ENVIRONMENTAL SETTING AT TOXIC HOT SPOTS

This section is a description of the physical environmental conditions in the vicinity of the proposed high priority known toxic hot spots, as they exist before the commencement of the project from both a local and regional perspective. The RWQCBs have used the hot spot definition in the SWRCB Guidance Policy to identify a number of toxic hot spots in coastal areas of the State.

In the following sections, the environmental setting at each high priority toxic hot spot is described. The general locations of the high priority toxic hot spots is presented in Figure 3. General descriptions of the environmental setting in each Region is presented in the FED prepared for the SWRCB Guidance Policy (SWRCB, 1998b). Several reports developed by the BPTCP are available that assess the conditions of selected enclosed bays, estuaries and coastal waters (e.g., Jacobi et al., 1998; Hunt et al., 1998a; Downing et al., 1998; Anderson et al., 1998; Phillips et al., 1998; Fairey et al., 1996; and Fairey et al., 1998). Each site environmental setting is a summary of the information presented in the Regional Toxic Hot Spots Cleanup Plans. For a complete description of the sites please refer to Appendix B.

North Coast Region (Region 1)

G&R Metals at the Foot of H Street Between First Street and Humboldt Bay Eureka, California (scrap yard)

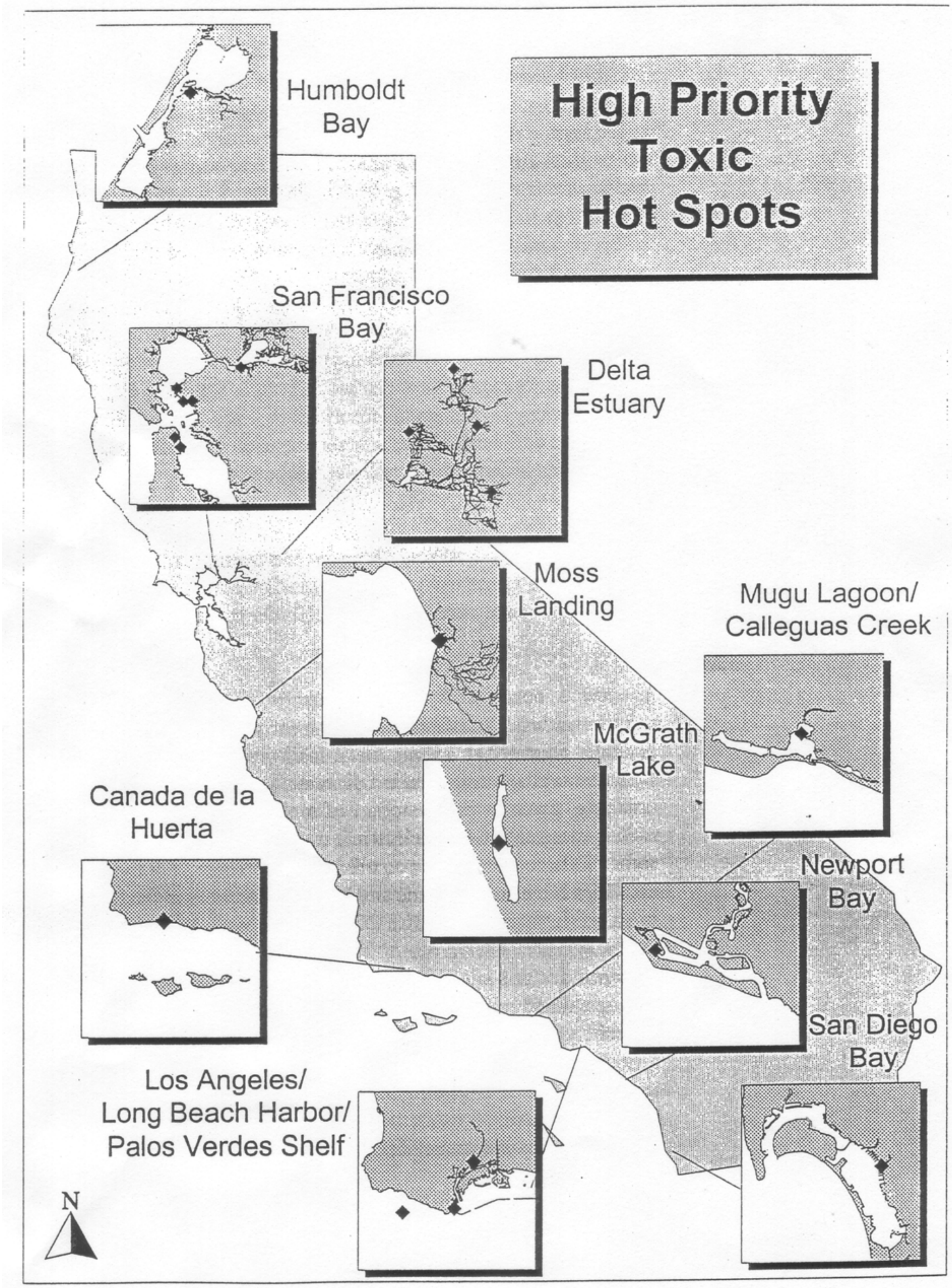
<u>Site Description</u>

Humboldt Bay includes Arcata Bay and three segments of Humboldt Bay. This whole area encompasses approximately 15,000 acres and is considered a shipping port, industrial center and a population hub. Fifteen sampling stations were located in the Humboldt Bay, The G&R Metals (scrap yard) site at the foot of "H" Street between first street and Humboldt Bay shore was found to rank high in the Toxic Hot Spot Ranking list due to sediment toxicity.

<u>Pollutants of Concern</u>

The pollutants of concern at this site are lead, arsenic, chromium, cadmium, cobalt, copper, mercury, zinc, and PCBs.

FIGURE 3: HIGH PRIORITY TOXIC HOT SPOTS



Background

The northern and central portions of the Bay are encircled by two cities and several small unincorporated communities. Along with these communities there are associated industrial activities, such as pulp mills, bulk petroleum plants, fossil fuel and nuclear power plants, lumber mills, boat repair facilities and fish processing plants. Small commercial and sport marinas have been constructed in the Bay and agricultural lands surround much of the Bay. Two large landfills are located adjacent to the Bay. Coal and oil gasification plants historically have been operated at various locations at the edge of the Bay. Municipal wastewater, industrial wastewater and storm water runoff have been discharged into the Bay throughout its 150 year history. Because there is a very narrow opening connecting Humboldt Bay and the Pacific Ocean, circulation and flushing are severely restricted, resulting in a high potential for sediment and pollutant deposition.

Areal Extent

The areal extent of the toxic hot spot has been estimated to be 3.5 acres with an average depth of pollution of 2 feet. The total polluted sediment quantity is about 10,000 cubic yards.

Sources

The site is located on the shore of Humboldt Bay and has been used for industrial activities since the early part of the century. It has been operated as a scrap metal facility since the early 1950s. Operations at the site included disassembly, incineration, and crushing of automobiles, storage of metals, batteries, radiators, metals reclamation from electrical transformers, and miscellaneous refuse. These operations occurred across the site. All industrial activities have ceased at the site but the historic uses have resulted in an area contaminated with PCBs, PAHs, metals and Methoxychlor. Cleanup and abatement activities remain to be performed at this site. These activities include: a.) performing an ecological and human health risk assessment, b.) conducting a feasibility study assessing remedial alternatives, and c.) performing appropriate cleanup and abatement activities. The site has not been used since 1980. On-going activity is limited to site assessment work to determine the extent of the contamination and the appropriate remediation needed to clean up the site.

San Francisco Region (Region 2)

The San Francisco Bay Region is comprised of most of the San Francisco estuary up to the mouth of the Sacramento-San Joaquin Delta. The San Francisco estuary conveys the water of the Sacramento and San Joaquin rivers into the Pacific Ocean. Located on the central coast of California, the Bay system functions as the only drainage outlet for waters of the Central Valley. It also marks a natural topographic separation between the northern and southern coastal mountain ranges.

The Sacramento and San Joaquin rivers, which enter the Bay system through the Delta at the eastern end of Suisun Bay, contribute almost all of the freshwater inflow to the Bay. Many smaller rivers and streams also convey fresh water to the Bay system. The rate and timing of these freshwater flows are among the most important factors influencing physical, chemical and biological conditions in the estuary. Flows in the region are highly seasonal, with more than 90 percent of the annual runoff occurring during the winter rainy season between November and April.

San Francisco Bay is typical of estuaries worldwide in that it provides critical habitat for aquatic species, including many commercially and ecologically important marine species that use estuaries as rearing grounds for sensitive early life-stages. San Francisco Bay is also home to hundreds of introduced exotic species, brought in over the last 150 years, primarily in ship ballast water. The San Francisco estuary is made up of many different types of aquatic habitats that support a great diversity of organisms. Suisun Marsh in Suisun Bay is the largest brackish-water marsh in the United States. San Pablo Bay is a shallow embayment strongly influenced by runoff from the Sacramento and San Joaquin Rivers. The Central Bay is the portion of the Bay most influenced by oceanic conditions. The South Bay, with less freshwater inflow than the other portions of the Bay, acts more like a tidal lagoon. Together these areas sustain rich communities of aquatic life and serve as important wintering sites for migrating waterfowl and spawning areas for anadromous fish.

San Francisco Bay

Site Description/ Background

San Francisco Bay is part of an estuarine system which conveys the waters of the Sacramento and San Joaquin rivers to the Pacific

Ocean. This is a highly complex system that includes large brackish marshes, tidal lagoons and freshwater rivers and creeks. The diversity of these ecosystems support a wide variety of organisms. While the upper part of the estuary has been widely used for mining and agricultural activities the San Francisco Bay region has been heavily urbanized and is the site of many industrial activities and ports.

The San Francisco estuary has high concentrations of metals due to contributions from numerous sources, both natural and anthropogenic. Natural sources include drainage of water from formations that are naturally enriched in some metals, such as the Franciscan Formation that is exposed throughout the Bay area, and the rocks that make up the Sierra Nevada Mountains. This drainage flows into the streams that empty into the Bay. Localized concentrations of these metals were exploited in a great wave of mining activity from the 1820's continuing, in some cases, into the 1970s.

Mercury was mined at numerous locations in the Coastal Range and then transported to the Sierra Nevada foothills to be used in the amalgamation of gold in placer and hydraulic mining. Drainage from natural mercury deposits, mine tailings, and directly from mining activities have had a major impact on the San Francisco Bay and estuary.

San Francisco Bay is an extremely dynamic depositional environment. Sediments flow from the major river systems and are deposited in the Bay. Strong winds and tidal currents resuspend and redeposit these sediments resulting in a system where sediments are well mixed. Bioaccumulative contaminants attach to sediments and are distributed and mixed by the same physical processes. Therefore, the sediment acts as a sink for contaminants. The sediment, however, is also a source of contaminants to organisms in the aquatic food chain and ultimately to humans.

Although the San Francisco estuary extends from the ocean up through the river systems, the jurisdiction of the San Francisco Bay RWQCB only extends to the area just west of Antioch. The Central Valley RWQCB includes the Delta and extends through the river systems. Since the health advisory on fish consumption effects both Regions, it is important that a coordinated strategy is developed, especially in regard to mercury contamination.

Reason for listing

In 1994, the BPTCP conducted a study to measure the levels of contaminants in fish in San Francisco Bay (SFBRWQCB, 1995). Results from the study indicated that six chemicals exceeded the screening levels based on U.S. EPA guidance (U.S. EPA, 1993, 1995) that were established prior to the study. These chemicals were PCBs, mercury, DDT, chlordane, dieldrin and dioxins. In response to the results of the study, the Office of Environmental Health Hazard Assessment (OEHHA) issued a health advisory on consumption of fish caught in San Francisco Bay and the Delta. The health advisory was primarily based on elevated levels of PCBs and mercury in fish tissue and the human health risk related specifically to these chemicals. While, DDT, dieldrin, chlordane and dioxins were also listed as chemicals of concern as a result of exceedance of screening values, OEHHA determined that the health concerns associated with these chemicals were less than for PCBs and mercury. Therefore, while the general discussion will include DDT, dieldrin, chlordane and dioxins, the remediation plan for San Francisco Bay will focus on mercury and PCBs.

Areal extent

The San Francisco Bay and Delta cover approximately 1631 square miles.

Sources

Mercury

Mercury was mined in the Coast Range from the early 1800s through the mid-1900s. Initially most of the mercury was used in the amalgamation of gold in placer and hydraulic mining operations. Mining activity introduced mercury into the San Francisco Estuary system in a number of ways. Runoff from mercury mines within the region transported sediment rich in mercury to the Bay and estuary. In the Sierra, mercury was added to sediment to aid in the separation of gold from waste in placer and hydraulic mining operations. Most of this mercury ended up in the aquatic system, becoming attached to sediment particles flushing downstream. The mining of gold and silver ores may also expose surrounding rock that was enriched in mercury by the same geologic processes that created the gold and silver deposits, again introducing sediment enriched in mercury to the stream systems that drain into San Francisco Bay. Ongoing drainage from these mines has introduced mercury and other metals into the streams that drain into the estuary.

Core samples of Bay sediment indicate background concentrations of mercury of 0.06 +/- 0.02 ppm dw (Hornberger et al., 1999). Superimposed upon these background levels are concentrations that reflect historic and ongoing loadings. Core samples of Bay sediment indicate that an historic gradient of contaminated sediment (up to 0.9 ppm Hg) entered the Bay from the Sacramento-San Joaquin Delta during the Gold Rush, then diffused into cleaner sediment as it moved seaward towards the Golden Gate. These core samples indicate a contaminated (0.5-0.9 ppm Hg) layer buried in the sediment, the depth of which varies from location to location, with the most concentrated levels of mercury in the upper estuary. Surficial sediments throughout the Bay system generally contain 0.3 to 0.4 ppm mercury, except in areas of the lower South Bay affected by drainage from the New Almaden mining area. Mixing between these two sediment layers is a key factor in determining the concentration of mercury in surficial sediments, the mass balance of mercury in the Bay and the rate at which concentrations can change.

The estuary, therefore, has become a sink for sediments rich in mercury and an ongoing source for the bioaccumulation of mercury up the food chain. Monitoring data from the BPTCP shows that mercury concentrations in the estuary are elevated and highly dispersed. There are a number of individual sites around the margins of the Bay where mercury concentrations higher than these generally elevated levels are found. These are usually due to past industrial practices such as the smelting of ore.

Although there is very little active mining in the San Francisco Bay drainage system, runoff from abandoned mines and mine tailings continue to be an ongoing source of mercury to the estuary. Data from the Sacramento River indicate that the Cache Creek drainage and the Sacramento drainage above the Feather River are major, ongoing sources to the lower watershed. In the southern part of San Francisco Bay, the major ongoing source is the drainage from New Almaden mining region. Other less significant sources include urban runoff, POTWs, industrial discharges and aerial deposition. Recent pollution prevention audits indicate that human waste, water supplies, laundry waste, household products, and waste from hospitals and dental facilities are the most significant sources to POTWs. Known industrial discharges of mercury are from raw materials used in the facilities. About half the aerial deposition appears to come from global fuel combustion and the other half from local fuel combustion.

The key environmental concern about mercury in the San Francisco Bay system is the extent to which it bioaccumulates in the food chain. Bioaccumulation, in turn, is governed by the level of methyl mercury in the aquatic environment. Methyl mercury is formed primarily by microbial activity, and only under certain physical and chemical conditions. A complex set of factors influence the rate and net production of methyl mercury by bacteria. These include chemical factors that change the oxidation state of mercury in the aquatic system; “habitat” characteristics that promote the growth of methylating bacteria such as the availability of sulfur compounds used as food and the presence of anoxic zones conducive to these bacteria; and much larger scale processes such as wind, tide, and runoff patterns that serve to mix and transport particle bound mercury throughout the estuary. Significant changes in any of these factors may potentially change the rate of mercury methylation. These processes must be better understood in order to appropriately manage environmental risks associated with the existing reservoir of mercury, as well as to regulate ongoing sources. A particular concern is to prevent the creation of environments, that is some subset of these physical and chemical factors, that may increase the rate of mercury methylation.

PCBs

PCBs have also accumulated in the sediments of the estuary due to historic use. This class of chemicals is comprised of 209 compounds called congeners. Mixtures of congeners have been manufactured in the U.S. since 1929 and sold under the trade name Aroclor. These mixtures were used extensively in the U.S. prior to 1979 when their manufacture, processing, use and application was banned, except in totally enclosed applications such as transformers. PCBs were used for industrial applications requiring fluids with thermal stability, fire and oxidation resistance, and solubility in organic compounds. PCBs have proven to be extremely persistent in the environment. RMP monitoring data indicate that in the water column PCBs exceed non-promulgated U.S. EPA water quality criteria throughout the estuary. This is most probably due to resuspension from the sediments, although ongoing sources may still contribute a significant amount of PCBs. BPTCP monitoring has shown that, except for a few areas, PCBs are fairly well mixed in the sediments of the estuary where they provide an ongoing source to organisms in the food chain.

Although the use of PCBs has been banned there are historic deposits in the sediment and on land. Point Potrero, at the Port of Richmond, had ten times the PCB concentration (19.9 ppm) of any other sample collected under this region's BPTCP and the highest concentration of any BPTCP sample in the state. Stormwater events can mobilize PCBs deposited on land and transport them into the estuary. Recent monitoring by the RMP has shown that there seems to be current sources contributing to PCB loads in the South Bay from Coyote Creek. In addition, a recent RMP workgroup evaluating PCBs has come to the preliminary conclusion that there are probably significant ongoing sources of PCBs to the Bay. Increased monitoring is necessary to identify and cleanup any ongoing sources.

Chlorinated Pesticides

Three chlorinated pesticides exceeded screening levels in the BPTCP fish study: DDTs, chlordanes and dieldrin. All three have similar properties in that they are extremely persistent in the environment and highly lipid soluble. Since these lipid soluble compounds are not easily metabolized or excreted, they are stored in fatty tissue and can readily bioaccumulate in fish tissue with high lipid content.

Although all three of these chemicals have been banned for use in the U.S. for approximately 20 years they are still commonly detected in sediments and in tissue. These compounds are dispersed in the sediments throughout the estuary. One large historic source of DDT, Lauritzen Canal in Richmond Harbor, has been recently cleaned up. Other sources may be detected through increased monitoring of stormwater.

Dioxins

Dioxins are released into the environment as by-products of thermal and chemical processes. These chemicals are not intentionally manufactured. Stationary sources include the incineration of municipal, hospital and chemical wastes, paper pulp chlorine bleaching, oil refining and the manufacturing of pesticides and PCBs. Mobile sources include combustion engines in cars, buses and trucks, particularly those that use diesel fuel. Since the great majority of dioxins are emitted directly to the air, their primary source to the aquatic environment is through aerial deposition and runoff. The Bay Area Air Quality Management District has estimated that 69% of the current dioxin emissions in the Bay area is from on and off road mobile sources and 15% from residential wood burning. The San Francisco Bay RWQCB staff has estimated that greater than 90% of dioxins entering the Bay are transported by stormwater runoff or result from direct deposition from the air to the Bay.

Castro Cove

Description of site

Castro Cove is a protected embayment located in the southern portion of San Pablo Bay in Richmond, California. Castro Cove is defined as the cove enclosed by a line drawn from the Point San Pablo Yacht Club breakwater to the northwest corner of the West Contra Costa Sanitary Landfill. The embayment is protected by diked margins on the west, south and most of its eastern margin. The southeastern portion, where Castro Creek enters the cove, is a salt marsh. Castro Cove is shallow with extensive mudflats and marshlands that are subject to tidal action. Castro Creek empties into a channel that is about 30 to 75 feet wide and about three to six feet deep at mean lower low water.

Historical Background

Since studies started in 1987 for Chevron's deep water outfall, petroleum hydrocarbons have been detected in Castro Cove. Several studies showed high levels of PAHs in the southwest portion of Castro Cove, the area where an historic outfall was located. The last surface sample collected in Castro Cove by the BPTCP, in 1995, had the highest concentration of PAHs measured in over 600 samples analyzed for PAHs statewide. The concentration of PAHs in this sample (227,800 ppb) was over four times the ERM and was collected in the top five centimeters of sediment. This was the highest concentration of PAHs ever collected at this site. Individual PAHs also exceeded ERMs. Several studies, including the BPTCP, also showed levels of mercury exceeding the ERM. In the last BPTCP sampling, chlordane was measured at levels exceeding the ERM and selenium and dieldrin were measured at elevated concentrations.

Toxicity tests have been conducted on sediments from Castro Cove on five separate occasions. Significant toxicity has been observed in several species of amphipods and in urchin and bivalve development tests during the five sampling events. The southwest portion of the cove always showed toxicity when sampled. The last samples collected by the BPTCP, in 1995, had 0% amphipod survival and 0% normal urchin development.

For three years, from 1988 to 1990, the State Mussel Watch Program deployed mussels in Castro Cove. Their results showed increasing concentrations of PAHs over these three years. In addition, the last sample collected had the second highest PAH concentration (40,210 ppb dry weight) of any sample measured statewide in the 20 year history of the program.

The benthic community at Castro Cove has been sampled three times, in 1989, 1990 and 1991. All three sampling events identified species in Castro Cove that were indicative of stressed or frequently disturbed environments. An evaluation of the 1991 data in the 1996 RMP Annual Report categorized this site as a moderately contaminated sub-assemblage due to the presence of species indicative of stressed environments.

As part of the PRMP gradient study conducted in Castro Cove in 1991, speckled sanddabs were exposed to Castro Cove sediment in the laboratory. Results showed increasing effects with increasing PAH concentrations. The most significant effects were seen in fish exposed to sediment from the area of the old outfall. Fish exposed to sediments collected at stations in Castro Cove showed statistically significant gill histopathology. Gill histopathology was significantly correlated with PAH concentration of the sediment, as well as with P4501A content in the gills and hepatic EROD activity, both indicators of exposure to PAHs.

To comply with State Order 86-4 and an NPDES permit requiring an investigation of sediment quality along a deep-water outfall, an E.V.S. study was undertaken in 1987. The focus was to determine the quality of the deep sediments at sites along the location of the deepwater outfall. Oil and grease and petroleum hydrocarbons were detected at one location just outside Castro Cove. The results of the amphipod survival test showed lower survival rates with sediments from Castro Cove. For the bivalve larvae bioassay, all five test samples had significantly lower rates of normal development that the sediment control.

A three-year monitoring program at Castro Cove conducted by Entrix determined that Castro Cove sediments were finer than those from Castro Creek and from San Pablo Bay. Oil and grease was detected both in Castro Cove and in offshore sediments. The greatest concentrations of oil and grease within Castro Cove were usually detected where Castro Creek enters Castro Cove. Mercury was detected at concentrations greater than the ERM in Castro Cove. Other Entrix investigations determined that Castro Cove sampling locations showed the top four species of benthic taxa, and they are considered indicators of stressed or frequently disturbed environments.

As part of the State Mussel Watch Program, bioaccumulation of contaminants was measured in Castro Cove (SWRCB, 1995). The concentration of PAHs from mussels collected on March 21, 1990 was the second highest concentration measured statewide in the 20 year history of the State Mussel Watch Program.

Castro Cove was sampled three different times under the BPTCP to determine if sediments were being naturally capped. Chemical analyses and toxicity tests were performed to determine if concentrations of contaminants or the levels of toxicity were decreasing. Samples were collected in Castro Cove under the Pilot Regional Monitoring Program (PRMP), the Reference Site Study and the Screening/Confirmation Studies.

The southwest sediment station, which was closest to the old outfall, had a PAH concentration greater that the ERM at depth and greater than the ERL on the surface. Porewater development tests for the deep core layers indicated significant toxicity at three of the four Castro Cove sites, including the southwest station, relative to the reference site. Only the southwest station exhibited toxicity in the deep core elutriate urchin larvae development test. It was determined that the benthic community at Castro Cove was representative of a moderately contaminated sub-assemblage due to the presence of species indicative of stressed environments. Castro Cove sediments showed alteration of the gills of speckled sanddabs, and indicated exposure to PAHs.

The 1995 Castro Cove sediment sample had the highest PAH concentration of the more than 600 sediment samples analyzed for PAHs statewide in the BPTCP. Mercury and chlordanes were detected at concentrations greater than the ERM. Selenium and dieldrin also had elevated concentrations. Toxicity test results showed 100% amphipod mortality and 100% abnormal development in the urchin development test.

Areal Extent

Based on the distribution of oil and grease and PAHs, two main areas of contamination can be delineated: the south/southwest and the north/northeastern portions of Castro Cove. Similar patterns in the surface distribution of mercury are also evident. The distribution of biological effects is slightly more extensive than the chemical distribution, but overlays the spatial area delineated by detection of oil and grease and PAHs. Although horizontal extent has not been bounded, the contaminated area is estimated to range between 10 and 100 acres based on past studies and the established boundaries of Castro Cove. The depth of contamination has not been determined, but in one set of core samples the depth of visible petroleum hydrocarbons seemed to extend from the surface to approximately three feet below the sediment surface, the maximum depth of the cores.

Sources

The Chevron refinery and the San Pablo Sanitary District discharged effluent directly into Castro Cove until the 1980's. Currently, the refinery and San Pablo Sanitary District discharge their waste effluent into San Pablo Bay via two separate deep-water outfalls. Contaminants may have also entered Castro Cove via Castro Creek due to urban runoff.

From the turn of the century, Chevron discharged wastewater which was only treated by an oil water separator into Castro Creek up to a rate of 50 MGD. The Chevron USA refinery discharged treated effluent into Castro Cove from 1972 until 1987. San Pablo Sanitary District discharged untreated sewage into Castro Creek near the confluence with Wildcat Creek until 1955 when construction of a municipal treatment plant was completed. From 1955 to 1981, the district discharged treated effluent directly into the cove through a channel running along the southern end of the West Contra Costa Landfill. In 1981, the district relocated its outfall to a deep-water site offshore of Point Richmond. These discharges were not associated with the Chevron Refinery effluent discharges.

Based on the historical discharge of untreated waste by the Chevron refinery and the presence of petroleum related contaminants (oil and grease and PAHs), Chevron is the most likely source of the contamination in Castro Cove.

Peyton Slough

Description of Site

Peyton Slough is located in Martinez, northern Contra Costa County, California. The slough discharges into the San Francisco estuary at the confluence of Suisun Bay and the Carquinez strait, near Bull Head Point, just east of the Benecia Bridge.

Sediments in Peyton Slough are comprised of firm clays that do not appear to erode easily. Sediments from Peyton Slough appear to have been dredged in the past with the dredge spoils deposited on the east and west shore forming levees. There are openings in the east levee downstream of the tidal gate that provide exchange between Peyton Slough and a large brackish wetland to the east of the slough.

During the winter, Peyton Slough receives fresh water discharge from the Contra Costa Canal and storm water runoff from the surrounding area. During the dry weather months, Peyton Slough receives fresh water treated discharge primarily from a waste water treatment plant (Mountain View Sanitary District) through a tidal gate. Some minor flow from the Contra Costa Canal may also occur during the dry months. A tidal gate had been configured such that fresh water from upstream can be released when the water level is greater on the upstream side of the gate. In 1998, this tidal gate was replaced with a newer gate which will allow water to flow from the bay into a wetland area situated upstream from Peyton Slough.

Two major historical industrial activities have taken place in the vicinity of Peyton Slough on a site currently owned and operated by Rhodia: sulfuric acid production and the smelting of copper. Historically, the first recorded industrial use near Peyton Slough was by the Mountain Copper Company (MOCOCO). This company used the site for a copper smelting operation from the early 1900s until 1966 at which time it was purchased by Stauffer Chemical Company. During the smelting of copper, a fused silicate slag was generated which was discharged over the north and south sides of the hillside housing the smelter. MOCOCO also roasted pyrite ore to recover its sulfur. Resulting cinders remain on site.

Cinder and slag, classified as Class B Mining Waste, from the smelting operations were stored in large piles on the site. The north cinder/slag area covers 8.3 acres, while the south cinder/slag covers 7.1 acres. Due to their weights, the cinder and slag piles subsided 30 to 35 feet into the softer bay mud below the existing ground surface. Stauffer Chemical Company bought the site from MOCOCO and removed the cinder/slag piles to the depth of the water table, but it is estimated that over 500,000 tons of waste material remains below the surface. The remaining north and south cinder/slag piles have been capped with a minimum of two feet of low permeability soil in 1978 and 1980 respectively.

In 1972, a leachate removal and containment system (LRCS) was installed in response to cease and desist order No. 71-21 issued by the RWQCB. The LRCS prevented leachate from moving to Carquinez Strait and Peyton Slough by a cut-off wall consisting of compacted bay mud along the bay shoreline. Prior to 1988, the leachate from the north cinder/slag area was pumped to a north solar evaporation pond. Leachate from the south cinder/slag piles was pumped from two deep sumps to the south solar evaporation pond. Starting in 1988, the Process Effluent Purification (PEP) system was installed and begun treating this leachate prior to discharge to a deep water outfall. Cutoff walls were not constructed along Peyton Slough. However, to date there is no evidence that leachate is being discharged into the slough.

Currently, the Contra Costa Mosquito Vector Control District (CCMVCD) is planning a restoration project in Shell marsh. This project intends to restore the marsh south of Peyton slough back to a brackish marsh with regular inputs of salt water from San Francisco Bay. As part of this project, the CCMVCD has replaced the tidal gate in Peyton Slough and is proposing to dredge Peyton Slough to allow for higher flows of saline water up the slough into Shell marsh. This project is partially funded by Caltrans to mitigate for discharge from Route 680 and to prevent flooding of the highway. Rhodia is also working with CCMVCD to coordinate the dredging of Peyton Slough. Regional Board staff has been helping to coordinate completion of the marsh restoration project in order to remediate the toxic hot spot, restore Shell marsh and alleviate flooding on Route 680.

<u>Reason for Listing</u>

Multiple investigations have shown that sediments from Peyton Slough have elevated concentrations of metals, especially copper and zinc. Copper and zinc concentrations in Peyton Slough were the highest from over 600 samples analyzed statewide by the BPTCP. The metal contamination can be traced to past activities at a nearby industrial site, and perhaps also to the continued presence of slag and cinder below the water table. The contaminated sediment was shown to exhibit recurrent toxicity over time to two different aquatic organisms, and the Toxicity Identification Evaluation (TIE) points to metals as the source of toxicity. In addition, although benthic community indices categorized this site as transitional, the upper and end stations rated only slightly higher than the cutoff of 0.3. Recent studies indicate that there are elevated concentrations of cadmium, copper, lead and zinc detected throughout Peyton Slough.

<u>Areal extent</u>

Elevated metal concentrations were detected from the mouth of Peyton Slough all the way to the tidal gate. Toxicity to aquatic organisms was found at all BPTCP locations, but recurrent toxicity was only measured at the upper sampling location. The areal extent of the channel is approximately 1.25 acres. In specific locations, vertical extent of contamination could not be determined as the deepest sample, 8 feet below the sediment surface, still showed elevated concentrations of one or more metals.

Sources

The most likely source of contaminants in Peyton Slough is the historical industrial activity associated with the creation of the cinder/slag piles. Potential current subsurface transport of metals in groundwater from the buried cinder piles to Peyton Slough is not known.

Stege Marsh

Site Description

Stege Marsh occupies approximately 23 acres on the western margin of San Francisco Bay in the City of Richmond, California. Stege Marsh is located on property currently owned by Zeneca Agricultural Products and the University of California Field Station. The cinder landfill separates east and west Stege marsh. The East Bay Parks District currently owns the land south of the historic railroad track which is now a hiking trail.

Eastern Stege marsh rests directly on the alluvial fan-deltaic deposits of Carlson Creek interspersed with Bay mud. Bedrock at the site is likely to be Franciscan Formation rocks, cretaceous and younger in age, consisting of an assemblage of marine sedimentary and volcanic, and some metamorphic rocks (The Mark Group, 1988). Western Stege Marsh is fed by Meeker Creek. Between 1947 and 1969, a railroad track was constructed just south of Stege marsh resulting in siltation and thus the extension of the tidal marsh into a previously subtidal area (May, 1995).

Stauffer Chemical Company utilized the industrial portion of the site to roast pyrite ores for the production of sulfuric acid from about 1919 until 1963. This industrial process resulted in the production of cinders, which were placed on the site surface. Elevation at the bottom of the cinders is at mean sea level throughout the facility, which indicated past placement of cinders at ground level. The presence of a layer of peaty silt under the base of the cinders also supports that cinders were disposed of on the site surface. The cinder pile extends along the north and east sides of Stege marsh. The cinders were covered with a one-foot clay layer, that was itself covered by a one-foot layer of topsoil to comply with RWQCB Order No. 73-12 and its 1974 amendment.

Besides pyrite cinders, other products that have been generated or utilized on the industrial site include fuels, sulfuric acid, ferric sulfate, proprietary pesticides, solvents and alum. Until recently, Zeneca produced proprietary agricultural chemicals on the industrial portion of the site. Currently, Zeneca uses the site solely as a research laboratory. The discharges resulting from past industrial activities were treated through a series of settling, neutralization and alum mud ponds ending in two evaporation ponds situated just north of the marsh. Effluent discharge from the two evaporation ponds into the marsh occurred at two points, one in between the two evaporation ponds and the other located southeast of the evaporation ponds. The ponds were closed in the early 1970s and replaced with new lined ponds. The discharge of stream waste to the marsh ended in the 1980s. Since then, treated effluent has been discharged from the evaporation ponds into the Richmond sanitary sewer system. Under wet weather conditions, when the city of Richmond cannot handle inflow and the holding capacity of the Zeneca Facility are exhausted, discharges to the marsh are permitted. Contaminated groundwater from the industrial portion of the site is being removed by an intercept trench, treated and discharged with the treated industrial effluent.

In western Stege marsh several explosives manufacturing companies had been in production since the 1840s. During this time various areas were used for the production of mercury fulminate, manufacturing of ammunition shells and blasting caps, and storage and testing of explosives (Jonas and Associates 1990).

Historical Background

In 1991, URS Corporation performed a site investigation for U.S.EPA and found elevated concentrations of metals and metalloids (arsenic, copper, lead, mercury, selenium, and zinc) and organic contaminants (DDTs and PCBs). A follow up sediment investigation by ICF Kaiser also found elevated concentrations of metals and metalloids (arsenic, copper, lead, and zinc). Organic contaminants were not detected by ICF Kaiser, but were reported with elevated detection limits due to analytical interferences. Zeneca and the RWQCB independently analyzed a split sediment sample from the north-western section of the marsh and found elevated concentrations of metals, metalloid and organic contaminants.

The BPTCP program collected screening sediment samples at three locations: 21401 in the Richmond field station, 21402 in the north-west section of eastern Stege marsh and 21403 near outfall 002 , as well as a reference sample in Carlson Creek (21404). All three marsh samples had elevated concentrations of metals, metalloids and organic compounds, and resulted in 100% mortality of *Eohaustorius estuarius*. Locations 21401 and 21402 were resampled as part of the BPTCP confirmation sampling. Both sediment samples were toxic to *Eohaustorius estuarius* with 99 and 100% mortality respectively. The Relative Benthic Indices of 0 were measured at these two sampling locations, indicating the lack of living organisms present at the time of the sampling. Stege marsh falls in the high priority toxic hot spot category due to elevated chemistry (including the highest concentrations of arsenic, selenium and several pesticides measured by the BPTCP statewide), recurrent sediment toxicity, and impairment to in-situ benthic organisms.

A summary of investigations conducted at Stege marsh is presented in the following sections.

ICI Americas Investigations (1987)

In 1987, ICI Americas sampled 10 foot cores of sludge and the underlying soil in the neutralization pond, surge pond, carbon column pond, agriculture yard pond and both evaporation ponds. The sludge samples were analyzed for total and WET extractable metals. Elevated concentrations of arsenic, copper and zinc were found in samples from the two evaporation ponds. Soluble threshold limit concentrations (STLC) were also exceeded for arsenic and lead in samples from the evaporation ponds. Effluent from these two evaporation ponds was regularly discharged to the marsh in the past. Samples from other ponds had elevated concentrations of copper, lead, selenium and zinc. These samples also had detected concentrations greater than STLCs for copper and zinc. Metal contaminated soil below the sludge in the ponds may contribute to these concentrations since both soil and sludge were sampled and homogenized. Relevant analytical results are listed in Table D-1. This study indicates that the evaporation ponds may have been a source of contaminants to Stege marsh.

The Mark Group Investigations (1990, 1991)

These two reports present the results of an underground site investigation of the cinder area next to Stege marsh. Hydrologic data are also reported but are not discussed in this report.

These investigations resulted in the production of cross-sections depicting the horizontal and vertical extent of the cinders in upland soils. Potential presence of cinders in the marsh was not investigated, although the presence of subsurface cinders was mapped in upland soils up to the edges of Stege marsh. Also, the chemical constituents of the cinders were not reported as part of this site investigation. Cinders may have been and/or remain a potential source of contamination in or near Stege marsh.

URS Corporation Investigation (1991)

URS Corporation performed an investigation of the chemistry of the marsh sediments in 1992 for the U.S. EPA. Elevated concentrations of arsenic, copper, lead, mercury, selenium, zinc, DDTs and PCBs were detected in samples throughout Stege marsh during this investigation. This investigation indicated that Stege marsh is contaminated with multiple chemicals.

Woodward-Clyde Consultants Investigation (1993)

Woodward-Clyde Consultants performed a subsurface investigation next to Stege marsh of the extent of cinders and groundwater hydrology and chemistry. Cinders were found next to the marsh, but the marsh was not investigated for the presence of cinders. Groundwater chemistry results showed low pH and elevated solution concentrations of metals and metalloids in some monitoring wells next to Stege marsh. This investigation suggests that subsurface transport of chemicals was and/or remains a pathway for contamination in Stege marsh.

ICF Kaiser Investigation (1997)

In 1997, ICF Kaiser undertook a follow-up investigation to that by URS Corporation. Arsenic, copper, lead and zinc were again detected with elevated concentrations. Mercury and selenium concentrations were detected but at lower concentrations than in the URS Corp. investigation. Since chemical concentrations were reported on a wet weight basis in this study, comparisons to other analytical results and to screening guidelines are not possible. DDTs, DDEs and DDDs were not detected in sediment samples in this investigation likely due to the elevated detection limits reported for these compounds. Mercury concentrations were not as elevated as in the URS investigation, but the areas with elevated mercury concentrations were not sampled by ICF Kaiser. As with the URS Corporation investigation, contamination of Stege marsh by metals and metalloids was evident in these data.

Zeneca and RWQCB sediment sample (1997)

In 1997, Zeneca and SFB-RWQCB jointly collected a sediment sample in the northwest corner of Stege marsh based on a complaint received by the SFB-RWQCB of a barren area in this location. Split samples were sent to two independent laboratories for chemical analyses. Metal results show elevated concentrations of arsenic, cadmium, copper, lead, selenium and zinc. Organic compounds detected at concentrations above San Francisco Bay ambient sediment concentration include chlordanes, dieldrin, hexachlorohexanes, DDTs and PCBs. Again note that the results from the Zeneca split sample are reported on a wet weight basis. Contamination of Stege marsh is evident by the elevated concentration of chemicals reported.

Bay Protection and Toxic Cleanup Program (1998)

Under the Bay Protection and Toxic Clean-up Program, the RWQCB collected three screening and two confirmation samples from Stege marsh, as well as a reference sample from Carlson Creek. Sampling location 21401 is located in the Richmond field station in the vicinity of the cinder pile. Sampling location 21402 is situated in the barren portion of the Stege marsh on Zeneca property. This is in the vicinity of the SFB-RWQCB sample discussed in the previous section. Sample location 21403 is situated in Stege marsh south of evaporation pond 1 near outfall 002. Reference samples (location 21404) were also collected from Carlson Creek during both screening and confirmation sampling events.

The three screening samples were analyzed for chemical constituents. As with the URS Corp. study, elevated concentrations of arsenic, copper, mercury, selenium, zinc and DDTs were detected at concentrations much greater than both ERM and ambient concentrations. Arsenic and selenium concentrations were the highest measured in 544 samples collected statewide in the BPTCP. In these samples, PCBs were also detected at concentrations much greater than both ERM and ambient concentrations. Also, multiple chlorinated pesticides were detected at elevated concentrations. Dieldrin, endosulfan sulfate, mirex, oxadiazon and toxaphene were detected in Stege marsh at the highest concentrations from over 600 samples collected statewide by the BPTCP. The mean ERM quotients were 2.7 (21401), 0.61 (21402) and 2.59 (21403). Mean ERM quotients greater than 0.5 are believed to represent elevated concentrations of mixtures of chemical compounds. These chemicals are detected at concentrations in Stege marsh that are believed to pose a threat to waters of the state.

Exposure to all three sediment samples from Stege marsh resulted in 100 percent mortality to *Eohaustorius estuarius* in the 10-day solid phase bioassay. The two confirmation samples also exhibited high mortality (99 and 100 percent) for the same bioassay. Urchin development bioassays using a sediment-water interface exposure resulted in 100 percent abnormal development for the two sediment screening samples. These results denote a significant impact of the sediments to these test species.

Benthic community analysis of the two confirmation samples from Zeneca marsh found no living individuals. The measured Relative Benthic Index was zero denoting the total absence of benthic organisms in these sediments. This represents a significant impact to the marsh biota.

Pacific Eco-Risk Laboratories

In 1998, Zeneca Agricultural performed a site investigation in sloughs and the northwest corner of eastern Stege marsh. The results showed elevated concentrations of arsenic, copper, lead, mercury, selenium and zinc in the sediments. Toxicity to the bivalve embryo *Mytilus edulis* was found at multiple locations in the sloughs and in the northwest corner of eastern Stege marsh (Table D-10). Toxicity to *Eohaustorius estuarius* was found at all locations sampled in Stege marsh. The pH of sediment and porewater samples at this site was, in general, unusually low. The pH of several highly acidic sediment and porewater samples was adjusted to a normal pH and toxicity tests were repeated. Although pH adjustment lowered the toxicity of most samples, high levels of toxicity remained in all undiluted porewater samples and in 1 out of the 2 sediment samples in which pH was successfully adjusted. In addition, there was toxicity at stations with normal pH. Low pH seems to contribute to toxicity at some stations at this site, however, it is clear that other factors play a significant role. Benthic community analyses showed decreased populations in the northwest corner of eastern Stege marsh.

<u>Areal extent</u>

Based on the distribution of elevated concentrations of metals, metalloids and organic compounds, three areas of contamination can be seen. The first is near evaporation pond 1 and outfall 2. This area has elevated concentrations of arsenic, mercury, zinc and DDTs. The second area is in the north-west corner of eastern

Stege marsh and is characterized by low pH measurements, elevated concentrations of arsenic, copper, zinc and DDTs, aquatic toxicity, and is devoid of benthic organisms. The third area is located in the U.C. Richmond Field Station. This location is characterized by elevated concentrations of arsenic, mercury, selenium, zinc, DDTs and aquatic toxicity, and is devoid of benthic organisms. Further study may show that these areas are continuous rather than discrete. Regardless, the areal extent of the THS is greater than 10 acres. The entire marsh encompasses an area of 23 acres.

Sources

Oxidation of pyrite cinders in the presence of sulfides is the most likely source of the low pH at the site. Leaching of metal at this low pH is a probable source of toxicity. Subsurface transport of metals from upland cinders may also be a source of contaminants to Stege marsh. Effluent discharge from the two evaporation ponds is also a likely source of contaminants to Stege marsh. Contaminants may have also entered the marsh via Carlson or Meeker Creeks in urban runoff or from upland industrial facilities. In western Stege Marsh munitions manufacturing is a possible source.

Point Potrero/Richmond Harbor

Site Description

The site designated Point Potrero/Richmond harbor is a 400 foot long intertidal embayment, the Graving Inlet, on the western side of the Shipyard #3 Scrap Area at the Port of Richmond. The Shipyard is currently used as a parking lot, but in the past the site has been used for shipbuilding, ship scrapping, sand blasting and metal recycling. The geographic feature identified with the site is Point Potrero, although the original configuration of the point has been modified by quarrying of a bedrock hillside and filling of intertidal mudflats.

The embayment known as the Graving Inlet was excavated in 1969 to allow ships to be beached in shallow water for final scrapping operations. Site investigations have shown that the sediments in the Inlet have the same types of contaminants found in the adjacent Shipyard #3, including heavy metals, PCBs and PAHs. While the most heavily contaminated sediments are in the intertidal zone and shallow subtidal zone within the Inlet, elevated levels of PCBs and metals are also found in the subtidal zone outside of the inlet.

Historical Background

Point Potrero has been listed as a candidate toxic hot spot due to the extremely high levels of bioaccumulative contaminants, including the highest levels of PCBs and mercury found by the BPTCP in over 600 samples collected statewide. These contaminants are listed in the San Francisco Bay/Delta Fish Advisory as primary chemicals of concern to human health due to fish consumption. In addition, there is a site-specific health advisory for the Richmond Harbor Channel area based on PCBs and DDTs that was issued by the Office of Environmental Health Hazard Assessment (OEHHA) and published by the California Department of Fish and Game. Lauritzen Canal, the source of the DDT was cleaned up, under CERCLA, by the summer of 1997.

Levels of contaminants found in the Inlet exceed ERMs in most cases. For example, PCBs exceed ERMs by up to 110 times and mercury by over 10 times. Attempts have been made to associate sediment concentrations of particular contaminants in fish tissue. Concentrations of PCBs at Point Potrero exceed the Washington State Department of Ecology proposed human health based sediment quality criteria by more than 3 orders of magnitude.

Regulatory agencies became involved with the onshore portion of the site in 1984, starting with investigations of leaking and/or unlabeled drums. PCBs, metals and oil and grease were identified in the soils and sandblast waste at the site. Between 1987 and 1988, preliminary remedial actions occurred onshore (removal of drums, sand blast waste and underground storage tanks), the site was graded, storm drains were installed and up to two feet of road base aggregate was added to the site.

Areal Extent

The area that has the highest levels of contaminants (Graving Inlet) has a well-characterized boundary and comprises about one acre. This area is surrounded on three sides by land and the open end of the inlet has been defined by five cores with subsamples at 0 to 0.5 feet, 0.5 to 2.5 feet and 2.5 to 4.5 feet. Other areas along the waterfront have elevated levels of metals (including mercury), PCBs and PAHs, but there is conflicting data on the concentrations and extent of contamination. It is possible that contaminants may extend over one or two additional acres.

Sources

The contaminants found in the sediments near Point Potrero are the same as those found on the adjacent upland: metals, PCBs and

PAHs. These areas were the site of shipbuilding operations during World War II and later ship scrapping activities. The sediments with the highest chemical concentrations are found in the Graving Inlet.

Industrial activities that have taken place at the site in the past include: shipbuilding, ship scrapping, and metal scrap recycling. Prior to 1920 the site consisted of unimproved marshland and tidal flats at the foot of the Point Potrero hills. During World War II, the U.S. government appropriated much of the waterfront for wartime ship construction. The two finger piers on the west side of the site were constructed between 1942 and 1949. From the end of World War II until 1964 the site was leased to Willamette Iron and Steel for use as a ship repair, construction, scrapping and steel fabrication facility. After 1964 the shipbuilding and steel fabrication ended when Levin Metals took over the site, but scrapping and recycling continued until 1987. In 1969, the Graving Inlet was excavated into the northwest shoreline of the property to allow final dismantling of the keels of scrapped ships. These activities are the most probable source of sediment contamination at the Graving Inlet and around Point Potrero.

Mission Creek

Site Description

Mission Creek is a 0.75 mile long arm of the Bay in the eastern side of the San Francisco waterfront. Formerly, the estuary of Mission Creek reached back a couple of miles. It was filled to roughly its present dimension before the turn of the century. Currently, the creek is 100 to 200 feet wide in most sections and narrower at the two bridges at 3rd and 4th Streets. Concrete rip rap and isolated bands of vegetation line Mission Creek's banks.

Ten to fifteen houseboats are docked at the Mission Creek Harbor located between 5th and 6th Streets along the south shore of the creek. Many of the houseboats have year round on-board residents.

The City and County of San Francisco operates seven combined sewer overflow structures in Mission Creek from 3rd Street to the upper end at 7th Street. Light industrial and urban development line the shores of Mission Creek. A new baseball stadium will soon open on the north shore at the mouth of Mission Creek near 2nd Street in China Basin. Currently, demolition debris cover the remainder of the north shore. According to City plans, new retail development will occupy this area in the near future. Along the south shore, there is a golf driving range near 6th Street, warehouse facilities, and a sand and gravel operation near the mouth of the Creek. Finally, Interstate Freeway 280 crosses over Mission Creek between 6th and 7th Streets.

Reason for listing

The upper end of Mission Creek in the vicinity of 6th Street meets the definition of a toxic hot spot due to impacts on aquatic life resulting from contaminated sediment. The primary basis for the determination is the BPTCP data. Also, data from a 1979 study the City and County of San Francisco commissioned support the determination. Below is a summary of these data and the specific reason for listing.

The BPTCP data show that the upper end of Mission Creek has recurrent sediment toxicity, elevated concentrations of chemicals, and an impacted benthic community. The report, Sediment Quality and Biological Effects in San Francisco Bay (Hunt et al., 1998a), contain details of these data. Also, the 1979 study the City and County of San Francisco commissioned to assess the impacts of their wastewater overflows (CH2M Hill, 1979) provides support that there are elevated metals and an impaired benthic community at this site.

The BPTCP results show recurrent toxicity to both the amphipod and sea urchin tests at a station located in the upper end of Mission Creek. The amphipod survival was 5 and 19 percent, in the screening and confirmation phases, respectively. Sea urchin larvae development was zero percent normal in the pore water and 11 percent normal in the sediment-water interface exposure. All of these results were lower than the respective reference envelope limits for that test, less than 90% the appropriate minimum significant difference (MSD), and significantly different than controls.

This toxicity is associated with mean ERM quotients of 0.51 for the screening phase and 3.93 for the confirmation phase. The value of 3.93 is the highest of all the BPTCP stations in the Bay. The chemicals consistently found above the ERM values are chromium, lead, and chlordane. Mercury, copper, silver, zinc, dieldrin, PCBs, phenanthrene, and PAHs were also found above the ERM values during confirmation sampling. In addition, chlorpyrifos and mirex levels were in the top 10% of samples in the statewide BPTCP database.

The 1979 study supports the conclusion that there are elevated metals in the sediments at this site. Data from a station 20 yards upstream of 6th Street show metals in the sediment above the ERM levels for copper, lead, mercury, nickel, silver, and zinc.

The BPTCP benthic community analysis for this site shows a Relative Benthic Index (RBI) of zero. A RBI of less than or equal to 0.3 is an indicator that pollutants or other factors are negatively impacting the benthic community.

The 1979 study found no benthic organisms with the exception of one invertebrate, an oligochaeta, in one out of five sampling events between February and April.

During the reference site study a large composite sediment sample was collected from Mission Creek for a Phase I TIE. This sample was toxic to the amphipod *Eohaustorius*. There were high levels of unionized ammonia and hydrogen sulfide in the sample. After the ammonia and hydrogen sulfide were removed toxicity remained. This residual toxicity had to be due to toxicants other than ammonia and sulfide, since those two compounds were reduced to non-toxic levels. However, the residual cause of the toxicity could not be determined (S.R. Hansen & Assoc., 1996).

Areal extent

Our best estimate of the areal extent of the toxic hot spot at this time is approximately 9 acres. This includes the entire width of Mission Creek from its upper end at 7th Street down to the 4th Street bridge. This is a rough estimate based on data from the BPTCP, as discussed below. The precise areal extent is unknown at this time because there are insufficient sampling locations. Additional sampling is necessary to define the actual areal extent, however, it is estimated that it may range from 5 to 12 acres.

The BPTCP collected samples at three stations along Mission Creek: one at the upper end near 6th Street, another near the mouth and a third (added during the confirmation phase) located midway between the two near 4th street. It is data from the upper end station that forms the primary basis for determining that this area is a toxic hot spot.

For the western boundary of the toxic hot spot, we assumed that the upper end station is representative of the sediments upstream to the end at 7th Street. This is a conservative assumption and accurate if the primary source of pollutants is from the combined sewage overflow discharge points located at 6th and 7th Streets.

Data from a 1979 study also supports this assumption. The data show elevated metals and impaired benthic community in sediment collected upstream of 6th Street (CH2M Hill, 1979).

We believe the eastern boundary of the toxic hot spot may extend to the 4th Street bridge based on data from the BPTCP midway station. The data show that the sediments here are somewhat impacted though not as impacted as at the upper end station.

<u>Sources</u>

The most likely source of pollutants is either historic or legacy source or storm water either by way of direct discharge to the channel or as discharged during the infrequent combined sewer overflows (CSO) operated by the City and County of San Francisco. Other sources may include deposition from air emissions from vehicles traveling the Interstate 280 overpass and surrounding streets. PAHs are associated with fossil fuel combustion and mercury along with other metals are a contaminant in diesel exhaust. The magnitude of these various sources is still to be determined, however it is probable that all sources have an effect on the toxicity at this location.

The City and County of San Francisco operates seven CSO discharge points into Mission Creek. The largest one is located at the upper end near 7th Street (often referred to as the Division Street overflow structure). The City reports that this CSO structure receives approximately 95% of the overflows. Other CSO structures are located along Mission Creek at 6th, 5th, 4th and 3rd Streets.

CSO discharges consist of sanitary sewage, industrial wastewaters, and storm water runoff from the City's combined sewer system. Currently, CSO discharges occur when storm water and wastewater flows exceed the treatment capacity of the City's treatment plants. The City is currently permitted to overflow an average of ten times per year to the structures in Mission Creek. Before about 1988, the overflows were untreated and occurred anytime rainfall exceeded 0.02 inches per hour. After 1988, newly constructed storage and consolidation facilities provided treatment of the overflows equivalent to primary treatment standards. Primary treatment involves removal of a significant portion of settleable and floatable solids from the wastewaters.

Although there is sparse data on the quality of the historic overflows to Mission Creek, data from recent discharges and other similar sources support the conclusion that the CSOs are source of the pollutants. These data show that most if not all the pollutants exceeding ERMs in the sediment at this site are also present in urban runoff and/or sewage. Additionally, a 1979 study commissioned by San Francisco concluded that the accumulative impact of the CSOs on the sediments was evident (CH2M Hill, 1979). The impact of CSO events on sediment distribution and the relationship of historic versus current discharges is uncertain.

Islais Creek

Site Description

Islais Creek is a one mile long channel of the Bay running east-west on the San Francisco waterfront near the foot of Potrero Hill and Caesar Chavez Street. Formerly, the estuary of Islais Creek reached back a couple of miles as far as Bayshore Boulevard, and was fed by a creek that ran down what is now Alamany Boulevard. Before the turn of the century, the area was filled to roughly its present size.

A bridge at Third Street forms a narrow 100-foot wide constriction that physically divides the channel into two segments. The eastern segment is approximately 400 to 500 feet wide; the western, 250 to 300 feet wide.

The City and County of San Francisco operates four wet weather overflow structures that discharge into the western segment. San Francisco also operates a sewage treatment plant effluent outfall that discharges into the western segment at Quint Street.

The banks of Islais Creek are covered with concrete rip-rap with narrow bands of vegetation in small isolated areas. Long stretches of creek bank in the eastern segment are under pier structures. Old pier pilings dot the southern shore of the western segment.

Light industrial and urban development surround Islais Creek. On the shores of the eastern segment are a sand and gravel facility, grain terminal, oil and grease rendering facility, warehouse, and container cargo terminal. Auto dismantlers and auto parts dealers, scrap metal recyclers, and warehouses make up the bulk of the current activities surrounding the western segment. Interstate 280 passes over the western end of Islais Creek.

Reason for listing

The western segment of Islais Creek meets the definition of a toxic hot spot due to impacts on aquatic life resulting from contaminated sediment. The primary basis for our determination is the BPTCP data. Data from various other studies also support our determination. Below is a summary of these data and the specific reasons for listing.

The BPTCP data show that the western segment of Islais Creek has sediment toxicity, elevated concentrations of chemicals, and an impacted benthic community. The report Sediment Quality and Biological Effects in San Francisco Bay (Hunt et al., 1998a) contain these data. The BPTCP report Evaluation and Use of Sediment Reference Sites and Toxicity Tests in San Francisco Bay (Hunt et al., 1998b) contain additional details. Also, a research study in 1987 and a study MEC conducted for San Francisco provide supporting data for our determination that this site is a toxic hot spot. Below are summaries of the data related to each of the three factors.

Recurrent Toxicity

The BPTCP results show recurrent toxicity to both the amphipod and sea urchin tests at a station located in the western segment of Islais Creek. The BPTCP collected sediment samples from this station during the reference site study in 1995 (which served as the screening for this site), and two years later during a confirmation phase.

The amphipod survival was 57% and 0%, in the screening and confirmation phase, respectively. The sea urchin larvae development was 0% normal in the pore water and sediment-water interface during the screening phase. In the confirmation phase, there was only 8% normal development. All of these results were lower than the respective reference envelope limits for that test, less than 90% of the appropriate minimum significant difference (MSD), and significantly different than controls.

During the reference site study, a large composite sediment sample was collected for a Phase I Toxicity Identification Evaluation (TIE). The results of the Phase I Characterization procedures indicated that the sediments from Islais Creek were toxic to the urchin *Strongylocentrotus p*). Sediments were high in unionized ammonia and hydrogen sulfide. When the ammonia and hydrogen sulfide were removed there was still toxicity remaining. The residual toxicity had to be due to toxicants other than ammonia and hydrogen sulfide since those two compounds were reduced to non-toxic levels. The cause of the remaining toxicity was not identified but may have been due to polar organics (S.R. Hansen & Assoc., 1996).

Data from a research study in 1987 supports the finding of toxicity in sediments in the western segment of Islais Creek. This study found toxicity to amphipods and mussel larvae (Chapman et al., 1987).

A study MEC conducted for the City and County of San Francisco in 1996 shows toxicity to amphipods compared to controls in four out of fifteen samples in the western segment (MEC, 1996). Although this study did not find toxicity at all locations in the western segment, the results still support recurrent toxicity and may suggest sediment quality is dynamic in this segment.

Elevated Chemicals

The toxicity described above is associated with a mean ERM quotient of 1.18 for the confirmation phase. This quotient is calculated from the concentrations of a list of metals and organic compounds divided by an average of sediment quality guideline values (ERMs) for those compounds. Sediments with a quotient of greater than 0.5 are considered to have elevated chemical concentrations. The chemicals found above the ERM values are chlordane, dieldrin, PCBs, and low molecular weight PAHs. In addition, endosulfan sulfate was in the top 10% of samples in the statewide BPTCP database.

Data from a 1979 study by CH2M Hill and another research study in 1987 support the conclusion that there are elevated PCBs in the sediments in the western segment. The 1979 study found a mean of 500 ug/kg total Aroclor; the 1987 study found total PCBs at 255 ug/kg (Chapman et al., 1987). Furthermore, the 1987 study found sediments with elevated low and high molecular weight PAHs.

These studies also found metals in the western segment sediments above ERM values. The metals include lead, mercury, and silver. Sediment monitoring in the western segment of Islais Creek by the City and County of San Francisco from 1990 to 1993 show levels of mercury exceeding the ERM in every year except 1990. The ERM value for lead was also exceeded in 1991 (CCSF, 1990-1993).

Impacted Benthic Community

The BPTCP benthic community analysis of the western segment of Islais Creek shows a RBI of 0.22. A RBI of less than or equal to 0.3 is an indicator that pollutants or other factors are negatively impacting the benthic community.

The 1979 study found few to no benthic organisms in five sampling events between February and April in the western segment of Islais Creek. There were a total of only eleven species, six of which the report's authors noted as being unusual because they were freshwater organisms or fly larvae common at sewage treatment plants.

A 1987 research study concluded that this area of Islais Creek was the most depauperate compared to other sites in the study, in terms of taxa richness and total abundance (Chapman et al., 1987).

Areal extent

At this time, our best estimate of the areal extent of the hot spot is approximately 11 acres, comprising the entire width of Islais Creek from its upper end at Selby Street down to Third Street. This is a rough estimate based on data from the BPTCP, as discussed below. The precise areal extent is unknown at this time because there are insufficient sampling locations. Additional investigation is necessary to determine the actual areal extent which may range from 5 to 35 acres.

The BPTCP collected samples at three stations along Islais Creek: one at the upper end near Selby Street, and the other two down stream about 200 feet west (mid-gradient) and 400 feet east (lower end) of the Third Street Bridge. The last two were added during the confirmation phase. It is data from the upper end station that forms the primary basis for determining that that area is a toxic hot spot. Therefore, the western boundary for the toxic hot spot is the upper end of Islais Creek at Selby Street.

The eastern boundary of the toxic hot spot extends out to the Third Street Bridge and probably farther east towards the Bay. The BPTCP data show that the sediments at the mid-gradient station are impacted though not as highly impacted as at the upper end station. The sediment at this station was toxic to sea urchin larvae with 47% normal development, had elevated chemicals with an ERM quotient of 0.6, and had a Relative Benthic Index (RBI) of 0.25.

Support for the statement that the toxic hot spot extends farther east of the Third Street Bridge comes from the last BPTCP station and other studies. These other studies show that the quality of sediments in the eastern segment of Islais Creek has high variability either spatially or temporally. These studies include one by the National Oceanic and Atmospheric Administration in

1992 (Long et al., 1992), another by the Lawrence Berkeley National Laboratory in 1995 (Anderson et al., 1995), and two others by Advanced Biological Testing in 1998 (ABT, 1998a and 1998b).

In 1997, the sediments at the BPTCP lower end station appear impacted. The sediment was toxic to amphipods with 49% survival, and had elevated chemicals with an ERM quotient of 0.62. However, the benthos was less impacted than the other two BPTCP stations with a RBI of 0.43.

A 1992 study collected sediments from Islais Creek at stations further east of the BPTCP stations. These data show mercury, PAHs, and PCBs at concentrations above ERM levels (Long et al., 1992). There was also observed cytogenetic effects on mussel and sea urchin larvae exposed to sediments at these stations compared to controls (Long et al. 1992). The 1995 study also found sediment in this vicinity to be toxic to sea urchins and mussels compared to a reference site (Anderson et al., 1995).

Studies conducted in 1998 for the Port of San Francisco sampled sediments midway along the north shore of the eastern segment of Islais Creek (ABT, 1998a; 1998b). The purpose of the studies was to characterize the sediments for maintenance dredging. The data did not show elevated concentrations of chemicals although several samples were toxic to mussel larvae and one sample was toxic to amphipods.

Sources

The most likely source of pollutants is some combination of storm water and urban runoff either entering the channel directly or through the combined sewer overflow (CSO) operated by the City and County of San Francisco. Another possible source is San Francisco's treatment plant discharge outfall at Quint Street. Because of recent improvements in treatment of the discharges from the CSO and the Quint Street outfall in the past two years, historic discharges from these sources are probably more of a factor than current discharges. Other sources may also contribute. And the actual magnitude of contribution of sources is still to be determined. Additional description of all these sources and potential sources are below.

CSOs

The City and County of San Francisco operates four CSO discharge points into Islais Creek. Two are at the upper end near

Selby Street (referred to as the Selby Street and Marin Street overflow structures). The other two CSO structures are at Third Street.

CSO discharges consist of sanitary sewage, industrial wastewaters, and storm water runoff from the City's combined sewer system. CSO discharges occur when storm water and wastewater flows exceed the treatment capacity of the City's treatment plants. The City is currently permitted to overflow an average of four times per year to the structures in Islais Creek. Newly constructed storage and consolidation facilities provide treatment of the overflows equivalent to primary treatment standards. Primary treatment involves removal of a significant portion of settleable and floatable solids from the wastewaters. However, prior to the completion of these consolidation facilities in 1996, the overflows were untreated and occurred anytime rainfall exceeded 0.02 inches per hour.

Although there is sparse data on the quality of the historic overflows to Islais Creek, data from recent discharges and other similar discharges support the conclusion that the CSOs are one of the sources of the pollutants. Most if not all the pollutants exceeding ERMs in the sediment at this site are or were pollutants in urban runoff and/or sewage. Additionally, a 1979 study commissioned by San Francisco concluded that the accumulative impact of the CSOs on the sediments was evident (CH2M Hill, 1979).

Quint Street Outfall

This outfall is at the south shore of Islais Creek at Quint Street just west of the Third Street Bridge. San Francisco uses this outfall when wastewater flows from the Southeast Wastewater Treatment Plant exceed the capacity of the main deep water discharge outfall to the Bay. The capacity of the deep water outfall is 100 million gallons per day.

After completing a re-piping project and increasing the secondary treatment capacity of the plant in 1997, San Francisco discharges only secondary treated wastewater to the outfall. Prior to 1997, the Quint Street outfall received a blend of primary and secondary treated wastewaters from the treatment plant.

Secondary treatment is a higher level of treatment than primary. Primary treatment relies on physical separation and removal of settleable and floatable solids. Secondary involves using biological treatment technologies which can remove dissolved pollutants. Secondary treatment standards require removal of at least 80% of the suspended solids and oxygen consuming matter from the sewage.

As is the case for the CSO, most if not all the pollutants exceeding the ERMs in the sediment at this site are or were pollutants in treated sewage. Therefore, the discharges from the Quint Street Outfall are or were a likely source of pollutants.

Other Potential Sources

Other sources of pollutants to Islais Creek may include sheet runoff or any past discharges from auto dismantlers and metal recycling facilities bordering Islais Creek. Deposition from air emissions from vehicles traveling the Interstate 280 overpass and surrounding streets may also contribute. PAHs are associated with fossil fuel combustion. Mercury and other metals are contaminants in diesel exhaust.

Central Coast Region (Region 3)

Moss Landing and Tributaries

<u>Site Description</u>

Moss Landing and the surrounding vicinity has special importance for both the State and Nation. Because of the unique nature of the marine environment within the area, the National Oceanic and Atmospheric Administration (NOAA) established the Monterey Bay National Marine Sanctuary in 1992. Elkhorn Slough is a NOAA National Estuarine Research Reserve. These designations reflect the high resource values found within the area.

Moss Landing Harbor receives drainage water from Elkhorn Slough watershed, Moro Cojo Slough watershed, Tembladero Slough watershed, the Old Salinas River, and the Salinas River.

The watershed areas include only the lower portions of the Salinas watershed. Some Salinas River water drains to the Old Salinas River and then to Moss Landing Harbor. A slide gate near the mouth of the Salinas River permits approximately 250 cubic feet per second to pass to the Old Salinas River (Gilchrist et al., 1997). Other watercourses such as the Blanco Drain and the Salinas Reclamation Canal also drain either directly or indirectly to Moss Landing Harbor.

Because of a “high” ranking for impacts to aquatic life due to sediment toxicity with confirming chemistry and tissue bioaccumulation, the areal extent of the problem, and the sensitive nature of the area, "high priority toxic hot spot" status is warranted for the Moss Landing area. The area was given a moderate ranking for Human Health because of pesticide levels in tissue repeatedly exceeding federal standards. It was not given a "high" ranking for Human Health because health advisories have not been issued recently.

Sediments from Moss Landing Harbor have been shown for a number of years to contain high levels of pesticides, in some cases at levels which cause concern for human and aquatic life. Concentrations of a number of pesticides in fish and shellfish tissue have exceeded National Academy of Sciences (NAS) Guidelines, USEPA Screening Values, and Food and Drug Administration (FDA) Action Levels.

In addition to pesticides, PCBs have also been identified as a concern in the Harbor and its watershed; they have been detected in shellfish tissue by the State Mussel Watch Program at elevated concentrations for many years.

High levels of Tributyltin exceeding EPA Screening Values have been detected in mussel tissue at several locations in the Harbor. The Harbor's watershed supports substantial agricultural and urban activities, which are sources of pesticides and other chemicals. Several chemicals detected by the program have been banned for many years. Although chemical types and usages have changed, banned chemicals, particularly chlorinated hydrocarbons, are still mobilized through eroding sediments. Actions to alleviate this problem consist of proper disposal of dredged materials, source control management measures for the chemicals of concern, and management of erosion of associated sediment.

Moss Landing was given a moderate "remediation potential" ranking according to BPTCP guidelines, since improvements may or may not occur over time without intervention. Although concentrations of persistent chemicals which have been banned will eventually decrease without action in aquatic systems, the time involved in significant reductions in the Harbor would have to be measured in decades. Reducing land erosion and implementing Best Management Practices in urban, agricultural and harbor areas will remediate the problem more rapidly and provide other benefits for both the land and Harbor. Both chemical concentrations and the volumes of sediment which must be dredged from the Harbor will be reduced, improving aquatic habitat and reducing problems with dredge spoil disposal. Implementation of appropriate erosion control practices will serve to restore and protect the status of beneficial uses including navigation, aquatic life, and human health.

Background and most likely sources of pollutants

The majority of chemicals found at excessive concentrations in the Harbor and its tributaries are pesticides, and most have already been banned. Chemical exceedances of State Mussel Watch and Toxic Substances Monitoring Program guidelines have been detected from fish and shellfish data collected within the Moss Landing watershed in the past ten years (Rasmussen 1991, 1992, 1993, 1995a, 1995b, 1995c, 1996, 1997). Tissue data (Rasmussen, 1995, 1996, 1997) shows that total DDT values in the southern Harbor increased dramatically after the end of the drought of the mid and late 1980's. Other pesticides follow a similar trend. Nesting failure of the Caspian Tern (a bird species of special interest) in Elkhorn Slough in the heavy rain year of 1995 was attributed to high tissue levels of DDT resulting from storm-driven sediments (Parkin, 1998). High flow events carry large amounts of chemical-laden sediments into sensitive aquatic habitats and the Moss Landing Harbor. Soil erosion from numerous sources is a major transport mechanism for a variety of chemicals impacting the Harbor (Kleinfelder, 1993).

Agricultural Activities

Past and present storage and use of agricultural biocides is a primary source of chemicals found in Moss Landing Harbor. Fine sediment in runoff from agricultural land is the primary transport mechanism for many chemicals (Kleinfelder, 1993; NRCS, 1994; AMBAG, 1997). Erosion from farm land is a concern for private landowners and the public alike. Though most of the chemicals of concern are no longer applied to agricultural land, they are still present in soils**.** Banned chemicals found in soils tested on agricultural land in the Elkhorn Slough watershed include DDT and its breakdown products, Dieldrin, Endrin, Chlordane and Heptachlor Epoxide (Kleinfelder, 1993, RWQCB, raw data 1998). Though PCBs were used extensively in industrial applications, prior to 1974 they were also components of pesticide products and may originate from agricultural as well as industrial sources (U.S. EPA Envirofacts, 1998). Several currently applied chemicals have been detected at various sites in the watershed, including Chlorpyrifos, Diazinon, Dimethoate and Endosulfan (Ganapathy et al., draft).

River and Stream Maintenance Activities

Local agency personnel indicate DDT was used for mosquito control in the sloughs draining to Moss Landing in past years (Stillwell, pers. comm., 1997). This must have introduced large amounts of DDT and its breakdown products directly into the river and estuarine systems.

River systems in the area have been treated for riparian plant control for a number of years in order to increase water supply and channel capacity (Anderson-Nichols & Co., 1985). Vegetation removal, which increases flow velocities and consequent sediment transport, may exacerbate erosion and transport of chemicals of concern.

Urban Activities

Large amounts of certain pesticides are used in the urban environment. These have included chlordane and dieldrin for treatment of termites and other wood boring insects, and diazinon and other chemicals for household and garden use.

PCBs were widely used in industrial applications prior to 1974, when their use was confined to transformers and capacitors. They have not been used in any application since 1979. Because of their diverse past use and extreme persistence, they are still present at many sites throughout the watershed.

Polyaromatic Hydrocarbons (PAHs) are petroleum related chemicals. These are common pollutants in urban runoff, from improperly handled waste oil, street and parking lot runoff, and other sources.

Sampling conducted in Tembladero Slough for BPTCP found highest levels of dieldrin below the City of Salinas, exceeding Effects Range Median (ERM) values by six-fold. Concentrations of this chemical generally decreased with distance below the City. Other concentrations for nearly all measured pesticides and PAHs were higher here than anywhere else measured in the drainage. Both sediment and water toxicity were found at this site. (SWRCB et al., 1998). Because agricultural activity occurs above the City of Salinas and no sampling site was placed upstream of the City, it is not possible to discriminate between agricultural and urban sources at this time. However, the decrease in concentrations in downstream agricultural areas indicate that urban sources may be significant contributors and should be the subject of further study.

Harbor Activities

Tributyltin has been documented over the years at several sites in Moss Landing Harbor. This chemical was the active ingredient in antifouling paint for boat bottoms. Its use has been banned for many years, but it is persistent in the environment. Other chemicals associated with Harbor activities include PAHs, copper, zinc, and other metals.

Cañada de la Huerta – Shell/Hercules Site

Site Description

The Shell Western/Hercules Gas Plant site (now owned by Aera Energy LLC (Aera)) is located adjacent to Cañada de la Huerta, approximately 18 miles west of Goleta in Santa Barbara County. The plant was constructed in 1963 and operated until 1988. It processed natural gas from offshore wells for pipeline transport. The site is located in a canyon (known as Cañada de la Huerta) that is approximately 3600 feet in length (from the headwaters of the canyon to the ocean) and approximately 1200 feet wide (from ridge to ridge). This canyon can be divided into four zones described as follows:

Sea Cliff - This zone is approximately 400 feet in length and includes the canyon's point of discharge from a three-foot diameter culvert to the sea wall and into the ocean. The culvert inlet is located on the north side of Highway 101 and runs beneath the highway and the Union-Pacific Railroad right-of-way.

Lower Canyon – This zone is approximately 700 feet in length and includes a riparian area with a perennial surface water flow fed by groundwater seepage.

Fill Pad – This zone is approximately 600 feet in length and was the former location of Shell Western E&P Inc.'s gas plant. Shell constructed a terraced fill pad, involving three levels, through this zone. The Fill Pad was constructed from soils excavated at the head of this canyon. A four-foot diameter culvert is located beneath and along the full length of this zone. The culvert's inlet is located in a sediment retention basin, described below, and terminates at the head of the Lower Canyon.

Upper Canyon – This zone is approximately 1500 feet in length and includes riparian areas along an ephemeral stream. There is a sediment retention basin at the south end of this zone. As indicated, the head of the Upper Canyon was the borrow site for constructing the Fill Pad.

In 1986 soils at the site were discovered to contain PCBs and other chemicals, due to operations and maintenance at the plant, and storage of a heat transfer fluid onsite. In 1988, a remedial investigation was initiated, as a result of a Consent Agreement between Shell Western and the Department of Toxic Substances Control. The investigation found soils containing PCBs in concentrations exceeding 50 parts per million (ppm). The soil was excavated from the site and removed to a landfill for disposal. A Human Risk Assessment comprised a large part of the analysis associated with the Remedial Action Plan. The analysis only considered individuals in direct contact with the site. Cleanup at 50 ppm was deemed appropriate to protect Human Health given a "Reasonable Maximum Exposed" individual. This corresponds to the Toxic Substances Control Act Protection Level for PCBs, but is considerably less protective than other suggested protection levels as published in the National Sediment Quality Survey (U.S. EPA, 1997).

Data collected as part of the post-remediation monitoring program in 1997- 98 indicate that PCB levels at the site still violate USEPA, Ocean Plan, and Basin Plan standards in both surface and ground water by orders of magnitude. Toxicity has been documented in both water and sediment. Sediment PCB levels from post-remediation sampling have ranged at some sites between 3,000 and 20,000 ppb (wet weight). These values are orders of magnitude higher than numerous protective levels referenced in the 1997 U.S. EPA document which are intended to provide protection for various beneficial uses.

A number of different species still show elevated tissue levels of PCBs, with many exceedances of EPA Screening levels (10 ppb), FDA Action Levels (2,000 ppb), and/or NAS Guidelines for protection of wildlife (500 ppb). Worm tissue collected at the site is particularly high in PCBs. Tissue from marine species, including mussels and shore crabs, are also elevated above EPA Screening levels and Maximum Tissue Residual Levels.

It was assumed at the onset of post-remediation monitoring that the site could take a year or more to stabilize following treatment. The first year of monitoring data indicates both water quality violations and tissue bioaccumulation concerns. In spite of prior remediation efforts, the site appears to qualify at this time as a high priority toxic hot spot based on Bay Protection and Toxic Cleanup

Program guidelines; we recommend that it be included as a "known toxic hot spot".

Aera (formerly Shell) owns 56 acres of this canyon (a portion of the Lower Canyon, the Fill Pad and Upper Canyon). Four acres of Aera's property was used as the gas plant site area (essentially the Fill Pad zone). It is unclear to what extent the remediation effort reduced the areal extent of contamination at the site, but it is likely that the areas remediated are still a source of contamination (e.g., soils were taken from a sediment retention basin onsite to fill the excavated area in the lower canyon). At least ten acres may still require additional remediation in order to fully protect beneficial uses. We are proposing amending the Post-Remediation Monitoring Program to address this issue.

Background and most likely sources of pollutants

The Shell Western E & P Inc. Hercules Gas Plant used a heat transfer fluid, Therminol oil, as part of the treatment process while in operation from 1963 to 1989. This fluid contained PCB. PCBs were released to site soils, ground waters and surface waters from Shell's various practices at this site. In addition to PCBs, activities at the plant caused releases to the environment of benzene, toluene, xylenes, ethylbenzene, total petroleum hydrocarbons and polynuclear aromatic hydrocarbons, along with many other chemicals and some metals.

Some pollution, though probably minimal, may possibly also originate from Highway 101 and railroad right-of-way stormwater runoff, which discharges to the seawall culvert onsite.

Los Angeles Region (Region 4)

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 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 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.

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 threat 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 may be affected through the consumption of contaminated fish (Ecological Risk Evaluation Report for the Palos Verdes Shelf, Draft report prepared by SAIC for United States 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 published recreational fishing advisories for most areas offshore of Los Angeles and Orange Counties and has closed commercial fishing for white croaker on the Palos Verdes Shelf.

Areal Extent of the 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. This entire area is proposed as a candidate known toxic hot spot. Studies by the U.S. Geological Survey 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.

In samples collected for the Bay Protection and Toxic Cleanup Program sediment concentrations at stations exceeded the ERM thresholds for Total DDT and Total PCB. Samples collected at other stations also exceeded the ERM thresholds for Total DDT and Total PCB. Porewater toxicity to abalone was recorded, as was a degraded benthic community at other stations in the area.

<u>Sources of Pollutants</u>

From 1947 to 1983, the Montrose Chemical Corporation of California, Inc., manufactured the pesticide dichloro-diphenyl-trichloroethane (DDT) at its plant 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 reportedly 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-effected 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, resuspension of 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.

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.

<u>Areal Extent of the Toxic Hot Spot</u>

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 waterbody 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 BPTCP 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 was 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 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.

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 RWQCB 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, 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 RWQCB.

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

Areal Extent of the 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. 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.

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. 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.

Los Angeles Inner Harbor/Dominguez Channel, Consolidated Slip

Areal Extent of the 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. 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 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.

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.

McGrath Lake

<u>Site Description and Background</u>

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.

Areal Extent and Pollutants of Concern

Sediment contamination appears to exist throughout most of McGrath Lake. 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 BPTCP 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.

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.

Central Valley Region (Region 5)

Mercury

Site 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. Waters from the Sacramento and San Joaquin River drainages meet to form the Delta which ultimately drains to San Francisco Bay. The Delta is a maze of river channels and diked islands covering roughly 1,150 square miles, including 78 square miles of water area.

Background

Mercury has been identified in 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 RWQCB 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. The widespread distribution of mercury contamination emphasizes the regional nature of the problem and the need for regional solutions.

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 OEHHA for San Francisco Bay and the Delta recommending no consumption of large striped bass and shark because of elevated mercury and PCB concentrations.

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 RWQCB 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 RWQCB 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 RWQCB 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 had tissue concentrations comparable to similar indicator organisms obtained from mainstem Sierra Nevada river gold mining activity indicating 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 RWQCB 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.

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.

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.

3. 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 (Grovhoug, personal communication).

San Joaquin River Dissolved Oxygen

Background

Low dissolved oxygen concentrations in the San Joaquin River in the vicinity of the City of Stockton has been identified in the cleanup plan as constituting a candidate BPTCP hot spot. In January 1998 the Central Valley RWQCB 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 Cleanup 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[10]. 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 RWQCB 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, and (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 RWQCB 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 RWQCB had considered the permit. The State Board remanded the permit back to the RWQCB for consideration of new Delta flow standards.

In the interim the Stockton RWCF refined the dissolved oxygen model for the River (Chen and Tsai, 1997). The model suggests

[10] 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.

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 new 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.

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.

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 nonpoint source discharges. River flow and water temperature were identified as two other variables strongly influencing oxygen concentrations.

~~**Pesticides**~~

~~Background~~

~~"Diazinon in orchard dormant spray runoff" was identified in the Central Valley Cleanup Plan as constituting a candidate hot spot in the Sacramento-San Joaquin Delta Estuary. Staff briefed the Central Valley RWQCB 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 BPTCP 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 RWQCB 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 toxic hot spot. The RWQCB 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 RWQCB 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 RWQCB 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 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[11]. 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

[11] Unfortunately, many agricultural pesticides are applied in the Central Valley and measured in the Rivers. When the risk assessment is repeated with multiple chemicals, 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.

occasion 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.

BPTCP 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 RWQCB reviewed the dormant spray data and unanimously concluded that the Sacramento and San Joaquin Rivers and Delta Estuary fit the recommended criteria for listing as a high priority candidate toxic hot spot.

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.

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).

Diazinon Orchard Dormant Spray Cleanup Plan

Background[12]

The Regional Board determined that diazinon in orchard dormant spray runoff caused toxic conditions in the Sacramento-San Joaquin Delta that warranted identifying the entire Delta as a candidate high priority toxic hot spot in 1999. The Consolidated Hot Spot Cleanup Plan adopted by the State Water Resources Control Board (State Board) in Resolution No. 99-065 identified this candidate hot spot as a known toxic hot spot that required a cleanup plan.

Diazinon in Delta waterways, as well as many other Central Valley waterbodies (see table below), have been identified in the State Board's 303(d) list as a high priority problem and committed to developing a waste load allocation (TMDL) by the year 2004. This plan addresses the cleanup plan requirements of the Bay Protection Program and is consistent with the proposed actions and schedules of the 303(d) listing.

303(d) List for Diazinon

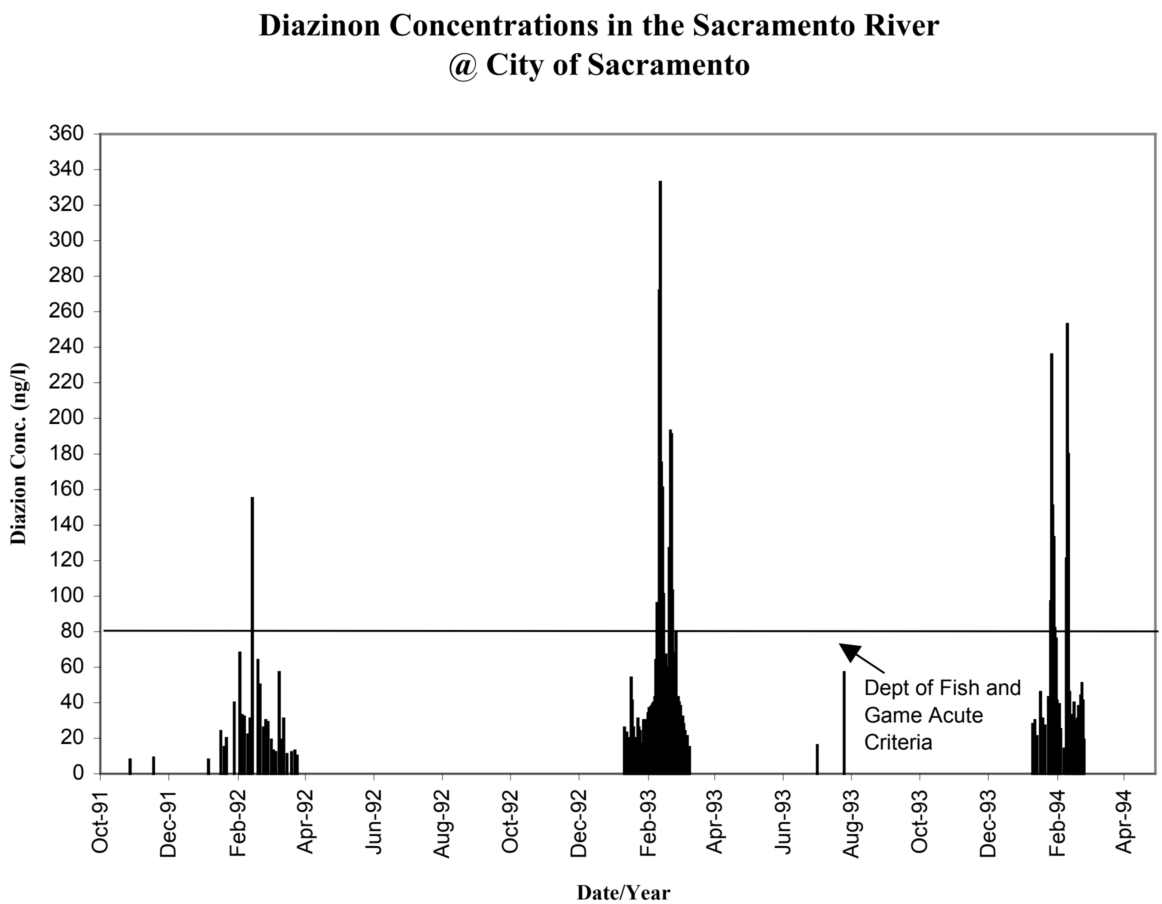
Waterbody	Affected size	Priority	TMDL End Date
Arcade Creek	10 miles	High	2003
Chicken Ranch Slough	5 miles	High	2003
Delta Waterways	48,000 acres	High	2004
Elder Creek	10 miles	Medium	2003
Elk Creek Grove	5 miles	Medium	2003
Feather River, lower	60 miles	High	2003
Five Mile Slough	1 mile	Medium	2012
Harding Drain	7 miles	Low	After 2015
Merced River Lower	60 miles	High	2006

[12] The Bay Protection Program (California Water Code § 13394(a), (b) and (d)) requires that the regional boards develop cleanup plans that include a priority ranking of all hot spots (§ 13394(a)), a description of the hot spots (§ 13394(b)), and an assessment of the most likely source(s) of the pollutants present at the hot spot site (§ 13394(d)). The information presented in this section was previously developed and included in the Statewide Consolidated Toxic Hot Spot Cleanup Plan adopted by the State Board. It is substantively unchanged (with the exception of the updated 303(d) listing information) but is presented for essential background information purposes.

Morrison Creek	20 miles	Medium	2003
Mosher Slough	2 miles	Medium	2012
Natomas East Main Drain	5 miles	Medium	2015
Orestimba Creek	10 miles	Medium	2010
Sacramento River (Red Bluff to Delta	30 miles	High	2003
Salt Slough	15 miles	Low	After 2005
San Joaquin River	130 miles	High	2003
Stanislaus River, lower	48 miles	High	2004
Strong Ranch Slough	5 miles	High	2003
Tuolumne River, lower	32 miles	High	2006

In the early 1990s, up to one million pounds of insecticide active ingredient was documented as being applied in the months January and February in the Central Valley on about half a million acres of dormant stonefruit and almond orchards to control boring insects (Foe and Sheipline, 1993). Diazinon accounted for about half the application. Numerous chemical studies and toxicity tests have measured diazinon in surface water samples in the Central Valley during winter months at concentrations toxic to sensitive invertebrates and exceeding the California Department of Fish and Game's criteria (See figure below; Foe and Connor, 1991; Foe and Sheipline, 1993; Ross, 1992 and 1993; Foe, 1995; Domagalski, 1995; Kratzer, 1997). Highest concentrations and longest exposures are typically found in small water courses adjacent to high densities of orchards. However, toxic concentrations of diazinon have been recorded after large storm events in the Central Valley's major waterbodies (Foe and Connor, 1991; Foe and Sheipline, 1993). The US Geological Survey and Regional Board traced pulses of diazinon from both the Sacramento and San Joaquin Rivers across the Delta in 1993 (Kuivilla and Foe, 1995). Toxic concentrations to the cladoceran invertebrate *Ceriodaphnia* were observed as far west in the Delta as Chipps Island, some 60 miles downstream of the City of Sacramento and the entrance to the Delta.

Concern was expressed that other contaminants might also be present in winter storm runoff from the Central Valley and contribute to invertebrate mortality. Therefore, in 1996, toxicity identification evaluations (TIEs) were conducted on three samples testing toxic in *Ceriodaphnia* toxicity tests from the San Joaquin River at Vernalis (Foe et al., 1998). The results confirmed 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 samples 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 conducted on samples from Orestimba Creek in the San Joaquin Basin and from the Sutter Bypass confirmed diazinon as the primary toxicant (Foe at al., 1998). No evidence was obtained suggesting a second contaminant.



The criteria specified in the State Board Bay Protection Toxic Cleanup Program Guidance for determining what constitutes a high priority toxic hot spot requiring a cleanup plan includes consideration of aquatic life impacts, frequent exceedances of water quality objectives, the areal extent of the impairment, identification of sources and potential for natural remediation. Aquatic toxicity has been demonstrated to occur repeatedly through toxicity tests, TIEs and chemical confirmation. The Regional Board previously determined that high concentrations of diazinon, frequently detected in the Sacramento River, San Joaquin River and in the Delta were toxic and these waterbodies merited consideration as a high priority toxic hot spot. The Consolidated Hot Spot Cleanup Plan adopted by the State Board in Resolution No. 99-065 identified this Regional Board high priority toxic hot spot as a known toxic hot spot. More information supporting the staff recommendation to list diazinon from dormant orchard spray runoff as a high priority toxic hot sport may be found in the Statewide Consolidated Hot Spot Cleanup Plan tables (see pages 5-3 through 5-7).

Although the extent of impairments is widespread, the sources are limited to the single activity of dormant spray applications. This impairment will not be corrected by natural processes, and cannot be remediated like some sediment contamination problems through site cleanup. Whereas sediment contamination can be removed and treated, diazinon from dormant orchard spray results in a water column problem which requires an effective upstream source control program in order to remediated the hot spot.

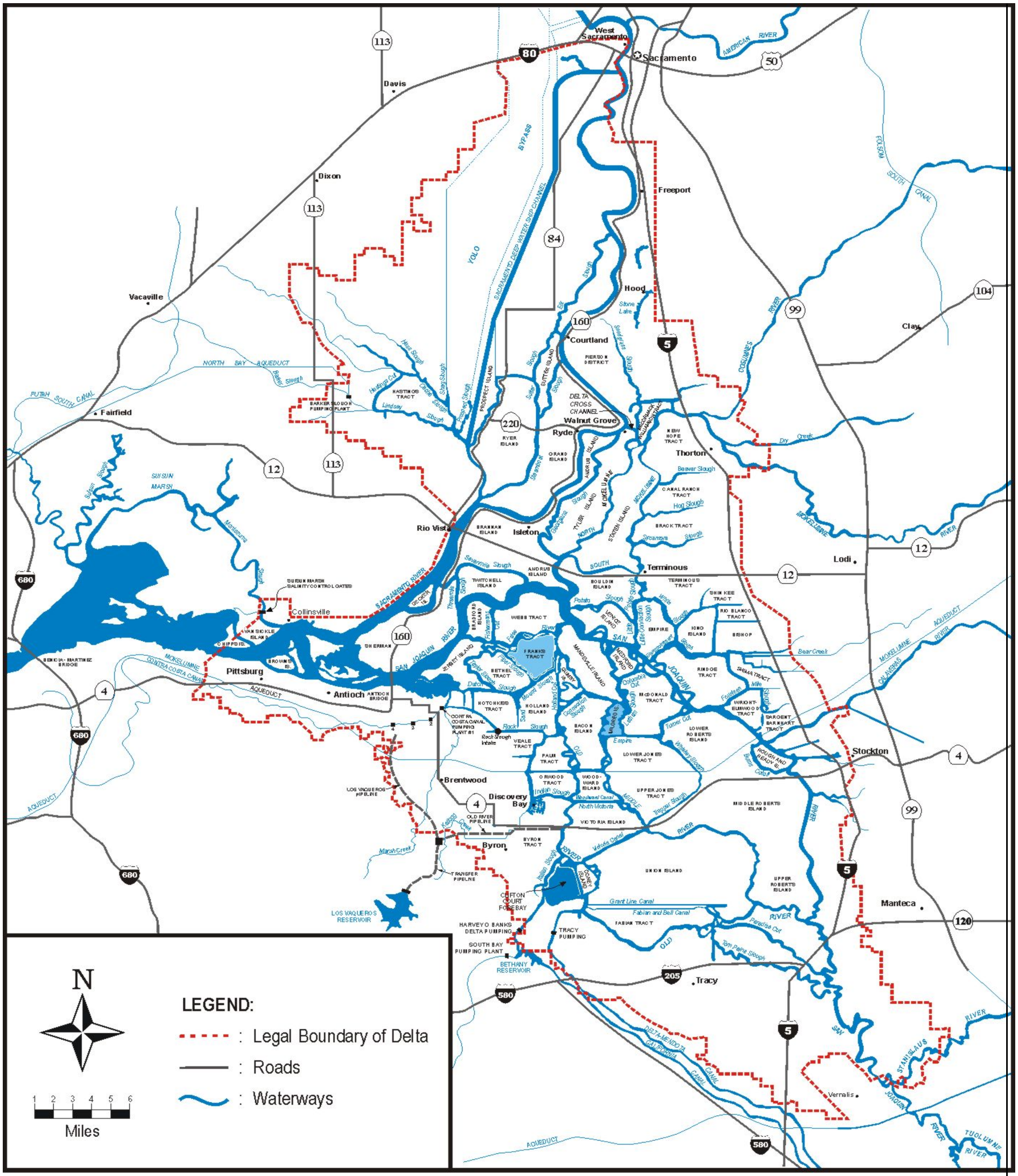
Areal Extent

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

Sources

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

Due to the many variables affecting the offsite movement of dormant applications of diazinon, it is not known at this time the relationship between pesticides applied to orchards and the loads in the waterways. Determining the factors influencing the offsite movement of diazinon to waterways and identifying the areas contributing to the hot spot is essential not only for assessing responsibility and source but also for successful development and implementation of agricultural management practices. However, farmers are required to report all applications of diazinon to the County Agricultural Commissioner's Office and the total quantity of pesticide applied by individual counties is available from the Department of Pesticide Regulation.



Sacramento/San Joaquin River Delta
(Source: California Department of Water Resources)

Urban Stormwater Pesticide Cleanup Plan for the Delta

Background

"Diazinon and chlorpyrifos in urban stormwater runoff" was identified in the Cleanup Plan as constituting a candidate toxic hot spot in several Delta backsloughs. 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 BPTCP 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 RWQCB 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 RWQCB 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 Cleanup 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 RWQCB 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 water bodies are within the legal boundary of the Delta. A modified phase I TIE was conducted on samples from each site which implicated 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 a 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 stormwater 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 RWQCBs, 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 water bodies 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.

BPTCP 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 RWQCB 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.

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.

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).

Background[13]

The Regional Board determined that diazinon and chlorpyrifos in urban stormwater runoff caused toxic conditions in the Sacramento-San Joaquin Delta that warranted identifying several Delta back sloughs and creeks collectively as a candidate high priority toxic hot spot. The Consolidated Hot Spot Cleanup Plan adopted by the State Board in Resolution No. 99-065 identified this candidate hot spot as a known toxic hot spot. Diazinon and chlorpyrifos from urban runoff have also been noted in the Central Valley Region's 303(d) list as water quality impairments in Delta back sloughs and creeks. This cleanup plan addresses the cleanup requirements of the BPTCP and is consistent with the proposed actions and schedules of the 303(d) listing.

Three hundred and forty thousand pounds of diazinon and seven hundred and seventy five thousand pounds of chlorpyrifos active ingredients were used in 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). However, these figures do not include homeowner purchases and likely underestimates total use by about one half. In February and again in October 1994 *Ceriodaphnia* toxicity test 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 water bodies are within the legal boundary of the Delta. A modified phase I TIE, conducted on samples from each site, implicated metabolically activated pesticide(s) (such as diazinon and chlorpyrifos) as responsible for the toxicity. Chemical analyses demonstrated that diazinon and occasionally chlorpyrifos were present at toxic concentrations. A phase III TIE was conducted on water collected from Mosher Slough on 1 May 1995 that confirmed that the primary cause of acute toxicity was a combination of diazinon and chlorpyrifos.

[13] The Bay Protection Program (California Water Code § 13394(a), (b) and (d)) requires that the regional boards develop cleanup plans that include a priority ranking of all hot spots (§ 13394(a)), a description of the hot spots (§ 13394(b)), and an assessment of the most likely source(s) of the pollutants present at the hot spot site (§ 13394(d)). The information presented in this background section was previously developed and included in the Statewide Consolidated Toxic Hot Spot Cleanup Plan adopted by the State Board. It is substantively unchanged but is presented for essential background information purposes.

Similar invertebrate toxicity test 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 and Central Valley Regional Water Quality Control Boards, DPR, 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 toxicity test, 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 diazinon appears to be primarily from urban sources, although agricultural orchard use may also be an important source. Chlorpyrifos appears to be predominately of urban origin but the impacts from agricultural use need to be evaluated. Similar results from urban sites in the Bay area indicate that pesticide storm runoff is a widespread problem.

The Regional Board monitoring focused on *Ceriodaphnia* toxicity tests, TIEs and water column chemistry because these measures of aquatic toxicity were specifically identified in the BPTCP as tools that could be used to define toxic hot spots. The use of *Ceriodaphnia* in the BPTCP as an indicator of aquatic toxicity was an innovative and sound approach. An analysis of 49 independent studies (U.S. EPA, 1999) concluded that the *Ceriodaphnia* test has been a particularly reliable predictor of instream biological impacts. In 1995, the Society for Environmental Toxicology and Chemistry assembled a panel of experts to analyze the question of how reliably the results of laboratory single species tests (such as the U.S. EPA *Ceriodaphnia* toxicity test) predict aquatic population responses. The panel concluded that, "it is unmistakable and clear that when the U.S. EPA toxicity test procedures are used properly, they are reliable predictors of environmental impact provided that the duration and magnitude of exposure are sufficient to effect resident biota" and that "a strong predictive relationship exists between ambient toxicity and ecological impact."

Bay Protection Toxic Cleanup Program Guidance prepared by the State Board specifies how to determine what sites or situations should be designated as high priority toxic hot spots (cleanup plans are required for high priority hot spots). The criteria for making this determination for water column toxicity includes consideration of aquatic life impacts, exceedances of water quality objectives, the areal extent of the impairment, identification of sources and potential for natural remediation. Aquatic toxicity has been demonstrated to occur repeatedly through toxicity tests, TIEs and chemical confirmation. The extent of impairments from urban pesticide discharges is relatively widespread. This impairment will not be corrected by natural processes, however many of the urban uses are being phased out as a result of a December 2000 agreement between U.S. EPA and manufacturers of diazinon and chlorpyrifos.

In 1999, the Regional Board determined that diazinon and chlorpyrifos in urban runoff caused toxic conditions in numerous back sloughs in the vicinity of Sacramento and Stockton that warranted identifying these sloughs as a candidate high priority toxic hot spot. In making this determination, the Regional Board specifically concluded that the pattern of pesticide detections observed in the sloughs was frequent and clearly fit the definition of a toxic hot spot. The Consolidated Hot Spot Cleanup Plan adopted by the State Board in 1999 in Resolution No. 99-065 identified this candidate hot spot as a known toxic hot spot. The tables in the Statewide Consolidated Cleanup Plan (see 5-3 through 5-7) summarize the determinations that support the staff recommendation that the back sloughs and creeks named above be listed as a high priority toxic hot spot for chlorpyrifos and diazinon.

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. In addition, runoff from urban areas in tributaries to the Delta contributes to the overall loads entering the Delta during storm events.

Sources

Detailed information on urban sources is not available for the Central Valley. However, in a Sacramento Stormwater Management Report (Busath, 2001), three sources of pesticides in Sacramento urban creeks were identified: 1) unreported residential and commercial applications, 2) reported applications by licensed pesticide applicators, and 3) pesticides transported from agricultural applications. This report and others (personal communication, Val Connor) suggest that diazinon in rainfall is a significant source in the Central Valley. Monitoring and pesticide use surveys in the Sacramento area confirm Bay area findings (Scanlin and Feng, 1997) that residential areas were a significant source but runoff from commercial areas may also be important.

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 suggests that concentrations in creeks may be attributable to proper use (Scanlin and Feng, 1997).

Irrigation Return Flow Pesticide Cleanup Plan For the Delta

~~Background~~

~~"Chlorpyrifos in irrigation tailwater" has been identified in the Cleanup Plan as constituting a candidate hot spot in various agriculturally dominated backsloughs within the Delta. Staff briefed the Central Valley RWQCB 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 RWQCB 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 1992. 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 its 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.

BPTCP 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 RWQCB 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.

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.

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.

Background[14]

The Regional Board determined that chlorpyrifos in irrigation return flow caused toxic conditions in various agriculturally dominated back sloughs within the Delta that warranted identifying Delta back sloughs as a candidate high priority toxic hot spot in 1999. The Consolidated Hot Spot Cleanup Plan adopted by the SWRCB in Resolution No. 99-065 identified this candidate hot spot as a known toxic hot spot.

[14] The Bay Protection Program (California Water Code § 13394(a), (b) and (d)) require that the regional boards develop cleanup plans that include a priority ranking of all hot spots (§ 13394(a)), a description of the hot spots (§ 13394(b)), and an assessment of the most likely source(s) of the pollutants present at the hot spot site (§ 13394(d)). The information presented in this section was previously developed and included in the Statewide Consolidated Toxic Hot Spot Cleanup Plan adopted by the State Board. It is substantively unchanged (with the exception of the updated 303(d) listing information) but is presented for essential background information purposes.

Chlorpyrifos has also been noted in the Central Valley 303(d) list as a water quality impairment in the San Joaquin River, Sacramento-San Joaquin Delta and several other tributaries (see table below). This plan primarily addresses the cleanup requirements of the BPTCP but has also been written to be consistent with the proposed schedule for the 303(d) list.

303(d) List for Chlorpyrifos

Waterbody	Affected size	Priority	TMDL End Date
Arcade Creek	10 miles	High	2003
Chicken Ranch Slough	5 miles	High	2003
Delta Waterways	48,000 acres	High	2004
Elder Creek	10 miles	Medium	2003
Five Mile Slough	1 mile	Medium	2012
Harding Drain	7 miles	Low	After 2015
Merced River Lower	60 miles	High	2006
Mosher Slough	2 miles	Medium	2012
Orestimba Creek	10 miles	Medium	2010
Salt Slough	15 miles	Low	After 2005
San Joaquin River	130 miles	High	2003
Strong Ranch Slough	5 miles	High	2003

One and a half million pounds of chlorpyrifos active ingredient were used in the Central Valley on agriculture in 1990 (Sheipline, 1993). Major uses are in March 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 toxicity test study was conducted in agriculturally dominated waterways in the San Joaquin Basin in 1991 and 1992. Chlorpyrifos was detected on 190 occasions between March and June of both years, at 43 times the 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 toxicity 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; Larson *et al*., 1994). In each instance the *Ceriodaphnia* toxicity test 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 suggests that the impairment was confined to back sloughs 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.

The Regional Board monitoring focused on *Ceriodaphnia* toxicity tests, TIEs and water column chemistry because these measures of aquatic toxicity were specifically identified in the BPTCP as tools that could be used to define toxic hot spots. The use of *Ceriodaphnia* in the BPTCP as an indicator of aquatic toxicity was an innovative and sound approach. An analysis of 49 independent studies (U.S. EPA, 1999) concluded that the *Ceriodaphnia* test has been a particularly reliable predictor of instream biological impacts. In 1995, the Society for Environmental Toxicology and Chemistry assembled a panel of experts to analyze the question of how reliably the results of laboratory single species tests (such as the U.S. EPA *Ceriodaphnia* toxicity test) predict aquatic population responses. The panel concluded that, "it is unmistakable and clear that when the U.S. EPA toxicity test procedures are used properly, they are reliable predictors of environmental impact provided that the duration and magnitude of exposure are sufficient to effect resident biota" and that "a strong predictive relationship exists between ambient toxicity and ecological impact."

A combination of toxicity test, chemical and TIE work demonstrate that chlorpyrifos was present periodically in at least four agriculturally dominated backsloughs at concentrations toxic to sensitive invertebrates. The source of the chlorpyrifos appears to be from agricultural use. These results led Regional Board staff to conclude that French Camp Slough, Duck Slough, Paradise Cut, and Ulatis Creek fit the BPTCP criteria for listing as candidate water column toxic hot spots because of elevated concentrations of chlorpyrifos.

Bay Protection Toxic Cleanup Program Guidance prepared by the State Board specifies how to determine what sites or situations should be designated as high priority toxic hot spots (cleanup plans are required for high priority hot spots). The criteria for making this determination for water column hot spots include consideration of aquatic life impacts, exceedances of water quality objectives, the areal extent of the impairment, identification of sources and potential for natural remediation. Aquatic toxicity has been demonstrated to occur repeatedly through toxicity tests, TIEs and chemical confirmation. The extent of impairments from irrigation return flow is relatively widespread. This impairment will not be corrected by natural processes.

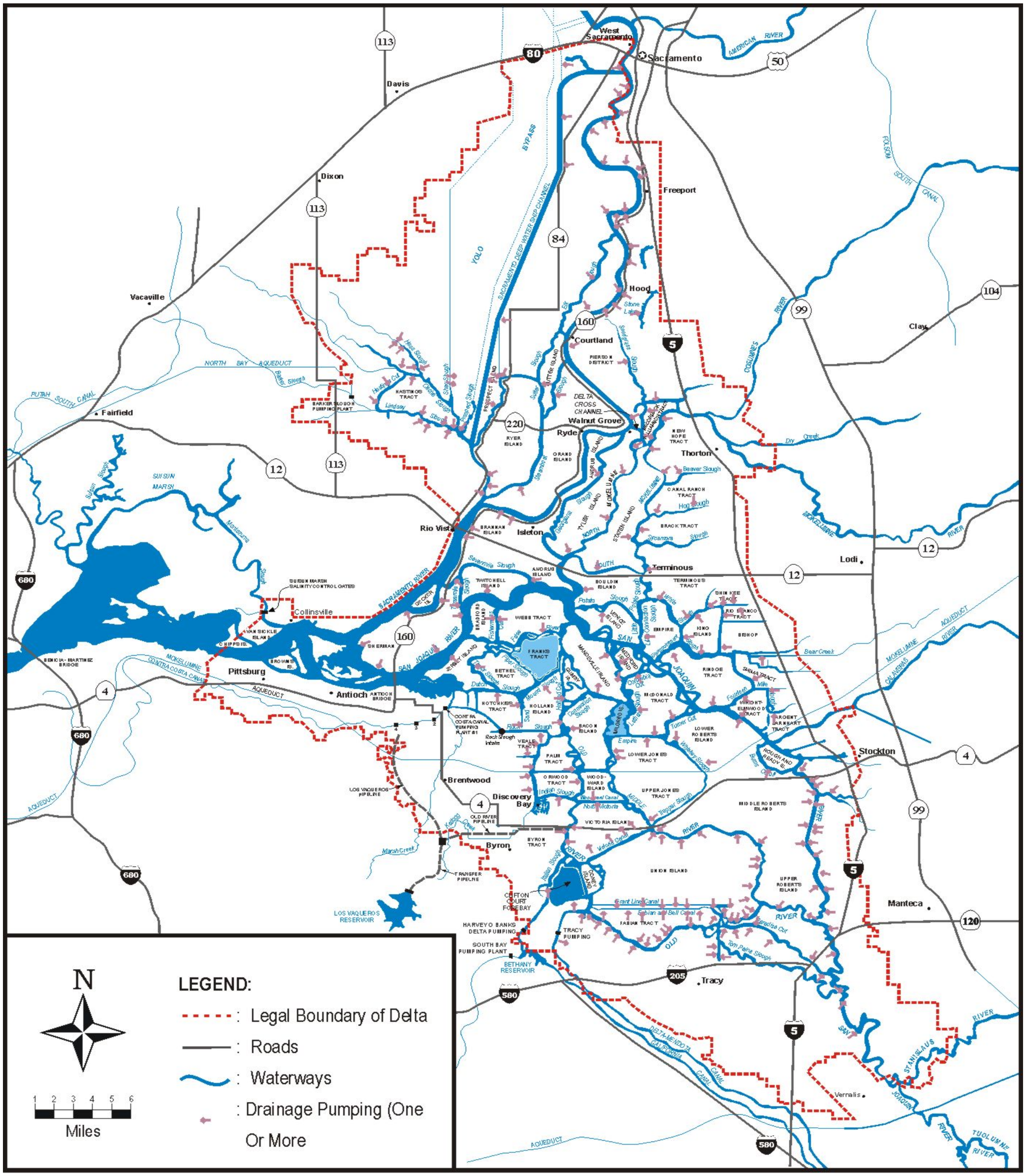
In 1999 the Regional Board determined that chlorpyrifos in agricultural return flow caused toxic conditions in numerous back sloughs in the Delta that warranted identifying these sloughs as a candidate high priority toxic hot spot. In making this determination, the Regional Board concluded that the pattern of pesticide detections observed in the sloughs was frequent and clearly fit the definition of a toxic hot spot. The 1999 State Board resolution adopting the Consolidated Hot Spot Cleanup Plan (Resolution No. 99-065) identified this candidate hot spot as a known toxic hot spot. The tables in the Statewide Consolidated Cleanup Plan (see pages 5-3 through 5-7) summarize the determinations that support the staff recommendation that the back sloughs in the Delta named above be listed as a high priority toxic hot spot for chlorpyrifos.

Areal Extent

For the Bay Protection Program, the potential aquatic threat posed by chlorpyrifos in agricultural return flow is confined to the four previously named Creeks and Sloughs: French Camp Slough, Duck Slough, Paradise Cut and Ulatis Creek. The areal extent of the impairment may be up to 15 linear miles of waterway within the legal boundary of the Delta. See attached map.

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. While it is not known at this time what the relative contribution of each application is, illegal use of pesticides has not been implicated as a significant component of the loads entering surface waters. It would appear that legal use of the pesticide is resulting in the observed water quality problems.



Sacramento/San Joaquin River Delta
(Source: California Department of Water Resources)

Santa Ana Region (Region 8)

Lower Newport Bay Rhine Channel

Site Description

Newport Bay is one of the largest small craft harbors in southern California. It is adjacent to the cities of Newport Beach, and Corona Del Rey and it is divided into an upper and a lower portion, and Upper Newport Bay is owned and managed by the State Department of Fish and Game as a State Ecological Reserve. Lower Newport Bay is heavily developed with housing, hotels, restaurants, marinas, and light marine industry such as boatyards and fuel docks. The Bay harbors approximately 10,000 small craft. Tributaries draining into the system include the San Diego Creek, and among other smaller tributaries, the Santa Ana-Delhi Channel and Big Canyon Wash. The entire Newport Bay watershed encompasses 154 square miles.

Background

The pollutants of concern found at the site are Arsenic, Copper, Lead, Mercury, Zinc, DDE, PCB, and TBT.

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 feet. length range. In 1964, there were 19 boat yards operating in the Lower Bay. Currently six boat yards operate along Rhine Channel The boat yards are currently regulated by General Waste Discharge Requirements. 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.

The RWQCB currently regulates the discharge of process wastewater and stormwater from all boat yard facilities in Lower Newport Bay and Huntington Harbor 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 TMDL for metals and pesticides will be developed by the RWQCB to address this impairment. The control of pollutant sources occurring in Rhine Channel will be a component of the TMDLs.

<u>Areal Extent</u>

The areal extent of the Toxic Hot Spot (THS) is assessed to be between 1.5 to 2.5 acres.

<u>Source</u>

The source of the problem are pesticides, and toxicants associated with sedimentation from urban and agricultural erosion entering the system from the tributary creeks. Other pollutant sources include boatyard and fueling operations of small craft discharges and stormwater runoff.

San Diego Region (Region 9)

Seventh Street Channel, National City

Site 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. The population of the Region is heavily concentrated along the coast.

In the southern portion of the Region 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, San Diego 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.

Areal Extent of the Toxic Hot Spot

Approximately three acres appear affected in San Diego Bay (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.

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.