total mercury load from the Sacramento watershed at Rio Vista (personal communication, Grovhoug).

C. Summary of Actions

Three actions have been taken in the Central Valley to begin addressing the human health problems posed by mercury. Each is summarized below.

Loading studies Bulk mercury loading studies conducted by the Central Valley Board (Foe and Croyle, 1998) and by Larry Walker and Associates (1997) on the Sacramento River have determined that new loads of metal enter the estuary each year during high flows. Coast Range inputs appear more important than Sierra Nevada ones as a significant fraction of the inputs from the latter are intercepted and trapped by foothill reservoirs. Cache Creek has been identified as an important Coast Range mercury source. Other sources on the Sacramento River upstream of the confluence of the Feather River may also be important but remain unidentified.

Bioavailability Studies by Slotton *et al.* have determined that fish tissue concentrations can be predicted from changes in mercury concentration in invertebrate trophic levels. This relationship has been used to standardize mercury food chain bioaccumulation in the Central Valley and identify local areas where fish may or may not be present but elevated concentrations of bioavailable mercury are accumulating in the food chain. The studies have identified areas with apparent high methylation potential in the Sierra Nevadas and Coast Range. All are associated with past intensive gold, silver and mercury mining. The process has also suggested that some sites with large bulk mercury loads, such as the Cache Creek drainage, might not be as vulnerable to methyl mercury production as their loads would suggest. Similar food chain studies need to be completed for all mercury rich areas in the Central Valley.

CALFED The CALFED Water Quality Common Program has identified mercury as a contaminant of concern. The program is developing actions to attempt to reduce mercury tissue concentrations in edible fish from the Central Valley and Delta to concentrations below health advisory levels. A draft of the Water Quality Common Program is presently being circulated among the public for comment.

The CALFED Category III Ecosystem Restoration Program has proposed to purchase large tracts of farmland in the Estuary, break levees, and convert the fields to shallow water intertidal habitat. Newly flooded wetlands are known to have elevated rates of methyl mercury production and concern has been expressed that CALFED restoration activities might increase methyl mercury concentrations in estuarine fish. The CALFED Category III program announced in December 1997 that they would fund a grant entitled "The effects of wetland restoration on the production of methyl mercury in the San

Francisco Bay Delta System" by Drs. Suchanek and Slotton. Purpose of the three year project is to quantify changes in methyl mercury production caused by restoration practices and evaluate the bioavailability and impact of the mercury on the Bay Delta Ecosystem. The ultimate intent of the Authors is to provide recommendations to managers for potentially modifying restoration approaches to minimize methyl mercury production.

D. Assessment of Actions Required

In January 1998 the Central Valley Regional Board adopted a revised 303(d) list, ranked mercury in fish tissue as a high priority impairment in several Central Valley water bodies and committed to adopting a TMDL to control mercury bioaccumulation by the year 2005. The purpose of the Bay Protection mercury clean up plan is to lay out a strategy for collecting the information needed to develop a phased TMDL with the initial emphasis in Cache Creek.

According to the U.S. EPA (1998), *"the goal of a TMDL is the attainment of water quality standards. A TMDL is a written quantitative assessment of water quality problems and the contributing pollutant sources. It specifies the amount of reduction needed to meet water quality standards, allocates load reductions among sources... and provides the basis for taking actions to restore a water body".*

It will be challenging to successfully implement a TMDL for mercury in the Central Valley as there are fundamental unresolved scientific questions about mercury bioaccumulation in aquatic food chains. Principal among these is a lack of knowledge about the primary chemical forms of mercury most efficiently methylated and the locations and processes which most stimulate the conversion. Therefore, Regional Board staff propose a phased mercury TMDL. Staff propose to commence pilot mercury control work in Cache Creek, a major source of mercury to the Estuary. As the necessary scientific information is obtained and success demonstrated in the control of bioavailable mercury in this watershed, then similar control efforts will be undertaken in other mercury enriched water courses and in the estuary itself. The working hypothesis for the estuary is that as all bioavailable sources of mercury to the estuary are identified and their discharge reduced to the maximum extent possible, then material already present in the system will gradually become buried and less bioavailable. The result will be a slow reduction in mercury fish tissue levels.

The U.S EPA (1998) suggests that the successful development of a TMDL requires information in six general areas: identification of a target, location of sources, quantification of the amount of reduction needed, allocation of loads among sources, an implementation plan, and monitoring and evaluation to track results and demonstrate compliance. Regional Board staff also believe that a seventh element, formation of a regional mercury taskforce, is needed to help guide the control effort. Each element, including the associated scientific uncertainties and resources needed to resolve these, is briefly described below.

1. **Task force**. A regional mercury control strategy task force should be formed. The Task Force should be composed of scientists, watershed stakeholder groups, and resource managers from both the Central Valley and San Francisco Bay area. The nucleus of the Task Force could be the Cache Creek Mercury Group. Purpose of the Task Force would be to advise Regional Board staff on the definition of an appropriate target, on the identification of sources and the allocation of loads, on developing the regional mercury control strategy, and as a clearing house for mercury information. Regional Board staff will take the Task Force's recommendations and develop the mercury TMDL Basin Plan amendment. If the Task Force is unable to make recommendations in a timely fashion, the staff will develop the TMDL considering all information and advice available. Finally, the Task Force should make recommendations to the Regional Board, CALFED, and other entities on funding priorities.

2. **Target**. Purpose of the Cache Creek mercury TMDL is to reduce fish tissue mercury concentrations to levels that are safe for ingestion by humans and wildlife. Several possible fish tissue mercury targets should be evaluated and one selected for incorporation into the TMDL. Possible options are the identification of a fish tissue concentration that would fully protect both wildlife and human health. An alternate target is the identification of a background Cache Creek fish tissue

concentration in areas of the watershed uninfluenced by mining or other anthropogenic activities which enhance mercury bioavailability.

Wildlife The U.S. Fish and Wildlife Service has identified *Mergus merganser,* the common merganser, as the wildlife species most likely at risk from elevated fish tissue mercury concentrations in Cache Creek (personal communication, Schwarzbach). The bird is known to breed in the Cache Creek basin and elevated mercury levels in its diet may cause reproductive impairment. Principal merganser prey items are small (3-7 inch) fish. The U.S. Fish and Wildlife Service estimate that the provisional "no and low effect dietary concentrations" for the common merganser range between 0.1 and 0.3 ppm mercury fish wet weight (personal communication, Schwarzbach). Limited data exist in the basin for mercury concentrations in small fish. Values collected in the lower basin range between 0.1 and 0.3 ppm (Davis, 1998) and in Bear Creek in late summer between 0.3 and 1.75 ppm whole body wet weight (personal communication, Schwarzbach). These values suggest that mergansers may presently experience reproductive impairment at some locations in the basin. The safe concentration estimate of 0.1 ppm wet weight is based upon a three generation mallard feeding study (Heinz, 1979). The safe value was calculated by dividing the lowest effect concentration by a factor of three. The U.S. EPA (1997) in their Report to Congress used a similar safety factor to estimate no effect concentrations. The Cache Creek wildlife target could be improved by completion of a mercury dietary study for a fish eating bird, such as a merganser, to verify the proposed no and low effect levels. The study should also evaluate seasonal changes in mercury concentrations in feathers. The risk posed by mercury to wildlife could be further strengthened by conducting an egg-feather survey in Cache Creek and elsewhere around the Estuary to ascertain how mercury concentrations in eggs and feathers of fish eating birds compare to those documented to be toxic in the merganser feeding study. Such studies are proposed in Table 1 as part of the basic scientific needs for completion of the TMDL implementation plan.

Human Health The U.S. EPA (1995) presently recommends a mercury screening value of 0.6 ppm wet weight in fish fillet to protect human health. International studies of the human health effects of mercury exposure via fish consumption are underway in the Seychelles and Faroes Islands. The reference level protective of human health may change as a result of these studies which are expected to be completed and analyzed within the next several years. A better estimate of a safe mercury concentration to protect human health should be available upon completion of this work.

Limited mercury fish tissue data is available for Cache Creek. Most of the data has been collected in the lower basin between the City of Woodland and the Settling Basin. As noted previously, average mercury concentrations in predacious fish of a size consumed by people range between 0.2 and 0.9 ppm wet weight. Staff of the California Office of Environmental Health Hazard Assessment (OEHHA) have evaluated this data and concluded that, while more information is needed, some of the concentrations appear elevated for human consumption (personal communication, Brodberg).

A follow-up fish tissue study is needed. The purpose of the study is two fold. The first objective is to determine mercury concentrations in fish caught throughout the basin to better characterize the threat posed to human health and wildlife by the consumption of fish from Cache Creek. The second objective is to establish statistically reliable baseline data to evaluate the effect of mercury remediation activity in the Basin. The study should emphasize the seasonal collection of a variety of fish species at locations most likely used by people and wildlife. The study should be coordinated with OEHHA, local offices of County Public Health, Fish and Game and U.S. Fish and Wildlife Service. Resources are requested in Table 1 to collect the fish tissue data. Funds are also requested for OEHHA to help organize the study and evaluate the data.

Baseline No baseline fish tissue data is available for Cache Creek. Efforts should be undertaken to establish such data at locations in the watershed unaffected by mining activity. Possible locations for evaluation include Rayhouse, Fiske, Cole, Kelsey, Adobe, Scott and Middle Creeks. One or more of these locations should be included in the fish tissue studies described above. The data would be evaluated to ascertain whether the baseline concentrations are lower than the concentrations necessary to protect human health and wildlife.

If so, the value might be considered an "anti-degradation" type of target.

3. **Sources.** Two mercury source studies were conducted in the Cache Creek Basin. The first was a loading study to determine the amount of total recoverable mercury exported from the watershed and the principal seasonal sources within the basin (Foe and Croyle, 1998). The second was an invertebrate bioavailability study to determine the major locations in the basin where mercury was bioaccumulating in the aquatic food chain (Slotton *et al.*, 1997b). Both are briefly reviewed below to help identify the major mercury sources needing remediation.

   Loading Studies Studies conducted between 1996-98 determined that Cache Creek was a major source of estuarine mercury (Foe and Croyle, 1998). Most of the mercury appeared to be transported on sediment particles. A correlation was noted between total mercury concentration at Road 102 and flow immediately upstream at the Town of Yolo. The relationship was employed to estimate bulk mercury loads. The basin was estimated to have exported 980 kg of mercury during the wet 1995 water year. Half of the metal appears to have been trapped by the Cache Creek Settling Basin while the remainder was exported to the Estuary. In contrast, little to no mercury was predicted to be transported out of the Basin during dry years emphasizing the importance of winter runoff in the off site transport of mercury.

   Seasonal studies demonstrate three general loading patterns: summer irrigation season, winter non-storm runoff periods, and winter storm runoff events. The irrigation season occurs during the six month period between April and October. Mercury transport rates in the upper basin were on the order of 10-50 g/day with most of the metal coming from Clear Lake. Probable source of the Clear Lake mercury is from the Sulfur Bank Mine, an EPA Superfund site. The winter non-storm period is the next most common event and occurs between November and March. The only observations to date have been make during wet winters. Mercury export rates were on the order of 100-1,000 g/day. Much of the mercury appears to have originated from Benmore and Grizzly Creeks which are tributaries to the North Fork of Cache Creek. Finally, storm runoff events were least common and occurred about 4-10 times per wet year. All subbasins of Cache Creek exported significant amounts of mercury but the majority of the metal appeared to come from the Cache Creek canyon between the confluence of the North and South Forks but above Bear Creek. The precise source(s) of the metal in the inaccessible canyon was not identified. Sulfur Creek and Harley Gulch, sites with extensive abandoned mining activity, also exported large amounts of mercury. Storm export rates were on the order of 5,000-100,000 g/day. Resuspension of mercury contaminated sediment appears to be a major source of mercury during all three time periods. Little dissolved and no methyl mercury data was collected. These two forms of mercury may provide a better correlation with *in situ* bioavailability than the bulk mercury mineral loads measured in this study.

Additional loading information is needed. Emphasis should be on collecting seasonal information on dissolved and methyl mercury loads at key locations throughout the basin including several background sites and all major mercury mining sources. Funding is requested for Cache Creek loading studies in Table 1.

<u>Bioavailability studies</u> In the spring of 1996 a one time benthic invertebrate survey was conducted in the upper Cache Creek basin to determine local mercury bioavailability (Slotton *et al.*, 1997). Representative benthic invertebrates were collected with a kick screen, sorted to taxa, grouped according to trophic level, and analyzed for total mercury body burden. All elevated invertebrate tissue burden samples were associated with drainage from known mercury mines or geothermal hot springs. These include Sulfur and Davis Creeks, Harley Gulch, and Clear Lake. No elevated mercury signal was observed in the North Fork of Cache Creek downstream of Benmore and Grizzly Creeks suggesting that these two non-mine impacted mercury enriched drainages might not be major sources of locally bioavailable mercury. The conclusions of the bioavailability study also differ from the loading one in that Clear Lake is identified as a major source of bioavailable mercury in the upper watershed. The loading study suggested that Clear Lake was only a major source of mercury during summer and on an annual basis did not account for much of the mercury transported in the basin. The bioavailability data collected downstream of Clear Lake emphasize the need to better understand the forms and processes which mediate

methyl mercury production and cycling in the Cache Creek aquatic food chain.

Additional information is needed on the correlation of mercury concentrations in water, sediment and invertebrate body burden levels. Invertebrates are emphasized as they are more ubiquitous than fish and, being closer to the bottom of the food chain, should respond more rapidly to changes in bioavailable mercury than any other life form. Also, in the Coast Range invertebrates often exhibit mercury concentrations very similar to small fish (personal communication, Slotton). More data is needed to establish the relationship between invertebrate body burden levels and mercury concentration in larger fish. Intensive seasonal monitoring of water and sediment coupled with changes in invertebrate body burden levels should be conducted at key locations in the watershed. The sediment sampling should determine flux rates of dissolved inorganic and methyl mercury from the sediment. The water, sediment and invertebrate studies should be closely coordinated with the fish tissue sampling effort. The purpose is twofold. First, establish baseline seasonal invertebrate bioavailability data for the watershed so that changes in mercury cycling may be more readily determined once remediation is undertaken. Second, by intensively sampling water/sediment and invertebrates, better identify the times, locations and mercury forms most important in the formation and movement of methyl mercury up the aquatic food chain. This information will be essential to quantify the amount of load reduction needed at different sources. Funding is requested for water, sediment and invertebrate sampling in Table 1.

<u>Site Remediation studies</u> As noted above, Sulfur Creek, Harley Gulch, and Clear Lake have been identified as major sources of total and bioavailable mercury. All three watersheds have abandoned mercury mines. In addition, Sulfur Creek has active geothermal activity which may also contribute mercury. Site remediation feasibility studies should be undertaken in Sulfur Creek and Harley Gulch to identify the major sources of the bioavailable mercury and the most practical, cost effective control methods which will insure that the TMDL goals for the site are met. Control efforts for evaluation may include runoff and waste material isolation studies, natural revegetation, waste rock removal and infiltration evaluations.

Sulphur Bank Mine is the likely source of the mercury in Clear Lake. The mine is an active U.S. EPA Superfund site. Downstream load reduction requirements should be coordinated with the Superfund cleanup activities to ensure that the beneficial uses of both Clear Lake and the downstream watershed are protected. Funding for Cache Creek site remediation feasibility studies are requested in Table 1. No funding is suggested for Sulphur Bank Mine as the site has been selected as a U.S. EPA Superfund site and the cost of remediation will be paid for by the Federal Government.

4. **Quantification of the Amount of Load Reduction Needed.** The key weakness in the development of this TMDL is our present lack of understanding about the relationship between inorganic mercury concentrations in water/sediment and methyl mercury concentrations in invertebrate and fish tissue. However, it is anticipated that detailed information about mercury concentrations in the water column from upstream transport and from *in situ* sediment fluxing coupled with changes in invertebrate and fish tissue concentration will help establish such a relationship. This information will be used to determine how much reduction in the various forms of mercury are needed downstream of each source. No implementation plan should be incorporated into the Regional Board's Basin Plan until these relationships are established.

5. **Implementation.** The Regional Board committed to adoption of a mercury TMDL implementation plan by the year 2005. While discussion of the contents of the implementation plan are premature, several factors are worth noting. First, as noted throughout the discussion, the development of the plan will require significant directed research. All research results should be reviewed by the Mercury Task Force and recommendations made to Regional Board staff prior to commencing implementation. The recommendations should include an evaluation of the scientific defensibility of the research conclusions and the likelihood of success should the implementation plan be incorporated into the Basin Plan and remediation control activity undertaken. Second, the plan will include a time schedule and recommendations on how to fund implementation. This may include a discussion of developing "Pollution Trading" opportunities whereby Central Valley and Bay Area Dischargers are allowed to fund more cost effective non point source cleanup projects in Cache Creek and

elsewhere *in lieu* of less effective abatement actions at their own facilities. Third, while the mine remediation feasibility studies have not yet been undertaken, it is likely that one of the conclusions will be that some of the principal sources of bioavailable mercury are from sites where the owners have insufficient resources to carry out the cleanup. So, in the interim, the State of California should pursue federal "Good Samaritan" legislation or identify some other legally defensible mechanism to minimize State liability and insure that public funds can be used for mercury control efforts wherever they are most cost effective. Finally, it is estimated that all the studies outlined above can be completed within 2.5 years of their being initiated. The mercury Task Force should be allowed an additional six months to evaluate the study results and make recommendations to Regional Board staff on lead allocations and an implementation plan. It should take an additional half a year for Regional Board staff to evaluate the data, all recommendations and develop a TMDL for insertion into the Basin Plan.

6. **Monitoring and Evaluation.** Significant monitoring will be required once the TMDL is implemented and site remediation is undertaken. It is predicted that methyl mercury concentrations in invertebrates close to the sources should decrease most rapidly (within a year or so of the completion of remediation). Concentrations in large fish and higher trophic level invertebrates more distant from the source will changes more slowly. If significant reduction in invertebrate body burden levels are not measured in a timely fashion close to the sources then further remediation or other adaptive management measures should be considered. The TMDL will be considered successful and will be terminated only when mean small and large fish tissue concentrations in the Basin reach the adopted target level.

7. **Other Studies Needed**. As previously mentioned, there are other major sources of mercury to the Sacramento-San Joaquin Delta Estuary besides Cache Creek. These include runoff from the historic placer gold fields in the Sierra Nevadas and runoff from other mercury producing areas in the Coast Range. Off site movement of this material has contributed to elevated mercury levels in sediment and biota in the Estuary and to the posting of health advisories warning the public to limit consumption of large striped bass and shark. The strategic plan

described above is a pilot TMDL with the initial emphasis being on determining mercury bioavailability and mine remediation feasibility studies in Cache Creek. The anticipation is that the information gained by intensively studying one watershed will result in the identification of cost effective solutions which can be employed elsewhere. However, in the interim, some directed studies will be needed outside of Cache Creek. Each area is briefly described below.

(A) Source identification. Mercury mass load studies (total recoverable, dissolved and methyl mercury) should continue in the Central Valley with an emphasis on watersheds where no data are available. These should include the San Joaquin, Mokelumne, and Consumnes Rivers. Detailed follow up studies should be undertaken in watersheds where the initial studies demonstrate that major sources of mercury come from. Follow up studies should include an assessment of inter-annual variability and the precise locations of all the major mercury sources within each watershed. The studies should also include assessments of the load contributions from major NPDES, storm water discharges and atmospheric input. The mass load work should be accompanied by biological surveys to identify locations with enhanced food chain mercury bioavailability. Funding for such loading studies are requested in Table 1.

(B) Public Health Mercury fish tissue studies should continue in the Delta. Studies should be designed and carried out in coordination with the Office of Environmental Health Hazard Assessment, Department of Health Services, and Fish and Game. The primary purpose is to establish the range of mercury in fish tissue in the Estuary to assess the public risk posed by their consumption. A secondary objective is to establish baseline conditions to evaluate the future success of upstream remediation activities.

(C) Bioavailability Studies Directed research should be undertaken to better understand mercury cycling in the Central Valley and Estuary. Research emphasis should be on evaluating the relative bioavailability of the different sources of mercuric material moving into the Estuary in comparison with concentrations already present and available in sediment porewater. At a minimum these should include an evaluation of inputs from the Cache Creek drainage in the Coast Range, Sierra Nevada Mountains and municipal, industrial, and storm water discharges. The studies should also include an evaluation of the importance of the remobilization of mercury from sediment by natural fluxing and release during dredging, disposal of dredge material on island levees, and creation of shallow water habitat. The ultimate objective of this directed research is to provide resource managers with recommendations on how to minimize mercury bioaccumulation in the Central Valley, Delta and San Francisco Bay.

E. An estimate of the total cost to implement the cleanup plan

An estimate of the costs to develop the information necessary to implement the TMDL are provided in Table 1 below. It is impossible until this information is obtained to estimate the actual cost of implementing the mercury TMDL. It should also be noted that while there are costs to implementing this plan there are also benefits. Currently, beneficial uses are being impacted by high concentrations of mercury in Bay and Delta fish. These concentrations have lead to a human health advisory on consuming fish but probably also impact other higher trophic level organisms, such as mammals and birds that have a much higher fish consumption rate than humans, as well as possibly the fish themselves. The beneficial uses that are impacted are SPORTFISHING (COMM), and probably WILDLIFE (WILD). Implementation of this plan would lower mercury concentrations in fish and minimize or eliminate the impacts on beneficial uses. For a more thorough description of the benefits to restoring beneficial uses see Appendix A.

Table 1. Estimate of cost to collect information to develop a mercury control strategy.

Task		Cost
TARGET		
Fish eating bird (merganser) study		200,000
Egg study		60,000
Coordination with OEHHA		75,000
	Total	335,000
MERCURY MONITORING IN CACHE CK (per yr)		
Methyl mercury sediment flux studies		200,000
Water, invertebrate and fish tissue work		200,000
Mercury Mass Loading Studies		160,000
	Multi-year Total	1,120,000
MINE REMEDIATION FEASIBILITY STUDIES		150,000
ESTUARINE MERCURY MONITORING STUDIES (per yr)		
Source Identification		100,000
Fish Tissue studies (wildlife and human health)		150,000
Bioavailability		500,000
	Multi-year Total	1,500,000
	Grand Total	3,105,000

F. An estimate of recoverable costs from potential dischargers

No cost recovery possible.

G. A two year expenditure schedule identifying funds to implement the plans that are not recoverable from potential dischargers.

Several potential sources of funding may be available. First, Clean Water Act 104(b)(3), 106 (g), and 319(h) grants have been used in the past by Regional Board's to address such issues. Second, the Sacramento River Toxic Pollutant Control Program may have fiscal year 1998 and 1999 appropriation money available for mercury work. ~~Finally, CALFED has indicated an interest in funding mercury work and asked the Regional Board in cooperation with Fish and Game to develop a mercury proposal. CALFED has not yet decided whether to fund the work.~~ CALFED has made mercury remediation a designated action and requested that the Regional Board, in cooperation with the California Department of Fish and Game, submit a proposal. CALFED recently informed the Regional Board that it has funded the proposal for $3.8 million. Work should begin in the fall of 1999. The CALFED grant includes funding for all the work outlined in the Regional Toxic Hot Spots Cleanup Plan.

San Joaquin River Dissolved Oxygen Cleanup Plan

Background

Low dissolved oxygen concentrations in the San Joaquin River in the vicinity of the City of Stockton has been identified in Part II of the cleanup plan as constituting a candidate BPTCP hot spot. In January 1998 the Central Valley Regional Water Quality Control Board (Regional Board) adopted a revised 303(d) list which identified low dissolved oxygen levels in Delta waterways in the lower San Joaquin River as a high priority problem and committed to developing a waste load allocation (TMDL) by the year 2011. The purpose of the Bay Protection Plan is to develop a strategy to collect the information necessary to implement the TMDL.

The San Joaquin River near the City of Stockton annually experiences violations of the 5.0 and 6.0 mg/l dissolved oxygen standard[2]. Violations are variable in time but usually occur over a ten mile River reach between June and November. Dissolved oxygen concentrations in the mainstem River can be chronically below the water quality objective and can reach below 2.5 mg/l.

In 1978 the Board adopted more stringent biochemical oxygen demand (BOD) and total suspended solid (TSS) effluent limits for the Stockton Regional Wastewater Control Facility (RWCF) with the intent of reducing or eliminating the low dissolved oxygen conditions in the San Joaquin River. The plant has constructed the necessary additional treatment facilities and has complied with the more stringent effluent limitations. Despite the Cities best efforts, the low dissolved oxygen conditions persist.

The City completed a river model (Schanz and Chen, 1993) assessing the impact of the Stockton RWCF on receiving water quality. Water quality parameters considered included TSS, BOD, ammonia, nitrate and dissolved oxygen. The model suggested that: (1) low dissolved oxygen conditions occur in the fall and spring due to a high mass loading of BOD and ammonia, (2) the current Stockton RWCF contributions are a significant portion of the oxygen demand of the River during critical low dissolved oxygen periods, ~~(3) addition of activated sludge/nitrification units to provide a carbonaceous biochemical oxygen demand (CBOD) of 5 mg/l and ammonia of 0.5 mg/l would increase dissolved oxygen levels in the River at the station most proximate to the RWCF from 2.5 to 3.0 mg/l during critical periods,~~ and ~~(4)~~ (3) the San Joaquin River would not meet the receiving water dissolved oxygen standards even if the entire discharge from the Stockton RWCF were eliminated from the River.

Taking these facts into consideration, the Board adopted a stricter permit in 1994 requiring the Stockton RWCF to further reduce CBOD and ammonia concentrations. Stockton appealed the permit to the State Board on a variety of grounds including that hydraulic conditions had changed in the River since the Board had considered the permit. The State Board remanded the permit back to the Regional Board for consideration of new Delta flow standards.

---

[2]The 5.0 mg/l standard applies between 1 December and 30 August while the 6.0 mg/l standard is for the period of 1 September through 30 November.

In the interim the Stockton RWCF refined the dissolved oxygen model for the River (Chen and Tsai, 1997). The model suggests that the principal factors controlling in-stream oxygen concentration are temperature, flow, upstream algal production, sediment oxygen demand (SOD), and discharge from the Stockton RWCF. Obviously, only one of these factors is within the ability of the Stockton RWCF to control. Solutions to the dissolved oxygen problem will require a more holistic watershed approach. Each factor is described briefly below.

Dissolved oxygen problems are most acute at high temperature in the San Joaquin River in late summer and early fall. Temperature is important because the oxygen carrying capacity of water decreases with increasing temperature while biotic respiration rates increase. Water temperature is controlled by air temperature and reservoir releases.

Flow of the San Joaquin River at Stockton is regulated by upstream reservoir releases and pumping at the state and federal pumping facilities at Tracy. Net flows at the City of Stockton are often zero or negative in late summer. The lowest dissolved oxygen levels in the River occur during prolonged periods of no net flow.

Algal blooms occasionally develop in the faster moving shallow upper River and are carried down past the City to the deeper slower moving deep water ship channel. Respiration exceeds photosynthesis here resulting in net oxygen deficits. Upstream algal blooms are controlled by turbidity and nutrient inputs from other NPDES dischargers, the dairy industry, erosion, stormwater runoff, and agricultural inputs.

Finally, the model identified discharge from the Stockton RWCF as contributing to the dissolved oxygen problem. The model indicates that improvements in effluent quality would increase dissolved oxygen levels in the River during critical periods. However, the model confirmed that exceedance of the dissolved oxygen water quality objective would persist if the entire discharge of the Stockton RWCF were removed from the River. The City of Stockton has expressed the concern that the estimated costs for the additional treatment are disproportionate to the benefits and that more cost-effective improvements in dissolved oxygen levels are possible.

Adult San Joaquin fall run chinook salmon migrate up river between September and December to spawn in the Merced, Tuolumne, and Stanislaus Rivers (Mills and Fisher, 1994). The Basin Plan dissolved oxygen water quality objective was increased from 5.0 to 6.0 mg/l between 1 September and 30 November to aid in upstream migration. The San Joaquin population has experienced severe declines and is considered a 'species of concern' by the U.S. Fish and Wildlife Service. Low dissolved oxygen may act as a barrier preventing upstream spawning migration. Also, low dissolved oxygen can kill or stress other aquatic organisms present in this portion of the Delta.

In conclusion, the San Joaquin River near the City of Stockton annually experiences dissolved oxygen concentrations below the Basin Plan water quality objective in late summer and fall. A model has been developed which identifies river flow and temperature, upstream algal blooms, SOD, and discharge from the Stockton RWCF as controlling variables. Only the latter variable is within the ability of the plant to influence. Fall run chinook salmon migrate upstream during this critical time period.

A. Areal Extent

The areal extent of the water quality exceedance is variable but may in some years be as much as 10 miles of mainstem River. The temporal extent is also variable but can be for as long as 4 months. Dissolved oxygen concentrations are often less than 2.5 mg/l in the mainstem River.

B. Sources

A computer model developed for the Stockton RWCF identified ammonia and BOD as the primary cause of the low dissolved oxygen concentration. The sources are discharges from the Stockton RWCF and surrounding point and non point source discharges. River flow and water temperature were identified as two other variables strongly influencing oxygen concentrations.

C. Summary of Actions

Low dissolved oxygen levels near the City of Stockton in late summer and fall are a well known problem. In 1978 the

Regional Board adopted more stringent effluent limits which the RWCF met but these did not correct the in-stream problem. A model developed for the Stockton RWCF suggested that further decreases in effluent BOD and ammonia would improve in-stream dissolved oxygen concentrations during critical periods but would not completely correct the problem. In 1994 the Regional Board further tightened BOD and ammonia permit limits to protect water quality. The permit was appealed to State Board because River hydrology had changed since the permit was adopted. State Board remanded the permit back to the Regional Board to reevaluate the modeling based upon new Delta flow conditions. In the interim, the Stockton RWCF installed a gauge at their discharge point to measure River flow and refined their computer model. The model concluded that the primary factors controlling dissolved oxygen concentration in the critical late summer and fall period were River flow and temperature, upstream algal blooms, SOD, and discharge from the Stockton RWCF. The model also made a preliminary evaluation of placing aerators in the River during critical periods. The results appeared promising. Finally, simulations coupling the dissolved oxygen and the San Joaquin River daily input-output model should be run. It may be possible by coupling the two models to predict exceedances of the Basin Plan dissolved oxygen standard about two weeks in advance. This could be valuable in that it raises the possibility of being able to conduct "real time management" to aid in correcting the problem.

D. Assessment of Actions Required

In January 1998 the Central Valley Regional Board adopted a revised 303(d) list which identified low dissolved oxygen levels in Delta Waterways near Stockton as a high priority impairment. The goal of the TMDL is to ensure that the San Joaquin River achieves full compliance with the Basin Plan Water Quality Objective for dissolved oxygen. To meet this objective, the Central Valley Regional Board intends to develop a strategy for collecting the information necessary to develop a TMDL.

According to the U.S. EPA (1998), "*the goal of the TMDL is the attainment of water quality standards. A TMDL is a written quantitative assessment of water quality problems and the contributing pollutant sources. It specifies the amount of* *reduction needed to meet water quality standards, allocates load reductions among sources... and provides the basis for taking actions to restore a water body*".

The U.S. EPA (1998) suggests that the successful development of a TMDL requires information in six general areas: identification of a target, location of sources, quantification of the amount of reduction needed, allocation of loads among sources, an implementation plan and monitoring and evaluation to track results and compliance. Regional Board staff also believe that a seventh element, the formation of a Steering Committee, is needed to help guide the control effort. Each of the elements are described briefly below.

Steering Committee. The Steering Committee shall be composed of representatives from the Stockton RWCF, upstream and adjacent NPDES dischargers, the dairy industry, irrigated agriculture, the environmental community, and state and federal resource agencies. A facilitator/coordinator will be needed to conduct the Steering Committee meetings. A cost estimate for this function is shown in Table 2. The primary role of the Steering Committee will be to establish a Technical Advisory Committee, determine other stakeholders who should be participants on the Steering Committee, review recommendations of the Technical Advisory Committee on what special studies should be performed, how the load reductions should be allocated, and the time schedule and strategy for implementing the TMDL. The Steering Committee will also be responsible for developing a financial plan to secure the funding for collecting the information needed to implement the TMDL.

The responsibilities of the Technical Advisory Committee will be to identify information needs, determine and prioritize special funding needs, recommend load allocations, direct and assist in the review of the Stockton RWCF model, collate and analyze existing data, conduct special studies, critique special study and data analysis results, establish a common data bank, develop cost estimates, draft implementation and monitoring plans, review monitoring data and advise on effectiveness of the implementation plan. Regional Board staff will make final recommendations to the Board about load allocations and the TMDL implementation. If it appears likely that the Steering and Technical Advisory Committees will be unable to make recommendations in a timely fashion, then staff will develop the load allocation and TMDL implementation plan in the absence of this information.

Target. The target of the TMDL is attainment of the Basin Plan dissolved oxygen water quality objective in the lower San Joaquin River. The dissolved oxygen objective for the time period of 1 September through 30 November is 6.0 mg/l and at all other times is 5.0 mg/l.

Sources and Causes. The Stockton RWCF dissolved oxygen model identified the following factors as the cause of the low dissolved oxygen levels: upstream and adjacent algal blooms, SOD, river flow, discharge from the Stockton RWCF and temperature. It is felt that there is a need for independent validation of the Stockton RWCF dissolved oxygen model. U.S. EPA has committed resources through Tetra Tech to do so. Model evaluation should occur after input has been obtained from both the Steering and Technical Advisory Committees. If validation shows that the model is reliable and that its initial findings are accurate, then the actions listed below are recommended.

<u>Summarize and Compile Data</u>. Collate all pertinent background data on the principle factors which contribute to the dissolved oxygen problem. These include information on all upstream and adjacent point and non-point source BOD and nutrient loads as well as all information on historical dissolved oxygen patterns in the San Joaquin River and changes in fisheries resources that may have been caused by the problem. All information gaps should be identified. Funds necessary for this task are shown in Table 2.

<u>Determine BOD and Nutrient Sources</u>. Collect all additional nutrient and BOD data needed to fill information gaps identified above. This will probably include additional studies on loadings from both local and upstream point and non-point source discharges. In addition, feasibility studies should be undertaken to evaluate the cost and efficacy of load reductions at the most important sources. Funding for this task is identified in Table 2.

<u>Determine Sources and Causes of SOD</u>. The Steering and Technical Advisory Committees will conduct investigations to

determine the sources and causes of SOD. Also, feasibility studies will be undertaken to identify the most effective solutions for controlling SOD. Funds necessary for this task are shown in Table 2.

Evaluate Engineered Solutions. The TMDL strategy should include evaluations of creative engineered solutions. At a minimum, the Steering and Technical Advisory Committees should evaluate the feasibility of river aeration and changes in San Joaquin River hydrology. Evaluations of river hydrology may include several options. One is real time management of flows at the head of Old River during critical periods. A second option might be pumping water south through the Delta Mendota Canal for release down Newman Wasteway to augment base flows in the lower San Joaquin River during critical periods. Either option might be significantly enhanced by linking the continuous monitoring data (flow, salinity, temperature, dissolved oxygen and pH) presently collected in the San Joaquin River with measurements of nutrients, and chlorophyll to determine sources and timing of high organic loads so that the head of Old River barrier can be operated in an adaptive management framework (Jones and Stokes Associates, 1998). A cost estimate for evaluating these options is shown in Table 2.

Amount of Load Reduction Needed. The load reduction needed is the difference between the load that would fulfill the Basin Plan Water Quality Objective for dissolved oxygen and the load that causes the dissolved oxygen concentrations presently measured in the main channel of the River.

Allocation of Loads Among Sources. The Steering and Technical Advisory Committees will make recommendations on load allocations to Regional Board staff after considering the following: importance of source, cost of correction per unit of dissolved oxygen increase obtained and probability of success of the action. The Steering and Technical Advisory Committees may also consider creative solutions such as funding aeration or hydrologic changes or the development of non-point source management practices. These are suggested as methods for assuring a contribution from other responsible parties who can make no load reductions. Finally, the load allocation process will include a safety factor to account for population growth in the Basin during the next 30 years.

Implementation Plan. While a full discussion of the implementation plan is premature, several facts are worth noting. First, the Steering and Technical Advisory Committees will make recommendations on load reduction allocations and the schedule and funding for implementing the TMDL. Regional Board staff will review these recommendations and propose a dissolved oxygen TMDL to the Board. It is anticipated that Regional Board staff will need about 6 months to review the recommendations and prepare the paperwork for the Basin Plan amendment. Second, the Basin Plan amendment will include load reduction allocations and a time schedule for meeting them. The reductions may necessitate revisions of NPDES permits and development and enforcement of management practices in the agriculture community.

~~It is anticipated that the TMDL will take three years to develop once funding has been secured. In the interim, the Regional Board will be revising NPDES permits for discharge to both the lower San Joaquin River and South Delta. Staff propose recommending to the Board when revising these NPDES permits, that no additional ammonia load reductions for correction of the dissolved oxygen problem will be sought while satisfactory progress is being made on the development of the TMDL and the discharge is not responsible for a significant portion of the dissolved oxygen problem. It will be assumed that satisfactory TMDL progress is being made if the majority of studies to determine load allocations are underway by December 1999 and it appears likely that the Steering Committee will recommend a TMDL implementation plan, including load allocations, to Regional Board staff by the year 2002.~~

It is anticipated that the TMDL will take three years to develop once funding has been secured. In the interim, the Regional Board will be draft new and revising existing NPDES permits for discharge to the lower San Joaquin River and South Delta. The Clean Water Act requires that NPDES permits contain effluent limits fully protective of receiving water quality, so any permits for discharges to impaired water bodies must contain stringent effluent limits. Where dischargers are a significant contributor to the River's dissolved oxygen problem, improvements in effluent quality may be required prior to completion of the TMDL. For new and expanded discharges, staff will recommend on a case-by-case basis stringent effluent limits to ensure no increase in oxygen demand to the South Delta. The time schedules for implementation of any stricter effluent limits may take into account the TMDL process. However, load reductions from existing dischargers will not be required if satisfactory progress is being made on TMDL development unless it is clear before the process has been completed that the specific load reduction would be required even under the TMDL. It will be assumed that satisfactory progress is being made if the majority of studies to determine load allocations are underway by December 1999 and, it appears likely, that the Steering Committee will recommend a TMDL implementation plan, including load allocations to Regional Board staff by the year 2002.

Monitoring and Reevaluation. The implementation plan will include monitoring. The purpose of monitoring is to verify compliance with the Basin Plan Dissolved Oxygen Objective. If monitoring demonstrates that the Water Quality Objective is not being met, then additional load reductions will be required. These new load reductions will be implemented after consultation with the Steering and Technical Advisory Committees. An estimate of funds necessary for monitoring is shown in Table 2.

E. An Estimate of the Total Cost to Develop the TMDL

A cost estimate for developing the TMDL is provided in Table 2. Although there are costs to implement this plan there are also benefits. Currently, beneficial uses are being impacted by the low dissolved oxygen levels in the South Delta. The beneficial uses that are being impacted are ESTUARINE HABITAT (EST) and SPORT FISHING (RECI). Implementation of the plan would increase dissolved oxygen concentrations and minimize or eliminate the impact on beneficial uses. For a more thorough description of the benefits to restoring beneficial uses see Appendix .

Table 2. Cost estimates for developing a dissolved oxygen TMDL in the lower San Joaquin River and an estimate of the time required to complete each task.

Task	Cost	Years from date funds available
Steering Committee		as long as required
Facilitator/Coordinator	$ 12,000[1]	
Problem Statement		
Summarize and compile data	$ 50,000	0.5
Source Analysis		
Validate D.O. Model	$ 30,000	0.5
Determine BOD and nutrient sources	$ 200,000	2.0
Evaluate feasibility of control options	$ 50,000	
Determine sediment contribution	$ 200,000	2.0
Evaluate feasibility of control options	$ 50,000	
Evaluate engineered solutions	$ 80,000	2.0
Implementation Plan		
TMDL for Regional Board consideration	--	2.5
Monitoring/Reevaluation		annually after TMDL adopted
Monitoring to evaluate load reductions	$ 20,000[1]	

[1] per year

F. An Estimate of Recoverable Costs from Potential Dischargers

No immediate funds are available from the discharge community to develop the TMDL. However, once the load reductions are allocated, then the responsible parties will be required to assume the costs of implementation.

G. Two Year Expenditure Schedule Identifying Funds to Implement the Plan that are Not Recoverable from Potential Dischargers.

Clean Water Act 104(b)(3), 106(g), and 319(h) grants are potential sources of funding and have been used in the past by Regional Boards to address such issues. CALFED may also be a source of funding.

References

Chen, C. and W. Tsai, 1997. Evaluation of alternatives to meet the dissolved oxygen objectives of the lower San Joaquin River. Prepared for SWRCB by Systech Engineering Inc. San Ramon, CA.

Foe, C. and W. Croyle 1998. Mercury concentrations and loads from the Sacramento River and from Cache Creek to the Sacramento-San Joaquin Delta Estuary. Central Valley Regional Water Quality Control Board Staff Report. Sacramento Office.

Gilmour, C. 1994. Mercury methylation in fresh water. In National Forum on mercury in fish, proceedings. EPA 823-R-95-002.

Jones and Stokes Associates. 1998. Potential Solutions for Achieving the San Joaquin River Dissolved Oxygen Objective. Report prepared for De Cuir and Somach and the City of Stockton. Jones and Stokes Associates, 2600 V Street, Suite 100, Sacramento, CA. 95818.

Larry Walker and Associates, 1997. Sacramento River mercury control planning project. Prepared for the Sacramento Regional County Sanitation District.

Mills, T. and F. Fisher, 1994. Central Valley anadromous sport fish annual run-size, harvest and population estimates, 1967 through 1991. Cal Dept. Fish and Game. Inland fisheries Div. Tech Report.

Montoya, B. 1991. An analysis of the toxic water quality impairments in the Sacramento-San Joaquin Delta Estuary. Staff report, Central Valley Regional Water Quality Control Board, Sacramento, CA.

San Francisco Bay Regional Water Quality Control Board, 1995. Contaminant levels in fish tissue from San Francisco Bay. Staff report prepared jointly by the San Francisco Regional Board, the State Water Resources Control Board, and the Department of Fish and Game.

Schantz, R. and C. Chen, 1993. City of Stockton water quality model: Volume I. Model development and calibration. Prepared by Phillip Williams and Associates, San Francisco, CA.

Slotton D., S. Ayers, J. Reuter, and C. Goldman. 1997a. Gold mining impacts on foodchain mercury in Northwestern Sierra Nevada Streams. Final Report. Div. of Env. Studies U.C. Davis, CA

Slotton D., S. Ayers, J. Reuter, and C. Goldman. 1997b. Cache Creek watershed preliminary mercury assessment, using benthic macroinvertebrates. Final Report. Div. of Env. Studies U.C. Davis, CA

U.S. EPA 1995. Guidance for assessing chemical contaminant data for use in fish advisories, Volume 1, Fish Sampling and analysis, 2nd edition, Office of Water. EPA 823-R-95-007, September 1995.

U.S. EPA 1997. Mercury Report to Congress Volume VI: An Ecological Assessment of anthropogenic mercury emissions in the United States. Office of Air Quality Planning and Standards and Office of Research and Development.

Pesticide Variance From Regional Toxic Hot Spot Cleanup Plan

High Priority Candidate Toxic Hot Spot Characterization Variance for Diazinon Orchard Dormant Spray Cleanup Plan

Background

"Diazinon in orchard dormant spray runoff" was identified in Part of the draft Central Valley Bay Protection Clean-up plan as constituting a candidate hot spot in the Sacramento-San Joaquin Delta Estuary (Ranking Matrix Table). Staff briefed the Central Valley Regional Board on 23 October 1998 on pesticide detection patterns in the Central Valley and requested guidance on whether these should be considered "frequent" as required by the Bay Protection Program in order to be considered as a candidate high priority toxic hot spot. In addition, guidance was sought on whether to prepare cleanup plans under Bay Protection or seek a variance and prepare a control program under section 303(d) of the Clean Water Act as the same pesticide excursions were also listed as a high priority 303(d) impairment. The Board unanimously determined that the pattern of pesticide detections observed in the Sacramento and San Joaquin Rivers and in the Bay-Delta were frequent and merited consideration as a high priority candidate Bay Protection Hot Spot. The Board also directed staff to seek a variance and regulate pesticides under the Clean Water Act. Outlined below are all required elements of the Bay Protection Clean Up Plan except sections D through G which address the assessment of the necessary control actions and their associated cost. The activities covered by these latter sections will be addressed by the Regional Board as it develops a waste load allocation program under section 303(d) of the Clean Water Act.

About a million pounds of insecticide active ingredient are applied each January and February in the Central Valley on about half a million acres of stonefruit and almond orchards to control boring insects (Foe and Sheipline, 1993). The organophosphate insecticide diazinon accounts for about half the application. Numerous bioassay and chemical studies have measured diazinon in surface water samples in the Central Valley during winter months at toxic concentration to sensitive invertebrates (Foe and Connor, 1991; Foe and Sheipline, 1993; Ross 1992;1993; Foe, 1995; Domagalski, 1995; Kratzer, 1997). The typical pattern is that the highest concentrations and longest exposures are in small water courses adjacent to high densities of orchards. However, after large storms in 1990 and 1992 diazinon was measured in the San Joaquin River at the entrance to the Delta at toxic concentrations to the cladoceran invertebrate *Ceriodaphia dubia* in U.S. EPA three species bioassays (Foe and Connor, 1991; Foe and Sheipline, 1993). Following up on these findings, the U.S. Geological Survey and Regional Board traced pulses of diazinon from both the Sacramento and San Joaquin Rivers across the Estuary in 1993 (Kuivila and Foe, 1995). Toxic concentrations to *Ceriodaphnia* were observed as far west in the Estuary as Chipps Island, some 60 miles downstream of the City of Sacramento and the entrance to the Delta.

Concern has been expressed that other contaminants might also be present in winter storm runoff from the Central Valley and contribute to invertebrate bioassay mortality. Therefore, in 1996 toxicity identification evaluations (TIEs) were conducted on three samples testing toxic in *Ceriodaphnia* bioassays from the San Joaquin River at Vernalis (Foe *et al.*, 1998). The results confirm that diazinon was the primary contaminant although other unidentified chemicals may also have contributed a minor amount of toxicity. The study was repeated in 1997 with the exception that samples were taken further upstream in the Sacramento and San Joaquin watersheds in the hope of collecting water with greater concentrations of unknown toxicants thereby facilitating their identification. TIEs were conducted on samples from Orestimba Creek in the San Joaquin Basin on 23 and 25 January and from the Sutter Bypass on 23, 25, and 26 January. Again, diazinon was confirmed as the primary toxicant (Foe *et al.*, 1998). No evidence was obtained suggesting a second contaminant.

No biological surveys have been undertaken to determine the ecological significance of toxic pulses of diazinon. However, Novartis, the Registrant for diazinon, has completed a diazinon probabilistic risk assessment for the Central Valley (Novartis Crop Protection, 1997). Little data were available for the Delta. The risk assessment, like chemical and bioassay studies, suggest that the greatest impacts are likely to occur in water courses adjacent to orchards. Lower concentrations are predicted in mainstem Rivers. The report predicts that the Sacramento and San Joaquin Rivers will experience acutely toxic conditions to the 10% of most sensitive species 0.4 and 11.6% of the time in January and February, the period of most intensive diazinon off site movement[3]. Novartis concludes that the risk of diazinon alone in the Sacramento-San Joaquin River basin is limited to the most sensitive invertebrates, primarily cladocerans. Furthermore, the report notes that cladocerans reproduce rapidly and their populations are therefore predicted to recover rapidly. Also, the report predicts that indirect effects on fish through reductions in their invertebrate prey are unlikely as the preferred food species are unaffected by the diazinon concentrations observed in the rivers. The study recommends though, that the population dynamics of susceptible invertebrate species in the basin be evaluated along with the feeding habits and nutritional requirements of common fish species.

In conclusion, the only major use of diazinon in the Central Valley in January and February is on stonefruit and almond orchards. In 1990, 1992, 1993, and 1996 diazinon was observed entering the Estuary from either the Sacramento or San Joaquin Rivers at toxic concentration in *Ceriodaphnia* bioassays. In 1993 the chemical was followed at toxic concentrations across the Estuary. On each occasions diazinon was confirmed as being present in toxic water samples by GC/MS analysis. In 1996 and 1997 TIEs implicated diazinon as the primary contaminant responsible for the toxicity. Finally, sensitive organisms like *Ceriodaphnia* are predicted to experience acutely toxic conditions in the Sacramento and San Joaquin Rivers about 0.5 and 12 percent of the time in January and February of each year. These frequencies translate to about 1 day every four years in the Sacramento River and 7-8 days per year in the San Joaquin River.

Bay Protection Toxic Cleanup Program guidance recommends that a site or situation be considered a candidate toxic hot spot for pesticides if toxicity in bioassays can be demonstrated, bioassay results are collaborated by both chemical analysis and TIEs, and the pesticide residues reoccur in a pattern of frequent pulses. On 23 October 1998 the Central Valley Regional Board reviewed the dormant spray data and unanimously concluded that the Sacramento and San Joaquin Rivers and Delta-Estuary fit the recommend criteria for listing as a high priority candidate toxic hot spot.

3 Unfortunately, many agricultural pesticides are applied in the Central Valley and measured in the Rivers. When the risk assessment is repeated with multiple chemicals (Appendix C), the mainstem San Joaquin River is predicted to experience acutely toxic conditions about 20 percent of the year to the 10 percent of most sensitive species. Diazinon is only one of the chemicals present in the River at toxic concentrations.

A. Areal Extent

Studies demonstrate that the potential areal extent of diazinon water column contamination from orchard runoff is variable by year but may include in some years the entire Sacramento San Joaquin Delta Estuary. The Delta Estuary is a maze of river channels and diked islands covering some 78 square miles of water area and 1,000 linear miles of waterway.

B. Sources

The only major use of diazinon in agricultural areas in the Central Valley in winter is as a dormant orchard spray. Virtually every study investigating off site movement into the Rivers and Estuary have concluded that the primary source of the chemical is from agriculture (Foe and Connor, 1991; Foe and Sheipline, 1993; Ross, 1992;1993; Domagalski, 1995; Kratzer, 1997).

Farmers must obtain a permit to apply diazinon as a dormant spray and their names and addresses are available through the County Agricultural Commissioner's Office. However, not known at this time is the relative contribution of each application to total offsite movement. More information is needed on the primary factors influencing off site movement and the relative contribution of different portions of the Central Valley watershed. Such information is essential not only for assessing responsibility but also for successful development and implementation of agricultural Best Management Practices (BMPs).

C. Summary of Actions

The Department of Pesticide Regulation (DPR) and the State Water Resources Control Board (SWRCB) both have statutory responsibilities for protecting water quality from adverse effects of pesticides. In 1997, DPR and the SWRCB signed a management agency agreement (MAA), clarifying these responsibilities. In a companion document, the Pesticide Management Plan for Water Quality (Pesticide Management Plan), a process was outlined for protecting beneficial uses of surface water from the potential adverse effects of pesticides. The process relies on a four-stage approach: Stage 1 relies on education and outreach efforts to communicative pollution prevention strategies. Stage 2 efforts involve self-regulating or cooperative efforts to identify and implement the most appropriate site-specific reduced-risk practices. In stage 3, mandatory compliance is achieved through restricted use pesticide permit requirements, implementation of regulations, or other DPR regulatory authority. In stage 4, compliance is achieved through the SWRCB and RWQCB water quality control plans or other appropriate regulatory measures consistent with applicable authorities. Stages 1 through 4 are listed in a sequence that should generally apply. However, these stages need not be implemented in sequential order, but rather as necessary to assure protection of beneficial uses.

Currently, DPR is coordinating a stage 2 effort to address effects of dormant sprays on surface water. DPR's stated goal is to eliminate toxicity associated with dormant spray insecticides (i.e., chlorpyrifos, diazinon, and methidathion) in the Sacramento and San Joaquin River Basins and Delta. As long as progress continues toward compliance with appropriate water quality objectives, stage 3 activities will be unnecessary.

The U.S. EPA requires Regional Boards under the Clean Water Act to maintain 303(d) lists of impaired water bodies. In January 1998 the Central Valley Regional Board approved a revised 303(d) list of impaired water bodies and provided a schedule for the development of Total Maximum Daily Loads. The Sacramento and San Joaquin Rivers and Delta-Estuary were listed, in part, because of diazinon impairments from orchards to water quality. The Regional Board ranked the impairment in all three locations as a high priority and committed to the development of a TMDL by the year 2005. Components of a TMDL include problem description, numeric targets, monitoring and source analysis, implementation plan, load allocations, performance measures and feedback, margin of safety and seasonal variation and public participation. If compliance monitoring demonstrates that the problem has not been corrected by 2005, then a TMDL waste load allocation, including an implementation schedule, must be adopted as a Basin Plan amendment by the Regional Board.

Several activities are underway in the Basin to develop agricultural BMPs to control orchard dormant spray runoff. These are summarized below by the Agency conducting the study.

Department of Pesticide Regulation. In addition to the activities already discussed, DPR is investigating orchard floor management as a means to reduce discharges of dormant sprays into surface waterways (Ross *et al.*, 1997). At an experimental plot at UCD, DPR staff measured discharges of chlorpyrifos, diazinon, and methidathion from a peach orchard with three orchard floor treatments. Investigations are continuing in a commercial orchard. At California State University at Fresno, DPR is investigating the effects of microbial augmentation and postapplication tillage on runoff of dormant sprays. Results will be highlighted in DPR's own outreach activities and will be made available to other groups interested in the identification and promotion of reduced-risk management practices.

DPR is also monitoring water quality at four sites--two each within the Sacramento and San Joaquin river watersheds. During the dormant spray use season, approximately January through mid-March, water samples will be collected five times each week from each site. Chemical analyses are performed on each sample; one chronic and two acute toxicity tests, using *Ceriodaphnia dubia*, are performed each week.

Novartis. The Registrant of diazinon distributed over ten thousand brochures last winter through U.C. Extension, County Agricultural Commissioner's Offices, and Pesticide distributors. The brochure described the water quality problems associated with dormant spray insecticides and recommended a voluntary set of BMPs to help protect surface waters. Novartis intends to repeat the education and outreach program this winter.

DowElanco and Novartis. The Registrants of chlorpyrifos and diazinon have undertaken a multiyear study in Orestimba Creek in the San Joaquin Basin with the primary objective of identifying specific agricultural use patterns and practices which contribute the bulk of the off-site chemical movement into surface water. The study involves an evaluation of pesticide movement in both winter storms and in summer irrigation return flows. Objectives in subsequent years are to use the data to develop and field test BMPs to reduce off site chemical movement. The first year of work is complete and a report may be released soon.

Biologically Integrated Prune Systems (BIPS). The BIPS program is a community-based project that supports implementation of reduced-risk pest management strategies in prune orchards. The reduction or elimination of organophosphate dormant sprays is a goal. The project has a strong outreach component that includes demonstration sites and "hands-on" training for growers and pest control advisors (PCAs). BIPS is a recipient of one of DPR's pest management grants.

Biologically Integrated Orchard Systems (BIOS). The BIOS program pioneered community-based efforts to implement economically viable, nonconventional, pest management practices. It emphasizes management of almond orchards in Merced and Stanislaus counties in ways that minimize or eliminate the use of dormant spray insecticides. BIOS was a recipient of a DPR pest management grant and a federal Clean Water Act (CWA) section 319(h) nonpoint source implementation grant.

Biorational Cling Peach Orchard Systems (BCPOS). This project has the same goals as the BIPS program, except that it focuses on primary pests in cling peach orchards. The University of California Cooperative Extension is acting as project leader, with Sacramento and San Joaquin valley coordinators. BCPOS is another recipient of a DPR pest management grant.

Colusa County Resource Conservation District. The Colusa County Resource Conservation District (RCD) is leading a runoff management project within the watershed of Hahn Creek. Project participants are trying to identify management practices that reduce runoff from almond orchards within the watershed, thereby reducing pesticide loads in the creek. Outreach and demonstration sites are part of this project. This project was the recipient of a CWA section 319(h) grant.

Glenn County Department of Agriculture. The Glenn County Department of Agriculture is organizing local growers and PCAs to address the use of dormant spray insecticides in the county. The local RCD is also involved; they are applying for grants to facilitate the implementation of reduced-risk pest management practices.

Natural Resources Conservation Service-Colusa Office. The Colusa County office of the Natural Resources Conservation Service (NRCS) was recently awarded over $100,000 from the Environmental Quality Incentives Program (EQIP), one of the conservation programs administered by the U.S. Department of Agriculture. EQIP offers contracts that provide incentive payments and cost sharing for conservation practices needed at each site. Most of these funds should be available to help implement reduced-risk pest management practices in almond orchards in the area.

Natural Resources Conservation Service--Stanislaus Office. The Stanislaus County office of NRCS was recently awarded $700,000 from EQIP. Half of the funds are allocated to address livestock production practices, but most of the remaining funds should be available to address dormant sprays and the implementation of reduced-risk pest management practices. Local work groups, comprised of Reds, NRCS, the Farm Services Agency, county agricultural commissioners, Farm Bureau, and others will determine how EQIP funds will be distributed. Applicants for EQIP funds will be evaluated on their ability to provide the most environmental benefits.

Nature Conservancy. The Nature Conservancy is enrolling more prune growers in the BIPS project as it proceeds with its Felon Island restoration project in the Sacramento Valley. This project is supported by a CWA section 319(h) grant.

U.C. Statewide Integrated Pest Management Project. In late 1997 the U.C. Statewide Integrated Pest Management Project was awarded a two year grant by the State Water Resource Control Board to: (1) identify alternate orchard management practices to prevent or reduce off site movement of dormant sprays, (2) provide outreach and education on these new practices to the agricultural community, and (3) design and initiate a monitoring program to assess the success of the new practices. A Steering Committee composed of representatives from Commodity groups, State Agencies including Regional Board staff, and U.C. Academics was formed to serve as a peer review body for the study.

D. Assessment of Actions Required.

In January 1998 the Central Valley Regional Water Quality Control Board adopted a revised 303(d) list, ranked diazinon impairments in the Sacramento and San Joaquin Rivers and in the Delta Estuary as high priority and committed to the development of a load reduction program by the year 2005. In October 1998 staff briefed the Regional Board on pesticide detection patterns in the Central Valley and requested guidance on whether these should be considered "frequent" as required by the Bay Protection Program in order to be considered as a candidate high priority hot spot. In addition, guidance was sought on whether to prepare cleanup plans under Bay Protection or seek a variance and prepare a control program under section 303(d) of the Clean Water Act. The Board unanimously decided that the pattern of pesticide detections observed in the Sacramento and San Joaquin Rivers and in the Bay-Delta from dormant spray applications was frequent and merited consideration as a high priority candidate Bay Protection Hot Spot. The Board also directed staff to seek a variance and begin pesticide regulation under section 303(d) of the Clean Water Act.

E. An estimate of the total costs to develop the plan.

Not Applicable.

F. An estimate of recoverable costs from potential discharges.

Not Applicable.

G. Two year expenditure schedule identifying funds to implement the plan that are not recoverable from potential dischargers.

Not Applicable.

Urban Stormwater Pesticide Cleanup Plan

Background

"Diazinon and chlorpyrifos in urban stormwater runoff" was identified in the draft Bay Protection Cleanup Plan as constituting a candidate toxic hot spot in several Delta backsloughs (Ranking Matrix Table). Staff briefed the Central Valley Regional Board on 23 October 1998 on pesticide detection patterns in the Central

Valley and requested guidance on whether these should be considered "frequent" as required by the Bay Protection Program to be considered as a candidate high priority toxic hot spot. In addition, guidance was sought on whether to prepare cleanup plans under Bay Protection or seek a variance and prepare a control program under section 303(d) of the Clean Water Act as the same pesticides excursions were also listed as a medium priority 303(d) impairment. The Board unanimously determined that the pattern of pesticide detections observed in urban runoff around the Delta were frequent and merited consideration as high priority candidate Bay Protection Hot Spots. The Board also directed staff to seek a variance and regulate pesticides under the Clean Water Act. Outlined below are all required elements of the Bay Protection Clean Up Plan except sections D through G which address the assessment of the necessary control actions and their associated cost. The activities covered by the latter sections will be addressed by the Regional Board as it develops a waste load allocation program under section 303(d) of the Clean Water Act.

Three hundred and forty thousand pounds of diazinon and 775 thousand pounds of chlorpyrifos active ingredients were used in reported landscape and structural pest control in California in 1994 for control of ants, fleas and spiders (Scanlin and Cooper, 1997; Department of Pesticide Regulation, 1996). The figure likely underestimates by about half the total use as it does not include unreported homeowner purchases. In February and again in October 1994 *Ceriodaphnia* bioassay mortality was reported in Morrison Creek in the City of Sacramento and in Mosher Slough, 5 Mile Slough, Calaveras River, and Mormon Slough in the City of Stockton (Connor, 1994;1995). All these waterbodies are within the legal boundary of the Delta. A modified phase I TIE was conducted on samples from each site which implicated a metabolically activated pesticide(s) (such as diazinon and chlorpyrifos). Chemical analyses demonstrated that diazinon and occasionally chlorpyrifos was present at toxic concentrations. A phase III TIE was conducted on water collected from Mosher Slough on 1 May 1995 which confirmed that the primary cause of acute toxicity was a combination of diazinon and chlorpyrifos.

It was not known at the time that the Bay Protection samples were being collected that an assessment of the frequency of pesticide excursions would be needed to determine whether a location should be considered as a candidate toxic hot spot. Therefore, no intensive sampling was conducted at Mosher, Five Mile, and

Mormon Sloughs, or the Calaveras River or Morrison Creek. However, in other testing 230 samples were collected from urban dominated waterways in the Sacramento and Stockton areas (Bailey *et al.* 1996). These sites are thought to exhibit water quality similar to those locations being considered here as candidate hot spots. All 230 samples were analyzed for diazinon. Eighty-five percent of the measured values (195 samples) exceeded Fish and Game recommended acute hazard criteria. Ninety samples were analyzed for chlorpyrifos. Eighty percent of the values (72 samples) also exceeded the recommended chlorpyrifos acute hazard criteria. Finally, *Ceriodaphnia* bioassays were run on 47 samples. Seventy-seven percent of these (36 samples) produced total mortality within 72 hours. Modified Phase I TIEs suggested that the toxicity was due to metabolically activated pesticides, such as diazinon and chlorpyrifos. Chemical analysis was consistent with these conclusions suggesting that the two organophosphate insecticides were the major contaminants.

In second set of data, the Sacramento River Watershed Program has monitored Arcade Creek in Sacramento monthly since 1996 for toxicity. Arcade Creek was selected to represent a typical urban creek. In the 1996-97 sampling period, Arcade Creek was monitored 13 times during 12 months. Seventy-seven percent of those samples exhibited significant *Ceriodaphnia* mortality. Diazinon and chlorpyrifos concentrations were measured in the seven samples causing 100% mortality. TIEs and pesticide detections in the seven samples confirm that both pesticides contributed to the observed toxicity. Toxicity was detected during both wet and dry weather (Larson *et al.*, 1998a). The 1997-98 sampling period data has been summarized for only five dates. In four of the five samples (eighty percent), 100% *Ceriodaphnia* mortality was detected and linked through TIEs to the presence of diazinon and chlorpyrifos. Again, toxicity was detected during wet and dry periods (Larson *et al.*, 1998b).

Background concentrations of diazinon in urban storm runoff in the Central Valley increase after application on orchards in January and February suggesting that urban use might not be the sole source of the chemical at this time (Connor, 1996). Volatilization following application is known to be a major diazinon dissipation pathway from orchards (Glotfelty *et al.*, 1990) and a number of dormant spray insecticides have previously been reported in rain and fog in the Central Valley (Glotfelty *et al.*, 1987). Therefore, composite rainfall samples were collected in South Stockton in

1995 which demonstrated that diazinon concentrations in rain varied from below detection to about 4,000 ng/l (ten times the acute *Ceriodaphnia* concentration). The rainfall study was continued through March and April of 1995 to coincide with application of chlorpyrifos on alfalfa for weevil control. Chlorpyrifos concentrations in composite rainfall samples increased, ranging from below detection to 650 ng/l (again 10 times the acute *Ceriodaphnia* concentration). However, unlike with diazinon, no study was conducted to ascertain whether chlorpyrifos concentrations in street runoff increased suggesting that agricultural inputs might be a significant urban source.

Similar invertebrate bioassay results coupled with TIEs and chemical analysis from the San Francisco Bay Area suggest that diazinon and chlorpyrifos may be a regional urban runoff problem (Katznelson and Mumley, 1997) This finding prompted the formation of an Urban Pesticide Committee (UPC). The UPC is an *ad hoc* committee formed to address the issue of toxicity in urban runoff and wastewater treatment plant effluent due to organophosphate insecticides, in particular diazinon and chlorpyrifos. The UPC is composed of staff from the U.S. EPA, the San Francisco Bay and Central Valley Regional Water Quality Control Boards, the Department of Pesticide Regulation, Novartis and Dow Elanco, municipal storm water programs, the Bay Area Stormwater Management Agencies Association, County Agricultural commissions, Wastewater treatment plants, the University of California, and Consultants. The members of the UPC are committed to working in partnership with the various stakeholders to develop effective measures to reduce the concentrations of organophosphate insecticides in urban runoff and wastewater treatment plant effluent.

In conclusion, a combination of bioassay, chemical, and TIE work demonstrate that diazinon and chlorpyrifos are present in urban stormwater runoff discharged to urban creeks and back sloughs around the Cities of Sacramento and Stockton at concentrations toxic to sensitive invertebrates. The source of the diazinon appears to be primarily from urban sources although agricultural orchard use may also be important. Chlorpyrifos appears to be predominately of urban origin but the impacts from agricultural use need to be evaluated. Finally, bioassay and chemical analysis suggest that about 75 percent of the samples collected from urban runoff dominated waterbodies will test toxic in *Ceriodaphnia* bioassays while eighty to eighty-five percent of the samples will contain diazinon and chlorpyrifos at concentrations exceeding the acute California Department of Fish and Game Hazard Assessment criteria.

Bay Protection Toxic Cleanup Program guidance recommends that a site or situation be considered a candidate toxic hot spot for pesticides if toxicity in bioassays can be demonstrated, bioassay results are collaborated by both chemical analysis and TIEs, and the pesticide residues reoccur in a pattern of frequent pulses. On 23 October 1998 the Central Valley Regional Board reviewed the data and unanimously concluded that pesticides in urban runoff dominated backsloughs around the Delta fit the recommended criteria for listing as a high priority candidate toxic hot spot.

A. Areal Extent

The potential threat posed by diazinon and chlorpyrifos in urban storm runoff is localized to Morrison Creek in the City of Sacramento and Mosher Slough, 5 Mile Slough, the Calaveras River, and Mormon Slough in the City of Stockton. Together the areal extent of impairment may be up to 5 linear miles of back sloughs within the legal boundary of the Delta.

B. Sources

Detailed information on urban sources are not available for the Central Valley. However, source information has been obtained for the Bay Area and the conclusions are thought to also apply in the Valley with the caveat that the Bay area does not receive significant amounts of diazinon in rainfall as appears to occur in the Central Valley (personal communication, Connor). Confirmatory studies are needed to verify that the Bay Area conclusions also apply in the Valley.

The primary source of diazinon and chlorpyrifos in Bay Area creeks is from urban runoff. Sampling in urbanized areas in Alameda County indicated that residential areas were a significant source but runoff from commercial areas may also be important (Scanlin and Feng, 1997). It is not known what portion of the diazinon and chlorpyrifos found in creeks is attributable to use in accordance with label directions versus improper disposal or over application. However, a preliminary study of runoff from residential properties suggest that concentrations in creeks may be attributable to proper use (Scanlin and Feng, 1997).

C. Summary of Actions

The discovery of diazinon in urban storm runoff in both the Central Valley and San Francisco Bay Region at toxic concentrations to *Ceriodaphnia* led to the formation of the Urban Pesticide Committee (UPC). The objective of the UPC is to provide a forum for information exchange, coordination and collaboration on the development and implementation of a urban pesticide control strategy. An additional advantage of the Committee is that it facilitates a more efficient use of limited resources. The initial characterization of the pesticide problem through extensive bioassay, chemical and TIE work occurred in the Central Valley with confirmation in the Bay Area while the follow-up studies identifying sources and loads has primarily occurred in the Bay Area.

The UPC has prepared three reports describing various aspects of the urban pesticide problem in the Bay Area and a fourth volume describing a strategy for reducing diazinon levels in urban runoff. The first report provides a compilation and review of water quality and aquatic toxicity data in urban creeks and storm water discharges in the San Francisco Bay Area focusing on diazinon (Katznelson and Mumley, 1997). The review also includes a discussion of the potential adverse impact of diazinon on aquatic ecosystems receiving urban runoff. The second report characterizes the temporal and spatial patterns of occurrence of diazinon in the Castro Valley Creek watershed (Scanlin and Feng, 1997). Runoff at an integrator point for the entire watershed was sampled during multiple storms to record both seasonal and within-event variations in diazinon concentration. The purpose of the third report was to compile information on the outdoor use of diazinon in urban areas in Alameda County including estimates of quantity applied, target pests, and seasonal and long term trends (Scanlin and Cooper, 1997). This information will be used in the development of a strategy to reduce the levels of diazinon in Bay Area creeks. Finally, the UPC has produced a strategy for reducing diazinon levels in Bay Area creeks (Scanlin and Gosselin, 1997). Since pesticides are regulated on the state and national level, much of the strategy focuses on coordinating with enforcement agencies. The strategy presents a framework of roles and responsibilities that can be taken by various agencies to achieve the overall goal. The strategy focuses on diazinon as it is the most common insecticide detected at toxic levels. In the Central Valley both diazinon and chlorpyrifos are regularly observed and must be simultaneously addressed in any cleanup plan.

As was explained in the diazinon orchard dormant spray clean up plan, DPR and the SWRCB both have statutory responsibilities for protecting water quality from adverse effects of pesticides. In 1997 DPR and the SWRCB signed a management agency agreement (MAA), clarifying these responsibilities. In a companion document, the Pesticide Management Plan for Water Quality (Pesticide Management Plan), a process was outlined for protecting beneficial uses of surface water from the potential adverse effects of pesticides. The process relies on a four-stage approach: Stage 1 relies on education and outreach efforts to communicative pollution prevention strategies. Stage 2 efforts involve self-regulating or cooperative efforts to identify and implement the most appropriate site-specific reduced-risk practices. In stage 3, mandatory compliance is achieved through restricted use pesticide permit requirements, implementation of regulations, or other DPR regulatory authority. In stage 4, compliance is achieved through the SWRCB and RWQCB water quality control plans or other appropriate regulatory measures consistent with applicable authorities. Stages 1 through 4 are listed in a sequence that should generally apply. However, these stages need not be implemented in sequential order, but rather as necessary to assure protection of beneficial uses. At present pesticides in urban storm water are managed through stage 1 of the MAA.

The U.S. EPA requires Regional Boards under the Clean Water Act to maintain 303(d) lists of impaired water bodies. In January 1998 the Central Valley Regional Board approved a revised 303(d) list of impaired water bodies and provided a schedule for the development of Total Maximum Daily Loads. Morrison Creek, Mosher Slough, and Five Mile Slough were listed because of diazinon and chlorpyrifos impairments to water quality. The Regional Board ranked the impairment in all three locations as a medium priority and committed to the development of a TMDL by the year 2011. Components of a

TMDL include problem description, numeric targets, monitoring and source analysis, implementation plan, load allocations, performance measures and feedback, margin of safety and seasonal variation and public participation. If compliance monitoring demonstrates that the problem has not been corrected by 2011, then the TMDL waste load allocation, including an implementation schedule, must be adopted as a Basin Plan amendment by the Regional Board.

D. Assessment of Actions Required.

In January 1998 the Central Valley Regional Water Quality Control Board adopted a revised 303(d) list, ranked diazinon and chlorpyrifos impairments in urban runoff dominated back sloughs around the Delta as a medium priority and committed to the development of a load reduction program by the year 2011. In October 1998 staff briefed the Regional Board on pesticide detection patterns in the Central Valley and requested guidance on whether these should be considered "frequent" as required by the Bay Protection Program in order to be considered as a candidate high priority hot spot. In addition, guidance was sought on whether to prepare cleanup plans under Bay Protection or seek a variance and prepare a control program under section 303(d) of the Clean Water Act. The Board unanimously decided that the pattern of pesticide detections observed in urban runoff were frequent and merited consideration as high priority candidate Bay Protection Hot Spot. The Board also directed staff to seek a variance and begin pesticide regulation under section 303(d) of the Clean Water Act.

E. An estimate of the total costs to develop the plan.

Not Applicable.

F. An estimate of recoverable costs from potential dischargers.

Not Applicable.

G. Two year expenditure schedule identifying funds to implement the plan that are not recoverable from potential dischargers.

Not Applicable.

Irrigation Return Flow Pesticide Cleanup Plan

Background

"Chlorpyrifos in irrigation tailwater" has been identified in the draft Bay Protection Clean-Up Plan as constituting a candidate hot spot in various agriculturally dominated backsloughs within the Delta (Ranking Matrix Table). Staff briefed the Central Valley Regional Board on 23 October 1998 on pesticide detection patterns in the Central Valley and requested guidance on whether these should be considered "frequent" as required by the Bay Protection Program to be considered as a candidate high priority toxic hot spot. In addition, guidance was sought on whether to prepare cleanup plans under Bay Protection or seek a variance and prepare a control program under section 303(d) of the Clean Water Act as pesticide excursions in the San Joaquin River and Delta-Estuary were also listed as a high priority 303(d) impairment. The Board unanimously determined that the pattern of pesticide detections observed in various Delta backsloughs from irrigated agriculture was frequent and merited consideration as a high priority candidate Bay Protection Hot Spot. The Board also directed staff to seek a variance and regulate pesticides under the Clean Water Act. Outlined below are all required elements of the Bay Protection Clean Up Plan except sections D through G which address the assessment of the necessary control actions and their associated cost.

One and a half million pounds of chlorpyrifos active ingredient were used in the Central Valley on agriculture in 1990 (Sheipline, 1993). Major uses in March are on alfalfa and sugarbeets for weevil and worm control and between April and September on walnuts and almonds for codling moth and twig borer control. Two minor uses are on apples and corn. A bioassay study was conducted in agriculturally dominated waterways in the San Joaquin Basin in 1991 and 92. Chlorpyrifos was detected on 190 occasions between March and June of both years, 43 times at toxic concentrations to *Ceriodaphnia* (Foe, 1995). Many of the crops grown in the San Joaquin Basin are also cultivated on Delta Tracts and Islands. Not known was whether these same agricultural practices might also contribute to instream toxicity in the Delta. BPTCP resources were used between 1993 and 1995 to conduct a bioassay monitoring program in the Delta. Chlorpyrifos toxicity was detected on nine occasions in surface water from four agriculturally dominated backsloughs (French Camp Slough, Duck

Slough, Paradise Cut, and Ulatis Creek; Deanovic *et al.*, 1996;1997). In each instance the *Ceriodaphnia* bioassay results were accompanied by modified phase I and II TIEs and chemical analysis which implicated chlorpyrifos. On four additional occasions phase III TIEs were conducted (Ulatis Creek 21 March 1995, Paradise Cut 15 March 1995, Duck Slough 21 March 1995, and French Camp Slough 23 March 1995). These confirmed that chlorpyrifos was the primary chemical agent responsible for the toxicity. Analysis of the spatial patterns of toxicity suggest that the impairment was confined to backsloughs and was diluted away upon tidal dispersal into main channels. The precise agricultural crops from which the chemicals originated are not known because chlorpyrifos is a commonly applied agricultural insecticide during the irrigation season. However, the widespread nature of chlorpyrifos toxicity in March of 1995 coincided with applications on alfalfa and subsequent large rainstorms. Follow up studies are needed to conclusively identify all responsible agriculture practices.

It was not known at the time that the Bay Protection samples were being collected that an assessment of the frequency of pesticide excursions would be needed to determine whether a location should be considered as a candidate toxic hot spot. Therefore, no intensive sampling was conducted in French Camp and Duck Sloughs or in Paradise Cut or Ulatis Creeks to determine the precise frequency of irrigation induced pesticide toxicity. However, as has been previously mentioned, the same agricultural crops and pesticide application patterns occur in the Delta as in the San Joaquin Basin. Novartis (1997) conducted an ecological risk assessment using all the available pesticide data and concluded that the mainstem San Joaquin River should experience acutely toxic conditions about 20 percent of the time (approximately 70 days/year) from a mixture of insecticides but predominately diazinon and chlorpyrifos. Diazinon was most commonly observed during the dormant spray season (January and February) while chlorpyrifos explained most of the toxicity during the irrigation season (March through September). It has previously been calculated that the mainstem San Joaquin River is expected to experience acutely toxic conditions for about 7 days in January and February from off site movement of diazinon. Therefore, it is estimated that acute toxicity will occur for about 63 days during the remaining year (70-7=63). Most of this toxicity is predicted to be from chlorpyrifos excursions.

In a more recent study, Dow AgroSciences, the primary registrant for chlorpyrifos, monitored diazinon and chlorpyrifos concentrations daily in Orestimba Creek for one year (1 May 1996-30 April 1997). Orestimba Creek is about 25 miles south of the Delta in the San Joaquin Basin. The water body was selected for study as it's water quality is thought to be typical of a local agriculturally dominated watershed. Diazinon and chlorpyrifos were measured at acutely toxic conditions to sensitive organisms like *Ceriodaphnia* for 50 days during the irrigation season (15 March-30 September; Dow AgroSciences, 1998). Forty-four of the fifty events (88%) were from elevated chlorpyrifos concentrations.

In conclusion, the frequency of toxicity from pesticides was not measured in agriculturally dominated back sloughs in the Delta. However, estimates of the frequency of toxicity from chlorpyrifos excursions in similar nearby watersheds range between 44 and 63 days per irrigation season. Similar frequency rates are expected in Delta backsloughs.

Bay Protection Toxic Cleanup Program guidance recommends that a site or situation be considered a candidate toxic hot spot for pesticides if toxicity in bioassays can be demonstrated, bioassay results are collaborated by both chemical analysis and TIEs, and the pesticide residues reoccur in a pattern of frequent pulses. On 23 October 1998 the Central Valley Regional Board reviewed the above data and unanimously concluded that Ulatis Creek, Paradise Cut, French Camp and Duck Sloughs fit the recommended criteria for listing as a high priority candidate toxic hot spot because of elevated concentrations of chlorpyrifos.

A. Areal Extent

The potential aquatic threat posed by chlorpyrifos in agricultural return flow is confined to the four previously named Creeks and Sloughs. The areal extent of the impairment may be up to 15 linear miles of waterway within the legal boundary of the Delta.

B. Sources

The only major use of chlorpyrifos in these four drainage basins is on agriculture. Detailed follow up studies are needed to determine the crop and precise agricultural practice which led to the off site movement.

C. Summary of Actions

As described previously, DPR and SWRCB both have statutory responsibilities for protecting water quality from adverse effects of pesticides. In 1997, DPR and the SWRCB signed a management agency agreement (MAA), clarifying these responsibilities. In a companion document, the Pesticide Management Plan for Water Quality (Pesticide Management Plan), a process was outlined for protecting beneficial uses of surface water from the potential adverse effects of pesticides. The process relies on a four-stage approach: Stage 1 relies on education and outreach efforts to communicative pollution prevention strategies. Stage 2 efforts involve self-regulating or cooperative efforts to identify and implement the most appropriate site-specific reduced-risk practices. In stage 3, mandatory compliance is achieved through restricted use pesticide permit requirements, implementation of regulations, or other DPR regulatory authority. In stage 4, compliance is achieved through the SWRCB and RWQCB water quality control plans or other appropriate regulatory measures consistent with applicable authorities. Stages 1 through 4 are listed in a sequence that should generally apply. However, these stages need not be implemented in sequential order, but rather as necessary to assure protection of beneficial uses.

The U.S. EPA requires Regional Boards under the Clean Water Act to maintain 303(d) lists of impaired water bodies. In January 1998 the Central Valley Regional Board approved a revised 303(d) list of impaired water bodies and provided a schedule for the development of Total Maximum Daily Loads. The San Joaquin River and Delta-Estuary were listed, in part, because of chlorpyrifos impairments to water quality. The Regional Board ranked the impairment in both locations as a high priority and committed to the development of a TMDL by the year 2005. Components of a TMDL include problem description, numeric targets, monitoring and source analysis, implementation plan, load allocations, performance measures and feedback, margin of safety and seasonal variation and public participation. The TMDL waste load allocation, including an implementation schedule, must be adopted as a Basin Plan amendment by the Regional Board should compliance monitoring demonstrate that the problem has not been corrected.

Two activities are underway in the Central Valley to develop BMPs to reduce pesticide movement into surface water in irrigated agriculture. Each are summarized below.

U.C. Statewide Integrated Pest Management Project. In December 1997 the U.C. Statewide Integrated Pest Management Project was awarded a three year one million dollar grant by the CALFED Bay Delta program. Objectives of the grant are to (1) Identify alternate urban and rural BMP practices to prevent and reduce off site movement of diazinon and chlorpyrifos into surface water. Study is to consider both summer and winter uses of the two insecticides. (2) Provide outreach and education on these new practices to the urban and agricultural community, and (3) design and initiate a monitoring program to assess the success of the new practices. Stanislaus County will be the focus of the study effort.

DowElanco The Registrant of chlorpyrifos has undertaken a multi year study in the San Joaquin Basin at Orestimba Creek to identify the specific agricultural use patterns and practices which contribute the majority of the off-site movement of their product into surface water. The study involves an evaluation of pesticide movement in both winter storms and in summer irrigation return flows. Objectives in subsequent years are to use the data to develop and field test BMPs to reduce off site chemical movement. The initial study is now complete. A report is expected soon.

Much similarity exits between agricultural practices in the San Joaquin Basin and the Delta. The results of the DowElanco work may be important in helping to identify the agricultural practices responsible for causing instream toxicity in the Estuary and also for developing successful BMPs to solve the problem. All promising solutions need to be field tested in Delta farmland.

D. Assessment of Actions Required

In January 1998 the Central Valley Regional Water Quality Control Board adopted a revised 303(d) list, ranked chlorpyrifos impairments in the San Joaquin River and in the Delta as high priority and committed to the development of a load reduction program by the year 2005. In October 1998 staff briefed the Regional Board on pesticide detection patterns in the Central Valley and requested guidance on whether these should be considered "frequent" as required by the Bay Protection Program in order to be considered as a candidate high priority hot spot. In addition, guidance was sought on whether to prepare cleanup plans under Bay Protection or seek a variance and prepare a control program under section 303(d) of the Clean Water Act. The Bòard unanimously decided that the pattern of pesticide detections observed in various Delta backsloughs were frequent and merited consideration as a high priority candidate Bay Protection Hot Spot. The Board also directed staff to seek a variance and begin pesticide regulation under section 303(d) of the Clean Water Act._Therefore, no further assessment of the actions required under the Bay Protection Plan are listed here.

E. An estimate of the total costs to develop the plan.

Not Applicable.

F. An estimate of recoverable costs from potential dischargers.

Not Applicable

G. Two year expenditure schedule identifying funds to implement the plan that are not recoverable from potential dischargers.

Not Applicable.

References

Bailey, H., J. Miller, M. Miller, L. Wiborg. 1997. Joint toxicity of diazinon and chlorpyrifos under the conditions of acute exposure to *Ceriodaphnia*. J. Env. Cont. Toxicol. 16(11):2304-2309

Bailey, H. L. Deanovic, K. Luhman, T. Shed, D. Hinton, and V. Connor. 1996. Pesticides in urban stormwater from the Sacramento Valley and San Francisco Bay Area. Poster presentation at State of the Estuary Conference. October 10-12 1996, San Francisco CA. p 51.

BIOS, 1995. BIOS for almonds. A practical guide to biologically integrated orchard system management. Community Alliance with family farmers foundation, Davis, CA.

Connor, V., C. Foe and L. Deanovic 1993. Sacramento River Basin biotoxicity Survey Results, 1988-90. Staff report, Central Valley Regional Water Quality Control Board, Sacramento, CA

Connor, V. 1994. Toxicity and diazinon levels associated with urban storm runoff. Staff memorandum, Central Valley Regional Water Quality Control Board, Sacramento, CA

Connor, V. 1995a. Status of urban storm runoff project. Staff memorandum, Central Valley Regional Water Quality Control Board, Sacramento, CA

Connor, V. 1995b. Algal toxicity and herbicide levels associated with urban storm runoff. Staff memorandum, Central Valley Regional Water Quality Control Board, Sacramento, CA

Connor, V. 1996. Chlorpyrifos in urban storm runoff. Staff memorandum, Central Valley Regional Water Quality Control Board, Sacramento, CA

Deanovic, L. H. Bailey, T.W. Shed and D. Hinton. 1996. Sacramento-San Joaquin Delta Bioassay monitoring report. 1993-94. First annual report to the Central Valley Regional Water Quality Control Board. Aquatic Toxicology Laboratory. University of California, Davis.

Deanovic, L. K. Cortright, K. Larson, E. Reyes, H. Bailey, D. Hinton 1997. Sacramento-San Joaquin Delta Bioassay monitoring report. 1994-95. Second Annual Report to the Central Valley Regional Water Quality Control Board. Aquatic Toxicology Laboratory. University of California, Davis.

Department of Pesticide Regulation, 1996. Pesticide use report, annual 1994. Information systems Branch, Department of Pesticide Regulation, Sacramento CA.

Domagalski, J. 1995. Nonpoint source pesticides in the San Joaquin River and California, inputs from winter storms: 1992-93. U.S. Geological Survey Open file report 95-165. 15p

Dow AgroSciences LLC, 1998. A monitoring study to characterize chlorpyrifos concentration patterns and ecological risk in an agriculturally dominated tributary of the San Joaquin River. Study ENV 96055 for Dow AgroSciences, 9330 Zionsville Road, Indianapolis, Indiana 46268.

Foe, C and V. Connor 1991a. San Joaquin bioassay results: 1988-90. Staff report, Central Valley Regional Water Quality Control Board, Sacramento, CA

Foe, C. and V. Connor 1991b. 1989 Rice season toxicity monitoring results. Staff report, Central Valley Regional Water Quality Control Board, Sacramento, CA

Foe, C. and R. Sheipline 1993. Pesticides in surface water from application on orchards and alfalfa during the winter and spring of 1991-92. Staff report, Central Valley Regional Water Quality Control Board, Sacramento, CA

Foe, C. 1995. Insecticide concentrations and invertebrate bioassay mortality in Agricultural return water from the San Joaquin Basin. Staff report, Central Valley Regional Water Quality Control Board, Sacramento, CA

Foe, C., L. Deanovic, D. Hinton. 1998. Toxicity identification evaluations of orchard dormant spray runoff. Central Valley Regional Water Quality Control Board staff report. Sacramento Office.

Fox, P and E. Archibald, 1997. Aquatic toxicity and pesticides in surface waters of the Central Valley. Final report. Prepared for the California Urban Water Agencies , Sacramento, CA.

Glotfelty, D., J. Seiber, L. Liljedahl 1987. Nature 325(6105):602-605

Glotfelty, D., C. Schomburg, M.M. McChesney, J. Sugebiel and J. Seiber. 1990. Chemosphere, 21:1303-1314.

Katznelson, R. and T. Mumley. 1997. Diazinon in surface water in the San Francisco Bay area: occurrence and potential impact. Report prepared for the Alameda Countywide Clean Water Program, Hayward, CA.

Kratzer, C. 1997. Transport of diazinon in the San Joaquin River Basin, California. U.S. Geological Survey open file report 97-411. Sacramento 22p.

Kuivila, K. and C. Foe. 1995. Concentration, transport and biological impact of dormant spray insecticides in the San Francisco Estuary, California. Env. Toxicol. and Chem. 14:1141-1150

Larsen, K., V. Connor, L. Deanovic and D. Hinton. 1998a. Sacramento River Watershed Program Toxicity Monitoring Results: 1996-1997. Prepared for the Sacramento Regional County Sanitation District by the U.C. Davis Aquatic Toxicology Laboratory.

Larsen, K., V. Connor, L. Deanovic and D. Hinton. 1998b. Sacramento River Watershed Program Toxicity Monitoring Results: 1997-1998. Prepared for the Sacramento Regional County Sanitation District by the U.C. Davis Aquatic Toxicology Laboratory.

Menconi M. and C. Cox 1994a. Hazard Assessment to the insecticide diazinon to aquatic organisms in the Sacramento San Joaquin River System. California Department of Fish and Game Env. Serv. Div. Administrative Report 94-2. Sacramento CA.

Menconi M. and A. Paul 1994b. Hazard Assessment to the insecticide chlorpyrifos to aquatic organisms in the Sacramento San Joaquin River System. California Department of Fish and

Game Env. Serv. Div. Administrative Report 94-1. Sacramento CA.

Novartis Crop Protection, 1997. An ecological risk assessment of diazinon in the Sacramento and San Joaquin River Basins. Technical report 11/07 Environmental and Public affairs department Greensboro, NC

Ross, L. 1992. Preliminary results of the San Joaquin River study: winter 91-92. Staff memorandum to Kean Goh. Environmental Hazard Assessment Branch, Department of Pesticide Regulation. Sacramento CA.

Ross, L. 1993. Preliminary results of the San Joaquin River study: winter 92-93. Staff memorandum to Kean Goh. Environmental Hazard Assessment Branch, Department of Pesticide Regulation. Sacramento CA.

Ross, L. K. Bennett, K. Kim, K. Hefner and J. Hernandez 1997. Reducing dormant spray runoff for orchards. Staff report Environmental Monitoring and Pest Management Department of Pesticide Regulation Sacramento, CA.

Scanlin, J. and A. Cooper 1997. Outdoor use of diazinon and other insecticides in Alameda County. Report prepared for the Alameda County Flood Control and Water Conservation District, Hayward CA.

Scanlin, J. and A. Feng. 1997. Characterization of the presence and sources of diazinon in the Castro Valley Creek Watershed. Prepared for Alameda County Clean Water Program and Alameda County Flood Control and Water Conservation District.

Scanlin, J. and S. Gosselin 1997. Strategy to reduce diazinon levels in Creeks in the San Francisco Bay Area. Prepared for Alameda County Clean Water Program and Alameda County Flood Control and Water Conservation District.

U.S. EPA 1994. Short-term methods for estimating the chronic toxicity of effluents and receiving water to freshwater organisms. (3rd edition). Research and Development. EPA-600-4-91-002.

U.S. EPA 1998. TMDL Program Update. Presented at the U.S. EPA Water Quality Standards meeting in Philadelphia, PA. 24-27 August, 1998.

Future Needs

1. Sediment More sediment bioassay and pore water chemical analysis needs to be conducted in the Delta and Estuary. This information would serve as baseline data for evaluating future BPTCP hot spots, *in situ* dredge operations, beneficial reuse of dredge spoils on delta island levees and creation of CALFED shallow water habitat.

2. Fish Tissue studies Several organochlorine compounds and mercury have been identified in multiple fish species inhabiting the Delta at concentrations in excess of FDA and the new U.S. EPA fish tissue screening values (Montoya, 1991). A fish tissue study needs to be undertaken in the Delta in conjunction with the California Office of Environmental Health Hazard Assessment to ascertain whether additional fish advisories are warranted to protect human health. A similar study was recently completed in the Bay area using BPTCP funding (San Francisco Regional Water Quality Control Board, 1995).

The CALFED water quality program has identified mercury and several of these organochlorine compounds as contaminants of concern and is proposing actions to reduce their loading to the Estuary. Collection of fish tissue data would serve as baseline information to assess the future success of the CALFED program.

3. Water column fish toxicity tests The Sacramento River is about 80% of the freshwater flow into the Estuary. About half of all water samples collected since 1991 at Freeport on the lower Sacramento River at the entrance to the Delta have tested toxic in 7 day U.S. EPA (1994) fathead minnow bioassays (summarized in Fox and Archibald, 1997). The typical toxicological pattern is a 30-50% mortality rate within 7 days. Other characteristics that are important are: (1) similar toxicity has been observed throughout the watershed, (2) follow-up toxicity work performed under the RWP has indicated that pathogens are a potential causative agent for observed toxicity, (3) questions exist whether the pathogen based toxicity is representative of field conditions or is a testing artifact, and (4) the Regional Board has been given $400,000 by CALFED for follow-up studies to confirm that pathogens are the primary cause of the impairment.

4. Algal TIEs About 2000 metric tons of herbicide are used annually in the Central Valley and Delta and some compounds are regularly detected in chemical analysis of estuarine surface water (Edmunds *et al.*, 1996). These include simazine, atriazine and diuron. The impact of herbicides on Delta primary production rates are not known. Furthermore, no algal TIE procedures have been developed to ascertain this.

On occasion water samples collected as part of the BPTCP which exhibited low algal primary production in the three species algal bioassay were eluted through a C8 resin column and retested. Often primary production rates in eluted samples were statistically enhanced, sometimes by as much as an order of magnitude, over unmanipulated ones (Deanovic *et al.*, 1996; 1997). This suggests that a non-polar organic compound was the potential cause of the observed toxicity. Chemical analysis was performed on splits of these water samples and diuron was observed in several urban runoff samples at toxic concentrations (Connor, 1995b). However, no chemical was usually identified. Algal TIE procedures need to be perfected for local diatom species (Delta algal community dominants) and estuarine surface water monitored to assess whether phytotoxins are present at concentrations impacting estuarine production.

Sites of Concern (Sites that do not qualify as Candidate Toxic Hot Spots)

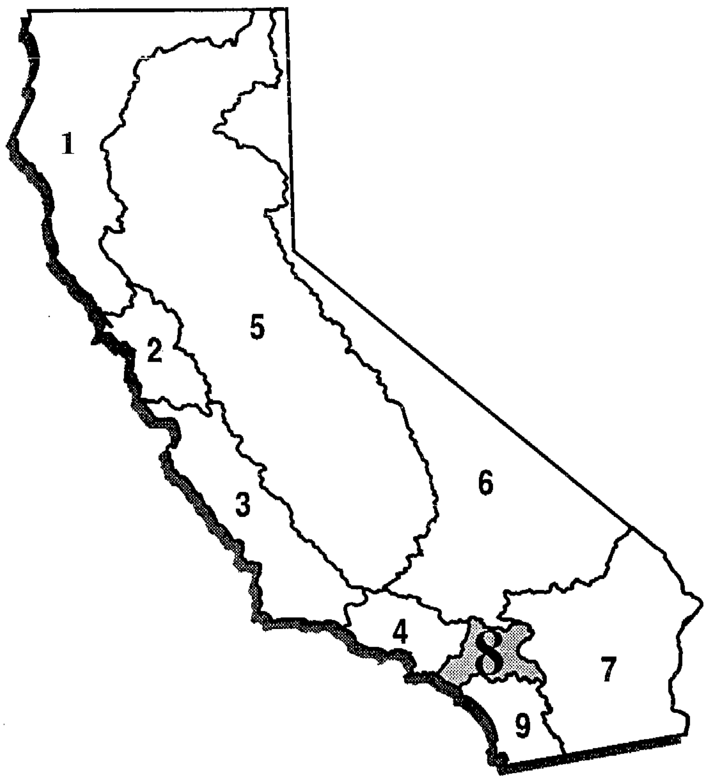
Water body Name	Segment Name	Site Identification	Reason for Listing	Pollutants present at the site	Report reference
Delta-Estuary	Various	Paradise Cut, Old River, Mcleod Lake	Aquatic life impairment	Diuron	1
Delta-Estuary	Various	Paradise Cut, Bishop Cut	Aquatic life impairment	Carbofuran	1, 2

References

1. Deanovic, L. H. Bailey, T.W. Shed and D. Hinton. 1996. Sacramento-San Joaquin Delta Bioassay Report. 1993-94. First annual report to the Central Valley Regional Water Quality Control Board. U.C. Davis Aquatic Toxicology Laboratory. U.C. Davis, Davis, CA.

2. Foe, C. and R. Sheipline. 1993. Pesticides in surface water from applications on orchards and alfalfa during the winter and spring of 1991-92. Staff report. Central Valley Regional Water Quality Control Board, Sacramento, CA.

REGIONAL WATER QUALITY CONTROL BOARD
SANTA ANA REGION



REGIONAL TOXIC HOT SPOT
CLEANUP PLAN

Region Description

The Santa Ana Region is the smallest of the nine regions in the state (2800 square miles) and is located in southern California, roughly between Los Angeles and San Diego. Although small geographically, the region's four-plus million residents (1993 estimate) make it one of the most densely populated regions.

The climate of the Santa Ana Region is classified as Mediterranean: generally dry in the summer with mild, wet winters. The average annual rainfall in the region is about fifteen inches, most of it occurring between November and March.

Candidate Toxic Hot Spot List

Water body name	Segment Name	Site Identification	Reason for Listing	Pollutants present at the site	Report reference
Anaheim Bay	Naval Reserve	BPTCP Site # 82030, Latitude - 33,44,12N, Longitude - 118,05,31W	Sediment toxicity	Chlordane, DDE	3, 4
Seal Beach NWR	Navy Marsh	82001, 33,43,88N, 118,04,72W	Sediment toxicity	DDE	3, 4, 6
Seal Beach NWR	Bolsa Ave.	82023, 33,44,65N, 118,04,66W	Sediment toxicity	Arsenic	3, 4
Seal Beach NWR	Middle Reach	82002, 33,44,44N, 118,04,40W	Sediment toxicity	Arsenic	3, 4
Seal Beach NWR	Left Reach	82040, 33,44,26N, 118,05,18W	Sediment toxicity	DDE	3, 4
Huntington Harbour	Upper Reach	80028, 33,42,80N, 118,03,67W	Sediment toxicity	Chlordane, DDE, Chlorpyrifos	3, 4, 5, 6
Bolsa Chica Ecological Reserve		82039, 33,41,75N, 118,02,76W	Sediment toxicity	DDE	3, 4
Upper Newport Bay	Narrows	85001, 33,38,083N, 117,53,454W	Sediment toxicity Exceeds objectives	Chlordane, zinc, DDE	1, 3, 4
Lower Newport Bay	Rhine Channel	85013, 33,36,721N, 117,55,670W	Sediment toxicity Exceeds objectives	Arsenic, copper, lead, mercury, zinc, DDE, PCB, TBT	1, 2, 3, 4, 6
Lower Newport Bay	Newport Island	85014, 33,37,251N, 117,56,174W	Exceeds objectives	Copper, lead, mercury, zinc, chlordane, DDE, PCB, TBT	1, 4

References

1. Anderson, B., Hunt, J., Tudor, S., Newman, J., Tjeerdema, R., Fairey, R., Oakden, J., Bretz, C., Wilson, C., La Caro, F., Stephenson, M., Puckett, M., Long, E., Fleming, T., Summers, K. 1996. *Chemistry, Toxicity and Benthic Community Conditions in Sediments of the Southern California Bays and Estuaries.* Report to the California State Water Resources Control Board, Environmental Protection Agency, National Oceanic and Atmospheric Administration, California Department of Fish and Game, University of California, Santa Cruz, and the Moss Landing Marine Laboratories. 140 pp + appendices.

2. California Regional Water Quality Control Board - Santa Ana Region. 1990. *Evaluation of Boat Yard Waste Treatment Technologies Within the Santa Ana Region.* 117 pp.

3. Moore, B., Klein, E., Hines, D., Au, M., Boon, R., Ashby, K., Nguyen, D. 1997. *Orange County NPDES Stormwater Program Annual Progress Report 1997 (NPDES Permit CAS618030).* Report to the Santa Ana Regional Water Quality Control Board. 60 pp. + appendices.

4. Phillips, B., Anderson, B., Hunt, J., Newman, J., Tjeerdema, R., Wilson, C., Sapudar, R., Long, E., Stephenson, M., Puckett, M., Fairey, R., Oakden, J., Dawson, S., and Smythe, H. 1998. *Sediment Chemistry, Toxicity, and Benthic Community Conditions in Selected Water Bodies of the Santa Ana Region.* Sacramento, CA. 104p + appendices.

5. Sapudar, R., Wilson, C., Reid, M., Long, E., Stephenson, M., Puckett, M., Fairey, R., Hunt, J., Anderson, B., Holstad, D., Newman, J., Birosik, S., Smythe, H. 1994. *Sediment Chemistry and Toxicity in the Vicinity of the Los Angeles and Long Beach Harbors.* Final Report to the California State Water Resources Control Board and the National Oceanic and Atmospheric Administration. 81 pp + appendices.

6. State Water Resources Control Board. 1998. State Mussel Watch Program Monitoring Database. Computer file.

Ranking Matrix

Water body Name	Site Identification	Human Health Impacts	Aquatic Life Impacts	Water Quality Objectives	Areal Extent	Remediation Potential	Overall Ranking
Anaheim Bay - Naval Reserve	BPTCP Site # 82030, Latitude - 33,44,12N, Longitude - 118,05,31W	No Action	Moderate	No Action	1 to 10 acres	Moderate	Moderate
Seal Beach NWR - Navy Marsh	82001, 33,43,88N, 118,04,72W	Low	Low	Low	1 to 10 acres	Moderate	Low
Seal Beach NWR - Bolsa Ave.	82023, 33,44,65N, 118,04,66W	No Action	Low	No Action	1 to 10 acres	Moderate	Low
Seal Beach NWR - Middle Reach	82002, 33,44,44N, 118,04,40W	No Action	Low	No Action	1 to 10 acres	Moderate	Low
Seal Beach NWR	82040, 33,44,26N, 118,05,18W	No Action	Low	No Action	1 to 10 acres	Moderate	Low
Huntington Harbour - Upper Reach	80028, 33,42,80N, 118,03,67W	Low	Low	Low	1 to 10 acres	Moderate	Low
Bolsa Chica Ecological Reserve	82039, 33,41,75N, 118,02,76W	No Action	Low	Low	1 to 10 acres	Moderate	Low
UNB - Narrows	85001, 33,38,083N, 117,53,454W	No Action	Moderate	Low	1 to 10 acres	Moderate	Moderate
LNB - Rhine Channel	85013, 33,36,721N, 117,55,670W	Low	High	Moderate	1 to 10 acres	High	High
LNB - Newport Island	85014, 33,37,251N, 117,56,174W	No Action	High	Low	1 to 10 acres	High	Moderate

Best professional judgment was used to assign ranks to several sites for some of the ranking criteria.

Human Health Impacts

If tissue residues from aquatic organisms contained elevated levels, such as exceeding Elevated Data Levels (EDLs) based on State Toxic Substances Monitoring Program or Mussel Watch data, but did not exceed FDA/DHS action levels or U.S. EPA screening levels, the site was ranked "Low". The medium and high ranks are defined in the Water Quality Control policy for Guidance on the Development of Regional Toxic Hot Spot Cleanup Plans (SWRCB, 1998).

Water Quality Objectives

Due to the absence of numeric objectives for toxic substances for Enclosed Bays and Estuaries contained in the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) (CRWQCB-SAR, 1995), best professional judgment was used to interpret the following narrative standards:

Toxic substances shall not be discharged at levels that will bioaccumulate in aquatic resources to levels which are harmful to human health.
The concentrations of toxic substances in the water column, sediments or biota shall not adversely affect beneficial uses.

Water column and sediment chemistry data and tissue residue data from aquatic organisms were used to assign the rank based on the frequency of exceedance of the objective. The water column chemistry data were compared to objectives formerly established by the Enclosed Bays and Estuaries Plan and sediment chemistry data were compared to sediment screening levels developed by NOAA (Long and Morgan, 1990, Long *et al*, 1995) and the State of Florida (MacDonald, 1994. The tissue residue data from aquatic organisms were compared against FDA/DHS action levels or U.S. EPA screening levels. The ranks were: Exceeded regularly (High), occasionally exceeded (Moderate), infrequently exceeded (Low).

Areal Extent of Toxic Hot Spot

Determination of areal extent of sites was based on the site location, site hydrology, the distribution of toxic substances between sites, potential dischargers in the area, and site history. There has not been a thorough site characterization at any of the sites that would produce a definitive areal extent measurement.

Natural Remediation Potential

The natural remediation potential of the sites was based on the site location, site hydrology, the distribution of toxic substances between sites, and site history.

High Priority Candidate Toxic Hot Spot Characterization

Lower Newport Bay - Rhine Channel

A. An assessment of the areal extent of the Toxic Hot Spot (THS).

Between 1.5 and 2.5 acres.

B. An assessment of the most likely sources of pollutants (potential discharger).

The area was historically a small inlet in the larger marsh system of Lower Newport Bay. In 1918, the first boat yard was built on the channel. A fish cannery was built in 1919, but was used predominately after 1935. The dredging of Lido Channel South occurred in 1920, with large scale dredging of Lower Newport Bay occurring in 1934-35 to provide safe harbor navigation. During the 1940's and 1950's the channel supported boat building activity for both the US Navy and the Mexican Navy during World War II and the Korean War. The boat yards produced midsize boats, mainly mine sweepers, subchasers, and rescue boats in the 45 to 135 ft. length range. In 1964, there were 19 boat yards operating in the Lower Bay. Currently six boat yards operate along Rhine Channel (see Figure 1). The boat yards are currently regulated by General Waste Discharge Requirements (see Section C). Historic practices at the boat yards are the most likely source of pollutants in Rhine Channel, although a thorough characterization of the depth of pollution has never been undertaken. An investigation of the extent of pollution depth and area would help to either eliminate or include likely historic sources.

C. A summary of actions that have been initiated by the Regional Boards to reduce the accumulation of pollutants at existing THSs and to prevent the creation of new THSs.

The Regional Board currently regulates the discharge of process wastewater and stormwater from all boat yard facilities in Lower Newport Bay and Huntington Harbour through General Waste Discharge Requirements (Order No. 94-26, as amended by Order No. 95-60 and 96-52). The boat yards were initially issued individual NPDES permits beginning in 1975. The main feature of Order No. 94-26, as amended, is the elimination of the discharge of process wastewater in accordance with the requirement of the Water Quality Control Policy for the Enclosed Bays and Estuaries of California. Process wastewater is defined by the Order to include the first one tenth of an inch of rain that is proceeded by seven days of dry weather. This permit requirement was to be implemented by April, 1996. Presently, five of the six boat yards in Rhine Channel have complied with this requirement.

The Newport Bay watershed is one of two watersheds within the Santa Ana Region that are the focus of intensive watershed management activities. The expected outcomes of this planning and management effort includes a further refinement of water quality problems, both in the Bay and watershed, the development and implementation of a watershed management plan that addresses these problems, and mechanisms for measuring the success of the plan and improvements in water quality.

Additionally, Lower Newport Bay is currently listed as water quality limited for metals and pesticides pursuant to Section 303(d) of the Clean Water Act. A Total Maximum Daily Load (TMDL) for metals and pesticides will be developed by the Regional Board to address this impairment. The control of pollutant sources occurring in Rhine Channel will be a component of the TMDLs.

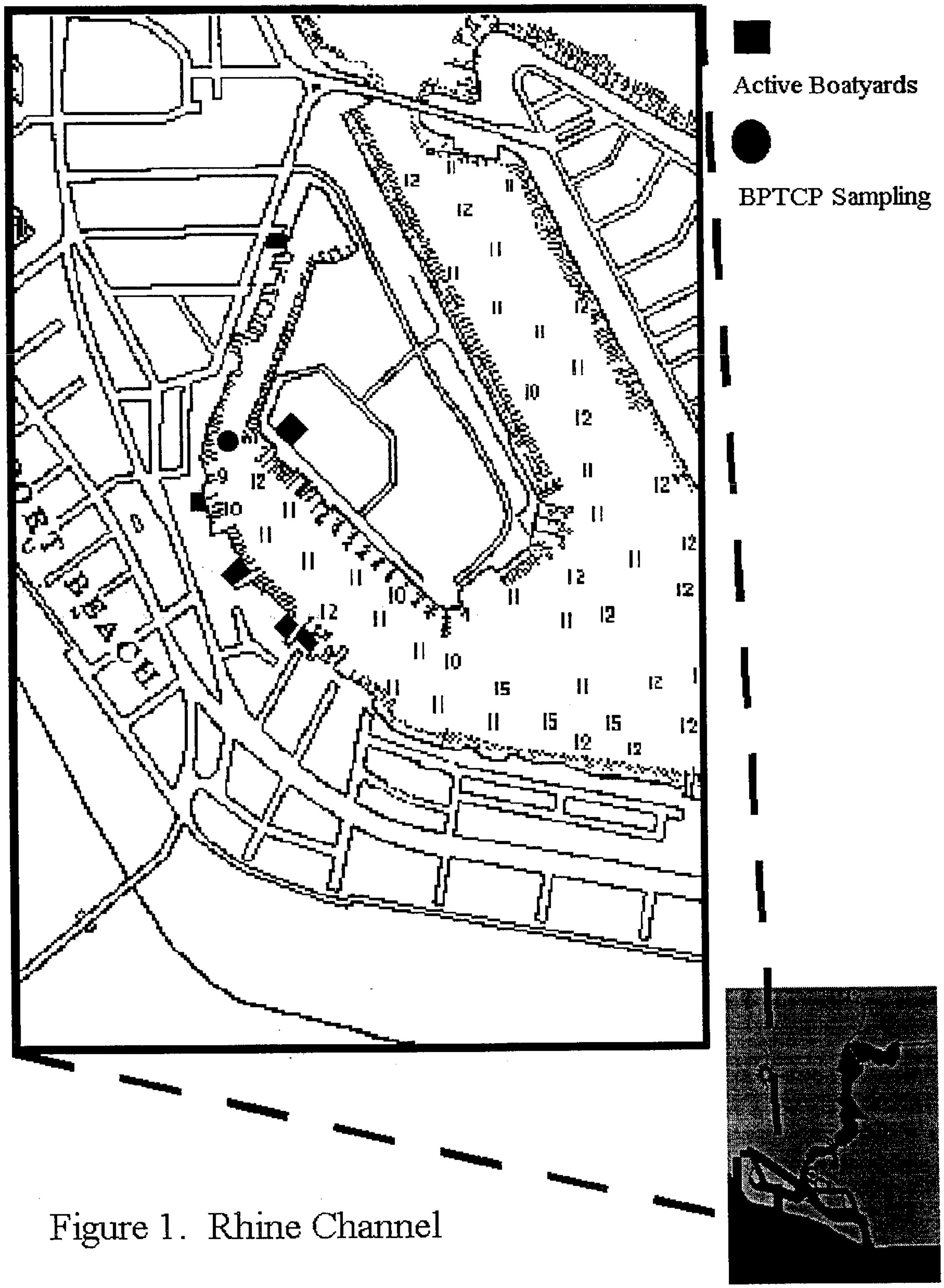


Figure 1. Rhine Channel

D. Preliminary Assessment of Actions required to remedy or restore a THS, including recommendations for remedial actions.

There are four options for cleanup of the Rhine Channel THS. These include ex-situ treatment, chemical separation, immobilization, and dredging. The ex-situ treatment of pollution at Rhine Channel could include either chemical separation or immobilization. Chemical separation would separate the weakly bound metals from the sediment, and the clean sediment would then be disposed. The problem with this treatment is the limited application of the method, the need for further treatment systems integration for a complete separation, and the need for a treatment site. This last factor is significant due to the urban setting of the site. Significant transportation costs would be incurred by hauling the sediment to a non-local treatment area.

Immobilization of trace metals by chemical fixation is another possible treatment. This treatment has been used extensively for solid wastes. A limitation with this treatment is the high moisture content of the sediment in Rhine Channel and the need for a treatment site.

The capping or containment of the site is not an option due to the shallow depth of Rhine Channel. Capping would effectively eliminate any navigation in the channel and adversely affect the economic activities of business that use the channel (i.e., the boatyards).

The only other viable treatment is dredging and off-site disposal. Dredging of the site would allow for a confined remediation area with a low potential for the off-site migration of toxic substances through the use of siltation curtains. It would also allow for the continued use of the channel without a significant disruption of access or business activity.

E. <u>An estimate of the total cost and benefits of implementing the cleanup plan.</u>

The dredging of Rhine Channel would involve the removal of approximately 23,000 cubic yards of sediment (2 acres x 7 feet deep). This is a rough estimate because there has not been a thorough characterization of the areal extent of pollution. These amounts should be considered conservative and preliminary. Additional costs could be incurred if alternative disposal transportation is required.

Sediment Removal		
Hydraulic dredge	(23,000 cy @ $10 cy)	$230,000
Silt screen (material, labor)	(600 ft @ $3 ft)	$1,800
Sediment Transport		
Truck	(23,000 cy @ $200 cy)	$4,600,000
Sediment Disposal		
Class I disposal facility (Hazardous waste)	(23,000 cy @ $250 cy)	$5,750,000
Total		$10,581,800

The benefits of implementing the cleanup plan are related to the beneficial uses of Lower Newport Bay. The beneficial uses of Lower Newport Bay are: Navigation (NAV); Water Contact Recreation (REC1); Non-contact Water Recreation (REC2); Commercial and Sportfishing (COMM); Wildlife Habitat (WILD); Rare, Threatened or Endangered Species (RARE); Spawning, Reproduction, and Development (SPWN); Marine Habitat (MAR); and Shellfish Harvesting (SHEL). The benefits would be improved ecosystem conditions, more abundant wildlife, lower concentrations of pollutants in water and sediment, lower concentrations of pollutants in fish and shellfish tissue, and an undegraded benthic community.

F. An estimate of recoverable costs from potential dischargers.

The recoverable costs from dischargers would be insufficient to perform cleanup activities. The boatyard operations are small businesses, with a few having financial difficulty implementing control measures currently required by the Regional Board. If the Regional Board were to issue Cleanup and Abatement Orders to the boatyards in an attempt to recover costs for the proposed cleanup activities, it is envisioned that several of the boatyards would claim bankruptcy rather than participate.

It is estimated that recoverable cleanup costs from dischargers would be from 1 to 10 %.

G. A two-year expenditure schedule identifying funds to implement the plans that are not recoverable from potential dischargers.

Year 1.

The activities conducted during the first year would be further site pollution characterization. These activities would include extensive sampling to determine the areal extent, depth, and severity of pollution in Rhine Channel. The cost would be approximately $900,000.

Year 2.

The activities conducted during the second year would be the development of an engineering report and operating plan for the cleanup site, obtaining the appropriate permits (e.g., 401/404), and producing appropriate environmental documentation (e.g., NEPA/CEQA). These services would be provided by a consulting firm. This would cost approximately $500,000.

References

California Regional Water Quality Control Board - Santa Ana Region (CRWQCB - SAR), 1995. Water Quality Control Plan for the Santa Ana River Basin. 7 sections + appendices.

Long, E. R., and L. Morgan, 1990. The potential effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52.

Long, E. R., D.D. MacDonald, S. L. Smith, and F. D. Calder, 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environmental Management* 19:81-97.

MacDonald, D.D., 1994. Approach to assessment of sediment quality in Florida coastal waters. Volumes I and II. Prepared for the Office of Water Policy, Florida Department of Environmental Regulation. MacDonald Environmental Services, Ltd., Ladysmith, British Columbia.

State Water Resources Control Board (SWRCB), 1998. *Water Quality Control Policy for Guidance on the Development of Regional Toxic Hot Spot Cleanup Plans*. 43 pp.

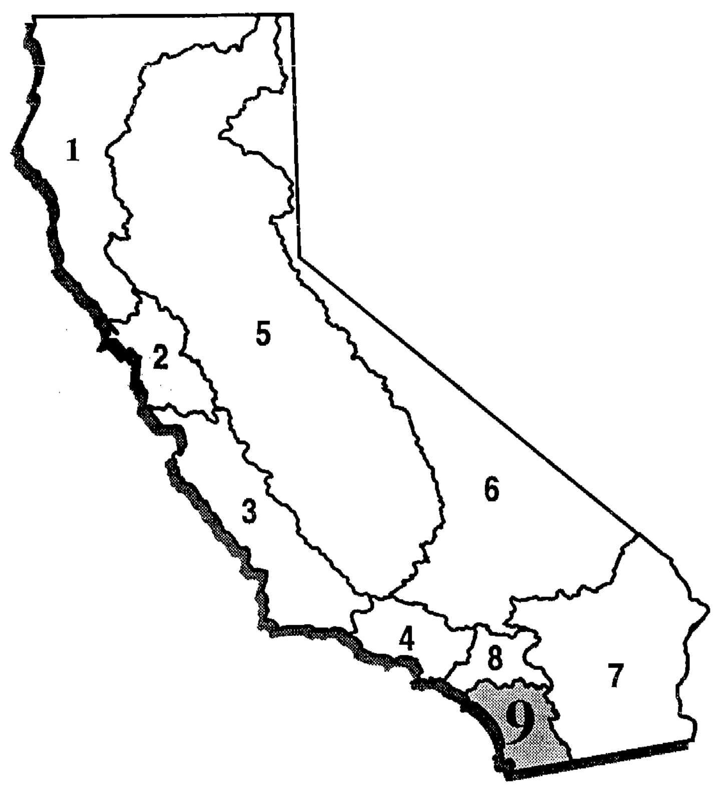
Future Needs

Several sites in the Region need additional characterization work to either include or exclude them from Candidate Toxic Hot Spot designation. These sites are listed in the following table.

Sites of Concern (Sites that do not qualify as Candidate Toxic Hot Spots)

Water body name	Segment Name	Site Identification	Reason for Listing	Pollutants present at the site	Report reference
Huntington Harbour	Middle Reach	BPTCP Site # 80027, Latitude - 33,42,80N, Longitude - 118,03,67W	Sediment toxicity (Not recurrent)	Chlordane, DDE	3, 4, 5
Huntington Harbour	Launch ramp	82005, 33,43,61N, 118,03,91W	Sediment toxicity (Not recurrent)	Lead, zinc, DDE	3, 4
Bolsa Bay	Mouth Of EGGW	82024, 33,42,40N, 118,03,35W	Sediment toxicity (Not recurrent)	Unknown	3, 4
Lower Newport Bay	Arches Drain	85015, 33,37,199N, 117,55,697W	Sediment toxicity (Not recurrent)	Chlordane, DDE, TBT	1, 4

REGIONAL WATER QUALITY CONTROL BOARD
SAN DIEGO REGION



REGIONAL TOXIC HOT SPOT CLEANUP PLAN

Region Description

The San Diego Region is located along the coast of the Pacific Ocean from the Mexican border to north of Laguna Beach in Orange County. The Region is rectangular in shape and extends approximately 80 miles along the coastline and 40 miles east to the crest of the mountains. The Region includes portions of San Diego, Orange, and Riverside Counties. Weather patterns are Mediterranean in nature with an average rainfall of approximately ten inches per year occurring along the coast. Almost all of the rainfall occurs during wet cool winters. The Pacific Ocean generally has cool water temperatures due to upwelling.

The population of the Region is heavily concentrated along the coastal strip. There are coastal lagoons at river mouths to the ocean, and two dredged small craft harbors, Dana Point and Oceanside Harbor in the north part of the Region. In the southern part two harbors, Mission Bay and San Diego Bay, support major recreational vessel and ship traffic. San Diego Bay is long and narrow, 15 miles in length averaging approximately one mile across. A deep-water harbor, the Bay has experienced waste discharge from former sewage outfalls, industries, and urban runoff. Up to 9,000 vessels may be moored in the Bay. San Diego Bay also hosts four major U.S. Navy bases with approximately 50 surface ships and submarines home-ported in the Bay.

Candidate Toxic Hot Spot List

Water Body Name	Segment Name	Site Identification	Reason for Listing [1]	Pollutants Present at the Site	Report Reference
San Diego Bay	North Bay	Between "B" Street and Broadway piers, San Diego (Stations 93205, 93206)	5	PAHs, total chemistry	1
San Diego Bay	Central Bay	Switzer Creek, San Diego (Station 90039)	2	Chlordane, Lindane, DDT, total chemistry	1, 3
San Diego Bay	Central Bay	Foot of Evans and Sampson Streets, San Diego (Stations 90020, 93211)	5	PCBs, antimony, copper, total chemistry	1
San Diego Bay	Central Bay	Chollas Creek, San Diego [2] (Stations 90006, 93212, 93213)	5	Chlordane, total chemistry	1
San Diego Bay	Central Bay	Seventh Street Channel/Paleta Creek, Naval Station (Stations 90009, 93227, 93228)	2, 5	Chlordane, DDT, total chemistry	1

[1] See candidate toxic hot spot definitions on page No. 2 is repeat amphipod sediment toxicity; No. 5 is multiple degraded benthic communities.

[2] The Chollas Creek watershed is one of two high-priority San Diego Region Total Maximum Daily Load (TMDL) projects proposed to be completed in the year 2000.

Reference list

State Water Resources Control Board. 1996 Chemistry, Toxicity and Benthic Community Conditions in Sediments of the San Diego Bay Region. Final Report.

State Water Resources Control Board. 1997 Chemistry, Toxicity and Benthic Community Conditions in Sediments of Selected Southern California Bays and Estuaries. Final Report.

State Water Resources Control Board. 1998 Chemistry, Toxicity and Benthic Community Conditions in Sediments of the San Diego Bay Region. Addendum Report.

Ranking Matrix

Water body Name	Site Identification	Human Health Impacts	Aquatic Life Impacts	Water Quality Objectives	Areal Extent	Remediation Potential	Overall Ranking
San Diego Bay	Seventh Street Channel/ Paleta Creek, National City	No action	High	No action	1 to 10 acres	High	High
San Diego Bay	Between "B" St. and Broadway piers, San Diego	No action	Moderate	No action	1 to 10 acres	High	Moderate
San Diego Bay	Switzer Creek, San Diego	No action	Moderate	No action	1 to 10 acres	High	Moderate
San Diego Bay	Foot of Evans and Sampson Streets, San Diego	No action	Moderate	No action	1 to 10 acres	High	Moderate
San Diego Bay	Chollas Creek, San Diego	No action	Moderate	No action	1 to 10 acres	High	Moderate

High Priority Candidate Toxic Hot Spot

Seventh Street Channel, National City

A. Assessment of the Areal Extent of the THS

Approximately three acres appear affected (Stations 90009, 93227, 93228); however, the area affected could be substantially larger or smaller. Dredging activities could have occurred in this area since San Diego Bay was sampled during the period 1992 to 1994. If so, this area or parts of this area may no longer be considered for designation as a candidate toxic hot spot.

B. Assessment of the Most Likely Sources of Pollutants (Potential Discharger)

Because benthic community analysis does not directly measure cause and effect relationships between chemicals and fauna living in the sediment, it is possible that some of the degraded benthic communities could have been caused by physical disturbance of the bottom from tug and ship propellers, or from disturbance caused by recent dredging.

Persistent chemicals, such as PAHs and Chlordane, could also have caused benthic community degradation and sediment toxicity at the Seventh Street Channel. Possible sources include industrial activities, atmospheric fallout, pesticides from lawns, streets, and buildings, and runoff from pest control operations.

C. Summary of Actions That Have Been Initiated by the RWQCB to Reduce the Accumulation of Pollutants at Existing THSs and to Prevent the Creation of New THSs

The following programs address water quality near the Seventh Street Channel. It is unknown whether any of the organizations or facilities named below have discharged chemical wastes at levels which could have caused the accumulation of pollutants at existing toxic hot spots.

NPDES Permits for the Naval Station. The Naval Station Graving Dock, which lies midway between Chollas Creek and the Seventh Street Channel and a half mile north of the Seventh Street Channel, currently is covered by its own National Pollutant Discharge Elimination System (NPDES) permit. Discharges from Navy industrial facilities are currently covered under the State Water Resources Control Board General Industrial Storm Water Permit. The Regional Board may issue NPDES permits for discharges from other Navy activities adjacent to San Diego Bay.

NPDES Municipal Storm Water Permit. In 1990, the Regional Board issued NPDES storm water permits to municipalities responsible for civilian areas, including those tributary to San Diego Bay. Activities underway in the Paleta Creek watershed by the City of National City include public education, public service announcements on television, and street sweeping. The storm water permit is now being revised.

Pacific Steel site. During the 1980s, the Regional Board took enforcement action against Pacific Steel, an automobile recycler. The company, which was located inland of the Seventh Street Channel, maintained a large "fluff" pile of non-ferrous waste. Runoff from the fluff pile was prohibited by the Regional Board from draining to San Diego Bay. The fluff pile was subsequently removed and the site cleaned up.

Military cleanups. The Regional Board has participated in Department of Defense Environmental Response Program (DERP) and Navy Installation Restoration (IR) activities to close former military hazardous waste sites on land adjacent to the Bay. Several disposal sites are located around the Seventh Street Channel.

D. Preliminary Assessment of Actions Required to Remedy or Restore a THS to an Unpolluted Condition Including Recommendations for Remedial Actions

The following discussion applies only to the limited area of three acres estimated to be contaminated. It is possible that a larger or smaller area could have been contaminated by industrial wastes.

Section 13360 of the Porter-Cologne Water Quality Control Act prohibits regional boards, the State Board, and the courts from designating the means of compliance with the California Water Code. For this reason, the options presented below are not meant to influence the ultimate solution, but are presented to comply with Bay Protection and Toxic Cleanup Program legislative requirements and to provide a starting point for discussion. The Regional Board could require potential responsible parties to submit CWC Section 13267 technical reports documenting the amounts and types of wastes discharged.

Regional Board procedures. A first step could be to convene a meeting between potential responsible parties to discuss the data and to receive comments and information about the site. After review by staff of available information, the Regional Board Executive Officer could ask potential dischargers to submit technical reports. Subsequently, the Board could require potential responsible parties to sample the site and surrounding area to document in detail the areal extent of the site and to identify specific pollutants at the site. Only after extensive review of all available information would the Regional Board require remediation actions.

Persistence of wastes at this site. The chemical wastes found in the Seventh Street Channel and at the mouth of Paleta Creek, the pesticides Chlordane and DDT, and the class of polynuclear aromatic hydrocarbon (PAH) "ring" compounds derived from fossil fuels, are known to persist in nature. These organic chemicals may be resistant to treatment or natural remediation processes such as oxidation, microbial degradation, and photolysis. For this reason, natural recovery or in situ treatment may not be feasible. In-place capping is presumed to be infeasible because of frequent vessel traffic in this area of the Bay. Two options which may be feasible are dredging followed by placement in an upland confined disposal facility, and dredging followed by contained aquatic disposal. There is precedent for both options in San Diego Bay. Dredging of contaminated bottom material has occurred at boat yards in north San Diego Bay and at the 24th Marine Terminal in the south Bay. A submerged aquatic disposal site has been completed in the north Bay off several storm drains known to have contributed PCBs to the Bay.

Dredging and upland disposal. Stations 90009, 93227, and 93228 are located in a heavily-used dredged channel frequented by barges, boats, and tugs. Navigation charts show depths of between 18 to 21 feet at mean lower low water, although the depths may be shallower or deeper due to sedimentation or recent dredging. There may be suitable sites on land nearby to build settling ponds to receive hydraulic dredge spoils. Sediment removal activities could include clamshell dredging or hydraulic dredging, and transportation to a suitable disposal site by barge, rail, or truck, or to settling ponds next to the Channel.

Dredging and contained aquatic disposal. Another method could involve dredging a disposal site at another location in San Diego Bay, depositing the contaminated dredge spoil from the candidate toxic hot spot site, and capping the site with suitable material. The following conditions would have to be met if this option were to be implemented:

Clean Water Act Section 404 dredging permits would be obtained from the U.S. Army Corps of Engineers for the contaminated site and for the aquatic disposal site State waste discharge requirements would be obtained from the Regional Board for the disposal site. The cap would provide adequate coverage to prevent the spread of contaminated material. Burrowing organisms would be prevented from mixing polluted sediments (i.e., bioturbation must not occur). The contaminated material covered would be able to support the cap. The bottom slope would be able to support the cap during seismic events. The cap would be well marked and protected against erosion or destruction from anchors, propellers, and strikes by vessels. The site would be located away from major navigation lanes. The exact location of the site would be noted on maps, charts, and deeds.

E. Estimate of the Total Cost to Implement the Cleanup Plan

This preliminary cost list is based on the schedule found in the 1997 guidance document. High and low costs are provided. It is assumed that if ocean disposal at the 100 fathom site is chosen, the U.S. Army Corps of Engineers would require extensive testing of the material removed from the Seventh Street Channel to be transported to the LA-5 site 6 miles from Pt. Loma. Costs were not able to be estimated for California Environmental Quality Act (CEQA) compliance, Section 404 dredging permit and state waste discharge requirements acquisition, or sampling to determine the areal extent of the candidate toxic hot spot.

Costs for dredging and upland disposal. High costs: Assume that 14,520 square yards (three acres) need remediation and that sediment to a depth of one yard would be removed. The 14,520 cubic yards of dredge spoil would then be placed on a barge, offloaded onto trucks, and transported to a suitable upland landfill. Low costs: Assume that the wastes are transported to a Class III site.

Comparison of High and Low Costs
for Dredging and Upland Disposal

High Cost per Cubic Yard		Low Cost per Cubic Yard	
Clamshell dredging	$10	Clamshell dredging	$10
Unloading from barge	TBD	Unloading from barge	TBD
Transport by truck	200	Transport by truck	200
Disposal at Class I site	300	Disposal at Class III site	30
Sub total per cubic yard	$510	Sub total per cubic yard	$240
14,520 cubic yards X $510 = $7,405,200 (not including permits)		14,520 cubic yards X $240 = $3,384,800 (not including permits)	

Costs for dredging and contained aquatic disposal. High costs: Assume that 14,520 square yards (three acres) need remediation and that sediment to a depth of one yard would be removed. An aquatic disposal site would be dredged and suitable material obtained for use as a cap. Another suitable cap to prevent burrowing animals from penetrating into the underlying contaminated sediment would be provided as well. The 14,520 cubic yards of dredge spoil would be placed on a barge and transported to the aquatic disposal site. The caps would then be constructed. Low costs: Assume that confinement at the disposal site is not necessary.

Comparison of High and Low Costs for
Dredging and Contained Aquatic Disposal

High Cost per Cubic Yard		Low Cost per Cubic Yard	
Excavation of disposal site	TBD	Clamshell dredging and disposal (assuming confined disposal is not needed)	$10
Clamshell dredging	$10		
Barge transport of waste (assume high truck costs)	TBD		
Disposal at aquatic site	9		
Cap at disposal site	TBD		
Monitoring at disposal site	TBD		
Sub total per cubic yard	$19	Sub total per cubic yard	$10
14,520 cubic yards X $19 = $275,880 total (not including creating and maintaining disposal site or acquiring permits)		14,520 cubic yards X $10 = $145,520 total (assuming a confined site is not needed)	

F. Estimate of Recoverable Costs From Potential Dischargers

No attempt has been made to ask potential responsible parties to participate in any remediation activities, so projected participation by responsible parties is based on conjecture. If fifty percent of the costs were recovered and the cleanup were to cost $7.4 million, the following schedule may be possible. Assume that $3.7 million is not recoverable.

G. Two-Year Expenditure Schedule Identifying Funds to Implement the Plans That Are Not Recoverable From Potential Dischargers

Assume that a total of more than $3.7 million would be needed, and that more than two years would be needed to remediate the Seventh Street Channel site.

Activity Deficit

Year 1:

- Meeting with responsible parties
- Request for technical information
- Discharger response
- Staff review of response
- Cleanup and abatement order
- Sampling plan to characterize aerial extent
- Request for bids for chemistry sampling and analysis
- Lab contract

estimate $800,000

Year 2:

- Site characterization
- Engineering report
- Section 404 dredging permit application
- State waste discharge requirements application
- NEPA and CEQA environmental documentation

estimate $900,000

Future Needs

Sampling information is needed to confirm whether toxic chemicals are present at sites that did not undergo repeat sampling. Follow-up information is also needed to adequately characterize toxic hot spots and sites of concern for toxic chemicals, both in the geographic area covered and by depth. Because of San Diego Regional Board experience and based on requests from industrial and government interests, it is felt new sampling trend data for the San Diego Region would be helpful to determine changes in the occurrence of toxic hot spots and sites of concern over time.

If the Regional Board cannot identify parties responsible for discharging historical chemicals such as Chlordane, DDT, PAHs, and PCBs there is a possibility the sites would not be cleaned up. There is a need, therefore, to obtain funding to clean up these "orphan" sites.

Sites of Concern

The stations on the Sites of Concern list shown below demonstrated biological degradation associated with elevated chemistry. Although the Bay Protection and Toxic Cleanup Program legislation only requires toxic hot spots to be identified and ranked, it was the consensus of the Bay Protection Program's Monitoring and Surveillance Task Force to present lists of sites which may be impaired, based on existing information. "Sites of concern" are not defined in the State Board's September 1998 *Water Quality Control Policy for Guidance on Development of Regional Toxic Hot Spot Cleanup Plans.* Criteria for identifying the sites in the San Diego Region are presented in the Regional Board's decision matrix tables used to identify toxic hot spots.

The Sites of Concern presented in the San Diego Region Cleanup Plan fall into two categories:

"High-priority" stations recommended by the Department of Fish and Game in technical reports for the San Diego Region, and

Stations with at least one "triad" biological hit under definitions 2 and 5 of the State Board's Policy with elevated chemistry sampled on the same date as the biological hits.

Sites of Concern (Sites that do not qualify as Candidate Toxic Hot Spots)

Water Body Name	Segment Name	Site Identification	Reason for Listing	Pollutants Present at the Site	Report Reference
Stations with single biologic triad hits and associated chemistry:					
Mission Bay	Northeast Bay	Rose Creek, San Diego (Station 93107)	Degraded benthic community	Chlordane, total chemistry	1
San Diego River	Flood control channel	Sunset Cliffs Bridge, San Diego (Station 93116)	Degraded benthic community	Chlordane	1
San Diego Bay	North Bay	Submarine Base, Ballast Point, San Diego (Station 90028)	Degraded benthic community	PAH	1
	North Bay	Laurel Street, San Diego (Station 90002[1])	Sediment toxicity, degraded benthic community	Chlordane, total chemistry	1
San Diego Bay	Central Bay	Area near Coronado Bridge, San Diego (Station 93179[1])	Sediment toxicity	PCB, PAH, total chemistry	1, 3
San Diego Bay	Central Bay	Indian Point, south of Coronado Bridge, San Diego (Station 90030)	Sediment toxicity	PAH, total chemistry	1

Sites of Concern, continued

Water Body Name	Segment Name	Site Identification	Reason for Listing	Pollutants Present at the Site	Report Reference
~~San Diego Bay~~	~~Central Bay~~	~~26th Street, San Diego (Station 93181)~~	~~Sediment chemistry~~	~~Total chemistry~~	~~1~~
~~San Diego Bay~~	~~Central Bay~~	~~Between Piers 3 and 4, Naval Station (Station 93223)~~	~~Degraded benthic community~~	~~Total chemistry~~	~~1~~
~~San Diego Bay~~	~~Central Bay~~	~~Between Piers 3 and 4, Naval Station (Station 90007)~~	~~Sediment toxicity~~	~~Mercury~~	~~1~~
~~San Diego Bay~~	~~Central Bay~~	~~Between Piers 3 and 4, Naval Station (Station 93224)~~	~~Degraded benthic community~~	~~Zinc~~	~~1~~
~~San Diego Bay~~	~~Central Bay~~	~~Between Piers 5 and 6, Naval Station (Station 90022)~~	~~Sediment toxicity, degraded benthic community~~	~~PAH, total chemistry~~	~~1, 3~~
~~San Diego Bay~~	~~Central Bay~~	~~South of Pier 14 Naval Station (Station 93229)~~	~~Degraded benthic community~~	~~PAH~~	~~1~~
~~Tijuana Estuary~~	~~North slough~~	~~El Centro Street, National Wildlife Refuge, Imperial Beach (Station 93118)~~	~~Sediment toxicity~~	~~DDE~~	~~1~~
~~Tijuana Estuary~~	~~North slough~~	~~Boundary Road islands, National Wildlife Refuge, Imperial Beach (Station 93119)~~	~~Sediment toxicity~~	~~DDE, DDT~~	~~1~~

continued

Sites of Concern, continued

Water Body Name	Segment Name	Site Identification	Reason for Listing	Pollutants Present at the Site	Report Reference
~~Tijuana Estuary~~	~~South slough~~	~~South of Tijuana River mouth, National Wildlife Refuge, Imperial Beach (Station 93175)~~	~~Sediment toxicity~~	~~DDE, DDT~~	~~1~~
San Diego Bay	Central Bay	26th Street, San Diego (Station 93181)	Sediment chemistry	Total chemistry	1
San Diego Bay	Central Bay	Between Piers 3 and 4, Naval Station (Station 93223)	Degraded benthic community	Total chemistry	1
San Diego Bay	Central Bay	Between Piers 3 and 4, Naval Station (Station 90007)	Sediment toxicity	Mercury	1
San Diego Bay	Central Bay	Between Piers 3 and 4, Naval Station (Station 93224)	Degraded benthic community	Zinc	1
San Diego Bay	Central Bay	Between Piers 5 and 6, Naval Station (Station 90022)	Sediment toxicity, degraded benthic community	PAH, total chemistry	1
San Diego Bay	Central Bay	South of Pier 14 Naval Station (Station 93229)	Degraded benthic community	PAH	1
Tijuana Estuary	North slough	El Centro Street, National Wildlife Refuge, Imperial Beach (Station 93118)	Sediment toxicity	DDE	1

continued

Sites of Concern, continued

Water Body Name	Segment Name	Site Identification	Reason for Listing	Pollutants Present at the Site	Report Reference
Tijuana Estuary	North slough	Boundary Road islands, National Wildlife Refuge, Imperial Beach (Station 93119)	Sediment toxicity	DDE, DDT	1
Tijuana Estuary	South slough	South of Tijuana River mouth, National Wildlife Refuge, Imperial Beach (Station 93175)	Sediment toxicity	DDE, DDT	1
Tijuana Estuary	South slough	North boundary of Border Field State Park, Imperial Beach (Station 93174)	Sediment toxicity	DDE, DDT	1
Stations with single biologic triad hits but without "threshold" levels of elevated chemistry:					
Dana Point Harbor	East basin	Central harbor south, Dana Point (Station 96016[1])	Degraded benthic community (and urchin fertilization effects)	(Copper TBT, Chlordane)[2]	2

continued

Sites of Concern, continued

Water Body Name	Segment Name	Site Identification	Reason for Listing	Pollutants Present at the Site	Report Reference
San Dieguito Lagoon	Southeastern slough	Fish hook slough, Del Mar (Station 95024[1])	Sediment toxicity, degraded benthic community (and urchin fertilization effects)	(Dieldrin)[2]	2

[1] Department of Fish and Game high-priority stations

[2] Chemicals present at the station but below threshold levels triggering an "elevated chemistry" designation

References

State Water Resources Control Board. 1996 Chemistry, Toxicity and Benthic Community Conditions in Sediments of the San Diego Bay Region. Final Report.

State Water Resources Control Board. 1997 Chemistry, Toxicity and Benthic Community Conditions in Sediments of Selected Southern California Bays and Estuaries. Final Report.

State Water Resources Control Board. 1998 Chemistry, Toxicity and Benthic Community Conditions in Sediments of the San Diego Bay Region. Addendum Report.