Bay Protection and Toxic Cleanup Program

Proposed Regional Toxic Hot Spot Cleanup Plan

December 1997

SAN FRANCISCO BAY REGION

REGIONAL WATER QUALITY CONTROL BOARD
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

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PROPOSED REGIONAL
TOXIC HOT SPOT CLEANUP PLAN

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REGIONAL WATER QUALITY CONTROL BOARD SAN FRANCISCO BAY REGION

Part I

I. INTRODUCTION

In 1989, The California State legislature established the Bay Protection and Toxic Cleanup Program (BPTCP). The BPTCP has four major goals: (1) provide protection of present and future beneficial uses of the bays and estuarine waters of California; (2) identify and characterize toxic hot spots; (3) plan for toxic hot spot cleanup or other remedial or mitigation actions; (4) develop prevention and control strategies for toxic pollutants that will prevent creation of new toxic hot spots or the perpetuation of existing ones within the bays and estuaries of the State.

This Regional Toxic Hot Spot Cleanup Plan is intended to provide direction for the remediation or prevention of toxic hot spots in the San Francisco Bay Region (pursuant to Water Code Sections 13390 et seq.). Pursuant to Sections 13140 and 13143 of the Water Code, this Cleanup Plan is necessary to protect the quality of waters and sediments of the State from discharges of waste, in-place sediment pollution and contamination, and any other factor that can impact beneficial uses of enclosed bays, estuaries and coastal waters. This plan shall be reviewed periodically to ensure that the plan is adequate to complete the mandates of the Bay Protection and Toxic Cleanup Program (Water Code Section 13390 et seq.).

This Plan includes a specific definition of a Toxic Hot Spot, site ranking criteria, and the monitoring approach used to identify the Water Code-mandated requirements for Regional Toxic Hot Spot Cleanup Plans.

Region Description

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 waters 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 region's waterways, wetlands and bays form the centerpiece of the fourth largest metropolitan area in the United States, including all or major portions of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano and Sonoma counties (Figure 1).

The San Francisco Bay Regional Water Quality Control Board (RWQCB) has jurisdiction over the part of the San Francisco estuary which includes all of the San Francisco Bay segments extending east to the Delta (Winter Island near Pittsburg). Coastal embayments including Tomales Bay and Bolinas Lagoon are also located in this Region. The Central Valley RWQCB has jurisdiction over the Delta and rivers extending further eastward.

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.

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

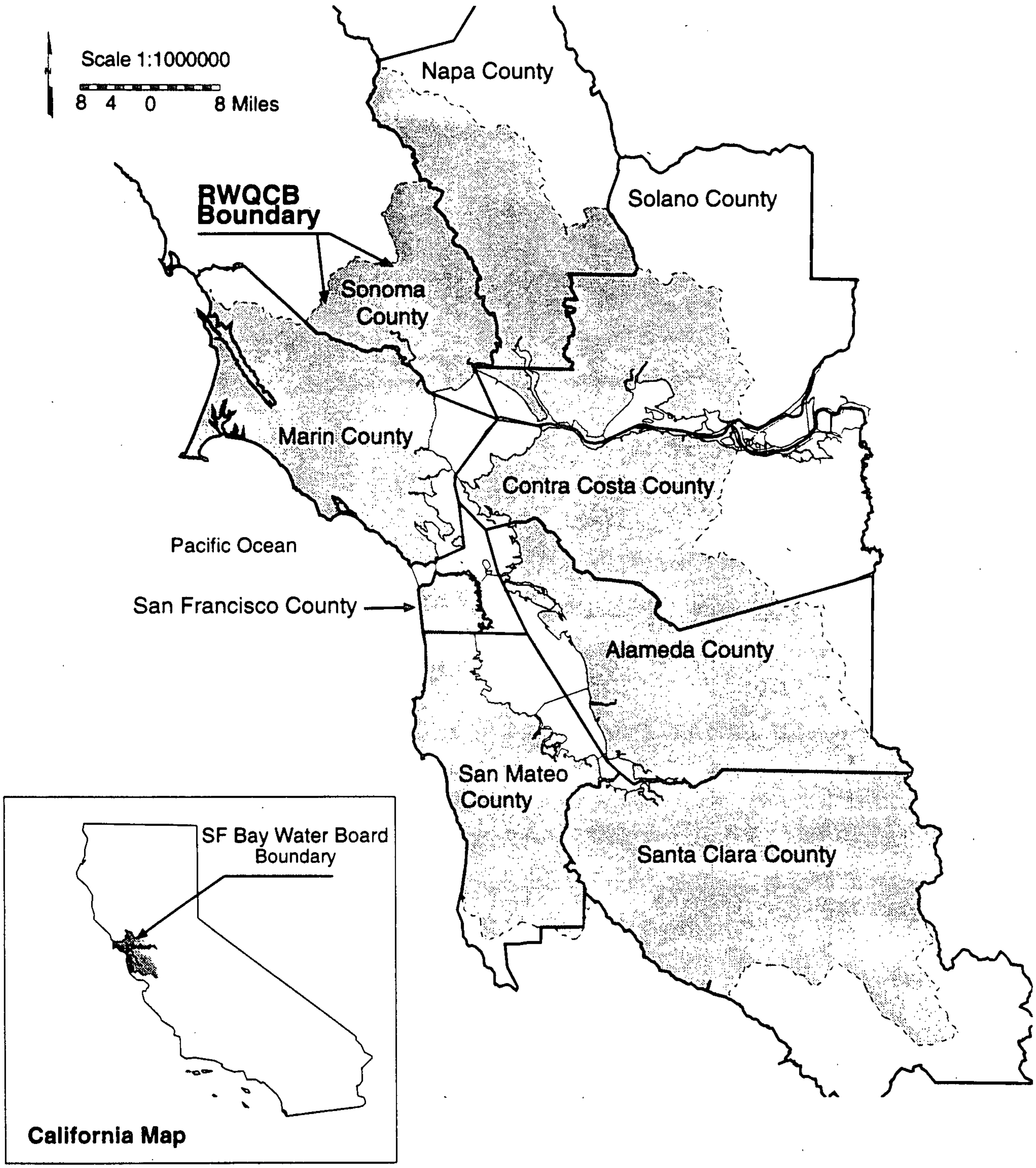

Figure 1. San Francisco Bay Region

Maps: Basins, Counties

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.

Legislative Authority

California Water Code, Division 7, Chapter 5.6 established a comprehensive program to protect the existing and future beneficial uses of California's enclosed bays and estuaries. SB 475 (1989), SB 1845 (1990), AB 41 (1989), and SB 1084 (1993) added and modified Chapter 5.6 [Bay Protection and Toxic Cleanup (Water Code Sections 13390-13396.5)] to Division 7 of the Water Code.

The BPTCP has provided a new focus on RWQCB's efforts to control pollution of the State's bays and estuaries by establishing a program to identify toxic hot spots and plan for their cleanup.

Water Code Section 13394 requires that each RWQCB complete a toxic hot spot cleanup plan. Each cleanup plan must include: (1) a priority listing of all known toxic hot spots covered by the plan; (2) a description of each toxic hot spot including a characterization of the pollutants present at the site; (3) an assessment of the most likely source or sources of pollutants; (4) an estimate of the total costs to implement the cleanup plan; (5) an estimate of the costs that can be recovered from parties responsible for the discharge of pollutants that have accumulated in sediments; (6) a preliminary assessment of the actions required to remedy or restore a toxic hot spot; and (7) a two-year expenditure schedule identifying State funds needed to implement the plan.

Limitations

This proposed regional toxic hot spot cleanup plan contains information on sites that are believed to be the worst sites in the Region. Much of the data collected as part of the BPTCP have not been reported and some analyses have yet to be completed. Consequently, this regional toxic hot spot cleanup plan is subject to revision as new information on toxic hot spot identification becomes available. In future versions of the Plan there is an expectation that (1) other sites may be identified as candidate toxic hot spots; (2) potential toxic hot spots will be addressed in future versions of the cleanup plan; (3) cleanup levels for sites may be added to the cleanup plan; and (4) site rankings may change as new information becomes available.

II. TOXIC HOT SPOT DEFINITION

Codified Definition of A Toxic Hot Spot

Section 13391.5 of the Water Code defines toxic hot spots as:

"...[L]ocations in enclosed bays, estuaries, or adjacent waters in the 'contiguous zone' or the 'ocean' as defined in Section 502 of the Clean Water Act (33. U.S.C. Section 1362), the pollution or contamination of which affects the interests of the State, and where hazardous substances have accumulated in the water or sediment to levels which (1) may pose a substantial present or potential hazard to aquatic life, wildlife, fisheries, or human health, or (2) may adversely affect the beneficial uses of the bay, estuary, or ocean waters as defined in the water quality control plans, or (3) exceeds adopted water quality or sediment quality objectives."

Specific Definition of A Toxic Hot Spot

Although the Water Code provides some direction in defining a toxic hot spot, the definition presented in Section 13391.5 is broad and somewhat ambiguous regarding the specific attributes of a toxic hot spot. The following specific definition provides a mechanism for identifying and distinguishing between "candidate" and "known" toxic hot spots. A Candidate Toxic Hot Spot is considered to have enough information to designate a site as a Known Toxic Hot Spot except that the candidate hot spot has not been approved by the RWQCB and the

SWRCB. Once a candidate toxic hot spot has been adopted into the consolidated statewide toxic hot spot cleanup plan then the site shall be considered a known toxic hot spot and all the requirements of the Water Code shall apply to that site.

<u>Candidate Toxic Hot Spot</u>:

A site meeting any one or more of the following conditions is considered to be a "candidate" toxic hot spot.

1. The site exceeds water or sediment quality objectives for toxic pollutants that are contained in appropriate water quality control plans or exceeds water quality criteria promulgated by the U.S. Environmental Protection Agency (U.S. EPA).

   This finding requires chemical measurement of water or sediment, or measurement of toxicity using tests and objectives stipulated in water quality control plans. Determination of a toxic hot spot using this finding should rely on recurrent measurements over time (at least two separate sampling dates). Suitable time intervals between measurements must be determined.

2. The water or sediment exhibits toxicity associated with toxic pollutants that is significantly different from the toxicity observed at reference sites (*i.e.*, when compared to the lower confidence interval of the reference envelope), based on toxicity tests acceptable to the SWRCB or the RWQCBs.

   To determine whether toxicity exists, recurrent measurements (at least two separate sampling dates) should demonstrate an effect. Appropriate reference and control measures must be included in the toxicity testing. The methods acceptable to and used by the BPTCP may include some toxicity test protocols not referenced in water quality control plans (*e.g.*, the Bay Protection and Toxic Cleanup Program Quality Assurance Project Plan). Toxic pollutants should be present in the media at concentrations sufficient to cause or contribute to toxic responses in order to satisfy this condition.

3. The tissue toxic pollutant levels of organisms collected from the site exceed levels established by the United States Food and Drug Administration (FDA) for the protection of human health, or the National Academy of Sciences (NAS) for the protection of human health or wildlife. When a health advisory against the consumption of edible resident non-migratory organisms has been issued by the Office of Environmental Health Hazard Assessment (OEHHA) or Department of Health Services (DHS), on a site or water body, the site or water body is automatically classified as a "candidate" toxic hot spot if the chemical contaminant is associated with sediment or water at the site or water body.

   Acceptable tissue concentrations are measured either as muscle tissue (preferred) or whole body residues. Residues in liver tissue alone are not considered a suitable measure for known toxic hot spot designation. Animals can either be deployed (if a resident species) or collected from resident populations. Recurrent measurements in tissue are required. Residue levels established for one species for the protection of human health can be applied to any other consumable species.

   Shellfish: Except for existing information, each sampling episode should include a minimum of three replicates. The value of interest is the average value of the three replicates. Each replicate should be comprised of at least 15 individuals. For existing State Mussel Watch information related to organic pollutants, a single composite sample (20-100 individuals), may be used instead of the replicate measures. When recurrent measurements exceed one of the levels referred to above, the site is considered a candidate toxic hot spot.

   Fin-fish: A minimum of three replicates is necessary. The number of individuals needed will depend on the size and availability of the animals collected; although a minimum of five animals per replicate is recommended. The value of interest is the average of the three replicates. Animals of similar age and reproductive stage should be used.

4. Impairment measured in the environment is associated with toxic pollutants found in resident individuals.

   Impairment means reduction in growth, reduction in reproductive capacity, abnormal development, histopathological abnormalities. Each of these measures must be made in comparison to a reference condition where the endpoint is measured in the same species and tissue is collected from an unpolluted reference site. Each of the tests shall be acceptable to the SWRCB or the RWQCBs.

   Growth Measures: Reductions in growth can be addressed using suitable bioassays acceptable to the State or Regional Boards or through measurements of field populations.

   Reproductive Measures: Reproductive measures must clearly indicate reductions in viability of eggs or offspring, or reductions in fecundity. Suitable measures include: pollutant concentrations in tissue, sediment, or water which have been demonstrated in laboratory tests to cause reproductive impairment, or significant differences in viability or development of eggs between reference and test sites.

   Abnormal Development: Abnormal development can be determined using measures of physical or behavioral disorders or aberrations. Evidence that the disorder can be caused by toxic pollutants, in whole or in part, must be available.

   Histopathology: Abnormalities representing distinct adverse effects, such as carcinomas or tissue necrosis, must be evident. Evidence that toxic pollutants are capable of causing or contributing to the disease condition must also be available.

5. Significant degradation in biological populations and/or communities associated with the presence of elevated levels of toxic pollutants.

This condition requires that the diminished numbers of species or individuals of a single species (when compared to a reference site) are associated with concentrations of toxic pollutants. The analysis should rely on measurements from multiple stations. Care should be taken to ensure that at least one site is not degraded so that a suitable comparison can be made.

In summary, sites are designated as "candidate" hot spots after generating information which satisfies any one of the five conditions constituting the definition.

Known Toxic Hot Spot:

A site meeting any one or more of the conditions necessary for the designation of a "candidate" toxic hot spot that has gone through a full SWRCB and RWQCB hearing process, is considered to be a "known" toxic hot spot. A site will be considered a "candidate" toxic hot spot until approved as a known toxic hot spot in a Regional Toxic Hot Spot Cleanup Plan by the RWQCB and approved by the SWRCB.

III. MONITORING APPROACH

As part of the legislative mandates, the BPTCP has implemented regional monitoring programs to identify toxic hot spots (Water Code Section 13392.5). The BPTCP has pioneered the use of effects-based measurements of impacts in California's enclosed bays and estuaries. The Program has used a two-step process to identify toxic hot spots. The first step is to screen sites using toxicity tests. In the second step, the highest priority sites with observed toxicity are retested to confirm the effects. This section presents descriptions of the BPTCP monitoring objectives and sampling strategy.

Monitoring Program Objectives

The four objectives of BPTCP regional monitoring are:

1. Identify locations in enclosed bays, estuaries, or the ocean that are potential or candidate toxic hot spots. Potential toxic hot spots are defined as suspect sites with existing information indicating possible impairment but without sufficient information to be classified further as a candidate toxic hot spot.

2. Determine the extent of biological impacts in portions of enclosed bays and estuaries not previously sampled (areas of unknown condition);

3. Confirm the extent of biological impacts in enclosed bays and estuaries that have been previously sampled; and

4. Assess the relationship between toxic pollutants and biological effects.

Sampling Strategy

Screening Sites and Confirming Toxic Hot Spots

In order to identify toxic hot spots in the sediment a two step process was used. Both steps are designed around an approach with three measures (sediment quality triad analysis) plus an optional bioaccumulation component. The triad analysis consists of toxicity testing, benthic community analysis, and chemical analysis for metals and organic chemicals.

The first step is a screening phase that consists of measurements using toxicity tests or benthic community analysis or chemical tests or bioaccumulation data to provide sufficient information to list a site as a potential toxic hot spot or a site of concern. Sediment grain size, total organic carbon (TOC), NH_3 and H_2S concentrations are measured to differentiate pollutant effects found in screening tests from natural factors.

A positive result or an effect in any of the triad tests would trigger the confirmation step (depending on available funding). The confirmation phase consists of performing all components of the sediment quality triad: toxicity, benthic community analysis, and chemical analysis, on the previously sampled site of concern. Assessment of benthic community structure may have not been completed if there was difficulty in measuring or interpreting the information for a water body.

Region-specific Modifications of the Monitoring Approach

In the San Francisco Bay Region, benthic community analyses have been difficult to interpret due to fluctuations in salinity, grain size and total organic carbon. Seasonal cycles of many organisms in the benthic community are also not well understood. In addition, non-indigenous organisms are continually being introduced and taking over the niches of established species. Through the San Francisco Estuary Regional Monitoring Program, pilot studies have been conducted to gain a better understanding of the causes behind fluctuations in the benthos.

In this Region, benthic organisms were collected at stations that went through the confirmation phase in order to conduct benthic community analysis. In addition, bioaccumulation tests using the 28 day *Macoma* test were also performed on sediments from these stations. Both sets of data will be analyzed. Evidence of high levels of bioaccumulative compounds in *Macoma* may be used as the third leg of the triad. In addition, all samples were analyzed for concentrations of PCBs and mercury due to the concern over possible sources of these contaminants in relation to the health advisory for consumption of fish. Selected samples were also collected for Toxicity Identification Evaluations (TIEs) and Simultaneously Extracted Metals/ Acid Volatile Sulfides (SEM/AVS) to determine the causes for toxicity at certain sites.

Surficial sediments were collected in this program to evaluate the effects of the bioavailable layer of sediment on aquatic organisms. Recurrent samples were collected for toxicity tests to determine if this layer remained toxic over time. Due to the dynamic nature of the sediments in this Region, sediment samples were collected to a depth of 5 cm., the same depth that is sampled in the RMP. In other Regions, the sample depth was 2 cm.

Special Studies Performed in the Region

Several other studies were conducted through the BPTCP in this region in addition to the screening and confirmation of toxic hot spots. In 1991 and 1992, the Pilot Regional Monitoring Program (PRMP) was conducted. The main purpose of this study was to develop the design and methods for an ongoing regional monitoring program. In 1993, the San Francisco Estuary Regional Monitoring Program (RMP) was established which is administered through the San Francisco Estuary Institute and funded by discharger groups. Through this program, water column chemistry and toxicity, sediment chemistry and toxicity and bioaccumulation are measured throughout the estuary several times a year. Special studies are also conducted in order to gain a better understanding of contaminants in the estuary. The PRMP also had a screening component where sediment chemistry and toxicity was measured in wetlands throughout the Bay. The third component was a gradient study, conducted in Castro Cove, to develop methods for the BPTCP and the RMP.

In 1994, a study was conducted under the BPTCP to measure contaminant levels in fish in San Francisco Bay. This was the first study conducted in the Bay to determine if concentrations of contaminants in fish being consumed by the public were elevated and if a health advisory was necessary. Results of the study indicated that six chemicals or chemical groups were potential chemicals of concern. These chemicals were mercury, PCBs, DDT, dieldrin, chlordane and dioxins. As a result of the study, the Office of Environmental Health Hazard Assessment (OEHHA) issued an interim health advisory on consuming fish caught in San Francisco Bay and the Delta. Regular monitoring of contaminants in fish, studies on consumption patterns and public outreach and education are currently being performed in this Region (see Cleanup Plan #1).

In 1994 and 1995, a study was conducted to identify sediment reference sites in San Francisco Bay, identify toxicity test methods that may be more appropriate for the Bay and to develop a statistical method to distinguish between a toxic site and ambient conditions. This study was important because sediment toxicity was being observed, using standard toxicological and statistical methods, at sites throughout the Bay that were selected to represent ambient conditions. Since the purpose of the BPTCP was to identify toxic hot spots, new methods needed to be developed that could distinguish between ambient conditions and sites potentially needing cleanup. This study identified five reference sites in the Bay (2 in San Pablo Bay, 1 in the Central Bay and 2 in the South Bay), evaluated nine different toxicity tests for use in toxic hot spot screening and confirmation studies and developed a statistical method to distinguish between ambient conditions and sites potentially needing cleanup. Once reference sites were identified, toxicity tests were chosen and the statistical method was developed, screening and confirmation studies began.

IV. CRITERIA FOR RANKING TOXIC HOT SPOTS

A value for each criterion described below was developed if appropriate information existed or estimates were possible. Any criterion for which no information exists was assigned a value of "No Action". The RWQCB created a matrix of the scores of the ranking criteria using the ranking criteria below. However, a modification of the State Board procedure to finally list sites as "high priority" was used in this Region.

State Board guidance indicates that if the majority of ranking criteria were "High" then the site is listed in the "high priority" list of Toxic Hot Spots. However, due to the fact that the entire Bay has a health advisory and many areas may exceed water quality objectives, certain sites would be listed "high priority" under the State Board procedure merely because they exist in San Francisco Bay. On the other hand, high priority issues, such as the health advisory on fish consumption, would not come out "high priority", even though it is listed "High" in the human health category, because all of the sources haven't been identified and there is some process of natural remediation occurring. The criteria that was used in this Region was if the site was ranked "High" in the category for which it was identified as a candidate toxic hot spot then the site was listed in the "high priority" list of Toxic Hot Spots. Ranking in the categories of pollutant source and remediation potential were taken into consideration. No site was ranked high that did not rank at least moderate in both of those categories. As in other Regions, cleanup plans were developed for sites that were listed "high priority". The following ranking criteria was used:

Human Health Impacts

Human Health Advisory issued for consumption of non-migratory aquatic life from the site (assign a "High"); Tissue residues in aquatic organisms exceed FDA/DHS action level and U.S. EPA screening levels ("Moderate").

Aquatic Life Impacts

For aquatic life, site ranking was based on an analysis of the preponderance of information available (*i.e.,* weight-of-evidence). The measures considered were: the sediment quality triad (sediment chemistry, toxicity, and benthic community analysis), water toxicity, toxicity identification evaluations (TIEs), and/or bioaccumulation.

Stations with hits in any two of the measures if associated with high chemistry, were assigned a "High" priority. A hit in one of the measures associated with high chemistry was assigned "moderate". Stations with high sediment or water chemistry only were assigned "low".

Water Quality Objectives[1]:

Any chemistry data used for ranking under this section were no more than 10 years old and were analyzed with appropriate analytical methods and quality assurance.

Water quality objective or water quality criterion: Exceeded regularly (assign a "High" priority), occasionally exceeded ("Moderate"), infrequently exceeded ("Low").

Areal Extent of Toxic Hot Spot

Select one of the following values: More than 10 acres, 1 to 10 acres, less than 1 acre.

Pollutant Source

Select one of the following values: Source(s) of pollution identified (assign a "High" priority), Source(s) partially known ("Moderate"), Source is unknown ("Low").

Natural Remediation Potential

Select one of the following values: Site is unlikely to improve without intervention ("High"), site may or may not improve without intervention ("Moderate"), site is likely to improve without intervention ("Low").

V. FUTURE NEEDS

This document is primarily oriented to the cleanup of specific sites that have contaminated sediments. However, the goals of the Bay Protection and Toxic Cleanup Program are not only to clean up toxic hot spots but

1. Water quality objectives to be used are found in Regional Water Quality Control Board Basin Plans or the California Ocean Plan (depending on which plan applies to the water body being addressed). Where a Basin Plan contains a more stringent value than the statewide plan, the regional water quality objective will be used.

also to prevent them from occurring. U.S. EPA and the State Board are strongly encouraging the development of watershed management plans to protect watersheds. However, to develop watershed management plans there must be watershed monitoring and assessment in order to identify and prioritize current or potential problems. Watershed monitoring is also important in the calculation of Total Maximum Daily Loads (TMDLs), which is required when a waterbody is listed under 303(d), and the development and implementation of waste load allocations as part of a watershed management plan.

Stormwater runoff is currently the major source of mass loading of contaminants that accumulate in the food chain and pesticides that cause acute toxicity to aquatic organisms. In the past several years, the RMP and the Bay Area Stormwater Management Agencies Association (BASMAA) have been conducting some monitoring of runoff from urban creeks. Through this monitoring Coyote Creek has been identified as a source of PCBs and chlorinated pesticides to the estuary. In other urban creeks, high levels of toxicity have been identified during runoff events possibly due to the pesticides diazinon and chlorpyrifos. Identification of the sources of these contaminants and plans for remediation are necessary to develop watershed management plans and to protect the beneficial uses of the estuary. Remediation might take the form of cleanup, the implementation of best management practices or pollution prevention. Yet, to solve watershed problems and plan for their prevention, a solid program of watershed monitoring and assessment is needed. At this time, the funding for the monitoring and assessment of watersheds is extremely inadequate and needs to be substantially increased if meaningful watershed management is to take place.

Sites of Concern

There are additional sites of concern in the San Francisco Bay Region that don't technically qualify as candidate toxic hot spots under the definition used in this program. Most of these sites are military bases slated for closure or redevelopment properties. Many of these sites are undergoing large scale investigations, including environmental risk assessments, and one (Shearwater/ U.S. Steel) will be starting cleanup in spring 1998. Lauritzen Canal which was previously listed as a potential toxic hot spot in 1993 went through a $2 million investigation under CERCLA and was cleaned up by the summer of 1997.

At military bases sediment pollution is evaluated in the larger context of determining the risk to human and ecological receptors. Ecological risk assessments are generally rigorous and are required under CERCLA, the primary regulatory authority driving environmental investigations at military bases. Jurisdictions other than the Regional Board , including the U.S. EPA, the U.S. Fish and Wildlife Service, the National Oceanic and Atmospheric Administration, the Ca. Department of Fish and Game and the Ca. Department of Toxic Substances Control also participate in designing and determining the scope of the characterization. Although efforts were made at these sites to follow methods and protocols being used by the BPTCP, and in the beginning of the program were visited by the BPTCP, the study designs and the scale of the investigations were distinctly different.

Limited funding focused the BPTCP on performing sediment screening at approximately 150 locations in the Bay to identify the highest priority sites. For the aquatic life definition, candidate toxic hot spots are those with recurrent high toxicity and associated high chemistry. To be a "high priority" site they must have another biological measurement such as impacted benthic communities or high bioaccumulation. For the human health definition, "high priority" candidate toxic hot spots are sites which have high levels of chemicals of concern established in a human health advisory. High priority sites will be required to further define the extent of contamination, develop feasibility studies and remediate, as appropriate. Environmental risk assessments may also be conducted.

Some military facilities were already identified for investigation due to suspected use or disposal practices, or elevated levels of contaminants identified upland. Therefore, full characterization of these sites was conducted. Study designs at these sites were driven by various programmatic requirements. Characterization included defining the nature and extent of chemical contaminants, conducting synoptic toxicity tests and determining the risk to vertebrate species in proximity to the sites by conducting ecological risk assessments. The fact that samples were taken at deeper depths (see p. 12), toxicity tests were not recurrent and benthic community analyses were not conducted made data collected at these sites difficult to compare to BPTCP criteria. In addition, the limited number of surficial sediment samples that the BPTCP took at these sites exhibited no toxicity and relatively low levels of chemicals of concern. Subsequent studies at some military bases have identified toxicity in areas not sampled by the BPTCP and elevated levels of chemical contaminants at deeper depths that may potentially be a risk to human and/or environmental health. However, since the cost of investigating one of these sites dwarfed the entire BPTCP budget, the BPTCP decided to concentrate on sites that were not already undergoing extensive investigations.

Several of the sites that were sampled by the BPTCP contained high levels of compounds, such as PAHs, that are known to cause chronic effects but do not cause acute effects, unless at very high concentrations, in the toxicity tests being used for screening. These sites should be resampled in the future when tests are developed that are more sensitive to the chronic effects of these compounds. These sites are also listed in the following table.

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

Waterbody Name	Segment Name	Site Identification	Pollutants Present	Status/Comments	Report reference
San Francisco Bay	South Bay	Hunters Point/Yosemite Creek & South Basin	PCBs, PAHs, DDT, chlordane, dieldrin, endrin, TBT, metals	Feasibility Study of alternatives for remediation to be submitted in spring 1998	6, 8, 15, 16, 23, 30
San Francisco Bay	South Bay	Alameda Naval Air Station	Cr, Hg, PAHs, DDT	Field work completed in spring 1996	11, 16, 19, 22
San Francisco Bay	Central Bay	Treasure Island Naval Station	fuels, metals	Field work completed in spring 1997	1, 3, 16, 17, 18, 30
Napa River	Mare Island Straits	Mare Island Naval Station	metals, TBT	Field work completed in spring 1997	12, 16, 30
Suisun Bay	Suisun Bay	Concord Naval Weapons Station	As, Cd, Cu, Pb, Zn	Most contaminated area cleaned up, rest undergoing investigation	14, 16, 21, 24, 25
San Francisco Bay	South Bay	Moffett Naval Air Station	PCBs, DDT, chlordane, PAHs, Hg, Pb, Zn	Developing Feasibility Study for cleanup of stormwater retention ponds and channels	9, 13, 16, 20, 26, 27
San Francisco Bay	San Pablo Bay	Hamilton Air Force Base	metals, petroleum	Under investigation	7, 16, 33, 34
San Francisco Bay	South Bay	Shearwater/ U.S. Steel	Pb, PCBs	Remediation plan approved, cleanup will start in spring 1998	16, 29, 30, 31, 32

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

Waterbody Name	Segment Name	Site Identification	Pollutants present	Status/Comments	Report reference
San Francisco Bay	South Bay	Warmwater Cove	PAHs	No toxicity in screening despite high levels of PAHs	4, 16, 30
San Francisco Bay	Central Bay	Gashouse Cove	PAHs	Finished report on study to characterize aerial extent of contamination	2, 16, 30
Delta	Delta	Dow Pittsburg	Hg, hexachlorobenzene	RWQCB preparing cleanup order	16, 28, 30
San Francisco Bay	Richardson Bay	Waldo Point	PCBs, PAHs	EIR released	5, 16, 30
San Francisco Bay	Central Bay	Catellus/Eastshore State Park	Cu, Hg, Pb, Zn, PCBs	Ongoing negotiations for purchase, planning Remedial Investigation	10, 16, 30

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Part II

Candidate Toxic Hot Spots

Waterbody Name	Segment Name	Site Identification	Reason for Listing	Pollutants present at the site	Report reference
S.F. Bay	S.F. Bay	S.F. Bay	Human Health	Hg, PCBs, dieldrin, chlordane, DDT, dioxin,	12, 24, 26, 27, 28, 30, 31, 32, 35
S.F. Bay	Central Bay	Point Potrero/ Richmond Harbor	Human Health	Hg, PCBs, Cu, Pb, Zn	2, 14, 15, 16, 17, 18, 20, 35, 36
S.F. Bay	San Pablo Bay	Castro Cove	Aquatic Life	Hg, Se, PAHs, chlordane, dieldrin	7, 8, 9, 11, 12, 27, 33, 34, 35
S.F. Bay	Central Bay	Zeneca Marsh	Aquatic Life	As, Cu, Se, Hg	19, 29, 35, 37
Suisun Bay	Suisun Bay	Peyton Slough	Aquatic Life	Cd, Cu, Hg, Sb, Se, Zn, PCBs, chlordane,	3, 12, 35
S.F. Bay	South Bay	Islais Creek	Aquatic Life	PCBs, chlordane, chlorpyrifos, anthropogenically enriched H_2S & NH_3	1, 4, 5, 6, 21, 22, 23, 35
S.F. Bay	South Bay	Mission Creek	Aquatic Life	Ag, Cr, Cu, Pb, Sb, Zn, chlordane, chlorpyrifos, anthropogenically enriched H_2S & NH_3	35
S.F. Bay	South Bay	San Leandro Bay	Aquatic Life	Hg, Pb, Sb, Se, Zn, PCBs, PAHs, DDT, chlordane, dieldrin, heptachlor, chlorpyrifos	10, 13, 35
S.F. Bay	Oakland Estuary	Pacific Dry Dock #1	Aquatic Life	Hg, Sb, PCBs, PAHs, chlorpyrifos, chlordane, DDT, dieldrin,	25, 35, 38
S.F. Bay	Oakland Estuary	Fruitvale	Aquatic Life	Sb, chlordane, PCBs	35

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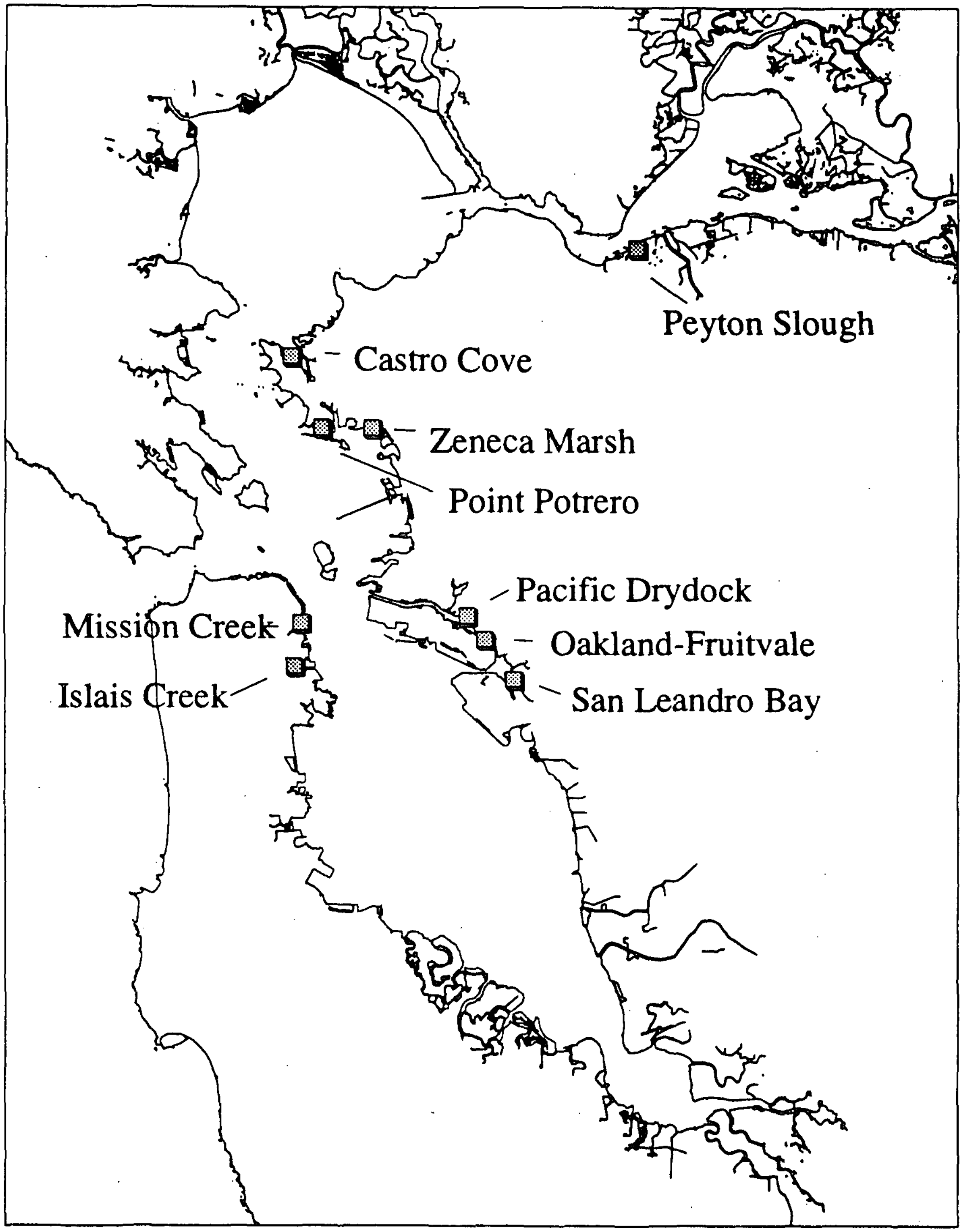

Figure 2. Locations of candidate toxic hotspots.

Ranking Matrix

Waterbody Name	Site Identification	Human Health Impacts	Aquatic Life Impacts	Water Quality Objectives*	Areal Extent	Pollutant Source	Remediation Potential
S.F. Bay	S.F. Bay	High	NA	NA	> 10 acres	Moderate	Moderate
S.F. Bay	Point Potrero/ Richmond Harbor	High	Low	NA	1-10 acres	High	High
S.F. Bay	Castro Cove	High	High	NA	> 10 acres	High	High
S.F. Bay	Zeneca Marsh	High	Moderate**	NA	1-10 acres	Moderate	High
Suisun Bay	Peyton Slough	High	Moderate**	NA	<1 acres	High	High
S.F. Bay	Islais Creek	High	Moderate**	NA	1-10 acres	High	High
S.F. Bay	Mission Creek	High	Moderate**	NA	1-10 acres	Moderate	High
S.F. Bay	San Leandro Bay	High	Moderate**	NA	unknown	Low	Moderate
S.F. Bay	Pacific Drydock	High	Moderate**	NA	<1 acre	High	High
S.F. Bay	Fruitvale	High	Moderate**	NA	<1 acre	Moderate	High

* We are currently analyzing data on water column chemistry generated through the San Francisco Estuary Regional Monitoring Program to identify waterbodies that exceed water quality objectives. This is part of the 303(d) program to list impaired water bodies. Once this analysis becomes available any sites that qualify to be candidate toxic hot spots will be listed.

** We have not received some of the data from this site. These data could provide additional evidence that this site is impacted. Therefore, after we receive and analyze these data this site may be changed to a rank of high.

Part III

High Priority Candidate Toxic Hot Spot Characterization

Site #1 - San Francisco Bay

Description of site/ 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 1970's.

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. Results from the study indicated that six chemicals were of potential concern for people who consume fish from the Bay. 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 issued a health advisory on consuming 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, although DDT, dieldrin, chlordane and dioxins were also listed as chemicals of concern.

A. <u>Assessment of the areal extent of the THS</u>

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

B. <u>Assessment of the most likely sources of pollutants</u>

Mercury

Mercury was mined in the Coast Range from the early 1800's through the mid-1900's. 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. Mining of gold and silver ores could 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 a 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 deep sediment, with the most concentrated levels of mercury in the upper estuary. Surficial sediments subject to remobilization generally contain about 0.3 ppm Hg throughout the Bay system, except in areas of the lower South Bay affected by drainage from the New Almaden mining area.

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 but highly dispersed. There are a number of individual sites around the margins of the Bay where mercury concentrations higher than these naturally elevated levels are found. These are usually due to past industrial practices such as the smelting of ore.

Although mining practices were historic, 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 POTWs, industrial discharges and aerial deposition. Recent pollution prevention audits indicate that human waste, water supplies, laundry waste, household products, thermometers, 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 Bay sediment system. Methyl mercury is formed primarily by microbial activity, and only under certain physical and chemical conditions. Different forms of mercury as well as different environmental conditions may increase the rate of mercury methylation. Methylation is the process by which mercury becomes incorporated into the food chain. This process must be better understood in order to regulate the current reservoir of mercury as well as ongoing sources and to prevent the creation of environments that may increase the rate of 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. BPTCP monitoring has shown that, except for a few areas (see Sites of Concern and Candidate Toxic Hot Spots), 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. 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. Increased monitoring is necessary to identify and cleanup any ongoing sources.

Chlorinated Pesticides

Three chlorinated pesticides were identified in the BPTCP fish study as being potential chemicals of concern: 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 this 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.

C. <u>Summary of actions that have been initiated by the Regional Board to reduce the accumulation of pollutants at existing THS and to prevent the creation of new THSs</u>

Mercury

The Regional Board has set up an in-house Mercury Task Force in order to develop a strategy that would, in the long term, reduce mercury concentrations in the estuary. Since there is no way to clean up the diffuse, historic sink of mercury in Bay sediments, except through natural processes such as outflow through the Golden Gate and capping by natural deposition, the strategy emphasizes the need to control all controllable sources. The two goals of the strategy are to: 1) reduce the inflow of controllable sources so that natural cleanup rates will be maximized and 2) identify human activities that increase the rate of mercury methylation in the system and to prevent the creation of environments that may increase that rate.

One of the main objectives of the strategy is to focus on the most cost effective measures first. A preliminary evaluation indicates that the most cost effective measures are to: 1) remediate abandoned mine sites on the western side of the Central Valley and the New Almaden district in the South Bay, 2) step up recycling programs for users such as mining on the east side of the Central Valley, dentists and hospitals, 3) improve household product substitution such as laundry bleach and thermometers and 4) check on whether all sludge incinerators have scrubber systems.

The overall strategy for mercury is being developed as a regional pollutant policy program and proposed as a Basin Plan amendment. Key elements that will be part of the proposal include institutional mechanisms for directing regulatory efforts to concentrate on the most significant ongoing sources. In order to decrease mass loading, a Watershed Based Loading Policy is being considered. A major focus of this policy is to develop a better understanding of the processes that controls the methylation of mercury and the subsequent bioavailability of mercury to the food chain. This understanding is necessary in order to determine the significance of the loading of different types of mercury and to prevent the creation of environments that may increase methylation. The policy would be based on the calculation of a Total Maximum Daily Load (TMDL). One of the ways of implementing the policy that is being considered is a mass based permit offset system to control the most significant sources. The proposed regional pollutant policy will serve as the basis for a TMDL for Central San Francisco Bay upstream. Adequate funding for this TMDL has not been identified. A second TMDL will be developed for inflows of mercury to the South Bay. A majority of the data collection for the South Bay TMDL will be conducted by the South Bay Dischargers.

Currently, the New Almaden mercury mine, the second largest mercury mine in the world, is being remediated under CERCLA. The Department of Toxic Substances Control is the lead agency, although the RWQCB provides input on water quality issues. The New Almaden mine is located in Southern Santa Clara County and is currently owned by the County Parks and Recreation Department. The Hacienda furnace yard was identified as the highest priority area, from a water quality perspective, of six areas in need of cleanup. In this location mine tailings were eroding directly into Los Alamitos Creek, a tributary to San Francisco Bay. Cleanup of this area began in the spring of 1996 and is now 90% complete. Drainage from the five other identified areas is to Guadalupe and Almaden Reservoirs. Because mercury strongly binds to particulates, these reservoirs may be serving as a sink for mercury, therefore minimizing fluxes to the Bay. Remediation of these five remaining areas is scheduled to begin in the spring of 1998 and should be completed in two years. These reservoirs are currently posted with a health advisory on consuming fish.

The RWQCB is currently completing a region-wide mine survey. Most of the historic mine sites have been identified and inspected. Very few of these have the potential to cause ongoing loadings to the watershed. One mercury mine with tailings present has been identified in the North Bay. This is the Bella Oaks mine in Napa. The water quality threat from this mine remains to be determined. Through the winter of 1997-98 the RWQCB is monitoring all of the North Bay tributaries to the Bay to identify sources of mercury.

In order to identify and cleanup mercury sources under the jurisdiction of the Central Valley RWQCB, interregional coordination is necessary. Because these sources contribute such a high load to the estuary, control of these sources as part of the San Francisco Bay Region's mercury strategy is essential. The ability of the State, however, to clean up mines has been brought to a halt due to recent court decisions. These legal issues need to be resolved at the federal level in order to clean up abandoned mines with no responsible party.

The RWQCB has worked with dischargers to set up programs for pollution prevention and source control of mercury and other chemicals of concern. The Palo Alto Regional Water Quality Control Plant and the City and County of San Francisco have devoted significant resources in their regions into identifying sources of these contaminants and determining methods of decreasing loads to their facilities.

PCBs

PCBs are ubiquitous and diffuse in the sediments throughout San Francisco Bay. Although several areas have been identified that have elevated concentrations (see Sites of Concern and Candidate Toxic Hot Spots) these levels do not approach concentrations measured in the Great Lakes or many East Coast harbors. Yet, the mass of PCBs in the estuary's sediment have contributed to levels in fish that are a potential threat to human health. Sites with historically elevated levels of PCBs should be evaluated for cleanup (see Cleanup Plan #2), however, identification and cleanup of ongoing sources is extremely important. The RWQCB has been working with dischargers, both point and nonpoint, and the RMP to identify sources of PCBs to the estuary.

Chlorinated Pesticides

Lauritzen Canal is an area in Richmond Harbor that had extremely elevated levels of DDT. This site was recently cleaned up under CERCLA. Although U.S.EPA was the lead agency, the RWQCB coordinated with U.S.EPA and other agencies to implement the cleanup.

As with the other chemicals previously discussed, it is important to monitor discharges (both point and nonpoint) to the estuary for the identification and cleanup of sources of chlorinated pesticides. The Regional Board is working with dischargers and the RMP to identify sources of these contaminants. However, as was discussed under Future Needs, increased resources for watershed monitoring and assessment are needed to address this issue in a significant manner.

Dioxins

The Regional Board is currently developing a dioxin strategy. Coordination with the Bay Area Air Quality Management District and the State Air Resources Board is essential in addressing this issue since the predominant source of this contaminant is through aerial deposition. A meeting was held in 1997 for scientists to present information on dioxin to the Regional Water Quality Control Board. Public hearings for consideration of a proposed strategy for the regulation of dioxin in the San Francisco Bay region will begin in early 1998. Since the majority of dioxins in the Bay Area is likely generated by fixed and mobile combustion of diesel fuel and emission into the air, regulation of point source discharges into the Bay is unlikely to have an impact on the concentration of dioxin in sediment or organisms. Since even areas removed from sources contain background levels of dioxins that are potentially harmful to humans and other organisms, and since this group of contaminants are very persistent and can be spread great distances through aerial deposition, a global strategy is truly needed.

Summary of actions by government agencies in response to health advisory

Due to the large reservoir of mercury and PCBs in the estuary it will probably take decades for contaminant levels in fish to reach acceptable levels, even with full implementation of the cleanup plan. Therefore, interim measures should be taken to: (1) determine the rate of change in chemical concentrations in fish to determine if natural processes and required cleanup measures are having an effect, and over what time scale, (2) determine the risk of consuming fish from the Bay and identify high risk populations and (3) conduct public outreach and education programs, especially to high risk populations, in order to minimize their risk.

The RWQCB has been leading an effort through the RMP to conduct studies to address the first two issues. Several committees have been put together with representatives from State and Federal agencies, environmental groups and dischargers (who fund the program). A five year plan has been developed to: 1) measure contaminant levels in fish throughout the Bay every three years, 2) conduct special studies on specific species, organs or chemicals of concern and 3) conduct a consumption study to quantify the parameters that would go into a risk assessment for San Francisco Bay and to identify high risk populations for public outreach and education.

The second monitoring study of contaminant levels in fish tissue in the Bay, after the BPTCP study, was carried out through the RMP in the summer of 1997 by the Department of Fish and Game. Results will be published in the RMP's 1997 Annual Report. Special studies will be conducted in the winter of 1997-98 to measure contaminant levels in shellfish and to determine if there is seasonal variability in contaminant levels in fish. The State Department of Health Services has been hired to conduct the consumption study.

The Department of Health Services has been chairing a committee for Public Outreach and Education on Fish Contamination. As a result, County Health Departments and the East Bay Regional Parks District have posted signs at public fishing areas in six different languages describing the advisory. Currently, the committee is developing a strategy to more effectively educate the public on this issue. This strategy, however , is limited due to the lack of funding for this effort and the fact that there is no legal mandate that requires any agency to address this issue. Environmental groups have been using various forums to educate people who eat Bay fish on how to decrease their risk, but their funding is also very limited.

D. <u>Preliminary assessment of actions required to remedy or restore a THS to an unpolluted condition including recommendations for remedial actions</u>

1. Finish the cleanup of the New Almaden Mine.

2. Clean up sediment at Point Potrero that is high in PCBs (see Cleanup Plan #2).

3. Implement a Region-wide Mercury Strategy so that, over the long term, mercury concentrations in the food chain will be reduced. The Mercury Strategy would have two components. The first component would be to develop a Regional Mercury Policy and Program. This would include the: (a) establishment of a Regional Mercury Control Strategy Task Force to coordinate the San Francisco Bay and Central Valley Regions and bring in needed expertise for policy and study development, (b) development of a Watershed Based Loading Policy, that may include a mass based permit offset system, to accelerate cleanup of mine sites in the Sacramento River watershed and (c) development of a Basin Plan amendment. The second component, which must be conducted in coordination with the first, would be to develop the needed technical information so that the Watershed Based Loading Policy and Basin Plan amendment can be developed and successfully implemented. This would include: (a) conducting a TMDL and, (b) performing studies to better understand the process of mercury methylation so that different types of mercury can be regulated based on their ability to bioaccumulate and so that environments are not created that can enhance that process.

4. Increase investigations into ongoing sources of mercury, PCBs, DDT, dieldrin, chlordane and dioxins and develop remediation plans for those sources. This action would require an increase in watershed monitoring and assessment (see Future Needs) and in the case of mercury would require coordination with the Central Valley RWQCB. PCBs should be fingerprinted to distinguish the difference between historic and ongoing sources. Biomarker methods could be used to more inexpensively screen for PCBs and dioxins.

5. Hold public hearings to support the development of a Dioxin Strategy in this Region. Measures to significantly control dioxins, however, must take place on a national and international level.

6. Continue RMP studies on fish contamination issues.

7. Increase public education to:

   a. Inform people who consume San Francisco Bay fish, especially high risk populations, about the health advisory and ways to decrease their risk and,

   b. Inform the public on product use and replacement in order to decrease concentrations of chemicals of concern. This could include the use of dioxin free paper, the substitution or conservation of diesel fuel, limiting the use of fireplaces and wood stoves and the substitution of mercury containing products such as mercury thermometers and laundry detergent. Inform people who consume San Francisco Bay fish, especially high risk populations, about the health advisory and ways to decrease their risk and,

E. <u>Estimate of the total cost to implement the cleanup plan</u>

1. Complete cleanup of New Almaden Mine - $4 million (total cost)

2. Point Potrero cleanup - $1 million - $1.6 million

3. Implement Mercury Strategy - $13 million

   a. Task Force and Policy development including:

      Regional Mercury Control Strategy Task Force
      Watershed Based Loading Policy
      Basin Plan Amendment

   b. Technical studies including:

      TMDLs
      Mercury methylation studies

4. Ongoing sources

    a. Watershed investigations to identify ongoing sources of the chemicals of concern in the San Francisco Bay and Central Valley Regions - $3-4 million over 5 years

    b. Costs of cleanup once sources are identified - Unknown

5. Dioxin workshops and regional strategy - $100,000

6. RMP studies (including monitoring of contaminant levels in fish every three years and special studies) - Average $75,000/year (1997-98) monitoring studies and consumption study are already funded)

7. Public Education

    a. Outreach and education to people consuming fish from the Bay to the Bay to reduce their health risk (including DHS staff, translations, training and educational materials) - $150,000 for first two years then $50,000/year

    b. Educational efforts on source control and product substitution - $50,000

Total to Implement Plan - Approximately $22 million to $24 million

F. Estimate of recoverable costs from potential dischargers

RMP studies ($75,000/year) could continue to be funded by the participants in the program. Cleanup of the New Almaden Mine ($4 million) and Point Potrero ($1 million to $1.6 million) could be paid for in full by the responsible parties. The total equals $5 million to $5.6 million plus $75,000/year for RMP studies.

G. <u>Two-year expenditure schedule identifying funds to implement the plans that are not recoverable from potential dischargers</u>

Although funding is available for continuation of the RMP studies and the cleanup of the New Almaden Mine and Point Potrero there is little or no funding for the other parts of the cleanup plan. The South Bay Dischargers are preparing to collect data for a South Bay TMDL. Some watershed investigations have been conducted by the RMP, BASMAA and certain cities and counties, however, they have been small in scale and limited in scope. Substantial additional funding is needed to supplement these components, as well as to implement other components of the cleanup plan.

Over Two Years

1. Start Mercury Strategy (this is a long term effort) - $3 million

   a. Set up Task Force and start policy development including:

      Regional Mercury Control Strategy Task Force
      Watershed Based Loading Policy
      Basin Plan Amendment

   b. Design and start technical studies including:

      TMDLs
      Mercury methylation studies

2. Start watershed investigations to identify ongoing sources - $1 million

3. Hold dioxin workshops and develop regional strategy - $100,000

4. Public Education

   a. Outreach and education to people consuming fish from the Bay - $150,000

   b. Source control and product substitution - $50,000

References

Office of Environmental Health Hazard Assessment (OEHHA). 1994. Health Advisory on Catching and Eating Fish-Interim Sport Fish Advisory for San Francisco Bay. Sacramento, CA

San Francisco Bay Regional Water Quality Control Board (SFBRWQCB), SWRCB, CDFG. 1995. Contaminant Levels in Fish Tissue from San Francisco Bay

San Francisco Estuary Institute (SFEI). 1994. 1993 Annual Report, San Francisco Estuary Regional Monitoring Program for Trace Substances, San Francisco, CA.

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SWRCB. Bay Protection and Toxic Cleanup Program Database.

Site #2 - Point Potrero/Richmond Harbor

Description of Site

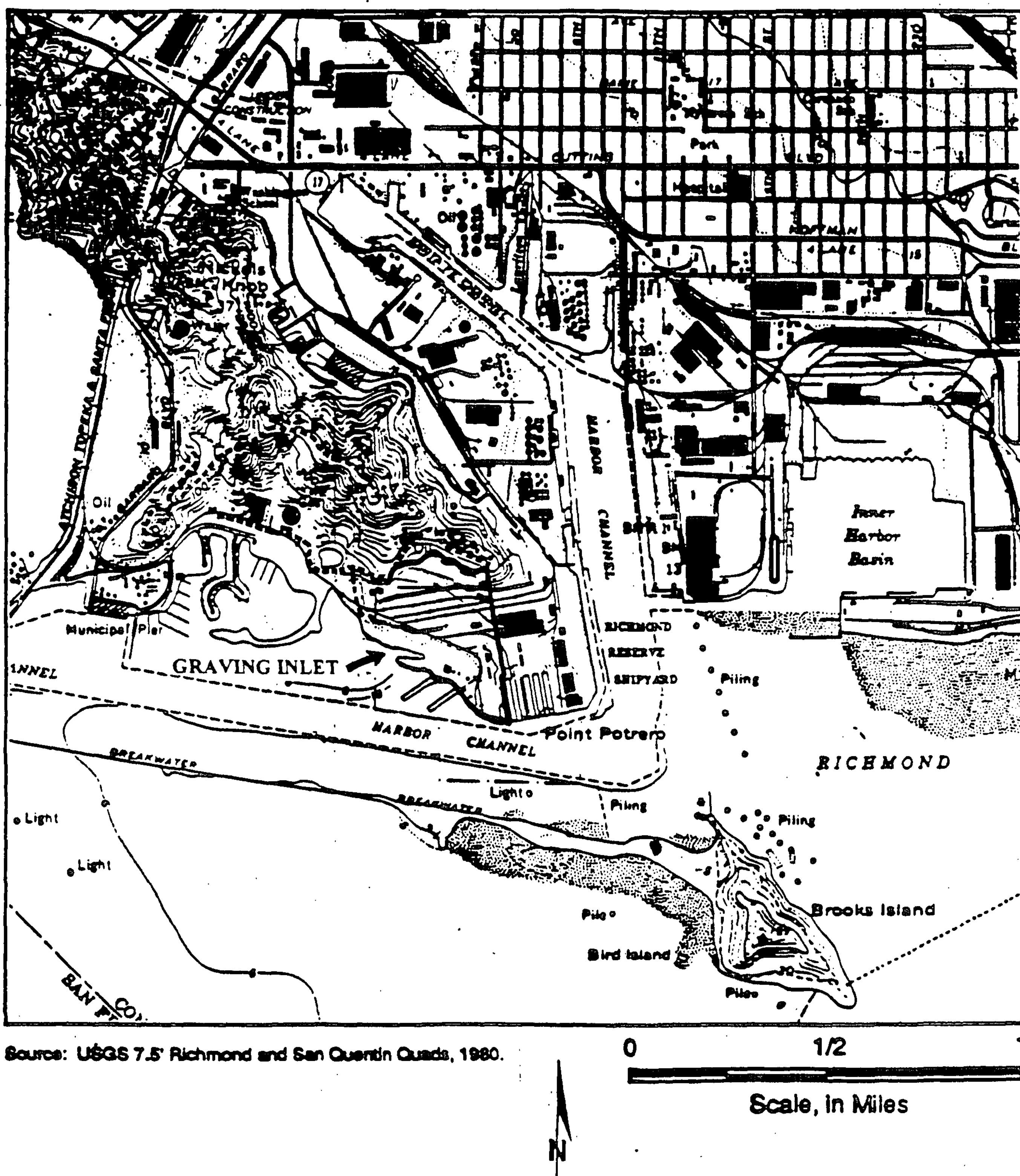
The site designated Point Potrero/Richmond Harbor is a 400 foot long intertidal embayment, the Graving Inlet, on the western side of the Shipyard #3 Scrap Area at the Port of Richmond (Figure 4). Shipyard #3 is currently used as a parking lot, but in the past the site has been used for shipbuilding, 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 (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 levels and types of contaminants found on the adjacent Shipyard #3, including heavy metals, PCBs and PAHs. While the most heavily contaminated sediments are in the upper intertidal zone, elevated levels of PCBs and metals are also found in the lower intertidal and subtidal zones.

Reason for Listing

Point Potrero has been listed as a Candidate THS due to the extremely high levels of bioaccumulative contaminants, including the highest levels of PCBs (19.9 mg/kg) and mercury (9.1 mg/kg) found by the BPTCP in San Francisco Bay. These two contaminants are listed in the San Francisco Bay/Delta Fish Advisory as primary chemicals of concern to human health due to fish consumption (OEHHA, 1994, RWQCB, 1995). 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, 1994) and published by California Department of Fish and Game (1997). Lauritzen Canal, the source of the DDT was cleaned up, under CERCLA, by the summer of 1997.

Figure 3. Location Map for Point Potrero/Richmond Harbor Candidate Toxic Hot Spot



The levels of contaminants found in the Inlet are shown in Table 1. Also included are Effects Range Median (ER-M) guidelines; NOAA derived values which are the 50th percentile value associated with adverse biological effects for any particular chemical. Levels of PCBs have been measured up to 19.9 ppm and levels of mercury have been measured up to 7.5 ppm. The table shows that PCBs exceed ER-Ms by up to 110 times and mercury by over 10 times. Metals such as copper, lead and zinc have been measured at levels exceeding ER-Ms by 6, 10 and 5 times, respectively. Attempts have been made to associate sediment concentrations with unacceptable concentrations of particular contaminants in fish tissue. The Washington State Dept. of Ecology has proposed a human health based sediment quality criteria for PCBs of 0.012 ppm based on 1% TOC (WA. State Dept. of Ecology, 1997). Concentrations of PCBs at Point Potrero are more than 3 orders of magnitude over this value. Ambient levels of PCBs and mercury in S.F. Bay are, in general, below 0.020 ppm and 0.5 ppm respectively (SFEI, 1993, 1994, 1995).

A. <u>Assessment of the areal extent of the THS</u>

Estimated area: At least 1 acre.

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.

B. <u>Assessment of the most likely sources of pollutants</u>

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.

Regulatory agencies became involved with 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 (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.

C. <u>Summary of actions that have been initiated by the Regional Boards to reduce the accumulation of pollutants at existing THSs and to prevent the creation of new THSs.</u>

Regional Board staff, in cooperation with staff of the Department of Toxic Substances Control, have overseen the design and implementation of a Remedial Investigation (Hart Crowser, 1993) and a Feasibility Study (Hart Crowser, 1994) for the upland area that recommended capping of the upland source of the contaminated sediments. Placement of dredged material on the site for drying and eventual capping of the upland area was in progress in December 1997.

Staff approved Supplemental Sediment Characterization in January 1997 and the preliminary results were made available in December 1997. The results provided better documentation of the horizontal and vertical extent of contamination at the mouth of the Graving Inlet. The data indicates that the areas of greatest contamination are limited to the Inlet and a smaller area at the southern extent of the property.

Regional Board staff have written Waste Discharge Requirements (WDRs) for the site. The WDRs serve to regulate the placement of dredged material on top of the upland source material to isolate it from human contact and provide a base for an asphalt surface.

D. Preliminary assessment of actions required to remedy or restore a THS to an unpolluted condition including recommendations for remedial actions.

Actions at this site to date have defined the horizontal and vertical extent of contaminants and shown that beneficial uses of waters of the state are impaired by the levels of contaminants in the Graving Inlet. The next step is to prepare a Remedial Investigation/Feasibility Study (RI/FS), possibly supported by an Ecological Risk Assessment.

Potential Remedial Actions in the Graving Inlet could include: (1) capping the intertidal zone with low permeability materials, such as dredged sediments; or (2) excavation of the contaminated materials and removal from the intertidal zone. Excavation or capping would require restoration of the site or restoration of an offsite location to mitigate for the loss of intertidal habitat.

One alternative, of interest to the property owner, is to cap the site with enough material to make it level with the adjacent upland, all of which will be converted to an asphalt parking lot. While this would provide a financial benefit to the landowner, it would require mitigation for loss of habitat and for filling of the Bay. This mitigation would require more than one acre of habitat restoration and/or public access improvements to be acceptable to the San Francisco Bay Regional Water Quality Control Board and the San Francisco Bay Conservation and Development Commission.

E. Estimate of the total cost to implement the cleanup plan

Potential Remedial Alternatives include: (1) cover the contaminated sediments with 12 to 15 feet of clean low permeability material and asphalt to create additional industrial property; would require monitoring and offsite mitigation; and (2) excavate 3 or more feet of contaminated sediments and debris, prevent recontamination from the adjacent upland, restore wetland conditions at the site.

The estimated cost for creation of new industrial property by filling the Inlet and covering it with asphalt would be about $200,000 to $400,000 depending on whether the fill could be locally available dredged material or would need to be imported clean soil. The loss of one acre of intertidal wetland would require offsite mitigation which could cost $50,000 to $250,000 for land purchase, restoration, monitoring and oversight.

The estimated costs for excavation and disposal of the top 3 feet of contaminated sediments range from $150,000 to $500,000 based on estimates of $30 per yard for disposal on the adjacent upland site and $100 per yard for disposal at a Class I landfill. Restoration of the site could cost $10,000 to $50,000 depending on difficulty of preventing recontamination of the site.

Additional costs for either of these remedial alternatives would include completion of a remedial investigation/feasibility study (potentially $500,000) and regulatory oversight (potentially $100,000 per year). The range of total cost could be from approximately $1 million to $1.6 million.

F. Estimate of recoverable costs from potential dischargers

The responsible party is accountable for all costs incurred as a result of site cleanup at Point Potrero, as well as cost for RWQCB staff oversight.

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

The first two-year expenditure schedule includes the remedial investigation and feasibility study, and possibly an ecological risk assessment. Remedial actions could be accomplished within a two-year time frame depending on the ability of the responsible party to respond to the regulatory requirements. All expended funds should be recoverable from the responsible party.

Table 1. Contaminant Levels in Point Potrero Graving Inlet (all units are mg/kg)											
Data Source	**Sample Location**	**Depth**	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Nickel**	**Zinc**	**PCBs Ar-1254**	**PAHs**
ER-M			9.6	370	270	218	0.71	51.6	410	0.180	44.8
Herzog (1986)	D1/2	NR	20	340	1600	2300	10 U	270	400	1.8	NA
Hart Crowser (1992)	SD-1	0-10 cm	4.4	190	870	840	7.5	84	2100	7.2	24
Hart Crowser (1992)	SD-1	11-18 cm	3.4	220	1000	560	6.3	110	1500	4.1	43
Hart Crowser (1997)	SD-1-s	0-15 cm	0.92	45	160	200	2.9	28	450	2.1	>1.0
BPTCP (1997)	21013.0	0-5 cm	NA	NA	NA	NA	4.6	NA	NA	19.9	NA

NA = Not Analyzed; NR = Not Reported; U = Below Detection Limit
< = Less than, data below detection limits counted as one half of the detection limit.

References

California Department of Fish and Game (CDFG). 1997. California Sport Fishing Regulations, Public Health Advisory on Fish Consumption, Richmond Harbor Channel, California

California Office of Environmental Health Hazard Assessment (OEHHA). 1994. Health Advisory on Catching and Eating Fish-Interim Sport Fish Advisory for San Francisco Bay. Sacramento, CA.

California Office of Environmental Health Hazard Assessment (OEHHA). 1994. Public Health Advisory on Fish Consumption , Richmond Harbor Channel, California.

Hart Crowser, Inc. 1993. Final Remedial Investigation Report, Volume I, Port of Richmond, Shipyard No. 3 Scrap Area Site. Richmond, CA.

Hart Crowser, Inc. 1994. Final Feasibility Study Operable Unit 1: Soil and Groundwater, Port of Richmond, Shipyard No. 3 Scrap Area Site. Richmond, CA.

Hart Crowser, Inc. 1995. Final Remedial Action Plan, Port of Richmond, Shipyard No. 3 Scrap Area Site. Richmond, CA.

Hart Crowser, Inc. 1997. Final Work Plan for Supplemental Sediment Characterization, Port of Richmond, Shipyard No. 3 Scrap Area Site, Operable Unit 2 and Operable Unit 3. Richmond, CA.

Herzog, Donald and Associates, Inc. 1989. Final Report, Remedial Investigation/Feasibility Study, Seacliff Marina, Richmond Shipyard No. 3, Richmond.

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San Francisco Estuary Institute (SFEI). 1994. 1993 Annual Report, San Francisco Estuary Regional Monitoring Program for Trace Substances, San Francisco, CA.

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Washington State Department of Ecology.1997. Developing Health Based Sediment Quality Criteria for Cleanup Sites: A Case Study Report. Ecology Publication 97-114.

Site #3 - Castro Cove

Description of site

Castro Cove is a protected embayment located in the southern portion of San Pablo Bay in Richmond, CA. 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 poorly flushed by the changing tides. 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.

Reason for listing

Chevron monitored sediments for metals, organic compounds and benthic organisms. The results of these monitoring activities are summarized in a series of reports (E.V.S. 1987 and 1991, Entrix 1990a and 1990b). The State Mussel Watch Program and the BPTCP have also conducted investigations of sediment quality at Castro Cove.

Each investigation is presented in chronological order with the following subsections: (1) Sampling Objectives and Designs, (2) Physical and Chemical Results, and (3) Toxicity/ Bioassay Results. A summary is included.

<u>E.V.S. investigations (1987)</u>

This study was performed in order to comply with State Order 86-4 and an NPDES permit requiring an investigation of sediment quality along a deep-water outfall. The 1987 E.V.S. study was undertaken to determine the quality of deep sediments at sites along the location of the deepwater outfall. As part of this investigation, three replicate cores from five stations in San Pablo Bay, including a reference site, were collected. Two of these stations were in Castro Cove. The three replicate cores from each station were composited and

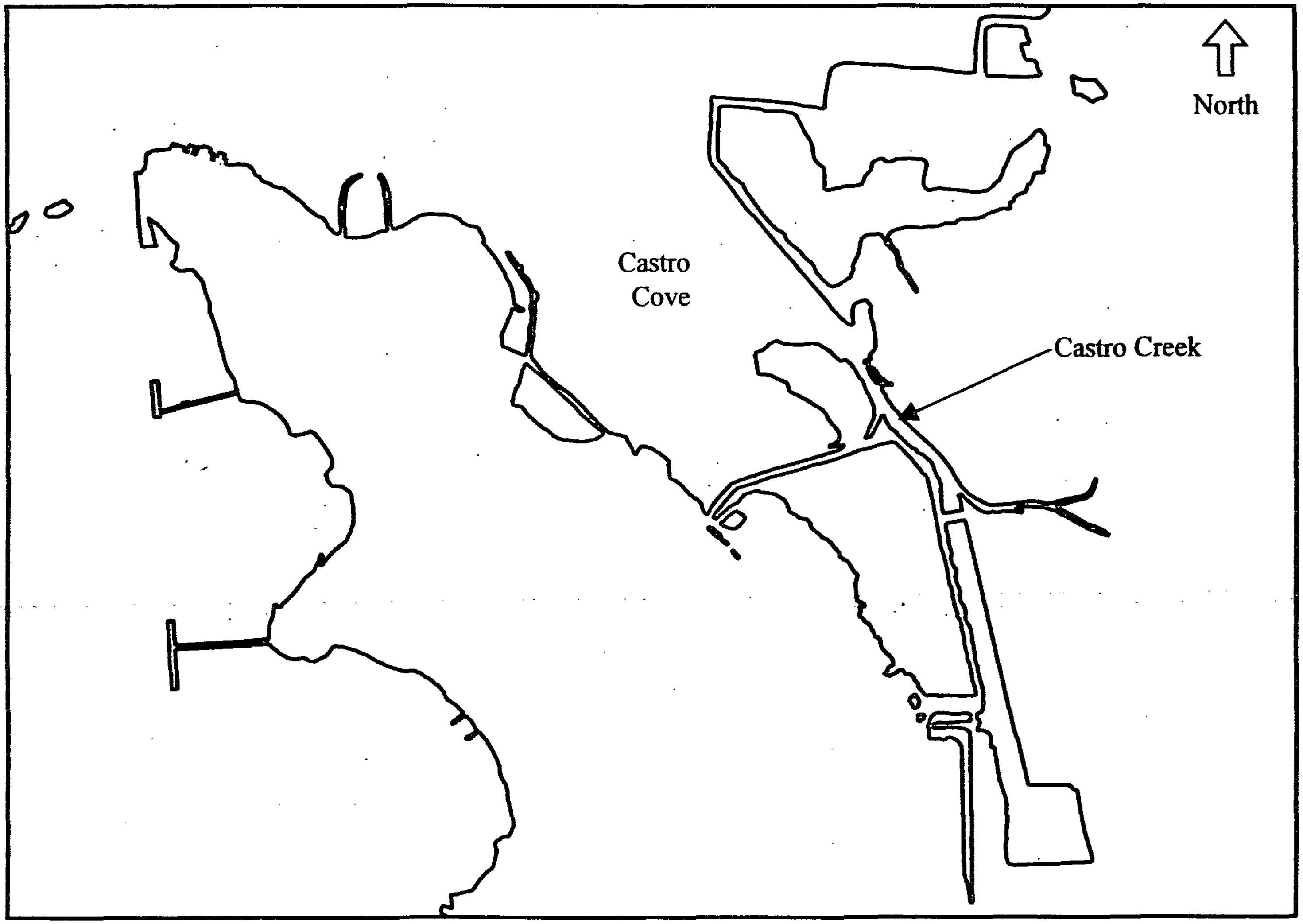

Figure 4: Site View of Castro Cove

homogenized. All five samples were analyzed for grain size, percent moisture, total organic carbon, total petroleum hydrocarbons, biochemical oxygen demand, and total and dissolved sulfides. Additionally, two sediment toxicity tests, a ten-day amphipod survival bioassay and a 48-hour suspended phase bivalve larvae development test, were performed for all five composite samples.

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 stations in Castro Cove. For the bivalve larvae bioassay, all five test samples had significantly lower rates of normal development than the sediment control.

Entrix Investigations (1990a, 1990b)

Entrix conducted a three-year monitoring program at Castro Cove and the adjacent portions of San Pablo Bay to monitor potential changes in sediment chemistry, benthic organisms, and eelgrass chemistry after relocation of the effluent discharge. The monitoring activity results are presented in two reports (Entrix 1990a, 1990b). Ten surface sediment locations within Castro Cove were sampled six times over a three-year period. Sediment and tissue samples were also collected at offshore and shoal locations. Sediment samples were analyzed for chemical and physical parameters, as well as for benthic organisms. Tissue samples were analyzed for metals only.

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 ER-M in Castro Cove.

The Benthic Community Monitoring Program Report (Entrix, 1990b) presented the results of the October 1989 and May 1990 sediment sampling and analysis. In both sampling events, the number of benthic taxa was greatest in Castro Cove followed by the area around the deep water outfall diffuser. The Castro Creek sampling locations had lower numbers of benthic taxa then the Castro Cove stations. The top four species detected in Castro Cove in both surveys were the same and are considered indicators of stressed or frequently disturbed environments.

E.V.S. study (1991)

This study was undertaken to complement the previous EVS study (EVS 1987) to complete the requirements of State Order 86-4. An NPDES permit also required Chevron to monitor sediments for metals, organic compounds and benthic organisms in Castro Cove and offshore areas. Core and grab samples were collected at 11 stations within Castro Cove and at two reference locations in San Pablo Bay. The sediment analyses included physical and chemical parameters, and two toxicity tests. Physical parameters consisted of grain size and percent solids. Chemical parameters consisted of oil and grease, total organic carbon, total sulfide, eight metals, SVOCs, phenols and organochlorine pesticides. A 10-day amphipod survival test and a 48-hour bivalve larvae development test were performed on the top 0.5-foot section of each core sample.

Most sediment samples had detected concentrations of oil and grease. Elevated concentrations of oil and grease were detected in the southwest portion, the area of an historic discharge, and at the entrance of Castro Cove. SVOCs were detected in surface sediments in the southwest of Castro Cove.

The surface sediments showed significantly decreased amphipod survival at both stations in Castro Creek and at five of nine stations in Castro Cove compared to that for reference and control sediments. Sediments from the southwest and northeast portions of Castro Cove exhibited the highest amphipod mortality. Sediments from the northeast and southern portion of Castro Cove exhibited significantly higher abnormal development in bivalves when compared to a control.

Mussel Watch Program (1988, 1990)

As part of the State Mussel Watch Program, bioaccumulation of contaminants was measured in Castro Cove (SWRCB, 1995). Mussels were deployed on three separate sampling events. They were collected on January 18, 1988, December 29, 1988, and on March 21, 1990. PAHs were detected in mussel tissues at concentrations of 12,530, 24,960 and 40,210 ppb dry weight, for those respective dates. 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.

Bay Protection and Toxic Cleanup 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, the Reference Site Study and the Screening/ Confirmation Studies.

Pilot Regional Monitoring Program (1994)

As part of the PRMP, sediment quality was assessed along a contamination gradient in Castro Cove in May 1991 (Flegal et.al,1994). The gradient study objectives were to evaluate sediment sampling, chemistry and toxicity test methods for the BPTCP and the RMP. Several different sediment toxicity tests were evaluated for a series of sampling stations for which previous studies had shown a gradient of chemical contamination. Three stations located in the southwest, middle and northeast of Castro Cove were sampled along with a reference site. The southwest station was located near the historic outfall. Shallow and subsurface sediments were collected Subsurface sediments had a noticeable smell of petroleum hydrocarbons. The sediments were analyzed for selected trace metals, PCBs, chlorinated pesticides, and PAHs. Toxicity tests performed were a 10-day amphipod survival test and elutriate and porewater bivalve larval development tests. Some experimental tests were also performed.

All sediment samples had mean metal concentrations less than their respective ER-M. In this study selenium, arsenic and mercury were not measured. The southwest sediment station, which was closest to the old outfall, had a PAH concentration greater than the ER-M at depth and greater than the ER-L on the surface.

In the amphipod test, all stations from Castro Cove, in both shallow and deep samples, showed toxicity when compared to control and reference sediment. However, amphipod mortality was greatest in the samples from the southwest and northeast stations. In a dilution series experiment, sediment from the southwest station had to be mixed with over 80% reference sediment in order to increase amphipod survival to acceptable levels. Porewater and elutriate tests on bivalve larvae showed no discernible trends for the shallow layers. 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 development test.

The benthic infauna displayed similar number of taxa at all stations within Castro Cove with the highest diversity at the northeast location and the lowest at the southwest location. Faunal assemblages were similar for all stations, with one or two species dominant in each of the three major taxonomic groups (amphipod, crustacean and polychaete). A reevaluation of the benthic assemblages concluded 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 (SFEI,1996).

As part of this same study, the effects of exposure to sediments on speckled sanddabs was investigated (Spies et al.,1993). This study compared sediments from three stations in Castro Cove with reference and control samples. The results showed increased biological effects with increasing PAH concentrations in the sediments. The most significant biological effects were seen at the station closest to the historic outfall. This station also had the highest concentration of PAHs. All sediments collected at stations in Castro Cove caused slight but statistically significant alteration of gills of speckled sanddabs. 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.

<u>Reference site study (1994)</u>

Under the BPTCP's reference site study, samples were collected in southwest Castro Cove in 1994. Ten-day amphipod survival tests were performed with two species, *Ampelisca abdita* and *Eohaustorius estuarius*. Echinoderm larvae development tests were performed on the sediment with two different exposures, interstitial water and sediment water interface. A statistically significant decrease in survival of both amphipod species was measured for the Castro Cove sediment as compared to reference and control sediments.

Screening/confirmation studies (1995)

Under the BPTCP's screening/ confirmation studies in 1995, samples were collected from the top 5 cm. of sediment in southwest Castro Cove. The sediment was analyzed for chemical parameters including metals, PAHs, PCBs and pesticides. Both the 10-day amphipod survival test and the urchin development test in porewater were performed on the sediment. Grain size and total organic carbon were measured in the sample. Ammonia and hydrogen sulfide were measured at the beginning and end of the toxicity tests.

This 1995 sample had the highest total PAH concentration (227,800 ppb) of the more than 600 sediment samples analyzed for PAHs statewide in the BPTCP. This was the highest level of PAHs ever collected in sediments at this site. Mercury and chlordanes were detected at concentrations greater than the ER-M. Selenium and dieldrin also had elevated concentrations. Toxicity test results showed 100 % amphipod mortality and 100 % abnormal development in the urchin development test.

Summary of the results of studies performed at Castro Cove

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 the 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 by the BPTCP. The concentration of PAHs in this sample (227,800 ppb) was over four times the ER-M 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 ER-Ms. Several studies, including the BPTCP, also showed levels of mercury exceeding the ER-M. In the last BPTCP sampling, chlordane was measured at levels exceeding the ER-M 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 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.

A. Assessment of areal extent of the THS

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 covers between 10 and 100 acres. 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.

B. Assessment of the most likely sources of pollutants

The Chevron refinery and the City of Richmond discharged effluent directly into Castro Cove prior to the installation of the deep-water outfall in 1987. Currently, the refinery discharges its waste effluent into San Pablo Bay via a deep-water outfall. Contaminants may have also entered Castro Cove via Castro Creek due to urban run-off.

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 U.S.A. refinery discharged treated effluent into Castro Cove from 1972 until 1987. In addition, Contra Costa County discharged up to 2 MGD treated municipal sewage into Castro Cove until the middle of the 1970s using the Chevron outfall.

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.

C. <u>Summary of actions that have been initiated by the Regional Board to reduce the accumulation of pollutants at existing THS and to prevent the creation of new THSs</u>

RWQCB actions regarding Castro Cove have been to control the sources of contamination through NPDES permitting and ACLs. The RWQCB has also conducted sampling and analysis of sediments in Castro Cove as discussed in the previous section. State Order 86-4 required Chevron to evaluate the quality of the sediments in Castro Cove resulting in the Entrix and EVS studies. Process effluent discharge from the Chevron refinery into Castro Cove was prohibited after July 1, 1987 under NPDES permit CA0005134, thereby eliminating the source of contaminated effluent into Castro Cove. This NPDES permit regulates discharges from the deep-water outfall. Discharges regulated by this NPDES permit include: thermal waste, cooling tower blowdown, gas scrubber blowdown from an incinerator, treated process wastewater, cooling water, and storm water.

D. <u>Preliminary assessment of actions required to remedy or restore THS to an unpolluted condition including recommendations for remedial actions</u>

Corrective actions for Castro Cove sediments will require the following phases:

1. Preparation of a Sampling and Analysis Plan (SAP) in order to delineate vertical and horizontal extent of contamination,
2. Completion of a Site Investigation to complete goals of SAP,
3. Preparation of a Feasibility Study (FS) based on the findings of the Site Investigation (at a minimum the following cleanup options will be considered: natural recovery, in-place containment, dredging with various disposal options and dredging and capping),
4. Sediment clean up following option(s) selected from the FS and,
5. Follow-up monitoring to make sure that the site has been cleaned up.

E. Estimate of the total cost to implement the cleanup plan

The uncertainty regarding the horizontal and vertical extent of sediment contamination results in a range of potential clean-up costs. The cost is estimated based on a minimum of 10 acres and a maximum of 100 acres. They will be assumed to be contaminated to a depth of at least three feet below the sediment surface. The most likely option for cleanup is dredging followed by capping. Dredging of the upper most three feet of contaminated sediments will be undertaken in conjunction with disposal in an upland facility, either a Class I landfill or a reuse site based on the degree of contamination. Capping of contaminated materials follows dredging and disposal. Natural recovery may be an option if areas with minimum contamination are delineated. The cost of performing a full site investigation and feasibility study is estimated at $2,000,000. The cost of remediating Castro Cove and follow-up monitoring is estimated at $2,000,000 to $20,000,000. RWQCB staff costs are estimated at $200,000 over the entire course of the project.

F. Estimate of recoverable costs from potential dischargers

The responsible party is accountable for all costs incurred as a result of site cleanup at Castro Cove as well as the cost for RWQCB and other regulatory staff oversight.

G. Two-year expenditure schedule identifying funds to implement the plans that are nor recoverable from potential dischargers

The first two-year expenditure schedule includes the site investigation and feasibility study, and the related staff time. This results in an expenditure of $2,100,000.

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