

Justification for Delisting Monterey Harbor for Lead, Monterey County, California

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Regional Water Quality Control Board
Central Coast Region
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1.0 PROJECT DEFINITION

Monterey Harbor is located in the southeastern portion of Monterey Bay, a National Marine Sanctuary. The Harbor is generally bounded by the shoreline on the south and east, the public pier on the north and the Coast Guard jetty on the west. A channel is maintained in the northwest portion of the harbor as an entrance to the marina and boat moorings in the area. A second public pier consisting mostly of retail development is located south of the main public pier.

In the 1980's, mussels in Monterey Harbor were found to have a significant lead content. Shoreline riprap slag with a high lead content was identified in the 1980's along a segment of Monterey Harbor shoreline. The source of the lead was from slag that had been placed along the southern shore of the harbor to stabilize railroad tracks that had run along the shore in that area. In the early 1990's, Southern Pacific Railroad (owner of original slag site and now part of Union Pacific Railroad, (UPRR)) conducted remedial actions of onshore slag removal and some harbor bottom sediment removal. The railroad submitted a report to the Water Board in 1993 detailing the removal and sediment sampling at about 15 locations in the harbor. In 1993, all samples were below National Oceanic and Atmospheric Administration (NOAA) PEL guidance values for lead (PELs are probable-effects level guides).

In 1996, State Mussel Watch (SMW) sampled four locations in the Harbor. In fall 2000, SMW reported all four locations had lead tissue levels above US Food & Drug Administration guidance levels of potential concern for human consumption. In 1998, the State Bay Protection program (BPTCP) sampled four locations in the harbor, finding all four with sediment lead levels below the NOAA-PEL. BPTCP also conducted toxicity tests at two locations, finding no toxicity at one location and possible mild toxicity at the second (where both metals and organic compounds had been detected). BPTCP did not list Monterey Harbor as a "toxic hot spot" needing further action.

Reviewing Water Board files, staff found UPRR was the responsible party for the site and, based on the 303(d) listing and the 1996 SMW data, issued a letter (August 2002) to UPRR requesting an investigation of the mussel tissue impairment. UPRR responded with a workplan that included a sediment sampling program and possible follow-up work depending on the sediment results.

On September 13, 2004, UPRR's consultant, MFG, Inc. (MFG) submitted a report titled "Monterey Harbor Lead in Sediment Study: Union Pacific Railroad" to the Water Board. The report summarized the results of the consultant's work to date. In addition to presenting their most recent findings (mussel tissue sampling and analysis), the report concluded with a proposal to conduct an additional phase of work (i.e., Phase 2 Report: Monterey Harbor Lead in Sediment Study) to be concluded by March 2005.

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The current submittal – Phase 2 Report: Monterey Harbor Lead in Sediment Study – includes:

- 1) A review of the toxicological literature to obtain information regarding the most relevant species of concern for Monterey Harbor.
- 2) Additional environmental sampling including water column, sediments, and in situ mussel tissue lead bioaccumulation tests consistent with the original investigation work.
- 3) Risk assessments using the updated project database.

Based on the results of the current and past submittals of the sediment and mussel sampling, Water Board staff evaluated whether or not Monterey Harbor Lead Impairment project would lead to a proposed regulatory action to delist the waterbody from California's CWA section 303(d) list.

Water Board staff used two approaches to guide this determination. First, staff used a modified version of the two-tiered approach framework from the *TMDL for Toxic Pollutants in San Diego and Newport Bay, California, Part H* (United States Environmental Protection Agency [USEPA], June 2002). Secondly, staff evaluated the submittals with respect to The State Board *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) list* (adopted September 2004) which provides guidance for interpreting data and information to establish a standardized approach for developing California's section 303(d) list, including California Listing Factors and Delisting Factors.

Based on the results of the above analyses, Board staff recommends that Monterey Harbor be removed from the 303(d) list for lead.

2.0 WATERSHED DESCRIPTION

Monterey Harbor was added to California's Clean Water Act (CWA) 303(d) list for lead in 1998, because levels of lead in the tissue of mussels (*Mytilus californianus*) exceeded Median International Standards (MIS) and were greater than Elevated Data Levels (EDLs) as reported by the State Mussel Watch Program. Also, the State Water Resources Control Board (State Water Board) determined that sediment lead levels were elevated and published their findings in the *Bay Protection and Toxics Cleanup Program, Monterey Lead Study* (published as part of the document *Chemical and Biological Measures of Sediment Quality in the Central Coast Region Final Report* [State Water Board, 1998]).

The California Regional Water Quality Control Board, Central Coast Region (Water Board) asked UPRR to conduct a sediment sampling study as a follow-up to the 1992 removal of a potential onshore source of lead to the Monterey Harbor, so that Water Board staff could determine if a lead total maximum daily load (TMDL) was needed for the Harbor.

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The following brief timeline of events and previous sampling efforts establishes context for this report.

- Circa 1880 The railroad builds a railroad spur line to service canneries in Monterey Bay Harbor.
- Circa 1905 The railway bed is stabilized along the shoreline using foundry slag that contains high levels of lead.
- 1981-1983 State Mussel Watch Program results indicate tissue lead concentrations exceed Monterey County Health Department advisory limits.
- 1988 Water Board sampling identifies the extent of lead contaminated sediments documented in *Monterey Harbor Lead Study, September 1988*, by Wilder and Jagger.
- 1989 Southern Pacific Transportation Company (SP) contracts International Technology Corporation (IT) to partially remove onshore slag.
- 1990 SP (IT) delineates extent of slag-related material onshore.
- 1992 SP removes the onshore lead impacted material and disposes of the material into a regulated landfill.
- 1993 SP (Entrix) sampling indicates declining concentrations of lead in sediments in the Harbor.
- 1996 State Mussel Watch Program results indicate tissue lead concentrations that exceed the State Mussel Watch Program's EDLs.
- 1998 State Water Board conducts sampling under *Bay Protection and Toxics Cleanup Program, Monterey Lead Study*, published as part of the document *Chemical and Biological Measures of Sediment Quality in the Central Coast Region Final Report* (State Water Board, 1998).
- 1998 Monterey Harbor is listed as an impaired water body under the provisions of Section 303(d) of the CWA.

2.1 Beneficial Uses

The *Water Quality Control Plan, Central Coast Basin – Region 3* (Basin Plan) identifies various beneficial uses for Monterey Harbor, as depicted in Table 1, below:

Table 1: Beneficial Uses for the Monterey Harbor

Designated Beneficial Uses of Monterey Harbor
Water Contact Recreation (anticipated use)
Non Contact Water Recreation
Industrial Service Supply
Marine Habitat
Navigation
Shellfish Harvesting
Commercial and Sport Fishing (anticipated use)
Rare, Threatened, or Endangered Species

These beneficial uses are listed because they are important as it relates to which water quality objectives to apply to Monterey Harbor.

2.2 Land Uses

The Harbor serves as a marina for pleasure and commercial craft. The Coast Guard jetty includes a boat maintenance facility. Urban parkland and commercial properties surround the harbor coastline.

2.3 Habitat and fisheries

Monterey Bay is a protected National Marine Sanctuary. Within the bay, Monterey Harbor is designated for a mixture of commercial (commercial fishing, navigable waters, industrial water supply, shellfishing) and recreational uses (contact and non-contact recreation, sport fishing).

3.0 WATER QUALITY OBJECTIVES

Lead Objectives

3.1 Water

According to the Central Coast Water Board's Basin Plan (Water Board 1994), there should not be any constituents present in water bodies at levels that compromise beneficial uses. Numeric objectives exist for water; however, no numeric objectives exist for either sediment or tissue. The Basin Plan contains both narrative (Table 2) and numeric (Table 3) water quality objectives for specific metals and beneficial uses. In this situation, the narrative objective is interpreted to mean that concentrations of lead, should not exist in a suspended or settleable form in the water column. Water quality objectives in the Basin Plan are expressed as concentrations of *total* metals in the water column.

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In addition to the Basin Plan, the California Toxics Rule (CTR) provides water quality objectives expressed as *dissolved* metals concentrations. The CTR supersedes the Basin Plan when it is more stringent than the Basin Plan. Similarly, if the Basin Plan is more stringent than the CTR, Basin Plan numeric criterion is used. It is now State Water Board policy to use dissolved metals measurements to evaluate compliance with aquatic life water quality standards because dissolved metal more closely approximates the bioavailable fraction of the metal in the water column than does total recoverable metal. Therefore, based on this policy and the rationale that dissolved metals more closely approximate the bioavailable fraction of metal in the water column, all water column samples collected during this study were analyzed for dissolved metals and compared to the CTR water quality standards, as this approach is the most protective of aquatic life (Table 4). In the case of lead in marine environments, the CTR is the most conservative (8.1 mg/l chronic, 210 mg/l maximum) and thus was considered as the numeric target for possible lead impairment of Monterey Harbor waters.

Table 2: Basin Plan’s Narrative Objective Description

Suspended Material	Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.
Settleable Material	Waters shall not contain settleable material in concentrations that result in deposition of material that causes nuisance or adversely affects beneficial uses.

Table 3: Basin Plan’s Numeric Water Quality Objectives for Metals in Marine Environments

Metal	Total Concentration (µg/l)
Cadmium	0.2
Chromium	50
Copper	10
Lead	10
Mercury	0.1
Nickel	2
Zinc	20

Table 4: California Toxics Rule Water Quality Standards for Metals in Marine Environments

Metal	Saltwater	
	Criterion Maximum Concentration, dissolved ($\mu\text{g/l}$)	Criterion Continuous Concentration, dissolved ($\mu\text{g/l}$)
Arsenic	69	36
Cadmium	42	9.3
Chromium (total)	1,100	50
Copper	4.8	3.1
Lead	210	8.1
Nickel	74	8.2
Selenium	290	71
Silver	1.9	NA
Zinc	90	81

3.2 Sediment

There are no existing sediment quality standards, however the NOAA SQiRT (Screening Quick Reference Table) tables provide one set of guidance values that are commonly used to evaluate sediment concentrations. SQiRT presents screening concentrations for inorganic and organic contaminants in various environmental media. These screening concentrations were derived initially using a database compiled from studies performed in both saltwater and freshwater in all different areas of North America and published in NOAA Technical Memorandum. The tables are intended for preliminary screening purposes only; they do not represent official NOAA policy and do not constitute criteria or clean-up levels. Users of SQiRT values are strongly encouraged to review supporting documentation to determine appropriateness for their specific use. Their use in certain situations may not be appropriate.

3.3 Tissue

Most metals do not have a standard tissue objective established by any of the following agencies: USEPA; California Office of Environmental Health Hazard Assessment (OEHHA); United States Food and Drug Administration (USFDA); California Department of Health Services (DHS); or the United States Fish and Wildlife Service (USFWS). The few metals that do have standards include: arsenic, cadmium, copper and chromium. All other metals do not have approved standards for tissues.

Although there are no approved United States standards against which to compare all tissue values, there are values called median international standards (MIS). MIS is a literature value criterion developed from a United Nations Food and Agriculture Organization publication of a survey of health protection criteria used by member nations (Table 5). Though the standards do not apply within the United States, they provide an indication of what other nations consider to be an elevated concentration of trace

elements in shellfish (State Mussel Watch Program, 2000). These MIS values will be used as literature values to evaluate the tissue data collected in this study.

Table 5: Median International Standards for Trace Elements

Element	Freshwater Fish (mg/kg)	Shellfish (mg/kg)	Range of Standards (mg/kg)	Number of Countries with Standards
Arsenic	1.5	1.4	0.1 – 5.0	11
Cadmium	0.3	1.0	0.05 – 2.0	10
Chromium	1.0	1.0	1.0	1
Copper	20.0	20.0	10 – 100	8
Lead	2.0	2.0	0.5 – 10.0	19
Mercury	0.5	0.5	0.1 – 1.0	28
Selenium	2.0	0.3	0.3 – 2.0	3
Zinc	45.0	70.0	40 – 100	6

4.0 DATA COLLECTED

4.1 Phase I Study

On September 15, 2004, MFG submitted a report titled “Monterey Harbor Lead in Sediment Study” to the Water Board describing the potential impacts of lead to the beneficial uses of Monterey Harbor (MFG, 2004). The objective of the September 15th report was to answer the following questions: (1) is lead present in Harbor sediments above threshold criteria? (2) If elevated lead concentrations are present in Harbor sediments or mussels, do they originate from the removed slag pile? (3) If elevated lead concentrations originating from the former slag pile are present, do they represent impairment to the beneficial uses of shellfish in the Harbor?

The September 15th report presented the following findings and conclusions:

Lead concentrations in mussel tissue samples taken from Monterey Harbor have been reduced significantly over the past decade as evidenced in the mussel tissue assessments carried out in 2003-2004. However, even though there has been a significant reduction in lead contamination, the data indicates that there remains a slight potential for beneficial use impairment.

There are several factors that should be considered in evaluating the potential for impairment to beneficial uses in Monterey Harbor:

- *Shellfish harvesting in Monterey Harbor for both humans and as a food source for wildlife is marginal due to the limited amount of suitable habitat.*

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- *The lead contaminant study in Monterey Harbor by Flegal, et al. 1987 indicates that there is uncertainty regarding the bioavailability of lead in mussels (sediment bound lead in gut) to higher trophic levels.*
- *Chemical analyses included in this study, including STLC and SEM:AVS, indicate that the lead is tightly bound in the sediment in forms that are not readily bioavailable.*
- *Preliminary avian and mammalian risk assessments, using the assumption that all lead in the mussel tissues is bioavailable, suggest that the MIS is not the most appropriate standard for Monterey Harbor and that a mussel tissue lead criterion could be adjusted upward.*

Using the current criteria (TEL and MIS) there is minimal environmental risk to humans and wildlife in Monterey Harbor.

Portions of the environmental data collected as part of this project, preliminary risk calculations, and other factors listed above support consideration of updated numeric targets for lead in Monterey Harbor. Additional environmental data, literature reviews, and risk calculations are needed to propose updated numeric targets for Monterey Harbor.

4.2 Phase II Study

Phase II was designed to address the additional needs discussed above, so that a determination of whether lead is continuing to be a source of impairment to Monterey Harbor could be made. The study design used a multi-stepped approach to investigate the levels of lead in the sediments, water column, and mussel tissues, and the potential impact any remaining lead in the sediments may have on the beneficial uses of Monterey Harbor. The steps of the Phase II study may be summarized as follows:

- **Step 1:** Sediment core samples were collected from 15 sites within Monterey Harbor where Southern Pacific removed the slag material and where previous monitoring efforts have been focused (Figure 4-1). The cores (12") were sectioned into two aliquots (upper 2" and lower 2") and analyzed for total lead, in an effort to provide additional data to assess (a) whether temporal declines in sediment lead concentrations have continued, and (b) whether lead concentrations in Harbor sediment exceed Threshold Effects Levels (TELs).
- **Step 2:** The bioavailability of the lead was evaluated (e.g., the ratio of simultaneously extracted metals to acid volatile sulfides – SEM:AVS) to assess the potential risk posed to shellfish and other organisms. This evaluation could support a) delisting for lead, b) a site-specific cleanup target, and/or c) a TMDL endpoint for lead, if necessary.

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- Step 3: Surface water was collected from 15 sites within Monterey Harbor to measure the total and dissolved fractions of lead in the water column (Figure 4-1).
- Step 4: Bioassessment monitoring of mussels (*Mytilus californianus*) was used to evaluate the potential for contamination of whole shellfish tissue originating from lead in the sediments. This monitoring used the protocols developed by the California State Mussel Watch Program, and was identical to the protocols that originally resulted in Monterey Harbor being listed for lead. The mussels were deployed at 10 sites during the winter months when the water conditions are their most turbulent and the chances of sediment-bound lead suspension are the greatest.
- Step 5: Small-scale ecological risk assessment using mussel tissues as a source of dietary lead to the most sensitive life stage of marine birds and protected mammals (sea otter and harbor seal).

5.0 DATA ANALYSIS

5.1 Numeric Targets

In evaluating the data collected in Phase II, preliminary planning for Monterey Harbor follows a pattern set by USEPA on the Newport Bay TMDL (June, 2002). This pattern included use of screening reference sediment guideline values developed by the US National Oceanic and Atmospheric Administration (NOAA-SQuiRT tables, Buchman 1999). These tables included two values, PELs and TELs, which are sediment guidance values extracted from the literature. They were: the level above which aquatic life effects are anticipated (**PEL**), and the level below which aquatic life are not anticipated to be affected (**TEL**).

The proposed numeric targets for the Monterey Harbor lead impairment would therefore be:

- **Tier One (no further action needed scenario) :**
 - $\leq 25\%$ of (at least 8) sediment samples randomly spaced throughout the harbor exceed the NOAA-PEL for lead of 112.18 mg/kg (i.e., exceed high sediment quality guideline); **OR**
 - $< 10\%$ of (at least 12 randomly spaced – in time and spatial extent over a three year period) water column samples exceed the appropriate CTR objective for dissolved lead (Chronic = 8.1 ug/L, Maximum = 210 ug/L); **OR**
 - $\leq 25\%$ of (at least 4) randomly placed (throughout the harbor) mussel samples exceed an appropriate tissue level for lead (e.g., MIS, 2.0 mg/kg wet weight).

- **Tier Two (no further action needed scenario) – At least two of the three bullets below must be met:**
- ≤ 10% of (at least 8) sediment samples randomly spaced throughout the harbor exceed the NOAA-TEL for lead of 30.24 mg/kg (i.e., exceed low sediment quality guideline); **OR**
 - < 2 of (at least 12 randomly spaced – in time and spatial extent over a three year period) water column samples exceed the appropriate CTR objective for dissolved lead (Chronic = 8.1 ug/L, Maximum = 210 ug/L); **OR**
 - ≤ 10 % of (at least 4) randomly placed (throughout the harbor) mussel samples exceed an appropriate tissue level for lead (e.g MIS, 2.0 mg/kg wet weight).

5.2 USEPA Two Tiered approach

In Tier 1, data should be compared to selected targets and if any target is *exceeded in any one category*, then a TMDL is required. Exceedence of at least one (or more) categories in Tier One should be taken as demonstrable evidence of “*impairment to aquatic life or probable adverse human health effects*” (USEPA, 2002).

In Tier 2, if there is an exceedence *in at least two of the three categories*, a TMDL is required. Tier 2 should be used when there are not enough data in any one category to justify developing a TMDL, where data sets are incomplete, or where there is evidence of potential future impairment based on water quality conditions in adjacent segments. Exceedences of two out of three categories in Tier Two should be taken as demonstrable evidence of “*possible effects to aquatic life or human health*” (USEPA, 2002).

In recommending to delist, USEPA recommends using both Tiers.

5.2.1 Tier One

Sediment: 4/30 sediment samples (13%) analyzed for total lead (mg/kg – dry weight) exceeded the NOAA-PEL for lead of 112.18 mg/kg. The range of observed total lead concentrations was 21.2 to 754 mg/kg.

Water: None of the 30 (0/30) surface water samples collected during both the 2004 and 2005 sampling events exceeded the CTR water quality criteria for dissolved lead (Chronic = 8.1 µg/L, Maximum = 210 µg/L). The range of observed dissolved lead concentrations was non-detect to 2.8 µg/l.

Mussel Tissue: 4/19 mussel tissue samples (21%) from both the 2004 and 2005 sampling events exceeded the MIS guideline of 2.0 mg/kg in shellfish tissue. The range of

observed mussel tissue lead concentrations was 0.9 to 3.0 mg/kg. In addition, there was a significant decrease between 2004 and 2005, in both the concentrations of tissue lead, and the number of exceedences of the MIS.

Conclusion: None of the three Tier One categories for impairment were exceeded. Delisting would be justified based simply on Tier One parameters. However, to conclude no further site action, both Tier One and Tier Two scenarios must be satisfied in accordance with the USEPA Newport Bay methodology (USEPA, 2002).

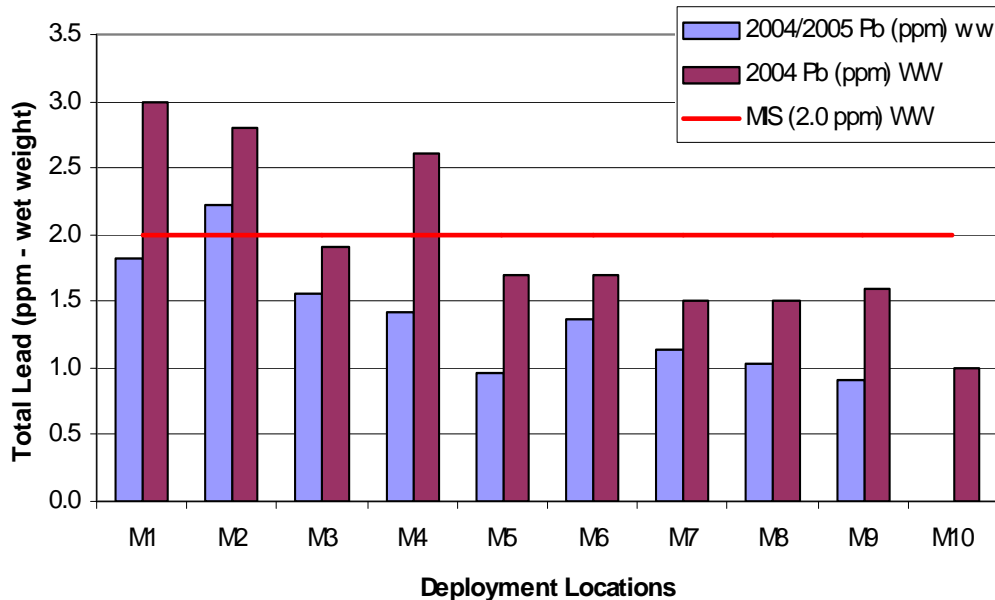
5.2.2 Tier Two

Sediment: 24/30 of sediment samples (80%) for total lead (mg/kg) from the 2004 and 2005 sampling events exceed the low sediment quality guideline (NOAA-TEL for lead of 30.2 mg/kg). There was a decrease in total lead concentrations, and exceedences of the TEL between the 2004 and 2005 sampling events.

Water: None of the surface water samples from either the 2004 or 2005 sampling events exceeded the appropriate CTR objective for dissolved lead (Chronic = 8.1 ug/L, Maximum = 210 ug/L).

Mussel Tissue: 4/19 tissue lead samples (21%) for both the 2004 and 2005 sampling events exceeded the MIS of 2.0 mg/kg – wet weight. The concentrations of tissue lead, and the number of exceedences of the MIS dropped significantly between 2004 and 2005. The 2005 sampling event found only 1/9 tissue samples (11%) exceeding the MIS (Figure 1).

Figure 1: Comparison of 2004 and 2004/2005 Mussel Tissue Lead Concentrations in Monterey Harbor (WW = wet weight)



5.2.3 Summary of Two Tiered Approach

None of the three Tier One categories for impairment are exceeded. Delisting would be justified based simply on Tier One categories. Two of the three Tier Two categories were exceeded. Most sediment samples exceeded the low sediment quality guideline (NOAA-TEL for lead of 30.2 mg/kg); whereas tissue lead samples only marginally exceed the tier two parameter for evidence of impairment [($>10\%$ of randomly placed mussel samples exceed an appropriate tissue level for lead (e.g., MIS 2.0 mg/kg wet weight)].

Tier One suggested no demonstrable impairment, and that delisting is warranted - while Tier Two suggested evidence of possible effects to aquatic life or human health. However, other lines of evidence suggested that the MIS, and the TEL may not be appropriate sediment and tissue numeric criteria for Monterey Harbor, as discussed below in the Weight of Evidence Approach.

5.2.4 State Water Board Policy Guidance for Delisting

The Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (State Water Board 2004) establishes California's policy for implementing parts of the Clean Water Act (CWA) by describing the conditions that must be met before a water body can be either listed or de-listed from the State's 303(d) list. This document provides guidance for interpreting data and information to establish a standardized approach for developing California's section 303(d) list, including California Listing Factors and Delisting Factors.

This policy does allow for a "weight of evidence" approach, providing that "the weight of evidence indicates that a water quality standard is attained. If the weight of evidence indicates attainment, the water quality segment shall be removed from the section 303(d) list. If warranted, a listing may be maintained if the weight of evidence indicates a water quality standard is not attained."

Below is a discussion of the data from the numerous studies performed in the Harbor as they relate to the State's Listing/De-Listing Policy (State Water Board 2004).

Water: No surface water samples from the monitoring events exceeded the CTR water quality objective of 8.1 $\mu\text{g/l}$ dissolved lead (Table 6). The ranges for dissolved lead in the 30 Monterey Harbor surface water samples between 2004 and 2005 were non-detect to 2.8 $\mu\text{g/l}$. These results meet the Delisting criteria set forth in the State Water Board 2004 policy, for numeric water quality objectives for toxicants in water.

Table 6: Results of Surface Water Lead Concentrations in Monterey Harbor

Sample ID	December 2004			February 2005		
	Total Pb (µg/l)	Dissolved Pb (µg/l)	TSS (mg/l)	Total Pb (µg/l)	Dissolved Pb (µg/l)	TSS (mg/l)
1	<1.0	<1.0	<6.0	5.4	1.7	<5
2	<1.0	1.05	6.0	5.9	2.1	<5
3a	2.29	<1.0	<6.0	10.0	2.1	40
3b	NS	NS	NS	10.6	2.8	10
4	2.51	<1.0	<6.0	8.1	2.2	6
5	1.65	<1.0	<6.0	5.0	1.6	<5
6	<1.0	<1.0	<6.0	4.1	1.2	<5
7a	<1.0	<1.0	6.0	3.8	1.5	<5
7b	<1.0	<1.0	<6.0	NS	NS	NS
8	<1.0	<1.0	<6.0	3.5	1.6	<5
9	<1.0	<1.0	<6.0	2.9	1.5	<5
10	<1.0	<1.0	<6.0	3.0	1.4	<5
11	<1.0	<1.0	<6.0	2.9	1.4	<5
12	<1.0	<1.0	<6.0	2.8	1.3	<5
13	<1.0	<1.0	<6.0	2.8	1.5	<5
14	<1.0	<1.0	<6.0	2.8	1.2	<5
15	<1.0	<1.0	<6.0	2.5	1.1	<5

NS= Not sampled

Sediment: 97 sediment samples (53 from the surface and 44 from depth (8-12") were collected from Monterey Harbor between 1993 and 2004 (Entrix 1993, MFG 2003, MFG 2004).

The Policy allows Water Boards to select sediment quality guidelines that have been published in peer-reviewed literature or by state and federal agencies, with the caveat that "only those sediment guidelines that are predictive of sediment toxicity shall be used (i.e., those guidelines that have been shown in published studies) to be predictive of sediment toxicity in 50 percent or more of the samples analyzed" (State Water Board, 2004).

The screening-level value that meets the aforementioned 50% requirement stated in the Policy is the NOAA-PEL for lead of 112.18 mg/kg. A minority of the Monterey Harbor sediment samples (10 out of 97) collected between 1993 and 2004 (Entrix 1993, MFG 2003, MFG, 2004) had total lead concentrations that exceeded the NOAA-PEL, with only 4 of them occurring in 2004/2005.

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State Water Board Policy Conditions - The Policy uses a binomial distribution model to determine the number of exceedances that are allowed based on the number of samples collected. The Policy states:

Using the binomial distribution, waters shall be removed from the section 303(d) list if the number of measured exceedances supports rejection of the null hypothesis as presented in Table 4.1.

The Policy's Table 4.1 indicates that for a sample size of $n = 95$ to 106 , "delist if the number of exceedances equal or is less than 8." The exceedances are:

- Total number of samples exceeding the PEL = 10
- Total number of surface samples exceeding the PEL = 4. (Table 4.1 from the Policy allows for 4 exceedances based on the number of surface samples being 53).
- Total number of depth samples exceeding the PEL = 6. (Table 4.1 of the Policy allows for 3 exceedances based on the number of depth samples being 44).

Therefore, based simply on "total" lead concentrations in sediment, delisting could be warranted for the surface samples but not for sediments found at a depth >8 " based on this factor. However, total lead is considered a poor indicator of the amount of bioavailable lead.

MFG used SEM:AVS analysis (USEPA Method 6020/7470) to determine the quantity of "available" lead in the sediment. Simultaneous extracted metal (SEM) minus (-) acid volatile sulfide (AVS) is a measure of sediment toxicity based on the amount of sulfide in the sediment that can bind with toxic heavy metals and make them unavailable to plants and animals.

The SEM/AVS molar ratios are an indicator of the amount of metals present in the sediment pore-water. When SEM/AVS ratios are <1 , the concentrations of metals in the sediment porewater are generally below toxic levels because of the low solubility of the metal sulfides.

SEM:AVS is a scientifically defensible methodology to determine the bioavailability of divalent metals. The SEM:AVS tests for Monterey Harbor sediment samples suggest that there exists sufficient volatile sulfide concentrations in most of the Harbor sediment to bind the lead as lead sulfide. Lead sulfide is not readily soluble in water. This lack of solubility was supported by the low concentrations of dissolved lead in the water column and non-detectable concentration of lead that could be leached using the weak acid extraction method of the STLC leachate test. Sulfide sequestration of lead reduces its bioavailability and, thus, results in normally toxic concentrations of lead becoming non-toxic to aquatic life.

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The SEM:AVS test indicated that all (100%) available lead in the Monterey Harbor sediment is below the PEL guidance (and TEL guidance). The analysis indicated that the concentration of (theoretically) available lead ranges between 0 to 87.6 mg/kg. According to the SEM:AVS test, over 50% of samples indicated concentrations of available lead at zero, indicating the lead was largely sequestered in sediment and sulfide phases.

Mussel Tissue: There were an insufficient number of tissue lead samples (N=19) to evaluate potential for delisting using the State Water Board policy conditions using the binomial distribution (State Water Board 2004, table 4.1, N=28 to 129).

However, State Water Board policy (June 2004) allows a weight of evidence approach to support a delisting. When making a delisting decision based on a situation-specific weight of evidence, the Water Board must justify its recommendation by:

- *Providing any data or information including current conditions supporting the decision;*
- *Describing in fact sheets how the data or information affords a substantial basis in fact from which the decision can be reasonably inferred;*
- *Demonstrating that the weight of evidence of the data and information indicates that the water quality standard is attained; and*
- *Demonstrating that the approach used is scientifically defensible and reproducible.*

MFG proposed the following “weight of evidence” of water quality standard attainment and protection of the designated beneficial uses of Monterey Harbor. MFG performed a review of the most current literature pertaining to bioaccumulation of lead in marine organisms and found that:

- Inorganic lead is transformed into granules by marine mollusks and benthic invertebrates, thereby reducing the bioavailability of lead;
- Absorption of lead from the gut of mussels and crabs is inefficient;
- Lead does not biomagnify up the food chain but, rather, biopurifies;
- Increases in anthropogenic lead fluxes do not result in an increase in lead contaminated otters;
- Lead consumed with food by waterfowl becomes chelated by various ligands that render the lead into non-soluble or non-bioavailable forms; and

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- Any soluble lead in the Monterey Harbor sediment has a high likelihood of being further sequestered by either granulation in invertebrates or chelated by ligands in waterfowl digestive tracts. This will result in the lead being rendered non-bioavailable and, therefore, most likely will not result in degradation of the beneficial uses of the harbor.

The literature indicated that, while lead can bioaccumulate in tissues, it does not biomagnify but rather “biopurifies” as it moves up the food chain. Thus, the “weight of evidence” suggested that lead is not currently a bioaccumulation hazard in Monterey Harbor.

In addition, MFG did a small-scale ecological risk assessment, which appears to adequately demonstrate that that avian and mammalian populations native to Monterey Harbor are not at risk from lead in the tissue of shellfish. This risk assessment used the working assumption that all lead in the mussel tissues is bioavailable and that the organisms would subsist on the exposed mussel tissues. This assumption provided a conservative (most protective) estimate of lead exposure. The risk assessments for Herring Gull, Southern Sea Otter, and Harbor Seal suggested that even using conservative assumptions (all lead bioavailable, MIS guideline of 2.0 mg/kg), there was no risk indicated to avian and mammalian species. The risk assessment also appeared to suggest that the MIS guideline was overly conservative, and not appropriate as a mussel tissue lead criterion in Monterey Harbor.

6.0 RATIONALE FOR DELISTING

Discussion-conclusions

Staff evaluated potential delisting for Monterey Harbor lead using two complimentary policy tools: the two-tiered approach used by USEPA for Newport Harbor TMDL (June, 2002), and *The Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (State Water Board 2004)*

With respect to the two-tiered framework USEPA used in Newport Harbor, Monterey Harbor is justified for delisting in accordance with Tier One parameters, but is potentially impaired in accordance with Tier Two standards (two of the three parameters are not met for delisting). Nominally, both Tier One and Tier Two parameters must be met to justify delisting.

However, UPRR provided evidence that much of the total lead in sediment is sequestered in lead sulfide phases, by using SEM:AVS analysis (EPA Method 6020/7470). When bioavailable lead is considered, using SEM:AVS results, it appears that virtually all of the sediment samples are below the PEL (highside endpoint) and TEL (lowside endpoint) numeric sediment quality guidelines.

In addition, none of the 30 surface water samples collected during both the 2004 and 2005 sampling events exceeded the CTR water quality criteria for dissolved lead

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(Chronic = 8.1 µg/l, Maximum = 210 µg/l). The range of observed dissolved lead concentrations was non-detect to 2.8 µg/l.

4/19 tissue lead samples (21%) for both the 2004 and 2005 sampling events exceeded the MIS of 2.0 mg/kg – wet weight. The concentrations of tissue lead, and the number of exceedences of the MIS dropped significantly between 2004 and 2005. The 2005 sampling event found only 1/9 tissue samples (11%), which only nominally exceeds the Tier Two tissue lead parameter of 10% exceedences.

In addition, MFG did a small-scale ecological risk assessment, which adequately demonstrated that avian and mammalian populations native to Monterey Harbor are not at risk from lead in the tissue of shellfish. This risk assessment used the working assumption that all lead in the mussel tissues is bioavailable and that the organisms would subsist on the exposed mussel tissues. Furthermore, review of the most current literature pertaining to bioaccumulation of lead in marine organisms demonstrated that absorption of lead from the gut of mussels and crabs is inefficient; lead does not biomagnify up the food chain, but rather biopurifies; lead consumed by waterfowl becomes chelated by various ligands that render the lead into non-soluble or non-bioavailable forms.

In accordance with State Water Board policy (September 2004), UPRR has adequately demonstrated that delisting is merited using binomial statistical distribution guidelines, and a weight of evidence approach for site-specific conditions.

In summary, surface water sampling, SEM:AVS analysis, ecological risk analysis, weight of evidence analysis, in conjunction with other evidence and literature review provided by UPRR, staff recommends that Monterey Harbor be delisted from the 303(d) list for lead.

7.0 REFERENCES

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