Economic Analysis of Proposed Water Quality Objectives for Mercury in the State of California

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Prepared For:
Ghulam Ali, WACOR
Matthew Mitchell, Alternative WACOR
U.S. Environmental Protection Agency
Office of Science and Technology, Engineering and Analysis Division
1200 Pennsylvania Ave., NW
Washington, D.C. 20460

Prepared By:
Abt Associates Inc.
Environment and Natural Resources Division
55 Wheeler Street
Cambridge, MA 02138

With
PG Environmental
570 Herndon Parkway, Suite 500
Herndon, VA 20170

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Table of Contents

Executive Summary 1
1 Introduction 1
1.1 Need for the Proposed Rule 1
1.2 Scope of the Analysis 1
1.3 Organization of this Report 2
2 Baseline for the Analysis 1
2.1 Water Quality Objectives 1
2.2 Implementation Policy 2
2.3 Sources of Mercury to Surface Waters 5
2.3.1 Municipal and Industrial Facilities 6
2.3.2 Stormwater Discharges 6
2.3.3 Abandoned Mines 10
2.3.4 Air Emissions 11
2.4 Impaired Waters 11
3 Description of Options 1
3.1 Water Quality Objectives 1
3.1.1 Human Health 1
3.1.2 Wildlife 1
3.2 Implementation Procedures 2
3.2.1 NPDES Wastewater 2
3.2.2 NPDES Stormwater 4
3.2.3 Wetlands 5
3.2.4 Mine Site Remediation 5
3.2.5 Non-Point Source Discharges 6
3.2.6 Dredging Activities 6
4 Estimated Compliance 7
4.1 Incrementally Impaired Waters 7
4.2 Municipal and Industrial Wastewater 7
4.3 NPDES Stormwater 8
4.3.1 MS4s 8
4.3.2 Caltrans 8

4.3.3 Industrial Stormwater 8
4.4 Abandoned Mines, Non-Point Sources, Dredging Activities, & Wetlands 9
5 Compliance Methods and Costs 1
5.1 Municipal Wastewater 1
5.1.1 Pollution Prevention 1
5.1.2 Process Optimization 2
5.1.3 Tertiary Treatment 4
5.1.4 Routine and Compliance Monitoring 6
5.2 Industrial Wastewater 7
5.2.1 Pollution Prevention 7
5.2.2 End-of-Pipe Treatment 8
5.3 NPDES Stormwater 9
6 Statewide Costs 1
6.1 Municipal Wastewater 1
6.2 Industrial Wastewater 2
6.3 MS4 Stormwater 2
6.4 Total Incremental Costs 2
6.5 Limitations and Uncertainties 3
7 References 1
Appendix A. TMDL Implementation Plans 5
Appendix B. Municipal and Industrial Discharger Estimated Compliance 1
Appendix C. Municipal Pollution Prevention Costs 1
Appendix D. Facility-Specific Incremental Cost Estimates 13

List of Exhibits

Exhibit ES-1: Water Quality Objectives ... 1

Exhibit ES-2: Water Column Concentrations (C) Based on Beneficial Use and Water Body Type. ... 2

Exhibit ES-3: Estimated Number of Municipal and Industrial Wastewater Dischargers Needing Incremental Reductions for Compliance with Projected Effluent Limits ... 3

Exhibit ES-4: Estimated Annual Incremental Compliance Cost for Municipal and Industrial Plants (2016$ per year). ... 4

Exhibit ES-4: Estimated Total Annual Incremental Compliance Cost under Proposed Policy Options (2016$ per year)[1] ... 5

Exhibit 2-1: Applicable Existing Basin Plan Objectives ... 1

Exhibit 2-2: SIP Procedures for Determining Reasonable Potential ... 4

Exhibit 2-3: Municipal Wastewater Treatment Plants and Industrial Discharges to Inland Surface Waters, Enclosed Bays, and Estuaries in California ... 6

Exhibit 2-4: Permit Requirements and SWMP Activities Specific to Mercury for Large MS4s in California ... 7

Exhibit 2-5: Summary of California 2012 303(d) List of Mercury Impairments ... 12

Exhibit 2-6: Sources of Mercury Impairment of Inland Waters, Enclosed Bays, and Estuaries in California ... 12

Exhibit 2-7: Summary of Mercury TMDLs in California ... 13

Exhibit 3-1: Fish Tissue Objective to Protect Human Health ... 1

Exhibit 3-2: Fish Tissue Objective to Protect Wildlife ... 1

Exhibit 3-3: Water Column Concentrations (C) Based on Beneficial Use and Water Body Type. 2

Exhibit 3-4: Implementation Options for NPDES Stormwater Dischargers ... 5

Exhibit 5-1: Mercury P2 Program Components and Potential Costs of Large WWTP (> 20 mgd) ... 2

Exhibit 5-2: Percent of Dischargers with Average Annual Mercury Concentrations Below Specified Level ... 5

Exhibit 5-3: Estimated Capital and O&M Unit Cost for Tertiary Filtration ($2016) ... 6

Exhibit 5-4: Estimated Annual Total Mercury Effluent Monitoring Costs ... 7

Exhibit 6-1: Potential Controls Needed for Compliance with Proposed WQBELs for Municipal WWTPs ... 1

Exhibit 6-2: Estimated Total Annual Incremental Compliance Cost for Industrial Dischargers ($2016 million per year)1 2
Exhibit 6-3: Estimated Total Annual Incremental Compliance Cost under Proposed Policy Options ($2016 per year)[1] 3
Exhibit 6-4: Summary of Limitations and Uncertainties of the Analysis 3
Exhibit A-1: Allocations and Implementation Plans for Mercury TMDLs 5
Exhibit C-1: Wastewater Characterization Costs: Per Event Sampling for Mercury and Methylmercury 2
Exhibit C-2: Mercury P2 Program Components and Potential Costs of Large WWTP (> 20 mgd) 8
Exhibit C-3: Amalgam Separators Description and Costs 9
Exhibit D-1: Incremental Costs by Facility 13

Abbreviations

AMEL	Average monthly effluent limit
BAF	Bioaccumulation factor
BAT	Best available technology economically achievable
BCT	Best conventional pollutant control technology
BLS CPI	Bureau of Labor Statistics Consumer Price Index
BMP	Best management practice
Caltrans	California Department of Transportation
CEDEN	California Environmental Data Exchange Network
CIWQS	California's Integrated Water Quality System
cm	centimeter
CTR	California Toxics Rule
CWA	Clean Water Act
EBMUD	East Bay Municipal Utilities District
ECA	Effluent concentration allowance
ENR CCI	Engineering News-Record Construction Cost Index
FTE	Full-time equivalent
FTO	Fish tissue objective
GIS	Geographic information systems
Hg	Inorganic mercury
ICIS-NPDES	Integrated Compliance Information System-National Pollutant Discharge Elimination System
lbs/yr	pounds per year
LID	Low impact development
MDEL	Maximum daily effluent limit
MEC	Maximum effluent concentration
MeHg	Methylmercury
MEP	Maximum extent practicable
mg	milligrams
mg/kg	milligrams per kilogram
mgd	million gallons per day
MS4	Municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and maintenance
OEHHA	Office of Environmental Health Hazard Assessment
OMR	Office of Mine Reclamation
ng/L	nanograms per liter
NLCD	National Land Cover Data
P2	Pollution prevention
RP	Reasonable potential
RWQCP	Regional Water Quality Control Plant

SD	Sanitation District
SIP	Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California
SWMP	Stormwater management plan
SWPPP	Stormwater Pollution Prevention Plan
TL	Trophic level
TMDL	Total maximum daily load
µg/L	micrograms per liter
U.S. EPA	United States Environmental Protection Agency
USFS	United States Forest Service
WDR	Waste discharge requirements
WLA	Wasteload allocation
WQBEL	Water quality based effluent limit
WWTP	Wastewater treatment plant

Executive Summary

The California State Water Resources Control Board (State Water Board) is considering fish tissue objectives for mercury for the protection of human health and wildlife, and implementation procedures for the objectives (November 2016 draft proposed Policy). Under a contract with the United States Environmental Protection Agency (U.S. EPA), Abt Associates provided the State Water Board with an analysis of economic factors related to the proposal, including compliance with the water quality objective options, available methods to achieve compliance with these options, and the costs of those methods.

Baseline and Proposed Policy

The proposed Policy implementation plan would not supersede implementation plans of any existing mercury TMDLs or site-specific fish tissue methylmercury objectives. The California Toxics Rule (CTR) currently establishes total recoverable mercury water quality criteria for the protection of human health of 50 nanograms per liter (ng/L) for consumption of water and organisms, and 51 ng/L for consumption of organisms only. These criteria apply to all inland waters, enclosed bays, and estuaries in the state. In addition, the Regional Water Board Basin Plans contain narrative criteria related to toxicity or bioaccumulation as well as site-specific objectives for mercury established under total maximum daily loads (TMDLs).

The proposed Policy would establish water quality objectives for mercury, as methylmercury concentrations in fish tissue, to protect human health and wildlife. The proposed policy contains the following fish tissue objectives, expressed as methylmercury concentrations, as illustrated in **Exhibit ES-1.**

Exhibit ES-1: Water Quality Objectives

Objective Type	Beneficial Use	Objective
Sport Fish	COMM, WILD, RARE	0.2 mg/kg in highest trophic level fish; 150 – 500 mm
Tribal Subsistence Fish	T-SUB	0.04 mg/kg in 70% trophic level 3 fish and 30% trophic level 4 fish; 150 – 500 mm
Subsistence Fish	SUB	0.05 mg/kg in highest trophic level fish; 150 – 500 mm
Prey Fish	WILD, MAR[1]	0.05 mg/kg in fish 50 – 150 mm
Prey Fish for the California Least Tern	California least tern habitat[2]	0.03 mg/kg in fish less than 50 mm

1. Where no trophic level 4 fish.
2. May be designated WILD, RARE, or MAR.

Incrementally Impaired Waters

The proposed Policy does not contain procedures for determining impairments. Under the current policy, for toxic numeric water quality objectives, a water is impaired if the number of measured exceedances supports rejection of the null hypothesis using the binomial distribution. For narrative objectives based on the bioaccumulation of pollutants in aquatic life tissue, a water is impaired if the tissue pollutant levels in organisms exceed a pollutant-specific evaluation guideline using the binomial distribution. In the past, Regional Water Boards have used evaluation guidelines published by U.S. EPA (i.e, guidelines of 0.3 mg/kg) or the Office of Environmental Health Hazard Assessment (OEHHA; i.e., a contaminant goal of 0.22 mg/kg) to determine impairments in water quality segments of receiving water bodies. Once the Policy is adopted, the new numeric water quality objectives would be the used to determined impairments. This analysis does not include an assessment of incremental impairments due to uncertainties regarding how newly developed beneficial uses are to be assigned to water quality segments.

Municipal and Industrial WWTPs

Abt Associates was provided by the State Water Board with mercury effluent data from the California integrated Water Quality System (CIWQS) database for all municipal and industrial dischargers subject to the proposed Policy with available data.

For implementation in NPDES permits, these water quality objectives would be interpreted as water column concentration targets according to the beneficial uses of the receiving water body, and the receiving waters flow regime:

Exhibit ES-2: Water Column Concentrations (C) Based on Beneficial Use and Water Body Type.

Beneficial Use	Water Body Type	Total Mercury Water Column Target (ng/L)
COMM, WILD, RARE	Flowing water bodies (generally, rivers, creeks and streams)	12
COMM, WILD, RARE	Slow moving water bodies (generally, lagoons and marshes)	4
COMM, WILD, RARE	Lakes and reservoirs	Case-By-Case[1]
T-SUB	Flowing water bodies (generally, rivers, creeks and streams)	4
T-SUB	Slow moving water bodies (generally, lagoons and marshes)	1
SUB	Any	Case-By-Case[1]
1. The permitting authority shall calculate C from the water quality objective, and may use available data, including U.S. EPA national bioaccumulation factors and translators.		

For statewide general implementation of the fish tissue objectives under the proposed Policy, a discharger has RP if there is an annual average exceedance of the water column target associated with the beneficial uses of the receiving water. Those dischargers exhibiting RP were assigned an annual average water quality-based effluent limitation (WQBEL), consistent with the procedures stipulated in the proposed Policy.

To determine whether a discharger would need to potentially reduce mercury concentrations under the proposed Policy, Abt Associates compared the maximum annual average concentration, or maximum effluent concentration (MEC) from the permit (if there are no effluent data in CIWQS), to our projected WQBEL. **Exhibit ES-3** shows the number of dischargers that would need reductions under the proposed policy.

Exhibit ES-3: Estimated Number of Municipal and Industrial Wastewater Dischargers Needing Incremental Reductions for Compliance with Projected Effluent Limits

Category	Type	Number of Affected Facilities
Municipal	Major	12
	Minor	1
Industrial	Major	6
	Minor	3
	Total	22

Abt Associates analyzed effluent data for municipal wastewater treatment plants (WWTPs) in California with secondary and tertiary treatment, Abt Associates estimated that dischargers needing reductions under the proposed Policy can meet the proposed effluent limits through pollution prevention (P2) programs or installation of tertiary filtration. In addition to compliance with effluent limitations, NPDES non-stormwater dischargers in the state may need to either increase the frequency of routine monitoring or utilize more sensitive analytical methods when monitoring.

To determine the statewide costs of compliance, Abt Associates used NPDES permits to classify existing treatment levels at major municipal WWTPs as secondary or tertiary. We assumed that dischargers with secondary treatment currently in place would install tertiary filtration for compliance and dischargers operating tertiary filtration plants that needed mercury reduction would implement P2 programs. For industrial dischargers, because detailed, site-specific information is not available for each facility to indicate the feasibility of P2/source control and advanced end-of-pipe treatment, we estimated costs based on a range of options, with the low end representing implementing P2 or process optimization and the high end representing tertiary filtration.

To capture changes in routine monitoring, Abt Associates conservatively assumed all non-stormwater NPDES permittees subject to the proposed policy would undertake quarterly monitoring and utilize clean-hands sampling methods. This likely represents a substantial overestimate of costs since not all permittees will sample at greater than required frequencies, nor does it take into account existing monitoring costs for mercury which are not attributable to the proposed Policy.

Exhibit ES-4 shows the results of the cost analysis for municipal and industrial dischargers.

Exhibit ES-4: Estimated Annual Incremental Compliance Cost for Municipal and Industrial Plants (2016$ per year).

Category	Type	Annual Incremental Cost ($millions)
Municipal	Major	$2.82
	Minor	$0.17
Industrial	Major	$0.23 - $2.7
	Minor	$0.35 - $4.4
Total		**$3.57 - $10.1**
1. All costs presented in 2016$ and annualized based on a 5% interest rate and 20 year expected project life.		

NPDES Stormwater

The State Water Board is proposing that municipal separate storm sewer systems (MS4s) and industrial stormwater dischargers implement a combination of source control and pollution prevention measures, and sediment and erosion control methods. Under the proposed Policy, MS4s would need to develop and implement programmatic controls for mercury in those communities where such control measures do not yet exist. To comply with the Policy 16 Phase I MS4s and an unknown number of Phase II MS4s would need to develop and implement new source control programs or, as is more likely, augment existing source control programs. Conservatively assuming that all permitted Phase II MS4s in the state and 16 Phase I MS4 were required to augment their pollution prevention programs, the annual incremental cost would be approximately $5.3 million per year. This likely represents a substantial overestimate since the actual number of Phase II MS4s with existing mercury control programs are unknown and the Phase I activities are likely duplicative of similar efforts at large WWTPs. In addition, there may already be controls required under an existing NPDES permit for stormwater dischargers that have not yet been implemented that would also reduce mercury loads; this could negate the need for enhanced controls under the proposed Policy.

Industrial stormwater permittees would need to meet new Numeric Action Levels for mercury (revised from 1,400 ng/L to 300 ng/L). Due to the site-specific nature of these controls, we are unable to develop specific cost estimates associated with the incremental control activities.

Abandoned Mines, Non-Point Sources, Dredging Activities & Wetlands

The proposed Policy does require the implementation of sediment and erosion control measures for all dischargers subject to Title 27 of the California Code of Regulations, section 22510.

In addition, the proposed Policy may result in the implementation of new erosions control measures for some non-point source dischargers, and the implementation of new wetland restoration and dredging management measures to minimize the production and release of methylmercury.

Due to limited available data and the site-specific nature of the control activities likely to occur at these sites, it is infeasible to estimate incremental costs attributable to the proposed Policy for these potentially affected populations. In many cases, existing requirements (e.g., existing sediment and erosion control practices at many abandoned mine sites) are expected to meet the requirements of the proposed Policy without the need to undertake additional control measures.

Summary

Exhibit ES-4 summarizes the estimated total annual incremental costs statewide under the proposed Policy. We were not able to quantify costs for all discharge types included in the Policy due to data limitations.

Exhibit ES-4: Estimated Total Annual Incremental Compliance Cost under Proposed Policy Options (2016$ per year)[1]

Category	Type	Annual Incremental Cost ($millions)
Municipal	Major	$2.82
	Minor	$0.17
	Sub-total	$2.99
Industrial	Major	$0.23 - $2.7
	Minor	$0.35 - $4.4
	Sub-Total	$0.57 - $7.0
MS4s		$5.3
Total		**$8.86 - $15.3**
1. All costs presented in 2016$ and annualized based on a 5% interest rate and 20 year expected project life.		

There are a number of uncertainties and limitations associated with the data and methods we used to estimate the potential incremental costs of the proposed Policy. Data limitations or lack of data altogether resulted in the largest uncertainties. For example, two data limitations led to potential overestimation of potential costs. First, assuming all small MS4s will need to augment or make significant updates to their source control programs. Second, for municipal and industrial dischargers, comparing a single maximum value where sufficient effluent data are available to projected effluent limits that are likely to be implemented as annual averages likely overstates the reductions needed, if any. A third data limitation prevented quantification of costs for industrial stormwater dischargers, mines, dredging, wetlands other nonpoint sources. In contrast, this data limitation potentially results in an underestimation of costs.

Introduction

The California State Water Resources Control Board (State Water Board) is considering fish tissue objectives for mercury for the protection of human health and wildlife, and implementation procedures for the objectives (2016 draft proposed Policy; "the Policy"). This report presents analysis of economic factors related to the proposal, including compliance with the water quality objective options, available methods to achieve compliance with these options, and the costs of those methods.

Need for the Proposed Rule

Under the Clean Water Act (CWA), states have primary authority for establishing designated uses for water bodies, and for developing water quality criteria to protect those designated uses. Under Section 303(c)(2)(B) of the CWA, whenever a state adopts new water quality standards, or reviews or revises existing water quality standards, it must adopt numeric water quality criteria for priority toxic pollutants if the absence of such criteria could reasonably be expected to interfere with a designated use of a water body.

California had been the only state in the nation for which CWA section 303(c)(2)(B) had remained substantially unimplemented after the United State Environmental Protection Agency's (U.S. EPA's) promulgation of the National Toxics Rule in December of 1992. Section 303(c)(4) of the CWA authorizes the U.S. EPA Administrator to promulgate standards where necessary to meet the requirements of the CWA. The Administrator determined that the California Toxics Rule (CTR) was a necessary and important component for the implementation of CWA section 303(c)(2)(B) in California. In promulgating the CTR in 2000, U.S. EPA agreed to update the mercury criteria based on consultation with the U.S. Fish and Wildlife Service and the U.S. National Marine Fisheries Service, pursuant to the Endangered Species Act.

In 2001, after review of the mercury human health criteria [(pursuant to Section 304(a) which requires U.S. EPA to review water quality criteria to ensure that the criteria accurately reflect the latest scientific knowledge on the kind and extent of all identifiable effects of pollutants on human health], U.S. EPA concluded that it is more appropriate to derive a fish tissue quality criterion for methylmercury than a water column-based mercury criterion for protection of human health. A fish tissue criterion is more closely tied to the CWA goal of protecting public health because it is based directly on the dominant human exposure route for methylmercury.

Thus, the State Water Board staff is developing mercury water quality objectives consistent with the U.S. EPA's recommendation. The Policy also establishes procedures for implementing the objectives.

Scope of the Analysis

The Porter-Cologne Water Quality Act requires the Regional Water Boards to take "economic considerations," among other factors, into account when they establish water quality objectives. The other factors include the past, present, and probable future beneficial uses of water; environmental characteristics of the hydrographic unit under consideration; water quality conditions that could reasonably be achieved through the coordinated control of all factors affecting water quality in the area; the need for housing; and the need to develop and use recycled water. The objectives must ensure the reasonable protection of beneficial uses, and the prevention of nuisance.

To meet the economic considerations requirement, the State Water Board (1999; 1994) concluded that, at a minimum, the Regional Water Boards must analyze:

Whether the proposed objective is currently being attained;

If not, what methods are available to achieve compliance; and

The cost of those methods.

If the economic consequences of adoption are potentially significant, the Regional Water Boards must explain why adoption is necessary to ensure reasonable protection of beneficial uses or prevent nuisance. The Boards can adopt objectives despite significant economic consequences; there is no requirement for a formal cost-benefit analysis.[1]

Under a contract with the U.S. EPA, Abt Associates provided the State Water Board with an analysis of economic considerations. Specifically, Abt Associates identified baseline requirements, potentially affected entities, likely incremental compliance actions, and costs for these entities under the proposed Policy.

Organization of this Report

This report is organized as follows:

Section 2 – describes the current applicable objectives and requirements that provide the baseline for the analysis of the incremental impact of the Policy.

Section 3 – describes the proposed Policy.

Section 4 – identifies whether the proposed objectives are currently being met and whether there are any incremental impacts of meeting the objectives.

Section 5 – describes the methods for compliance and their costs.

Section 6 – provides estimates of potential incremental statewide costs of the proposed Policy.

[1] Water quality objectives establish concentrations protective of beneficial uses and the fishable/swimmable goals of the CWA, and thus are based on science and not economics. Economics can play a role in establishing water quality standards through the analysis of use attainability [removal of a beneficial use which is not an existing use under 40 CFR 131.10(g)]. However, the applicable economic criterion in such an analysis is not efficiency (i.e., maximizing net benefits, based on cost-benefit analysis) but distributional impacts (a determination of whether there will be substantial and widespread economic and social impacts from implementing controls more stringent than those required by sections 301(b) and 306 of the CWA). This criterion may also be employed at the local level in the evaluation of temporary variances.

Appendices provide detailed information on total maximum daily load (TMDL) implementation plans, municipal pollution prevention (P2) programs, and incremental compliance/costs associated with numeric water quality based effluent limits (WQBELs).

Baseline for the Analysis

This section describes the applicable baseline for evaluating the potential incremental costs of the proposed Policy options, including current water quality criteria for mercury, potential sources of mercury, and the current levels of mercury impairment of inland surface waters, enclosed bays, and estuaries in California.

Water Quality Objectives

The CTR establishes total recoverable mercury water quality criteria for the protection of human health of 50 nanograms per liter (ng/L) for consumption of water and organisms, and 51 ng/L for consumption of organisms only. These criteria apply to all inland water, enclosed bays, and estuaries in the state, except in waterbodies where site-specific objectives have been established or where a TMDL applies (see Section 0 for a discussion of TMDLs). In addition to these numeric criteria, most Basin Plans also contain narrative criteria related to toxicity or bioaccumulation as shown in **Exhibit 2-1.**

Exhibit Error! No text of specified style in document.-**1: Applicable Existing Basin Plan Objectives**

Region	Narrative Criteria
North Coast (Region 1)	Toxicity – All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life.
San Francisco Bay (Region 2)	Bioaccumulation – Controllable water quality factors shall not cause a detrimental increase in concentrations of toxic substances found in bottom sediments or aquatic life. Toxicity – All waters shall be maintained free of toxic substances in concentrations that are lethal to or that produce other detrimental responses in aquatic organisms.
Central Coast (Region 3)	Toxicity – All waters shall be maintained free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in, human, plant, animal, or aquatic life.
Los Angeles (Region 4)	Bioaccumulation – Toxic pollutants shall not be present at levels that will bioaccumulate in aquatic life to levels which are harmful to aquatic life or human health. Toxicity – All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life.
Central Valley (Region 5)	Toxicity – All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. This objective applies regardless of whether the toxicity is caused by a single substance or the interactive effect of multiple substances.
Lahontan (Region 6)	Effluent discharged to waters of the Region shall contain essentially no mercury. Toxicity – all waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life.

Exhibit Error! No text of specified style in document.-**1: Applicable Existing Basin Plan Objectives**

Region	Narrative Criteria
Colorado River (Region 7)	Toxicity – all waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life. Chemical Constituents – no individual chemical or combination of chemicals shall be present in concentrations that adversely affect beneficial uses. There shall be no increase in hazardous chemical concentrations found in bottom sediments or aquatic life.
Santa Ana (Region 8)	Toxic Substances – Toxic substances shall not be discharged at levels that will bioaccumulate in aquatic resources to levels which are harmful to human health. The concentrations of toxic substances in the water column, sediments or biota shall not adversely affect beneficial uses.
San Diego (Region 9)	Toxicity – All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life.

The San Francisco Regional Water Board also has the following aquatic life criteria for mercury:

Marine 4-day avg: 0.025 micrograms per liter (µg/L) (excludes San Francisco Bay)

Marine 1-hr avg: 2.1 µg/L

Freshwater 4-day avg: 0.025 µg/L

Freshwater 1-hr avg: 2.4 µg/L

The Central Coast Regional Water Board has mercury objectives for agricultural use in livestock watering of 10,000 ng/L and for cold and warm water fisheries of 0.20 µg/L maximum, 0.050 µg/L average, and maximum total mercury in aquatic organism of 500 micrograms per gram (µg/g) wet weight.

Implementation Policy

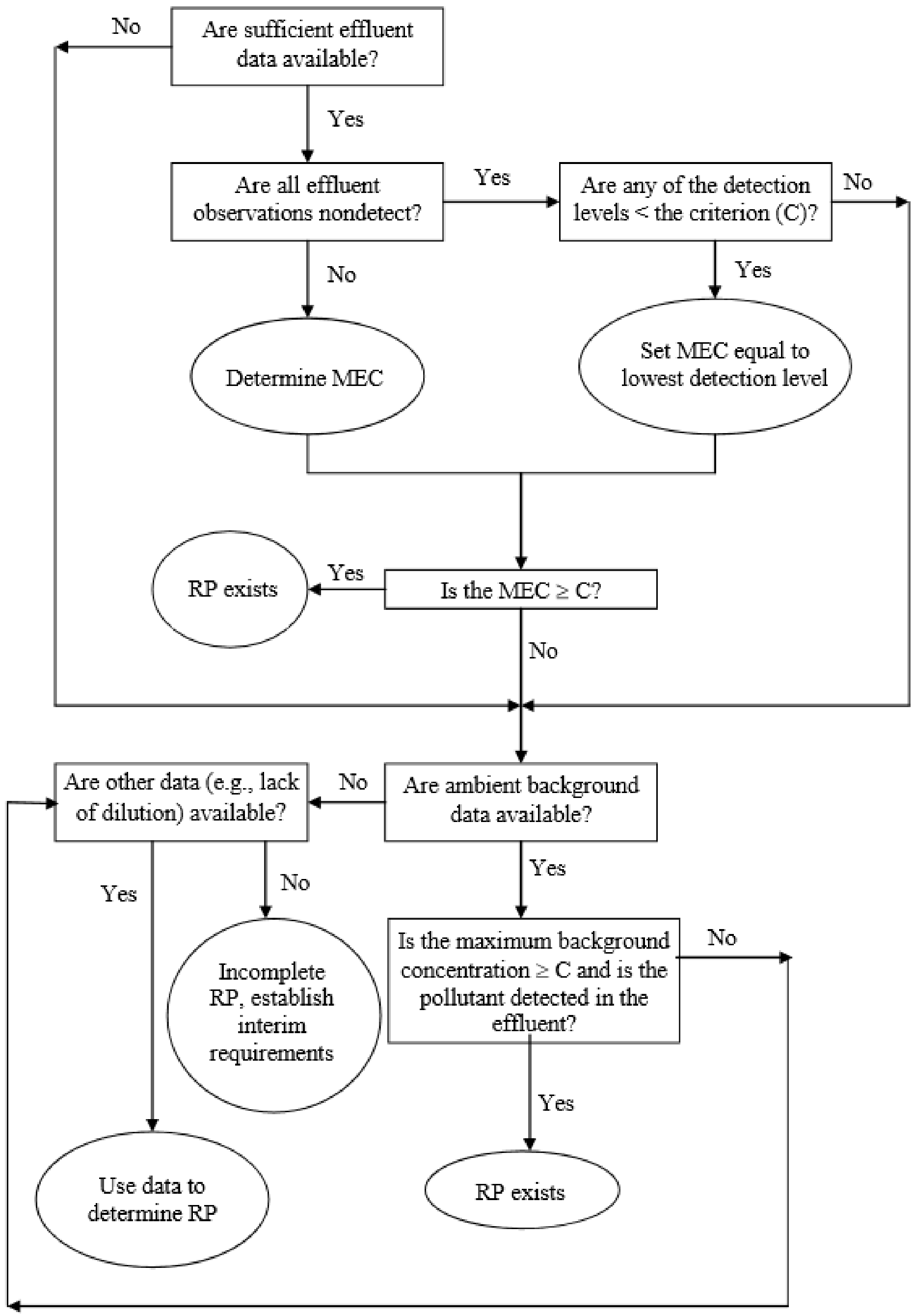
Regional Water Boards currently use the state's Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SIP) to implement CTR criteria in National Pollutant Discharge Elimination System (NPDES) permits. Under the SIP, a permit writer first evaluates whether a facility has reasonable potential (RP) to cause or contribute to an exceedance of the criteria and, if so, calculates effluent limits.

Under the SIP, RP exists if the maximum effluent concentration (MEC) is greater than or equal to the lowest applicable criterion.[2] RP also exists if the maximum ambient concentration is greater than the criterion and the pollutant is detected in the effluent. There is no RP if both the maximum ambient concentration and MEC are lower than the criterion. If data are unavailable or insufficient to conduct the RP analysis, or if all reported detection limits are greater than or equal

[2] If all of the effluent observations are nondetect, the SIP specifies to use the lowest detection limit as the MEC.

to the criterion, the facility receives interim requirements to collect effluent data using sensitive analytical methods. **Exhibit 2-3** shows the process for determining RP using SIP procedures.

Exhibit Error! No text of specified style in document.-**2: SIP Procedures for Determining Reasonable Potential**



For facilities for which there is RP, the first step in the SIP procedures involves calculating the effluent concentration allowance (ECA):

$$ECA = C + D(C - B) \qquad when\ C > B$$

$$ECA = C \qquad when\ C \leq B$$

Where,

C = criterion

D = dilution (ratio of receiving water flow to effluent flow)

B = maximum ambient background concentration

For human health criteria, the average monthly effluent limit (AMEL) is equal to the ECA, and the maximum daily effluent limit (MDEL) would be calculated by multiplying the AMEL by the ratio of the MDEL multiplier to the AMEL multiplier using the following equations:

$$AMEL\ multiplier_{95} = \exp(z\sigma_n - 0.5\sigma_n^2)$$

Where,

σ_n = $[\ln(CV^2/n + 1)]^{0.5}$

σ_n^2 = $\ln(CV^2/n + 1)$

z = 1.645 for 95th percentile probability basis

n = number of samples per month (if sampling frequency is 4 times a month or less, n=4)

CV = coefficient of variation (calculated as the standard deviation divided by the mean)

$$MDEL\ multiplier_{99} = \exp(z\sigma - 0.5\sigma^2)$$

Where,

σ = $[\ln(CV^2 + 1)]^{0.5}$

σ^2 = $\ln(CV^2 + 1)$

z = 2.326 for 99th percentile probability basis

$$MDEL = AMEL * \left(\frac{MDEL_{multiplier99}}{AMEL_{multiplier95}} \right)$$

Note that the SIP specifies use of a CV of 0.6 if there are fewer than 10 samples available, or when more than 80% of the values are nondetect.

Sources of Mercury to Surface Waters

Mercury can be introduced to surface water through natural and human activities (U.S. EPA, 2000). As shown in Section 0, potential mercury sources to surface waters include municipal and industrial point source dischargers, stormwater discharges, resource extraction and mine runoff, runoff and soil erosion from agricultural lands, and air emissions. This section describes the relevant baseline requirements and activities for each of these sources.

Municipal and Industrial Facilities

A number of different industrial, commercial, and institutional facilities discharge mercury to municipal wastewater treatment plant (WWTPs). Dentists and hospitals are some of the most common commercial dischargers of mercury. Other common sources include laboratories, automobile service centers, secondary schools and universities, and potteries (AMSA, 2002). Households may also be a significant source of mercury because human waste contains mercury, as does a number of household products such as toothpaste, deodorant, soaps, household cleaners, food, condiments, contact lens solution, batteries, fluorescent light bulbs, thermometers, thermostats, over-the-counter disinfectants and nasal sprays, cosmetics, paints and coatings, and appliances (e.g., freezer lights, electric space heaters, portable phones) (Huber, 1997).

Industrial processes use or release mercury through five primary routes (Huber, 1997):

Component in equipment

Ingredient in chemicals

Contaminant in raw materials

Intentional use in manufactured products

Incidental release to a production process.

There are approximately 460 NPDES permitted municipal and industrial dischargers in the state and, of these, more than half are expected to fall within the scope of the proposed Policy. Of the potentially affected permittees, 147 are municipal dischargers, 151 are industrial dischargers, and 10 are federally-owned dischargers which primarily discharge treated sanitary waste. **Exhibit 2-3** provides a summary of these California dischargers by discharge type.

Exhibit Error! No text of specified style in document.**-3: Municipal Wastewater Treatment Plants and Industrial Discharges to Inland Surface Waters, Enclosed Bays, and Estuaries in California**

Treatment Facility Type	Major Facilities	Minor Facilities	Total
Municipal	92	55	147
Industrial	23	128	151
Federal	3	7	10
Total	**118**	**190**	**308**
Source: SWRCB (2016).			

Stormwater Discharges

Urban stormwater runoff can be a significant source of mercury to surface waters (SFBRWQCB, 2006). Regional Water Boards regulate most stormwater discharges under general permits.

General permits often require compliance with standards through an iterative approach based on stormwater management plans (SWMPs), rather than through the use of numeric effluent limits. In other words, permittees implement best management practices (BMPs) identified in their SWMPs. Then, if those BMPs do not result in attainment of water quality standards, Regional Water Boards would require additional practices until pollutant levels are reduced to the appropriate levels. Because Regional Water Boards use this iterative approach that increases requirements until water quality objectives are met, current levels of implementation may not reflect the maximum level of control required to meet existing standards (CSU Sacramento, 2005). The State Water Board has four existing programs for controlling pollutants in stormwater runoff to surface waters: municipal, industrial, construction, and California Department of Transportation (Caltrans). Municipal, Caltrans, and industrial stormwater dischargers may have requirements specific to mercury.

Municipal

The municipal program regulates stormwater discharges from municipal separate storm sewer systems (MS4s). The MS4 permits require the discharger to develop and implement a SWMP, with the goal of reducing the discharge of pollutants to the maximum extent practicable (MEP). MEP is the performance standard specified in Section 402(p) of the CWA. The management programs specify the BMPs that will be used to address public education and outreach; illicit discharge detection and elimination; construction and post-construction; and good housekeeping for municipal operations.

There are 22 NPDES permits for large MS4s in California that discharge, at least in part, to inland surface waters, enclosed bays, or estuaries. However, Phase I and Phase II MS4 permits do not specify particular controls for mercury and methylmercury and, instead, rely on implementation of programmatic requirements. **Exhibit 2-4** describes those MS4s with permit requirements or SWMP activities specific to mercury; all MS4s have general requirements to reduce the discharge of pollutants to surface waters.

Exhibit Error! No text of specified style in document.**-4: Permit Requirements and SWMP Activities Specific to Mercury for Large MS4s in California**

MS4 Name (NPDES No.)	Affected Water Bodies	Permit Requirements and SWMP Activities
Region 2 – Municipal Regional Stormwater Permit (CAS612008)	San Francisco Bay; Suisun Bay and Suisun Marsh	• Monitor mercury (Hg) a total of 80 samples per year. • Permittees to collaboratively meet a mercury WLA of 82 kg/year by 2028 (interim target of 120 kg/year by 2018) through a combination of source control, treatment control, and pollution prevention strategies. • Develop and implement an assessment methodology for assessing attainment of mercury load reductions by permittees. • Plan and implement green infrastructure improvements designed to assist in meeting mercury load targets. • Implement a risk reduction program to address public health impacts associated with mercury in San Francisco Bay/Delta fish.

Exhibit Error! No text of specified style in document.-**4: Permit Requirements and SWMP Activities Specific to Mercury for Large MS4s in California**

MS4 Name (NPDES No.)	Affected Water Bodies	Permit Requirements and SWMP Activities
Region 4 – Ventura County (CAS004002)	Ventura River, Santa Clara River, Calleguas Creek, Malibu Creek	• Meet interim mass-based wasteload allocations (WLAs) ranging from 1.7 pounds per year (lbs/year) to 64.4 lbs/year depending on location and flow. • Conduct a source control study, develop, and submit an Urban Water Quality Management Program, and implement program. • In cooperation with agricultural dischargers, include monitoring for mercury (and other metals) in the pesticides TMDL special study.
Region 5 - Sacramento County (CAS082597)	Sacramento-San Joaquin Delta	• Continue to implement the 2004 Hg reduction strategy. • Total Hg and MeHg monitoring in select areas/sites.
Region 5 – East Contra Costa (CAS083313)	Sacramento-San Joaquin Delta	• Meet WLA set in Delta TMDL by 2030. • Implement pollution prevention measures and BMPs to minimize total Hg discharges to meet the Delta TMDL. • Report on the results of Hg monitoring and provide a description of implemented pollution prevention measures and the effectiveness in reducing Hg discharges. • Conduct MeHg control studies to monitor and evaluate the effectiveness of existing BMPs on the control of MeHg, and develop and evaluate additional BMPs as needed to reduce Hg and MeHg discharges to the Delta. • Monitor Hg an average of four wet weather events per year. • Monitor for MeHg an average of two wet and two dry weather events per year.
Region 5 – City of Stockton and San Joaquin County (CAS083470)	Sacramento-San Joaquin Delta	• Develop and implement a Hg reduction strategy. • Total Hg and MeHg monitoring in select areas/sites.

Exhibit Error! No text of specified style in document.-**4: Permit Requirements and SWMP Activities Specific to Mercury for Large MS4s in California**

MS4 Name (NPDES No.)	Affected Water Bodies	Permit Requirements and SWMP Activities
Region 5 - Port Stockton (CAS0084077)	Central Delta and San Joaquin River	• Meet MeHg WLAs set in Delta TMDL by 2030. • Implement pollution prevention measures and BMPs to meet the MeHg WLAs. • Report annually on the results of Hg monitoring and provide a description of implemented pollution prevention measures and the effectiveness in reducing Hg discharges. • If MeHg loads are determined to be greater than the Port's WLAs, conduct control studies to monitor and evaluate the effectiveness of existing BMPs on the control of MeHg, and to develop and evaluate additional BMPs as needed. • Develop, fund, implement, and report on an Exposure Reduction Program. • Monitor for Hg and MeHg using grab samples.
Region 8 – San Bernardino County (CAS618036)	Big Bear Lake	• Participate in the development and implementation of monitoring programs and control measures, including any BMPs that the City is currently implementing or proposing to implement.
Region 8 – Orange County (CAS618030)	Rhine Channel	• Meet WLA for mercury in the Rhine Channel.
BMP = best management practice Hg = Inorganic mercury MeHg = methylmercury WLA = wasteload allocation TMDL = total maximum daily load		

In addition, there are 235 small MS4s required to reduce the discharge of pollutants and comply with any TMDL requirements.

In California, typical permit requirements that are now being included in all Phase I MS4 permits and the Phase II General Permit include:

Specific thresholds for "Priority Projects" that must include both source and treatment control BMPs in the completed projects;

A list of source control (both nonstructural and structural) BMPs and treatment control BMPs to be included or considered;

Specific water quality design volume and/or water quality design flow rate for treatment control BMPs;

A requirement for flow control BMPs when there is potential for downstream erosion; and

Adopt a standard model or template for identifying and documenting BMPs including a plan for long-term operations and maintenance of BMPs.

Caltrans

In 1996, Caltrans requested that the State Water Board consider adopting a single NPDES permit for stormwater discharges from all Caltrans properties, facilities, and activities that would cover both the MS4 requirements and the statewide construction general permit requirements. The State Water Board issued the Caltrans general permit in 1999 and a renewed permit in 2012. The permit requires Caltrans to control pollutant discharges to the MEP and implement a stormwater program designed to achieve compliance with water quality standards, over time through an iterative approach. If discharges are found to be causing or contributing to an exceedance of an applicable objective, Caltrans is required to revise its BMPs (including use of additional and more effective BMPs).

Industrial

Under the industrial program, the State Water Board issues a general NPDES permit that regulates discharges associated with ten broad categories of industrial activities. This general permit requires the implementation of management measures that will achieve the performance standard of best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT). The permit also requires that dischargers develop a Stormwater Pollution Prevention Plan (SWPPP) and a monitoring plan. Through the SWPPP, dischargers must identify sources of pollutants, and describe the means to manage the sources to reduce stormwater pollution. For the monitoring plan, facility operators may participate in group monitoring programs to reduce costs and resources. NPDES permits applicable only to hazardous waste treatment storage or disposal facilities specifically require monitoring for mercury.

Abandoned Mines

Resource extraction (or mining) is the leading cause of mercury impairments throughout the state (see Section 0). Drainage structures and sluices associated with abandoned hydraulic gold mines are a potential source of mercury to surface waters. The California Nonpoint Source (NPS) Program Plan does not contain management measures for abandoned mines, and there is no specific, comprehensive program at either the state or federal level for cleaning up abandoned and inactive mines other than coal. Rather, abandoned and inactive mine cleanup is carried out under a variety of state, federal, and local programs.

Regional Water Boards may issue waste discharge requirements (WDRs) to the most serious sites and include implementation policies regarding mining operations in basin plans. For example, the San Francisco Bay Regional Water Board has a nonpoint source control program for mines and mineral producers. Under this mineral and mining program, the Regional Water Board intends to identify all existing and abandoned mines and mineral production sites and responsible parties, as well as any potential funding alternatives for cleanup activities. Once identified, the Regional Water Board will consider issuing individual permits or a general permit for such discharges, or will otherwise allow coverage under a general permit for stormwater discharges associated with industrial activity.

On the federal level, the Superfund Program addresses the most extreme pollution sites, such as Iron Mountain Mine. Federal land management agencies have specific, marginally funded programs for cleaning up abandoned mines on federal land, but most projects address safety hazards rather than water quality. California's Title 27 Program regulates discharges of wastes to land, and can be used to pursue mine cleanups.

As a land-managing agency, the U.S. Forest Service (USFS) also has an abandoned mine reclamation program. The program includes an inventory of abandoned mines and locations, environmental and/or resource problems present, rehabilitation measures required, and potential sources of funding. The USFS has worked with various Regional Water Boards on numerous occasions in the rehabilitation of mine sites. Restoration funding comes from USFS funds, the Comprehensive Environmental Response and Compensation Liability Act, and Resource Conservation and Recovery Act sources. All lands disturbed by mineral activities must be reclaimed to a condition consistent with resource management plans, including air and water quality requirements (SWRCB, 2000; SWRCB 2003).

Mining projects that could impair water quality or beneficial uses are also subject to NPDES permits or conditions under the CWA section 401 Water Quality Certification Program.

Enforcement actions, however, are costly and have not been effective because responsible parties can be difficult to locate (especially for abandoned mines), and current property owners either do not have or will not spend money to clean up their sites (SWRCB, 2003).

Despite these programs, however, there is no systematic, statewide approach to abandoned mine management. Typically, regulatory agencies in California address sites on a case-by-case basis, and the Office of Mine Reclamation (OMR) focuses abatement efforts on control of water exiting from abandoned mine tunnels.

Air Emissions

Coal-burning power plants are the largest human-caused source of mercury emissions to the air in the United States, accounting for over 50% of all domestic human-caused mercury emissions based on the 2005 National Emissions Inventory. U.S. EPA has estimated that about one quarter of U.S. emissions from coal-burning power plants are deposited within the contiguous United States and the remainder enters the global cycle. Burning hazardous wastes, producing chlorine, and breaking mercury products can also release mercury into the environment. Significant mercury emissions also come from international sources. However, because the State Water Board does not have authority to directly regulate air emissions, we do not include them in the analysis.

Impaired Waters

A 2004 policy establishes procedures for including California waters on the state 303(d) list as impaired. For toxic numeric water quality objectives, a water is impaired if the number of measured exceedances supports rejection of the null hypothesis using the binomial distribution.

For narrative objectives based on the bioaccumulation of pollutants in aquatic life tissue, a water is impaired if the tissue pollutant levels in organisms exceed a pollutant-specific evaluation guideline using the binomial distribution. Regional Water Boards may select evaluation guidelines published by U.S. EPA or the Office of Environmental Health Hazard Assessment (OEHHA). U.S. EPA's evaluation guidelines for mercury tissue concentrations are based on 0.3 mg/kg, and OEHHA's fish contaminant goal is 0.22 mg/kg for protection of women aged 18 to 45 years and children aged 1 to 17 years.

The 2012 303(d) list for California includes 194 inland surface water, enclosed bay, and estuary segments that exceed existing objectives for mercury. However, it is not clear if the CTR objectives or the U.S. EPA and OEHHA fish tissue guidelines are used for assessing the impairment listings. **Exhibit 2-5** summarizes the number of water bodies impaired for mercury by region.

Exhibit Error! No text of specified style in document.**-5: Summary of California 2012 303(d) List of Mercury Impairments**

Regional Water Board	Estuaries, Bays, and Harbors		Lakes /Reservoirs		Rivers /Streams		Total Segments
	Segments	Acres	Segments	Acres	Segments	Miles	
North Coast (1)	0	0	9	26,545	4	1,072	13
San Francisco Bay (2)	16	325,272	16	6,496	4	49	36
Central Coast (3)	0	0	5	12,205	1	10	6
Los Angeles (4)	3	471	6	6,243	2	6	11
Central Valley (5)	8	43,614	47	235,456	53	1,323	108
Lahontan (6)	0	0	6	3,057	7	84	13
Colorado River Basin (7)	0	0	0	0	1	65	1
Santa Ana (8)	1	20	1	2,865	0	0	2
San Diego (9)	1	53	1	1,104	0	0	2
Total	29	369,430	91	293,972	72	2,608	181

Source: SWRCB (2015).
Note: Detail may not add to total due to rounding.

There are a number of different causes of mercury impairment, including resource extraction, nonpoint sources, atmospheric deposition, natural sources, and municipal and industrial point sources. **Exhibit 2-6** summarizes the potential sources of mercury impairments as listed on the 303(d) list (SWRCB, 2015). Note that some segments have multiple potential sources.

Exhibit Error! No text of specified style in document.**-6: Sources of Mercury Impairment of Inland Waters, Enclosed Bays, and Estuaries in California**

Potential Sources	Number of Water Body Segments
Atmospheric Deposition	5
Industrial Wastewater	6
Municipal Wastewater	4
Natural Sources	9

Exhibit Error! No text of specified style in document.-**6: Sources of Mercury Impairment of Inland Waters, Enclosed Bays, and Estuaries in California**

Potential Sources	Number of Water Body Segments
Resource Extraction	13
Source Unknown	181
Unspecified Nonpoint Source	6
Unspecified Point Source	3
Urban Runoff	2
Source: SWRCB (2015).	

Exhibit 2-7 provides a summary of mercury TMDLs for inland surface waters, enclosed bays, and estuaries throughout the state. As part of the TMDL development process, Regional Water Board staff can develop site-specific objectives that are adopted by the Regional Water Board in their Basin Plans, or establish numeric targets that are not adopted in Basin Plans. The summary indicates that several TMDLs already include U.S. EPA's methylmercury fish tissue criterion (0.3 mg/kg) or lower fish tissue concentrations as a numeric target for calculating wasteload allocations (WLAs).

Exhibit Error! No text of specified style in document.-7**: Summary of Mercury TMDLs in California**

TMDL	Numeric Basis for TMDL	Mercury Objective or Target
Region 2		
San Francisco Bay	Objective	0.2 mg/kg Hg, TL3 and TL4 fish (size specified for certain species) 0.03 mg/kg Hg, 3-5 cm fish 0.025 µg/L Hg (4-d average), marine and freshwater 2.1 µg/L Hg (1-hr average), marine 2.4 µg/L Hg (1-hr average), freshwater
Tomales Bay	Target	0.2 mg/kg MeHg, legal halibut (55 cm) 0.05 mg/kg MeHg, 5-15 cm TL3 fish
Walker Creek, Soulajule Reservoir, Guadalupe River[1]	Objective	0.1 mg/kg MeHg,15-35 cm TL3 fish 0.05 mg/kg MeHg, 5-15 cm TL3 fish
Region 3		
Hernandez Reservoir and Clear Creek	Target	0.050 µg/L total Hg 0.3 mg/kg MeHg, fish tissue
Lake Nacimiento and Las Tablas Creek (not approved by State Water Board or U.S.EPA)	Target	0.050 µg/L total Hg 0.486 mg/kg Hg, sediment
Region 4		

Exhibit Error! No text of specified style in document.-7**: Summary of Mercury TMDLs in California**

TMDL	Numeric Basis for TMDL	Mercury Objective or Target
LA Lakes TMDL: El Dorado Park Lakes, Puddingstone Reservoir and Lake Sherwood	Target	0.081 ng/L dissolved MeHg 0.22 mg/kg MeHg, 350 millimeters (mm) largemouth bass
Calleguas Creek Watershed Mugu Lagoon Metals	Target	0.050 µg/L total Hg 0.3 mg/kg MeHg, fish tissue 0.1 mg/kg MeHg, 15-35 cm TL3 fish 0.05 mg/kg MeHg, 5-15 cm TL3 fish 0.03 mg/kg MeHg, fish < 5 cm < 0.5 mg/kg Hg, bird eggs
Dominguez Channel and Greater Los Angeles and Long Beach Harbor Toxics	Target	0.050 µg/L total Hg 0.15 mg/kg Hg, sediment
Region 5		
Clear Lake	Objective	0.19 mg/kg MeHg, 30-40 cm TL4 fish (largemouth bass, catfish, brown bullhead; 20-30 cm crappie) 0.09 mg/kg MeHg, TL3 fish (< 30cm catfish; otherwise no size)
Cache Creek and Bear Creek	Objective	0.23 mg/kg MeHg, 25-35 cm TL4 fish 0.12 mg/kg MeHg, 25-35 cm TL3 fish
Harley Gulch	Objective	0.05 mg/kg MeHg, 7.5 -10 cm TL2 and TL3 fish
Sacramento-San Joaquin Delta & Yolo Bypass	Objective	0.24 mg/kg MeHg, 15-50 cm TL4 fish 0.08 mg/kg MeHg, 15-50 cm TL3 fish 0.03 mg/kg MeHg, fish <5 cm
Sulphur Creek	Objective	1,800 ng/L Hg (low flow) Suspended sediment ratio: 35 mg/kg Hg (high flow)
Region 8		
Toxic Pollutants San Diego Creek and Newport Bay	Target	0.13 ppm dry weight Hg, sediment 0.3 mg/kg MeHg, fish tissue

cm = centimeter
NA = not applicable
Hg = Inorganic mercury
MeHg = methylmercury
mm = millimeters
TL = trophic level
TMDL = total maximum daily load
1. Full water body description: Walker Creek, Soulajule Reservoir and tributaries, Guadalupe River Watershed, except Los Gatos Creek and its tributaries upstream of Vasona Dam, Lake Elsman, Lexington Reservoir, and Vasona Lake.

Implementation plans for these TMDLs outline the requirements by source to meet the TMDL allocations. For example, for the San Francisco Bay Mercury TMDL, municipal and industrial wastewater dischargers are covered under a watershed-based NPDES permit that establishes individual WLAs and effluent limits for each facility, and requires the dischargers to implement source control measures and process optimization to reduce mercury loads. However, based on current effluent concentrations and flows the dischargers are in compliance with the WLAs and mercury reductions are not needed. For watersheds with urban stormwater contributions, MS4 permits include mercury-specific source control or pollution prevention requirements. Other plans require additional studies to better characterize source contributions and mercury methylation. 0 provides detailed descriptions of TMDL implementation plans.

Description of Options

This section describes the November 2016 draft proposed Policy water quality objectives and implementation procedures as outlined in the draft proposed amendment to the SIP .

Water Quality Objectives

The proposed Policy would establish water quality objectives for mercury, as methylmercury concentrations in fish tissue, to protect human health and wildlife.

The water quality objectives that protect people who consume fish apply to waters with the following beneficial uses: commercial and sport fishing (COMM); tribal tradition and culture (CUL); tribal subsistence fishing (T-SUB); and subsistence fishing (SUB).

The water quality objectives that protect wildlife that consume fish apply to waters with the following beneficial uses: wildlife habitat (WILD); marine habitat (MAR); rare, threatened, or endangered species (RARE); warm freshwater habitat (WARM); cold freshwater habitat (COLD); estuarine habitat (EST); and inland saline water habitat (SAL).

Human Health

The State Water Board has proposed three water quality objectives based on the concentration of methylmercury in fish tissue protective of varying populations depending on fish consumption rates (**Exhibit 3-1**). .

Exhibit Error! No text of specified style in document.-**8: Fish Tissue Objective to Protect Human Health**

Water Quality Objective	Protected Beneficial Uses	Calendar Year Average Methylmercury Objective (mg/kg)
Sport Fish	COMM, CUL, WILD, MAR	0.2
Tribal Subsistence Fishing	T-SUB	0.04
Subsistence Fishing	SUB	Site-Specific
mg/kg = milligram per kilogram of fish tissue		

Wildlife

The State Water Board is considering additional mercury water quality objectives to protect threatened and endangered species and other wildlife, also as fish tissue concentrations of methylmercury. The California Least Tern Prey Fish Water Quality Objective would protect sensitive endangered species based on protection of the least tern, a particularly vulnerable species of bird that feeds exclusively on fish. The Prey Fish Water Quality Objective would protect other wildlife species. These objectives would apply to much smaller fish than those consumed by humans (**Exhibit Error**! No text of specified style in document.-**9**).

Exhibit Error! No text of specified style in document.-**9: Fish Tissue Objective to Protect Wildlife**

Water Quality Objective	Protected Beneficial Uses	Methylmercury Objective (mg/kg)

Exhibit Error! No text of specified style in document.-**9: Fish Tissue Objective to Protect Wildlife**

Water Quality Objective	Protected Beneficial Uses	Methylmercury Objective (mg/kg)
Prey Fish[1]	WILD, MAR	0.05[2]
California Least Tern Prey Fish[3]	WILD, MAR, RARE	0.03[4]
1. Objective does not apply to water body segments where the California Least Tern Prey Fish Water Quality Objective applies. Must only be assessed in waters that lack black bass or other trophic level 4 fish. 2. Methylmercury concentration in wet weight fish tissue in fish between 50 to 150 mm in total length during the breeding season. 3. Only applies to habitat of the California lest tern. 4. Average during the period April 1 through August 1. Applicable to wet weight concentration in whole fish less than 50 mm in total length.		

Implementation Procedures

The State Water Board is considering adopting procedures for implementing the objectives, including general procedures for all inland surface waters, enclosed bays, and estuaries. The implementation options would not supersede the implementation plans of any existing mercury TMDL.

NPDES Wastewater

Wastewater point sources typically receive numeric WQBELs following a determination of RP. Under the proposed Policy, the fish tissue water quality objectives would be interpreted as water column concentration, as shown in **Exhibit 3-3**.

Exhibit Error! No text of specified style in document.-**10: Water Column Concentrations (C) Based on Beneficial Use and Water Body Type.**

Beneficial Use	Water Body Type	Total Mercury Water Column Target (ng/L)
COMM, WILD, RARE	Flowing water bodies (generally, rivers, creeks and streams)	12
COMM, WILD, RARE	Slow moving water bodies (generally, lagoons and marshes)	4
COMM, WILD, RARE	Lakes and reservoirs	Case-By-Case[1]
T-SUB	Flowing water bodies (generally, rivers, creeks and streams)	4
T-SUB	Slow moving water bodies (generally, lagoons and marshes)	1
SUB	Any	Case-By-Case[1]
1. The permitting authority shall calculate C from the water quality objective, and may use available data, including U.S. EPA national bioaccumulation factors and translators.		

Currently, the SIP contains procedures for determining RP (see Section 0). Under the proposed policy, the SIP procedures for determining RP would be modified as follows:

Step 1: Replace Step 1 of the SIP with the following: Identify the applicable water column concentration (C) for the lowest (most stringent) mercury water quality objective applicable to the receiving water (denoted as C in the SIP).

Step 2: The proposed Policy makes no changes to Step 2 of the SIP.

Step 3: Replace Step 3 of the SIP with the following: Determine the mercury concentration for the effluent (denoted as MEC in the SIP) using the highest observed annual average effluent mercury concentration. The annual average shall be calculated as an arithmetic mean. For any sample reported as below the detection limit, one half of the detection limit shall be used to calculate the arithmetic mean. For any sample reported as below the quantitation limit and above the detection limit, the estimated concentration shall be used to calculate the arithmetic mean. The annual average concentration is used to account for the long-term nature of the methylmercury bioaccumulation process, which may not otherwise be reflected using the maximum concentration as required by the SIP.

Step 4: Apply as set forth in the SIP, but utilize the annual average mercury concentration from Step 3 (rather than an MEC) to compare to the C from Step 1.

Step 5: Apply as set forth in the SIP, but replace the determination of the "maximum" ambient background concentration for mercury (denoted as B in the SIP), with the highest observed annual average ambient background. The annual average shall be calculated as arithmetic mean as described in Step 3, above.

Once a permit writer determines RP, effluent limits would be set based on procedures at section 1.4 of the SIP with the following alterations:

Step 1: Use the same value for "C" as used for the Reasonable Potential Analysis, rather than the fish tissue mercury water quality objective

Step 2: Apply as set forth in the SIP, except the ambient background concentration (referred to as B in the SIP) shall be calculated as an arithmetic mean as described Step 3 of the RPA, above. Dilution shall be prohibited if the mercury concentrations in fish tissue in the receiving water exceed the mercury water quality objectives.

Steps 3 – 5: Steps 3-5 are inapplicable because the procedures account for short-term averaging periods (1 hour or 4 days) and the exceedance frequencies for aquatic life criteria to protect organisms from toxicity though water contact or ingestion.

Step 6: Set the effluent limitation as an annual average of total mercury (rather than a monthly average) equal to ECA (the same as C). Neither a monthly average effluent limitation nor a maximum daily average effluent limitation shall be calculated because methylmercury toxicity is the result of long term processes, and shorter duration total mercury concentrations may have little significance compared to the long term average.

Step 7: Step 7 is inapplicable because it relates to Steps 3-5.

Under the proposed Policy, the permitting authority is authorized to consider the following exceptions to the RPA and WQBEL calculation process:

1. Small Disadvantaged Communities. The permitting authority is authorized to exempt POTWs serving small disadvantaged communities[3] if the regulator makes a finding that the discharge will have no reasonable potential to cause or contribute to an exceedance of the mercury water quality objectives. For POTWs only serving small disadvantaged communities that do not have an effluent discharge prior to permit issuance or renewal that is representative of the quality of the proposed discharge, the permitting authority is authorized to make this determination and exempt the POTW only after the first year of effluent discharge.
2. Insignificant Discharges. The permitting authority is authorized to exempt certain insignificant dischargers[4] from some or all of the provisions if the permitting authority makes a finding that the discharge will have no reasonable potential to cause or contribute to an exceedance of the mercury water quality objectives.

Under the proposed Policy options, all dischargers are required to use U.S. EPA-approved method that has a quantitation limit lower than 0.5 ng/L for total mercury, and lower than 0.06 ng/L for methylmercury. In addition, NPDES-permitted dischargers are required to perform routine monitoring under the following conditions:

Dischargers with mercury effluent limitations that are authorized to discharge at a rate equal to or greater than five million gallons per day are required to conduct routine total mercury monitoring in the effluent at a frequency no less than once each calendar quarter for the duration of the permit.

Dischargers with mercury effluent limitations that are authorized to discharge at a rate less than five million gallons per day are required to conduct routine total mercury monitoring in the effluent at a frequency no less than once each year for the duration of the permit.

Dischargers without mercury effluent limitations are required to conduct total mercury monitoring in the effluent at a frequency of no less than once per permit cycle.

NPDES Stormwater

Under the proposal, implementation options for NPDES-permitted stormwater dischargers include different BMPs (**Exhibit 3-4**).

[3] Municipalities with populations of 20,000 persons or less, or a reasonably isolated and divisible segment of a larger municipality encompassing 20,000 persons or less, with an annual median household income that is less than 80 percent of the statewide annual median household income.

[4] NPDES discharges that are determined to be a very low threat to water quality by the permitting authority.

Exhibit Error! No text of specified style in document.-**11: Implementation Options for NPDES Stormwater Dischargers**

Applicability	Description
Phase I and Phase II MS4s	Pollution prevention measures; requirements for erosion and sediment controls
Industrial	Revise Numeric Action Level that trigger BMP requirements from 1,400 ng/L to 300 ng/L.
MS4s = municipal separate storm sewer systems	

Pollution prevention measures which may be implemented at Phase I and Phase II MS4s include the following:

Thermometer exchange programs and fluorescent lamp recycling programs, or enhancement of household hazardous waste collection programs to better address mercury-containing waste products (potentially including thermometers and other gauges, batteries, fluorescent and other lamps, switches, relays, sensors and thermostats).

Public education and outreach on disposal of household mercury-containing products and use of non-mercury containing alternatives.

Education of auto dismantlers on how to remove, store, and dispose of mercury switches in autos.

Survey of use, handling, and disposal of mercury-containing products used by the MS4 discharger agencies and development of a policy and time schedule for eliminating the use of mercury containing products by the discharger.

Wetlands

Under the proposed Policy options, the State and Regional Water Board staff may, at their discretion, require project applicants that establish or restore wetlands to include design features or management measures to reduce the production of methylmercury in the wetland, including minimizing the wetting and drying of soil by keeping the wetland flooded and sediment control measures to reduce the transport of total mercury or methylmercury out of the wetland, particularly in areas with elevated mercury concentrations, when adopting, re-issuing, or modifying a water quality certification or WDRs or waivers of WDRs.

Mine Site Remediation

Under the proposed Policy options, the State and Regional Water Board staff shall require implementation of erosion and sediment control measures to prevent or control mercury in discharges when adopting, re-issuing, or modifying WDRs or waivers of WDRs for dischargers subject to the requirements of Title 27 of the California Code of Regulations, section 22510 (closure and post-closure of mining sites), from land where mercury was mined or mercury was used during ore processing.

Non-Point Source Discharges

Under the proposed Policy options, the State and Regional Water Board staff may, at their discretion, require dischargers to implement erosion and sediment control measures in WDRs or waivers of WDRs, particularly in areas with elevated mercury concentrations.

Dredging Activities

Under the proposed Policy options, the State and Regional Water Board staff may, at their discretion, require dischargers to implement total mercury monitoring and procedures to control the disturbance and discharge of mercury-contaminated material during dredging and disposal of dredged material, particularly in areas with elevated mercury concentrations.

Estimated Compliance

This section contains an evaluation of attainment of the water quality objectives based on available discharge data and the potential impacts to dischargers of mercury.

Incrementally Impaired Waters

The proposed Policy does not contain procedures for determining impairments, and it is not clear how the current listing procedures would be applied to the proposed objectives. In addition, no information is available at this time regarding the identities of waters to be classified as T-SUB or SUB, as to be determined by the Regional Water Boards. In the absence of more complete available information, an analysis of incremental impairments was not feasible to complete.

Municipal and Industrial Wastewater

The proposed Policy will only have incremental impacts on municipal WWTPs that are not already covered under an approved TMDL (see **Exhibit** Error! No text of specified style in document.-7Exhibit 2-7) because these waters are exempt from the Policy. The incrementally affected dischargers would be regulated through the general statewide program implementation procedures.

The State Water Board has proposed a series of several fish tissue objectives protective of specific beneficial uses for varying types of water body types, as illustrated in **Exhibit** Error! No text of specified style in document.-**10Exhibit 3-3**. Under the proposed implementation procedures described in section 3, we assess RP, probably WQBELs, and likely compliance scenarios for affected population of municipal and industrial NPDES dischargers.

0 provides the detailed RP and proposed effluent limit compliance analyses for the population of affected NPDES dischargers subject to the proposed Policy. For the incrementally affected dischargers, we used data from California Integrated Water Quality System (CIWQS) database, as available, or the MEC as reported in the facility's permit for the RP and proposed limit compliance analyses. To develop MECs, individual samples for each facility reported from 2009 – 2015 were averaged, arithmetically, on a calendar year basis. In instances where effluent data was not available from CIWQS, the single-sample MEC reported in the plant's NPDES permit were used as the MEC. Use of the MEC from the most recent permit likely results in overestimating potential incremental impacts because actual annual average effluent concentrations on which compliance with effluent limits is likely to be based may be much lower than the reported MEC. Note that effluent data are not available for 66 municipals (29 majors and 37 minors) and 130 industrials (13 majors and 117 minors) from which to estimate compliance with the proposed Policy.

Exhibit Error! No text of specified style in document.-**12Exhibit 4-1** shows the number of municipal and industrial wastewater dischargers that would need to reduce effluent mercury concentrations for compliance with projected effluent limits under the proposed Policy options. Effluent data for minor dischargers are not as readily available as data for major dischargers. However, due to their low flows, they are less likely to have the potential to cause or contribute to exceedances of water quality standards. In many cases, they are also likely to fall under the exemptions for either (1) small disadvantaged communities, or (2) insignificant dischargers.

Exhibit Error! No text of specified style in document.**-12: Estimated Number of Municipal and Industrial Wastewater Dischargers Needing Incremental Reductions for Compliance with Projected Effluent Limits**[1]

Category	Type	Number of Affected Facilities
Municipal	Major	12
	Minor	1
Industrial	Major	6
	Minor	3
	Total	22

NPDES Stormwater

Implementation under the proposed Policy may vary for MS4s, Caltrans permittees, and industrial stormwater dischargers.

MS4s

Under the proposed Policy, the State Water Board and Regional Water Boards must include permit provisions requiring MS4s to implement erosion and sediment control measures for dischargers to waters subject to the proposed Policy. In addition, MS4's would be required to implement pollution prevention measures (e.g., thermometer exchange programs). Under the Policy, Phase I and Phase II MS4s would be required to implement a mercury source reduction program. While general pollution prevention and minimization is required under existing NPDES permits, programs specifically targeting mercury are not a baseline requirement unless an implementation plan for a TMDL requires one. As shown in **Exhibit** Error! No text of specified style in document.-**4Exhibit 2-4**, there are already six large MS4s with requirements to implement mercury source control programs. Thus, municipalities in the remaining 16 large MS4 permits (all of which discharge at least in part to inland surface waters, enclosed bays, and estuaries) may incur incremental costs associated with implementing a mercury source control program under the proposed Policy. However, these MS4s are likely to work in conjunction with the WWTPs incrementally affected by the Policy to implement a municipality-wide program applicable to all sources in the service area.

Caltrans

Under the proposed policy, only municipal and industrial stormwater permittees are subject to implementation requirements. Therefore, Caltrans is not expected to experience incremental impacts or incur incremental costs as a consequence of the proposed Policy.

Industrial Stormwater

The proposed Policy requires the revision of the Numeric Action Level for mercury, which triggers additional BMP controls, to be revised from 1,400 ng/L to 300 ng/L. As described in Section 0, existing NPDES permits require dischargers to identify sources of pollutants, and describe the means to manage the sources to reduce stormwater pollution. However, these control measures may not be sufficient to meet the revised Numeric Action Level for mercury and, therefore, those dischargers affected are likely to incur incremental costs in order to come into compliance with the proposed policy. Due to the site-specific nature of these controls, we are unable to develop specific cost estimates associated with the incremental control activities.

Abandoned Mines, Non-Point Sources, Dredging Activities, & Wetlands

The proposed Policy would not supersede implementation plans of any existing mercury TMDLs. However, the proposed Policy does require the implementation of sediment and erosion control measures for all dischargers subject to Title 27 of the California Code of Regulations, section 22510. In addition, the proposed Policy may result in the implementation of new erosions control measures for some non-point source dischargers, and the implementation of new wetland restoration and dredging management measures to minimize the production and release of methylmercury.

Due to limited available data and the site-specific nature of the control activities likely to occur at these sites, it is infeasible to estimate incremental costs attributable to the proposed Policy for these potentially affected populations. In many cases, existing requirements (e.g., existing sediment and erosion control practices at many abandoned mine sites) are expected to meet the requirements of the proposed Policy without the need to undertake additional control measures.

Compliance Methods and Costs

This section describes available methods for compliance with the objectives, and the costs of those methods.

Municipal Wastewater

For the municipal WWTPs that need to reduce annual average mercury concentrations for compliance with WQBELs under the proposed Policy, control methods could include:

Develop and implement pollution prevention (P2) programs to minimize mercury in sewage

Optimize existing processes to further reduce particle-bound total mercury (e.g., increasing retention in aeration tanks or primary and secondary clarifiers, change chemicals in coagulation to target mercury) or identify unknown sources of mercury (e.g., chlorination chemicals may contain trace amounts of mercury)

Upgrade to tertiary treatment (e.g., multimedia filtration) to remove a greater percentage of particulate mercury.

In addition, a WWTP can increase effluent disposal to land. Although this strategy would not help in lowering concentrations to meet a concentration-based effluent limit, it would reduce total mercury loads to receiving waters by diverting them to land disposal.

Pollution Prevention

P2 or pollution minimization strategies focus on reducing the pollutant at the source where it is more concentrated and may be more easily controlled, rather than treating larger volumes of wastewater to remove diluted contaminants. Because of the cost-effectiveness of source controls, and the lack of cost effectiveness and demonstrated performance from end-of-pipe controls for pollutants like mercury, P2 is a key strategy for compliance with very low effluent limitations.

A number of municipal dischargers have developed P2 programs that provide a basis for estimating P2 components and costs. The costs to municipalities, industries, businesses, and households associated with a municipal P2 program for mercury vary based on the community size and makeup, the extent of P2 efforts already underway, and the knowledge and experience of the municipality in this area. Municipal dischargers would likely target dentists, hospitals, medical facilities, educational institutions (primarily universities and high schools), households, and industries to reduce mercury discharges to the treatment plant. Based on program reports and information from municipalities in California currently implementing mercury P2 programs, components are likely to include:

Wastewater characterization – sampling and analysis of mercury and methylmercury concentrations to characterize pollutant levels at the facility and track treatment effectiveness

Program development – for source identification, materials development, program implementation, and management

Conducting site visits/inspections and holding workshops

Hazardous waste collection programs and mercury-free product replacements

Advertising – to promote and inform the community of various activities and events taking place

Website development – to provide the community with additional resources and serve as another means of promoting P2 activities.

Exhibit 5-1 provides a summary of potential P2 program components and costs for large municipal dischargers that have already implemented such programs. Appendix C provides the details on the costs of each component.

Exhibit Error! No text of specified style in document.-**13: Mercury P2 Program Components and Potential Costs of Large WWTP (> 20 mgd)**

Component	Annual Cost ($2016)[1]
Wastewater Characterization	$12,000
Program Development/Operation	$129,000
Site Visits and Workshops	$62,000
Mercury-Free Products	$4,000
Advertising	$8,000
Website Development/Maintenance	$2,000
Total	$217,000

mgd = million gallons per day
P2 = pollution prevention program
WWTP = wastewater treatment plant
1. Costs reflect experiences of large communities. Costs for a number of components (e.g., program development; site visits and workshops) may be proportionately less for smaller communities.

With total potential costs for larger municipalities approximating $220,000 per year, costs for medium-sized municipal dischargers (e.g., 5 to 20 mgd) may be in the range of $170,000 annually, and for small municipal major dischargers (e.g., 1 to 5 mgd) in the range of $110,000 annually. Minor municipal dischargers serve much smaller areas and populations than major dischargers and have fewer mercury sources to target. Thus, cost may be substantially less (e.g., half) of that for small major WWTP, or in the range of $60,000 annually. Actual costs will vary with community makeup and other factors including the ability to adopt or reuse off the efforts of other municipalities.

Process Optimization

Process optimization entails adjusting existing treatment technologies to obtain additional pollutant removals. It would likely be another low-cost means for attaining compliance with mercury effluent limitations. This option would be most feasible where relatively low pollutant reductions are needed or monitoring data indicate that pollutant loads increase throughout the treatment process as a result of chemical additions or treatment techniques.

Process optimization usually involves process analysis and process modifications. Process analysis is an investigation of the performance-limiting factors of the treatment process and is a key factor in achieving optimum treatment efficiency. Performance-limiting factors for common wastewater treatment processes (e.g., sedimentation, activated sludge, filtration) may include operator training, response to changes in wastewater quality, maintenance activities, automation, and process control testing. The cost of process analysis includes the cost of additional or continuous monitoring throughout the treatment process, and a treatment performance evaluation. These costs vary based on the number of treatment processes analyzed and the magnitude of the reductions needed.

Process modifications include activities short of adding new treatment technology units (conventional or unconventional) to the treatment train. For increasing pollutant removal efficiencies, process modifications could include adjusting coagulant doses to increase settling, equalizing flow if pollutant concentrations spike during wet weather events, increasing filter maintenance activities or backwash cycle frequency, training operators, and installing automation equipment including necessary hardware and software. Several months of adjustments may be needed to achieve a desired level of process optimization. In practice, the process modifications necessary would be determined by the process analysis study.

Treatment processes vary widely among industrial facilities. Thus, identifying specific process modifications applicable or appropriate for any particular industrial discharger is site specific. Optimizing municipal wastewater treatment for mercury removal involves maximizing solids removal because secondary and tertiary treatment technologies primarily remove particulates. Operational changes that can be made to increase solids removal include (Metcalf and Eddy, 2003):

Check for short circuiting

Modify baffling

Addition of chemicals

Reduce return flows from other processes

Modify backwash frequency for tertiary filtration.

In addition to operational changes, plant managers can also upgrade physical facilities to improve treatment performance. For example, remedial actions to address inadequate solids removal could include (Metcalf and Eddy, 2003):

Addition of chemical treatment and flocculation

Addition of high-rate clarification

Install baffles at effluent weirs

Addition of energy dissipation inlet

Modify flow distribution

Modify circular clarifier center feedwell (secondary clarifiers)

Add tube or plate settlers to secondary clarifiers

Modify effluent weir configuration

Addition of flow equalization to prevent solids washout in biological treatment or overloads.

In addition, chemicals used in wastewater treatment could contain contaminants (e.g., chlorine contaminated with low levels of mercury). Thus, switching chemicals or the source of chemicals could be another low-cost process optimization control option.

The effectiveness of process optimization largely depends on the efficiency of current operations, the existing treatment processes, and the fate and transport of the pollutant through the treatment train. For example, if a facility is already well maintained and operated, process optimization may not result in additional pollutant reductions because the existing treatment processes are already performing at their feasible limits. Also, because most conventional treatment technologies are designed to maximize removal of suspended solids, process optimization aimed at increasing those removal efficiencies may not result in significant reductions for pollutants existing primarily in dissolved form. Given the available information for the affected facilities, it is generally not possible to determine the reductions achievable with process optimization; rather, a detailed, site-specific study would be necessary.

Tertiary Treatment

In California, a number of WWTPs have installed tertiary treatment processes to comply with other NPDES requirements such as Title 22 regulations (for reuse) or numeric limits for pollutants such as ammonia. Thus, the State Water Board already considers these controls to be feasible for most treatment plants. While not typically designed to specifically remove mercury, tertiary treatment can achieve relatively low levels of mercury in the effluent because mercury is most commonly attached to particulate matter, and technologies such as filtration maximize removal of suspended solids.

For California, data from the CIWQS database provide some indication of achievable effluent concentrations from municipal dischargers using secondary versus tertiary treatment. Treatment levels are indicated in facility NPDES permits. We included dischargers with effluent data reported from 2009 through 2015 and excluded dischargers for which all values are non-detect above 200 ng/L because they are not using clean analytical methods; other non-detect values are included at the reported detection limit. Tertiary treatment consists solely of filtration; none of the facilities employ treatment technologies such as reverse osmosis or ion exchange.

When compared to the potential aqueous mercury targets, approximately 70% of secondary treatment plants have average discharge concentrations that would comply with the target of 12 ng/L. For tertiary treatment plants, approximately 70% are discharging less than the aqueous target of 4 ng/L total mercury, on average. However, only approximately 20% of tertiary treatment plants are discharging below the lowest aqueous target of 1 ng/L. **Exhibit 5-2** summarizes these results.

Exhibit Error! No text of specified style in document.-**14: Percent of Dischargers with Average Annual Mercury Concentrations Below Specified Level**

Treatment Level	No. with Sufficient Data	Aqueous Mercury Targets		
		<12 ng/L	<4 ng/L	<1 ng/L
Secondary	44	68%	50%	16%
Tertiary	59	83%	69%	20%
ng/L = nanograms per liter				

As shown in Appendix B, all municipal and industrial point source dischargers with readily available effluent mercury data are anticipated to be associated with the 12 ng/L water column concentration target. However, among the rest of the affected population, it is uncertain which specific dischargers may be assigned more stringent water column concentration targets. Consequently, incremental control costs under the proposed Policy were estimated on the basis of meeting the 12 ng/L water column target for flowing waters. As discussed below, it is anticipated that permittees which must meet more stringent targets, may feasibly do so through a combination of mercury P2 programs and tertiary treatment technologies. Since we assume similar control strategies for both the 12 ng/L target and the 4 ng/L target, incremental control costs for P2 programs and for end-of-pipe treatment (i.e., tertiary filtration) are expected to be very similar on a unit cost basis.

A detailed study of the fate and transport of mercury at the San Jose/Santa Clara Water Pollution Control Plant (WPCP) showed that total average mercury concentrations after primary treatment were 87.6 ng/L (SJSC WPCP, 2007). The secondary treatment (i.e., activated sludge with nitrification) processes further reduced the average total mercury concentrations by 94% to 5.2 ng/L (SJSC WPCP, 2007). The subsequent tertiary filtration process reduced total mercury from 5.0 ng/L to 2.2 ng/L (an additional 56% reduction) (SJSC WPCP, 2007). Note that this facility also has a mercury P2 program already in place, and is likely operating optimally.

Given these data, we assumed that most municipal WWTPs operating secondary treatment could upgrade to tertiary treatment and achieve effluent mercury concentrations of 4 ng/L or less. However, WWTPs that need reductions to meet limits corresponding to lower values, such as those derived from the tribal subsistence objective (1 ng/L), may not be able to do so with tertiary treatment. Due to limited available information on the permittees likely to be subject to this target, this analysis does not estimate costs for complying with the 1 ng/L target. The State Water Board or Regional Water Boards may use compliance schedules, site-specific objectives (with extended compliance schedules), TMDLs, or variances if the effluent limitation is unachievable. In cases where variances are adopted, it is anticipated that Regional Water Boards would require the implementation of source control measures and tertiary treatment as a condition of the variance.

Paranjape et. al (2010) estimated costs for various types of tertiary filtration for the Westside Regional WWTP in Florida. Similar to California, a number of WWTPs in Florida need tertiary filtration to meet the treatment standards for wastewater reuse. We calculated unit costs by dividing the total estimated capital and operation and maintenance (O&M) costs by the applicable flows, and escalated to 2013 dollars using the Engineering New Record (ENR) Construction Cost Index (CCI). **Exhibit 5-3** shows the unit costs for various types of tertiary filters.

Exhibit Error! No text of specified style in document.**-15: Estimated Capital and O&M Unit Cost for Tertiary Filtration ($2016)**

Filtration Technology	Peak Loading Rates (gpm/ft2)	Power Consumption (kW-hr/year)	Land Required (ft2)	Capital Unit Cost ($2016/gpd)[1]	O&M Unit Cost ($2016/MG)[2]
Deep bed granular media filters	5 - 8	66,000	12,900	$1.07	$50.18
Cloth media filters	6.5	20,000 - 30,000	4,200 - 19,000	$1.20	$59.46
High-rate disk filters	16	260,000	1,800	$0.89	$70.19
Compressible synthetic media filters	30	997,000	3,500	$1.41	$78.61

Source: Based on information in Paranjape, et al. (2010).
ft2 = square feet
gpd = gallons per day
gpm = gallons per minute
kW-hr = kilowatt hour
MG = million gallons treated
O&M = operation & maintenance
1. Includes installation (10%-25% of equipment), concrete ($650/yd3), building ($125/ft2), project contingency (10%-30%), contractor general conditions, overhead and profit, sales tax, escalation, engineering and administration. Excludes potential costs of purchasing additional land. Unit costs derived by dividing total capital cost by the facility design flow of 15 mgd, and escalating to 2016 dollars using the ENR CCI.
2. Includes energy ($0.065 kW-hr), labor ($25/hr), and media replacement (total replacement cost divided by 20 years). Unit costs derived by dividing total O&M costs by the facility average daily flow of 7.1 mgd and 365 days per year.

Based on these data, average capital unit costs could be approximately $1.14 per gallon per day, and O&M costs could be approximately $65 per million gallons treated.

Routine and Compliance Monitoring

Under the proposed Policy, prescriptive monitoring frequencies have been proposed for routine monitoring and for compliance monitoring when an effluent limitation has been established. In addition, there is a strong incentive for permittees to utilize clean-hands sampling techniques and analytical methods with low detection limits since, under the proposed policy, RP may be determined on the basis of low sensitivity analytical methods in the absence of a detection in the effluent. Since compliance and RP is determined on the basis of an annual average and not on individual sampling events, there is an additional incentive to sample more frequently in order to minimize the effect of occasional high sample values.

Therefore, we have developed estimated costs for performing total mercury monitoring which assumes the use of sensitive methods and a high test frequency (i.e., once per quarter) for all potentially affected NPDES permittees. **Exhibit 5-4** illustrates the estimated costs anticipated under these assumptions.

Exhibit Error! No text of specified style in document.**-16: Estimated Annual Total Mercury Effluent Monitoring Costs**

Discharger Type	No. of Potentially Affected Dischargers	Annual Monitoring Cost[1, 2]
Municipal Majors	95	$174,000
Municipal Minors	62	$114, 00
Industrial Majors	23	$42,000
Industrial Minors	128	$235,000
Total	**308**	**$565,000**

Source: Based on information in proposed Policy Staff Report (Appendix P)
1. Costs do not account for baseline monitoring requirements in NPDES permits and, thus, are likely to be substantial overestimates of potential costs.
2. Costs are rounded. Total results may not sum to those presented due to rounding.

Industrial Wastewater

For the industrial dischargers that need to reduce annual average mercury concentrations for compliance with WQBELs under the proposed Policy, control methods could include:

- Develop and implement P2 programs to minimize mercury within industrial processes
- Install end-of-pipe treatment (e.g., multimedia filtration) to remove a greater percentage of mercury.

In addition, as with municipal WWTPs, effluent disposal to land helps reduce total mercury loads, but not concentrations, unless the entire discharge to surface waters is eliminated.

Pollution Prevention

There is little information available on the cost of mercury P2 programs for industrial dischargers because facility budgets typically do not account for pollutant-specific P2 costs as an item that can be verified apart from other source control costs. For example, one industrial discharger spends between $5 and $6 million a year on waste minimization and P2 activities for a variety of pollutants and media (e.g., air, water, solid wastes), but only a small portion of that is related to mercury (Barrett, 2005). In addition, P2 activities for industrial dischargers vary greatly based on facility type, volume of wastewater discharged, existing wastewater treatment processes (if any), and the manufacturing processes and chemicals potentially responsible for mercury loads.

For example, a discharger that uses chlorine for disinfection or to prevent scaling may find that the type of chlorine used is contaminated with mercury. Reducing effluent mercury concentrations could be as simple as switching to mercury-free chlorine. However, the identification of sources and solutions may not be as straightforward at another type of industrial facility, especially those with multiple internal waste streams and industrial processes. Despite these differences though, industrial facilities will likely implement the basic components of a P2 program, including process analysis and process modifications.

During process analysis the discharger would identify pollutant uses and quantities within the facility (i.e., inventory facility), identify pollutant use and potential contamination in process streams, and identify P2 options for reducing the pollutant at the plant (e.g., on-going management of pollutants, recycling, and product and raw material substitutions). After the process analysis step, the discharger would need to implement the identified P2 options and make any necessary process modifications.

Assuming a two-month (approximately 340 hours) study to identify potential pollutant sources and sample process waste streams, and the average hourly wage in California for an environmental engineer [$49.03 per hour, including employer benefits (BLS, 2016; 2014b)], study costs may be approximately $25,000 (340 × $49.03; rounded up to $25,000).[5]

We assumed that industrial wastewater dischargers would monitor mercury and methylmercury in the influent (or internal waste stream, depending on the set up) and effluent, as discussed above for municipal wastewater dischargers. Costs for these analyses could be approximately $985 per event, or $12,000 for monthly samples over a year. Thus, total process analysis for industrial facilities would be approximately $37,000 ($25,000 + $12,000).

Process analysis costs will likely only be incurred during the first year. However, because process modifications are highly site-specific, we assumed that facilities would continue to incur the process analysis cost of $37,000 per year to monitor and evaluate any process modifications such as replacing mercury-containing equipment at the end of its useful life, product substitution, switching chemical manufacturers, or installing treatment on internal waste stream where mercury is most concentrated.

End-of-Pipe Treatment

There are a number of end-of-pipe treatment technologies that could remove mercury from industrial wastewaters. The selection of specific technologies would be facility- and process-specific. Given the performance data for tertiary filtration for municipal WWTP, we assumed that filtration would also be an effective option for industrial wastewaters as well. A detailed facility-level analysis would be needed to identify the variety of treatment controls applicable to the incrementally affected industrial dischargers in California. For example, if a facility is

[5] BLS (2013) describes an environmental engineer (standard occupations classification 17-2081) as one that can "design, plan, or perform engineering duties in the prevention, control, and remediation of environmental health hazards utilizing various engineering disciplines" and "work may include waste treatment, site remediation, or pollution control technology."

primarily discharging dissolved mercury and not particulate mercury, media filtration is not likely to have much impact on effluent concentrations; controls such as reverse osmosis may be necessary to target the dissolved fraction of mercury in the effluent.

Of the affected population with available data, no permittees are expected to be subject to the 4 ng/L target. Instead, all will likely be required to comply with the 12 ng/L target. However, we anticipate that some number of dischargers lacking available data for this analysis discharging to wetlands or marshes may be subject to the 4 ng/L target. Those permittees subject to the 4 ng/L target and unable to immediately comply would most likely adopt end-of-pipe filtration treatment in order to comply with mercury effluent limitations.

Due to limited available information on the permittees likely to be subject to the 1 ng/L target, this analysis does not estimate costs for complying with the 1 ng/L target. The State Water Board or Regional Water Boards may use compliance schedules, site-specific objectives (with extended compliance schedules), TMDLs, or variances if the effluent limitation is unachievable. In cases where variances are adopted, it is anticipated that Regional Water Boards would require the implementation of source control measures and tertiary treatment as a condition of the variance.

Costs for filtration for industrial wastewater could be similar to those presented in **Exhibit 5-3**.

NPDES Stormwater

Under the Policy, Phase I and Phase II MS4s would be required to implement a mercury source reduction program. While general pollution prevention and minimization is required under existing NPDES permits, programs specifically targeting mercury are not a baseline requirement unless an implementation plan for a TMDL requires one. As shown in Exhibit **2-4**, there are already six large MS4s with requirements to implement mercury source control programs. Thus, municipalities in the remaining 16 large MS4 permits (all of which discharge at least in part to inland surface waters, enclosed bays, and estuaries) may incur incremental costs associated with implementing a mercury source control program under the proposed Policy. However, these MS4s are likely to work in conjunction with the WWTPs incrementally affected by the Policy to implement a municipality-wide program applicable to all sources in the service area. Therefore, these costs are similar to the municipal point source costs discussed above.

If the Phase I and Phase II MS4s were to required to augment their existing pollution prevention programs we would expect them to incur costs at approximately 30 percent the rate of similar WWTP implementing a *de novo* P2 program—or approximately $66,000 per large MS4 and $18,000 for a small MS4. However, this likely represents a substantial overestimate since the actual number of Phase II MS4s with existing mercury control programs are unknown and the Phase I activities are likely to duplicative of similar efforts at large WWTPs. In addition, there may already be controls required under an existing NPDES permit for stormwater dischargers that have not yet been implemented that would also reduce mercury loads; this could negate the need for enhanced controls under the proposed Policy.

Statewide Costs

This section provides descriptions of the methods we used to estimate incremental statewide costs associated with the proposed Policy options and results.

Municipal Wastewater

To estimate total statewide incremental compliance costs, we used the following decision matrix based on the type of existing treatment train currently operating at each WWTP (**Exhibit 6-1**).

Exhibit Error! No text of specified style in document.-17**: Potential Controls Needed for Compliance with Proposed WQBELs for Municipal WWTPs**

Existing Treatment Level	Controls Needed[1]	
	Max. Annual Average < WQBEL	Max Annual Average > WQBEL
Secondary	None	Filtration[2]
Tertiary	None	P2 or Process Optimization[2]

P2 = pollution prevention program
WQBEL = water quality based effluent limit
WWTP = wastewater treatment plant
1. We compared the maximum annual average mercury concentration to the proposed WQBEL to determine compliance. If annual average data were not available, we used the MEC in the discharger's National Pollutant Discharge Elimination System (NPDES) permit.
2. For dischargers that need to meet effluent limits of 1 ng/L, the State Water Board or Regional Water Boards may use compliance schedules, site-specific objectives (with extended compliance schedules), TMDLs, or variances if the effluent limitation is unachievable. In cases where variances are adopted, it is anticipated that Regional Water Boards would require the implementation of source control measures and tertiary treatment as a condition of the variance..

For existing tertiary treatment plants, process optimization costs are highly facility-specific, and we do not have the necessary data to estimate such costs. However, the annual costs are likely much less than the cost of installing filtration. Thus, in the absence of process optimization costs we used annual P2 program implementation costs for tertiary WWTPs needing reductions to comply with WQBELs under the proposed Policy.

We estimated the annual incremental compliance costs under the proposed Policy to be approximately $2.99 million per year in total ($2,816,000 per for majors, and $174,000 per year for minors) for municipal plants. These costs are included in the costs summarized for the Policy in Exhibit 6-2 and Exhibit 6-3. Beneficial uses associated with the most stringent water column target (1 ng/L) have not been assessed. For plants discharging to waters with T-SUB or SUB beneficial, we estimate that those dischargers would install tertiary filters at unit capital costs of $1.14/gpd and unit O&M costs of $64.61/million gallon, and would be likely to pursue a variance. These costs would be in addition to the costs summarized for the Policy in Exhibit 6-2 and Exhibit 6-3. 0 shows the detailed estimated cost for each discharger needing reductions under the proposed Policy.

Industrial Wastewater

For industrial facilities, we estimated a range of potential incremental costs based on dischargers either implementing P2 programs (low cost estimate) or installing media filtration end-of-pipe (high cost estimate). Detailed data on existing treatment trains, industrial process operations, chemical usage, potential for product substitutions, and the form of mercury in effluents would be necessary for facility-specific estimates. **Exhibit Error!** No text of specified style in document.-**18** summarizes the costs for industrial dischargers with data indicating a need for reductions to comply with proposed WQBELs.

Exhibit Error! No text of specified style in document.-**18: Estimated Total Annual Incremental Compliance Cost for Industrial Dischargers ($2016 million per year)1**

Industrial Facility Type	Incremental Cost Range ($millions/year)
Majors	$0.23 - $2.7
Minors	$0.35 - $4.4
Total	$0.57 - $7.0
1. Range of costs based on dischargers implementing P2/source control programs (low cost) or filtration (high cost), and monitoring.	

MS4 Stormwater

If Phase I and Phase II MS4s were required to augment their existing pollution prevention programs we would expect them to incur costs at approximately 30 percent the rate of similar WWTP implementing a *de novo* P2 program—or approximately $66,000 per large MS4 and $18,000 for a small MS4. Assuming all Phase II MS4s and those large MS4s without existing mercury P2 programs incurred these costs, the expected incremental compliance cost is approximately $5.3 million per year. However, this likely represents a substantial overestimate since the actual number of Phase II MS4s with existing mercury control programs are unknown and the Phase I activities are likely to duplicative of similar efforts at large WWTPs. In addition, there may already be controls required under an existing NPDES permit for stormwater dischargers that have not yet been implemented that would also reduce mercury loads; this could negate the need for enhanced controls under the proposed Policy.

Total Incremental Costs

Exhibit 6-3 summarizes the total estimated annual incremental costs statewide. We were not able to quantify costs to stormwater dischargers, abandoned mines, dredging, wetlands, and other nonpoint sources due to data limitations.

Exhibit Error! No text of specified style in document.-**19: Estimated Total Annual Incremental Compliance Cost under Proposed Policy Options ($2016 per year)**[1]

Category	Type	Annual Incremental Cost ($millions)
Municipal	Major	$2.82
	Minor	$0.17
	Sub-total	$2.99
Industrial	Major	$0.23 - $2.7
	Minor	$0.35 - $4.4
	Sub-Total	$0.57 - $7.0
MS4s		$5.3
Total		**$8.86 - $15.3**
1. All costs presented in 2016$ and annualized based on a 5% interest rate and 20 year expected project life.		

Limitations and Uncertainties

There are a number of uncertainties and limitations associated with the data and methods we used to estimate the potential incremental costs of the proposed Policy. **Exhibit 6-4** provides a summary of these uncertainties and the potential impact on the cost estimates.

Exhibit Error! No text of specified style in document.-**20: Summary of Limitations and Uncertainties of the Analysis**

Assumption/Uncertainty	Potential Impact on Costs	Explanation
Compared the MEC as reported in the NPDES permit to the proposed WQBEL to determine potential reductions needed when effluent data are not available to calculate an annual average concentration,.	+	A single maximum concentration likely overestimates the long-term or annual average concentration on which compliance with effluent limits is likely to be measured.
Unable to assign newly developed beneficial uses to waterbodies.	-	Insufficient information was available to anticipate where newly developed beneficial uses will be assigned to waterbodies or to develop site-specific water column targets. These beneficial uses will likely be associated with lower water column targets than existing beneficial uses.

Exhibit Error! No text of specified style in document.-**20: Summary of Limitations and Uncertainties of the Analysis**

Assumption/Uncertainty	Potential Impact on Costs	Explanation
Unable to assign cost based on slow moving water bodies.	-	At this time, insufficient information exists regarding which waterbodies will be assigned a "slow moving" status by Regional Water Boards. Costs for complying with the 12 ng/L target and 4 ng/L target are approximately similar. Among permittees subject to the 4 ng/L target, costs are expected to increase for those permittees already complying with the 12 ng/L target but who are unable to comply with the lower 4 ng/L target.
Did not consider background in assessing reasonable potential due to limited availability of data.	-	Had complete background datasets been available, additional permittees may have received effluent limitations in the analysis.
Assumed greater frequencies for routine monitoring than required under the proposed policy, and did not account for baseline monitoring requirements in existing NPDES permits.	+	Many dischargers currently incur monitoring costs in their existing NPDES permits which are not attributable to the proposed Policy. In addition, some dischargers may not utilize greater than required monitoring frequencies even when doing so may be in their interest.
For industrial dischargers, estimated costs based on implementation of either P2/source control programs or filtration.	?	The selection of technologies would be facility- and process-specific. Detailed data on existing treatment, industrial operations, chemical usage, potential for product substitutions, and the form of mercury in effluents would be necessary for facility-specific estimates
Based urban stormwater, - and industrial stormwater unit costs on a range of potential BMPs.	?	The mix of stormwater controls that would be needed for compliance is site-specific. The incremental level of control needed also depends on existing permit requirements and level of existing BMP implementation.
Prevalence of existing pollution prevention programs at MS4s	+	Due to a lack of site-specific data, estimates are likely a substantial overestimate.
Did not estimate the incremental cost associated with the shift in abandoned mine clean-ups.	?	Lack of sufficient data for the location of abandoned mines from which to identify those potentially affecting impaired waters.
Unable to estimate cost associated with dredging, wetlands, and other nonpoint sources.	?	Lack of sufficient data on the number of sites where requirements might increase costs.

Exhibit Error! No text of specified style in document.-**20: Summary of Limitations and Uncertainties of the Analysis**

Assumption/Uncertainty	Potential Impact on Costs	Explanation
Key: "+" = potential costs likely overestimated "-" = potential costs likely underestimated "?" = impact on cost unknown		

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TMDL Implementation Plans

Exhibit A-1: Allocations and Implementation Plans for Mercury TMDLs

Source	Allocations	Implementation Plan
San Francisco Bay (SFBRWQCB, 2006)		
Bed erosion	220 kg Hg/yr (53% reduction)	None identified
Central Valley watershed	330 kg Hg/yr (24% reduction)	See Delta TMDL for details
Urban stormwater	82 kg Hg/yr (48% reduction)	Monitor MeHg levels and implement source control under watershed permit for large MS4s
Guadalupe River watershed	2 kg Hg/yr (98% reduction)	See Guadalupe River TMDL for details
Atmospheric deposition	27 kg Hg/yr (current)	No mandated actions
Nonurban stormwater	25 kg Hg/yr (current)	None identified
Municipal wastewater	11 kg Hg/yr (35% reduction)	Comply with watershed permit (e.g., implement source control and process optimization)
Industrial wastewater	1.3 kg Hg/yr (current)	Comply with watershed permit (e.g., implement source control and process optimization)
Guadalupe River Watershed (SFBRWQCB, 2008a; 2014)		
Mining waste	0.2 mg Hg/kg (dry wt., median) in erodible waste and erodible sediment from depositional areas in creeks that drain mercury mines	Identify potential for mining waste runoff and implement erosion controls
Impoundments	1.5 ng MeHg/L in the hypolimnion of impoundments downstream of mercury mines	Conduct studies on the suppression of mercury methylation in impoundments
Urban stormwater	0.2 mg Hg/kg suspended sediment (dry wt., annual median)	Covered under San Francisco Bay watershed permit for MS4s
Nonurban stormwater	0.1 mg Hg/kg suspended sediment (dry wt., annual median)	None
Atmospheric deposition	23.2 µg Hg/sm/yr	No mandated actions
Walker Creek (SFBRWQCB, 2008b)		
Background (areas not near Gambonini Mine)	0.2 mg Hg/kg (sediments)	None

Exhibit A-1: Allocations and Implementation Plans for Mercury TMDLs

Source	Allocations	Implementation Plan
Downstream depositional areas	0.5 mg Hg/kg in suspended particulates (d/s of creekside lands adjacent to Arroyo Sausal, Salmon and Walker creeks)	Dischargers under WDRs or waivers of WDRs to control pathogens, nutrients, or sediments or Section 401 projects must incorporate management practices or provisions that minimize Hg discharges and MeHg production. Comply with conditions of Marin County's Creek Permit Program Update Marin County's Creek Permit Guidance for Unincorporated Areas of Marin to include specific guidance for projects in areas that may contain Hg-enriched sediments
Soulajule Reservoir	0.04 ng dissolved MeHg/L	Submit a monitoring and implementation plan and schedule to characterize fish tissue, water, and suspended sediment Hg concentrations, and develop and implement MeHg production controls necessary to achieve TMDL targets
Gambonini Mine	5 mg Hg/kg suspended sediments	Apply for coverage under the state's Industrial Stormwater General Permit Submit to the Water Board for approval a SWPPP, implementation schedule, and monitoring plan
Clear Creek and Hernandez Reservoir (CCRWQCB, 2004)		
Clear Creek	236 g Hg/yr	Removal and/or entombment of mining wastes Capping of residual material with clean soil Revegetation of disturbed areas
Hernandez Reservoir	1015 g Hg/yr	Load reductions in Clear Creek are expected to reduce loads in Hernandez Reservoir to meet allocations
Las Tablas Creek and Lake Nacimiento (CCRWQCB, 2002)		
General soils	7.67 kg Hg/yr (current loads)	None
Roads	0 kg Hg/yr (100% reduction)	San Luis Obispo County will pave road segment of Cypress Mountain road or will conduct equivalent actions to eliminate mercury runoff
Mines	4.52 kg Hg/yr (88.2% reduction)	Owner of mines must apply for new NPDES permit or WDR that will include specific permit conditions to limit the sediment and mercury load runoff from the properties. Options may change if Buena Vista Mine is added to National Priorities List
Cache Creek (CVRWQCB, 2004a; 2004b; 2005)		

Exhibit A-1: Allocations and Implementation Plans for Mercury TMDLs

Source	Allocations	Implementation Plan
Mines	Bear Creek: 5% of existing Hg loads (Rathburn, Petray North and South, and Rathburn-Petray) Harley Gulch: 5% of existing Hg loads (Abbott and Turkey Run) Sulphur Creek: 30% of existing Hg loads (geothermal springs, soil erosion, mines, streambeds, and atmospheric deposition) Cache Creek at Yolo: 66 g MeHg/yr (46% reduction) Settling Basin: 34.7 g MeHg/yr (60% reduction) Bear Creek at gauge: 3.2 g MeHg/yr (85% reduction)	Public outreach regarding the levels of safe fish consumption and monitoring; Remediation of inactive mines; Control of erosion in mercury-enriched upland areas and in floodplains downstream of the mines and in the lower watershed; Conducting feasibility studies and evaluating possible remediation at the Harley Gulch delta; Identifying sites and projects to remediate or remove floodplain sediments containing mercury and implement feasible projects; Addressing methylmercury reductions through studies of sources and possible controls in Bear Creek and Anderson Marsh, controlling inputs from new impoundments, wetlands restoration projects, or geothermal spring development
Clear Lake (CVRWQCB, 2002a; 2002b)		
Atmospheric Deposition	2 kg Hg/yr (max load estimated)	None
Tributaries and Surface Water Runoff	90% of existing Hg input (about 16 kg Hg/yr)	Reduce transport of contaminated sediments from Oaks Arm into the rest of lake
Sulphur Bank Mine	Active sediment Hg contribution reduced by 49% (about 340 kg Hg/yr)	Control and possible treatment of surface water runoff from mine; Control of groundwater flow into Clear Lake from mine; Capping of waste rock mine dam; Eliminating contributions to surficial sediment layer previously deposited due to mine related processes (e.g., dredge contaminated sediment, cap with clean sediments, or natural burial of contaminated sediments)
Delta Waterways (CVRWQCB, 2008)		

Exhibit A-1: Allocations and Implementation Plans for Mercury TMDLs

Source	Allocations	Implementation Plan
Delta Waterways	Central Delta: 668 g/yr MeHg (current load) Marsh Creek: 1.6 g/yr MeHg (73% reduction) Mokelumne/Cosumnes Rivers: 53 g/yr MeHg (64% reduction) Sacramento River: 1,385 g/yr MeHg (44% reduction) San Joaquin River: 195 g/yr MeHg (63% reduction) West Delta: 330 g/yr MeHg (current load) Yolo Bypass: 235 g/yr MeHg (78% reduction)[1]	Reduce MeHg discharges to Delta and Yolo Bypass from existing MeHg sources, including the Cache Creek Settling Basin Reduce Hg discharges to comply with MeHg allocations and the San Francisco Bay TMDL Hg allocation, with particular focus on nonpoint sources in the tributary watersheds that discharge the most Hg-contaminated sediment to the Delta and Yolo Bypass
Rhine Channel (U.S. EPA Region 9, 2002; Anchor Environmental, 2005)		
Stormwater	0.0171 kg Hg/yr	None specified
Caltrans	0.0027 k Hg/yr	None specified
Boatyards	0 kg Hg/yr	None specified
Other NPDES	0.0027 kg Hg/yr	None specified
Existing sediment	0.063 kg Hg/yr	Dredge sediment and dewater prior to transporting to an approved off-site upland disposal facility; or Dredge sediment and place within an off-site nearshore confined disposal facility; or Dredge sediment and dispose of within a confined aquatic disposal area excavated near channel mouth
Undefined sources	0.0045 kg Hg	None specified

Hg = Inorganic mercury
MeHg = Methylmercury
MS4 = Municipal Separate Storm Sewer System
TMDL = Total maximum daily load
WDR = Waste Discharge Requirements
1. Sources include sediment flux, NPDES dischargers, agricultural drainage, and urban runoff.

Municipal and Industrial Discharger Estimated Compliance

The exhibits below show the analyses for each of the criteria and implementation options based on numeric WQBELs for those dischargers with effluent mercury data.

Exhibit B-1: Estimated Compliance with Proposed Policy by Facility

NPDES No.	Facility	County	Major/Minor	Waterbody Type	Water Column Concentration (ng/L)	Max of Avg Annual Conc (ng/L)	RP?[1]	Annual Average WQBEL (ng/L)	Exceeds WQBEL?[2]
Municipal Dischargers									
CA0004995	Corning WWTP	Tehama	Major	Flowing Waterbody	12	3.12	N	--	--
CA0022713	Arcata City WWTF	Humboldt	Major	Flowing Waterbody	12	2.88	N	--	--
CA0022888	Ukiah City WWTP	Mendocino	Major	Flowing Waterbody	12	2.50	N	--	--
CA0022977*	**Cloverdale City WWTP**	**Sonoma**	**Major**	**Flowing Waterbody**	**12**	**27.00**	**Y**	**12**	**Y**
CA0023345*	**Windsor Town WWTP**	**Sonoma**	**Major**	**Flowing Waterbody**	**12**	**26.00**	**Y**	**12**	**Y**
CA0025135*	**Healdsburg City WWTP**	**Sonoma**	**Major**	**Flowing Waterbody**	**12**	**200**	**Y**	**12**	**Y**
CA0037788	Burlingame WWTP	San Mateo	Major	Flowing Waterbody	12	3.81	N	--	--
CA0038776	Calera Creek Water Recycling Plant	San Mateo	Major	Flowing Waterbody	12	1.40	N	--	--
CA0049224	**San Luis Obispo WWTP**	**San Luis Obispo**	**Major**	**Flowing Waterbody**	**12**	**20.00**	**Y**	**12**	**Y**

Exhibit B-1: Estimated Compliance with Proposed Policy by Facility

NPDES No.	Facility	County	Major/Minor	Waterbody Type	Water Column Concentration (ng/L)	Max of Avg Annual Conc (ng/L)	RP?[1]	Annual Average WQBEL (ng/L)	Exceeds WQBEL?[2]
CA0053619	Pomona WRP	Los Angeles	Major	Flowing Waterbody	12	1.93	N	--	--
CA0053651*	**Ventura WRF**	**Ventura**	**Major**	**Flowing Waterbody**	**12**	**20**	**Y**	**12**	**Y**
CA0053856	Terminal Island WRP	Los Angeles	Major	Flowing Waterbody	12	10.30	N	--	--
CA0053911	San Jose Creek WRP	Los Angeles	Major	Flowing Waterbody	12	1.51	N	--	--
CA0053961	Ojai Valley WWTP	Ventura	Major	Flowing Waterbody	12	0.75	N	--	--
CA0054011	Los Coyotes WRP	Los Angeles	Major	Flowing Waterbody	12	1.55	N	--	--
CA0054119	Long Beach WRP	Los Angeles	Major	Flowing Waterbody	12	1.79	N	--	--
CA0054216	Valencia WRP	Los Angeles	Major	Flowing Waterbody	12	0.64	N	--	--
CA0054313	Saugus WRP	Los Angeles	Major	Flowing Waterbody	12	0.83	N	--	--
CA0055531	Burbank WRP	Los Angeles	Major	Flowing Waterbody	12	0.77	N	--	--
CA0056227	**Donald C. Tillman WRP**	**Los Angeles**	**Major**	**Flowing Waterbody**	**12**	**17.20**	**Y**	**12**	**Y**
CA0064556*	Newhall Ranch WRP	Los Angeles	Major	Flowing Waterbody	12	1.20	N	--	--
CA0077691	Easterly WWTP	Solano	Major	Flowing Waterbody	12	1.73	N	--	--
CA0077704	Anderson WWTP	Shasta	Major	Flowing Waterbody	12	5.78	N	--	--
CA0077712	Auburn WWTP	Placer	Major	Flowing Waterbody	12	10.45	N	--	--
CA0077828	Lake	Nevada	Major	Flowing Waterbody	12	2.19	N	--	--

Exhibit B-1: Estimated Compliance with Proposed Policy by Facility

NPDES No.	Facility	County	Major/Minor	Waterbody Type	Water Column Concentration (ng/L)	Max of Avg Annual Conc (ng/L)	RP?[1]	Annual Average WQBEL (ng/L)	Exceeds WQBEL?[2]
	Wildwood WWTP								
CA0077836	Olivehurst WWTP	Yuba	Major	Flowing Waterbody	12	0.93	N	--	--
CA0077895	UC Davis Main WWTP	Solano	Major	Flowing Waterbody	12	1.28	N	--	--
CA0078034	Willows WWTP	Glenn	Major	Flowing Waterbody	12	1.13	N	--	--
CA0078662	Deer Creek WWTP	El Dorado	Major	Flowing Waterbody	12	4.29	N	--	--
CA0078671	El Dorado Hills WWTP	El Dorado	Major	Flowing Waterbody	12	4.00	N	--	--
CA0078891	Red Bluff WRP	Tehama	Major	Flowing Waterbody	12	0.10	N	--	--
CA0078948	Turlock WWTP	Stanislaus	Major	Flowing Waterbody	12	4.13	N	--	--
CA0078956	Hangtown Creek WRF	El Dorado	Major	Flowing Waterbody	12	1.05	N	--	--
CA0078981	Quincy WWTP	Plumas	Major	Flowing Waterbody	12	5.75	N	--	--
CA0079022	Live Oak City WWTP	Sutter	Major	Flowing Waterbody	12	2.90	N	--	--
CA0079081	Chico WWTP	Butte	Major	Flowing Waterbody	12	4.57	N	--	--
CA0079103	City of Modesto WWTP	Stanislaus	Major	Flowing Waterbody	12	2.40	N	--	--
CA0079103	City of	Stanislaus	Major	Flowing Waterbody	12	2.40	N	--	--

Exhibit B-1: Estimated Compliance with Proposed Policy by Facility

NPDES No.	Facility	County	Major/Minor	Waterbody Type	Water Column Concentration (ng/L)	Max of Avg Annual Conc (ng/L)	RP?[1]	Annual Average WQBEL (ng/L)	Exceeds WQBEL?[2]
	Modesto WWTP								
CA0079235	Oroville WWTP	Butte	Major	Flowing Waterbody	12	2.90	N	--	--
CA0079260	Yuba City WWTF	Sutter	Major	Flowing Waterbody	12	8.33	N	--	--
CA0079316	Placer County Sewer Maintenance District No 3	Placer	Major	Flowing Waterbody	12	4.21	N	--	--
CA0079502	Dry Creek WWTP	Placer	Major	Flowing Waterbody	12	1.66	N	--	--
CA0079511	Shasta Lake WWTF	Shasta	Major	Flowing Waterbody	12	2.43	N	--	--
CA0079651	**Linda County Water District WWTP**	**Yuba**	**Major**	**Flowing Waterbody**	**12**	**15.70**	**Y**	**12**	**Y**
CA0079731	Clear Creek WWTP	Shasta	Major	Flowing Waterbody	12	2.38	N	--	--
CA0079898	Grass Valley City WWTP	Nevada	Major	Flowing Waterbody	12	2.68	N	--	--
CA0081434	Galt WWTP & Reclamation Facility	Sacramento	Major	Flowing Waterbody	12	4.71	N	--	--
CA0081759	El Portal WWTF	Mariposa	Major	Flowing Waterbody	12	0.50	N	--	--

Exhibit B-1: Estimated Compliance with Proposed Policy by Facility

NPDES No.	Facility	County	Major/Minor	Waterbody Type	Water Column Concentration (ng/L)	Max of Avg Annual Conc (ng/L)	RP?[1]	Annual Average WQBEL (ng/L)	Exceeds WQBEL?[2]
CA0082589	Stillwater WWTF	Shasta	Major	Flowing Waterbody	12	1.59	N	--	--
CA0084476	Lincoln City WWTF	Placer	Major	Flowing Waterbody	12	0.52	N	--	--
CA0084573	Pleasant Grove WWTP	Placer	Major	Flowing Waterbody	12	1.03	N	--	--
CA0085235	**Clovis WWTF**	**Fresno**	**Major**	**Flowing Waterbody**	**12**	**75.50**	**Y**	**12**	**Y**
CA0085308	Atwater Regional WWTF	Merced	Major	Flowing Waterbody	12	4.88	N	--	--
CA0104477	**Valley SD WWTP**	**Riverside**	**Major**	**Flowing Waterbody**	**12**	**22.50**	**Y**	**12**	**Y**
CA0104493	**Coachella SD WWTP**	**Riverside**	**Major**	**Flowing Waterbody**	**12**	**27.50**	**Y**	**12**	**Y**
CA7000009	Calexico City WWTP	Imperial	Major	Flowing Waterbody	12	1.00	N	--	--
CA8000395*	**Corona WWRF No. 3**	**Riverside**	**Major**	**Flowing Waterbody**	**12**	**26.00**	**Y**	**12**	**Y**
CA8000409*	**IEUA Regional Plant No. 1**	**San Bernardino**	**Major**	**Flowing Waterbody**	**12**	**50.00**	**Y**	**12**	**Y**
CA0053176	Whittier Narrows WRP	Los Angeles	Major	Flowing Waterbody	12	1.91	N	--	--
CA0064564	Naval Facilities Engineering and	Ventura	Minor	Flowing Waterbody	12	0.37	N	--	--

Exhibit B-1: Estimated Compliance with Proposed Policy by Facility

NPDES No.	Facility	County	Major/Minor	Waterbody Type	Water Column Concentration (ng/L)	Max of Avg Annual Conc (ng/L)	RP?[1]	Annual Average WQBEL (ng/L)	Exceeds WQBEL?[2]
	Expeditionary Warfare Center WWTP								
CA0077852	Lake California WWTP	Tehama	Minor	Flowing Waterbody	12	3.30	N	--	--
CA0077933	Williams WWTP	Colusa	Minor	Flowing Waterbody	12	2.28	N	--	--
CA0078999	Colusa WWTP	Colusa	Minor	Flowing Waterbody	12	2.81	N	--	--
CA0079367	Placer County No 1 WWTP	Placer	Minor	Flowing Waterbody	12	2.51	N	--	--
CA0079391	Jackson City WWTP	Amador	Minor	Flowing Waterbody	12	3.23	N	--	--
CA0079430	Mariposa WWTP	Mariposa	Minor	Flowing Waterbody	12	5.17	N	--	--
CA0079529	Colfax WWTP	Placer	Minor	Flowing Waterbody	12	5.78	N	--	--
CA0079901	Nevada City WWTP	Nevada	Minor	Flowing Waterbody	12	3.05	N	--	--
CA0081507	Cottonwood WWTP	Shasta	Minor	Flowing Waterbody	12	38.20	Y	12	Y
CA0081574	Hammonton Gold Village WWTP	Yuba	Minor	Flowing Waterbody	12	0.67	N	--	--
CA0081621	Donner Summit PUD WWTP	Nevada	Minor	Flowing Waterbody	12	2.55	N	--	--

Exhibit B-1: Estimated Compliance with Proposed Policy by Facility

NPDES No.	Facility	County	Major/Minor	Waterbody Type	Water Column Concentration (ng/L)	Max of Avg Annual Conc (ng/L)	RP?[1]	Annual Average WQBEL (ng/L)	Exceeds WQBEL?[2]
CA0083241	Cascade Shores WWTP	Nevada	Minor	Flowing Waterbody	12	0.87	N	--	--
CA0084697	Thunder Valley Casino WWTP	Placer	Minor	Flowing Waterbody	12	0.64	N	--	--
CA0085201	Angels City WWTP	Calaveras	Minor	Flowing Waterbody	12	1.29	N	--	--
CA0104299	Imperial CCD WWTP	Imperial	Minor	Flowing Waterbody	12	0.01	N	--	--
CA0104451	Niland WWTP	Imperial	Minor	Flowing Waterbody	12	1.00	N	--	--
Industrial Dischargers									
CA0000809*	**Shell Oil Products US-Carson Distribution Facility**	**Los Angeles**	**Major**	**Flowing Waterbody**	**12**	**100.00**	**Y**	**12**	**Y**
CA0001309*	**Santa Susana Field Laboratory**	**Los Angeles**	**Major**	**Flowing Waterbody**	**12**	**890.00**	**Y**	**12**	**Y**
CA0004821	Pactiv Molded Pulp Mill	Tehama	Major	Flowing Waterbody	12	0.60	N	--	--
CA0055387*	**ExxonMobil Oil Corporation - Torrance**	**Los Angeles**	**Major**	**Flowing Waterbody**	**12**	**262.00**	**Y**	**12**	**Y**

Exhibit B-1: Estimated Compliance with Proposed Policy by Facility

NPDES No.	Facility	County	Major/Minor	Waterbody Type	Water Column Concentration (ng/L)	Max of Avg Annual Conc (ng/L)	RP?[1]	Annual Average WQBEL (ng/L)	Exceeds WQBEL?[2]
	Refinery								
CA0057827	**Inglewood Oil Field**	**Los Angeles**	**Major**	**Flowing Waterbody**	**12**	**350.00**	**Y**	**12**	**Y**
CA0109169*	**Naval Base San Diego**	**San Diego**	**Major**	**Flowing Waterbody**	**12**	**8300.00**	**Y**	**12**	**Y**
CA0109185*	**US Naval Base Coronado (NBC)**	**San Diego**	**Major**	**Flowing Waterbody**	**12**	**440.00**	**Y**	**12**	**Y**
CA0053176	Whittier Narrows Water Reclamation Plant	Los Angeles	Major	Flowing Waterbody	12	1.91	N	--	--
CA0004111*	**Aerojet Sacramento Facility**	**Sacramento**	**Minor**	**Flowing Waterbody**	**12**	**20.00**	**Y**	**12**	**Y**
CA0030058	Bottling Group LLC	Alameda	Minor	Flowing Waterbody	12	2.06	N	--	--
CA0038342	EBMUD Orinda Filter Plant	Contra Costa	Minor	Flowing Waterbody	12	0.53	N	--	--
CA0062162	Gardena Groundwater Remediation System Facility	Los Angeles	Minor	Flowing Waterbody	12	0.38	N	--	--

Exhibit B-1: Estimated Compliance with Proposed Policy by Facility

NPDES No.	Facility	County	Major/Minor	Waterbody Type	Water Column Concentration (ng/L)	Max of Avg Annual Conc (ng/L)	RP?[1]	Annual Average WQBEL (ng/L)	Exceeds WQBEL?[2]
CA0080357	**Sierra Pacific Industries Quincy Division Sawmill**	**Plumas**	**Minor**	**Flowing Waterbody**	**12**	**17.91**	**Y**	**12**	**Y**
CA0081833	General Electric GWCS	Merced	Minor	Flowing Waterbody	12	1.16	N	--	--
CA0081957	Wheelabrator Shasta Energy Co	Shasta	Minor	Flowing Waterbody	12	1.13	N	--	--
CA0082406	**I'SOT Geothermal Project**	**Modoc**	**Minor**	**Flowing Waterbody**	**12**	**24.15**	**Y**	**12**	**Y**
CA0083046	The Vendo Company Groundwater Remediation System	Fresno	Minor	Flowing Waterbody	12	0.10	N	--	--
CA0083721	Bell Carter Industrial WWTP	Tehama	Minor	Flowing Waterbody	12	1.19	N	--	--
CA0085171	Empire Mine State Historic Park	Nevada	Minor	Flowing Waterbody	12	0.98	N	--	--
CA0108952	Sweetwater Authority Groundwater Demin	San Diego	Minor	Flowing Waterbody	12	5.65	N	--	--

Exhibit B-1: Estimated Compliance with Proposed Policy by Facility

NPDES No.	Facility	County	Major/Minor	Waterbody Type	Water Column Concentration (ng/L)	Max of Avg Annual Conc (ng/L)	RP?[1]	Annual Average WQBEL (ng/L)	Exceeds WQBEL?[2]

'--' = no data to quantify
ng/L = nanograms per liter
RP = reasonable potential
WQBEL = water quality based effluent limit
WWTP = wastewater treatment plant
WRP = water reclamation plant
* MEC from facility permit
1. Represents effluent annual average or permit MEC greater than the aqueous target.
2. Represents maximum average annual mercury concentration or MEC in exceedance of the aqueous target.

Note: All dischargers with data available and "slow moving water bodies" possessed currently applicable TMDL wasteload allocations which take precedence over the water quality objectives contained in the proposed Policy.

Municipal Pollution Prevention Costs

Pollution prevention (P2) or pollution minimization strategies focus on reducing the pollutant at the source where it is more concentrated and may be more easily controlled, rather than treating larger volumes of wastewater once diluted. Because of the cost-effectiveness of source controls, and the lack of cost effectiveness and demonstrated performance from end-of-pipe controls for pollutants like mercury, P2 is a key strategy for compliance with very low effluent limitations.

A number of municipal dischargers have developed P2 programs that provide a basis for estimating program components and costs. The costs to municipalities, industries, businesses, and households associated with a municipal P2 program for mercury vary based on the community size and makeup, the extent of P2 efforts already underway, and the knowledge and experience of the municipality in this area. Municipal dischargers would likely target dentists, hospitals, medical facilities, educational institutions (primarily universities and high schools), households, and industries to reduce mercury discharges to the treatment plant. Based on program reports and information from municipalities in California currently implementing mercury P2 programs, components are likely to include:

Wastewater characterization – sampling and analysis of mercury and methylmercury concentrations to characterize pollutant levels at the facility and track treatment effectiveness

Program development – for source identification, materials development, program implementation, and management

Conducting site visits/inspections and holding workshops

Hazardous waste collection programs and mercury-free product replacements

Advertising – to promote and inform the community of various activities and events taking place

Website development – to provide the community with additional resources and serve as another means of promoting P2 activities.

Wastewater Characterization

As part of the sampling and analysis task, municipal dischargers should characterize mercury and methylmercury inputs to the treatment plant and track program effectiveness. Characterization involves measuring mercury and methylmercury influent and effluent concentrations to produce a better understanding of the load entering the plant and treatment process removal efficiency. This enables the discharger to determine how much of the resulting effluent loading is due to treatment performance and removal efficiencies, and how much is the result of industrial, commercial, institutional, or residential discharges. Dischargers should address any in plant sources or issues in addition to focusing efforts on potential influent sources.

Although municipalities may sample frequently at the start of the program, they may reduce this frequency over the life of the program after developing an understanding of mercury and methylmercury behavior within the plant. Therefore, on average, municipalities would likely sample on a monthly basis using Method 1631, which requires clean sampling techniques for mercury and methylmercury determination. The Central Valley Regional Water Board (2010) estimates total sampling costs, including labor, shipping, and QA/QC, for mercury and methylmercury in the effluent of $430 per event (in 2007 dollars). Because municipalities would need to sample influent as well as effluent for the characterization, we double this cost and escalate to 2016 dollars using the Bureau of Labor Statistics Consumer Price Index (BLS CPI) as shown in **Exhibit C-1**.

Exhibit C-1: Wastewater Characterization Costs: Per Event Sampling for Mercury and Methylmercury

Component	Influent Hg and MeHg (2007$)	Effluent Hg and MeHg (2007$)	Total (2007$)	Total (2016$)[1]
Laboratory Analysis	$289	$289	$578	$673
Sampling Labor[2]	$25	$25	$50	$58
Shipping	$45	$45	$90	$104
Sampling Subtotal	$359	$359	$718	$836
QA/QC[3]	$72	$72	$144	$167
Total	$431	$431	$862	$1,003

Source: Based on CVRWQCB (2010).
1. Escalated to 2016 dollars using the BLS CPI (2016).
2. Based on paying a 2 person team $140 per hour.
3. Represents 20% of sampling subtotal.

Therefore, total sampling costs may be approximately $1,003 per month, or approximately $12,000 per year for monthly influent and effluent sampling.

Program Development

P2 program development involves identifying potential mercury sources, determining appropriate or cost-effective measures for targeting those sources, developing materials, implementing the program, and evaluating progress/effectiveness of the program.

There are a large number of potential sources of mercury to any municipal wastewater treatment plant (WWTP), but there are few data on these sources from which to accurately predict the mercury load measured at the headworks of a facility. Nevertheless, several municipal dischargers have attempted to quantify their mercury sources. For example, the Palo Alto Regional Water Quality Control Plant (RWQCP) estimates that dental offices account for 60% of its influent mercury load, human waste attributable to amalgam fillings accounts for 18.5%, permitted industries account of 9%, residential and human waste not related to amalgam fillings accounts for 8%, stormwater inflow accounts for 4%, and other sources (e.g., water supply, groundwater, and infiltration) account for 0.4% (Barron, 2002). The East Bay Municipal Utilities District (EBMUD) estimates that 34% of their influent mercury load is from dental offices, 20% from the residential sector, 12% from inflow and infiltration, 11% from known commercial dischargers, and 10% from hospitals and medical facilities (EBMUD, 2004). Both of these dischargers estimated the source loadings from a combination of available monitoring studies and actual sampling efforts. Therefore, to reduce costs, facilities could use information collected and developed from other WWTPs to identify potential sources of mercury, as well as to roughly estimate influent mercury contributions from those sources. Note, however, that the only way to truly characterize influent loads would be through site-specific sampling.

Determining which P2 efforts to pursue requires evaluation of the contribution to total mercury loadings, relative magnitude of loading, feasibility of control, and effectiveness of proposed efforts. Source control efforts could be implemented through existing pretreatment programs. P2 practices could include best management practices (BMPs), production/process changes at industrial facilities, and public outreach and education programs targeting local businesses (e.g., dentists, hospitals, and laboratories), consumers, and schools.

Currently, most municipal WWTPs initially target dental offices and the residential sector through public outreach efforts. Municipalities can develop and distribute materials for dental offices that outline BMPs they can implement to reduce the amount of mercury discharged to the treatment plant. They may also encourage or develop permit programs that require dentists to install amalgam separators, which often remove over 95% of amalgam particles prior to discharge. For example, the Central Contra Costa Sanitary District (CCCSD) developed a brochure for dentists that describes the mercury problem in the area, the role that dentists play in this problem, and measures that dentists can take to reduce their mercury contributions (CCCSD, 2005). Developing brochures may not be necessary for smaller facilities if there are relatively few dental offices in the service area. For example, the Mt. View SD was able to conduct site visits to each of the four dental offices in their area, and use a checklist developed by the Bay Area Pollution Prevention Group (BAPPG) to guide the visit and recommend actions each dentist could take to reduce mercury discharges (Engler, 2005).

In comparison, some municipalities issue pretreatment permits with treatment requirements or numeric targets for mercury. For example, the Palo Alto RWQCP implemented a sewer use ordinance that required all dental offices to install approved amalgam separators by March 31, 2005, and provide certification to the facility that they had done so. The facility also requires dentists to implement BMPs that:

- Prohibit rinsing chairside traps, vacuum screens, or amalgam separator equipment in a sink or other sanitary sewer connection
- Require staff to be trained in the proper handling and disposal of amalgam materials and fixer-containing solutions
- Prohibit the use of bleach or other chlorine containing disinfectants to clean the vacuum line system
- Prohibit the use of bulk liquid mercury; only precapsulated dental amalgam is permitted
- Require that amalgam waste be stored in accordance with recycler or hauler instructions.

The Palo Alto RWQCP developed its program in cooperation with the Mid-Peninsula Dental Society, the California Dental Association, and other stakeholders. The City also coordinated the program's work plan and implementation with the City of San Francisco and the EBMUD.

Similarly, the EBMUD regulates its indirect dischargers through permits. The permits for dental facilities required all dentists to install an ISO 11143 standard amalgam separator by June 30, 2005, and recommend implementation of specific BMPs. Dental facilities must also submit a report self-certifying installation of the separator and implementation of recommended BMPs.

The most common activities targeting the residential sector include distributing educational material in the form of brochures or billing inserts, or organizing events to collect mercury-containing equipment or products and ensure that they are properly disposed of or recycled. Some municipalities offer a mercury-free alternative in exchange for the mercury-containing one. Collection events held at easily accessible places such as schools, community centers, and grocery stores are more successful than events held at the facility. For example, the Palo Alto RWQCB collected about 2,000 mercury thermometers over a couple of years by relying on individuals to bring their thermometers to the treatment plant at their convenience. However, once the City decided to hold events at a scheduled date and time within the community, they were able to double the number of thermometers collected in a much shorter time period (Bobel, 2005).

Other potentially significant sources of mercury to a municipal WWTP are hospitals/medical facilities and educational institutions. Most of the mercury from these sources can be found in equipment such as thermometers, manometers, and blood pressure cuffs and chemical reagents. Municipalities may develop materials or conduct workshops aimed at encouraging these facilities to conduct an inventory of mercury-containing equipment, switch to mercury-free alternative equipment, and implement BMPs that prevent releases of mercury from the equipment. For example, Sacramento Regional County Sanitation District (SRCSD), with support from the Department of Health Services (DHS), teamed up with area hospitals to identify mercury-containing equipment and chemicals that are potential sources of mercury pollution and replace these items with mercury-free items. Additionally, they trained local hospitals and medical facilities on the proper disposal of mercury-containing products and improved management of mercury spills. Sampling conducted since this outreach has shown that hospitals and medical facilities are not a significant source of mercury in wastewater in the SRCSD service area.

EBMUD, under a grant from U.S. EPA, partnered with the University of California, Berkeley to develop a mercury reduction program for educational institutions. Under the program, EBMUD replaced mercury-containing laboratory equipment with mercury-free alternatives, collected elemental mercury, worked with specific departments on campus to replace any additional mercury-containing devices, and developed a template based on these experiences for use at other institutions (EBMUD, 2007). In 2007, EBMUD worked with two local school districts and one university to collect and properly dispose of 112 pounds of mercury waste and replace equipment with nonmercury alternatives (e.g., thermometers and some laboratory devices).

Costs of program development vary based on the level of effort and size of the service area. The Palo Alto RWQCP (design flow of 38 mgd) has a P2 program sector of its environmental compliance division that includes 4 staff. The staff works on various tasks and outreach efforts for a number of different pollutants including mercury. In 2005, the program director estimated that approximately a quarter of the four staff members' time was spent working on mercury-related tasks (Bobel, 2005). Similarly, at EBMUD (design flow of 79.6 mgd), one staff member spent about 80% of her time on new mercury P2 tasks (Mena, 2005). Employee labor is used to identify potential source sectors, develop and evaluate alternative P2 strategies, develop outreach and education materials, request and draft changes to sewer use ordinances, schedule and organize collection events, conduct educational workshops for specific source sectors, maintain contact information for facilities within each sector, and put together annual program status reports. Thus, these estimates of 1 full-time equivalent (FTE) staff position are likely to be representative of costs for program development for large facilities. Note that over time, the personnel requirements for P2 programs will decrease. When contacted in 2014, a representative from Palo Alto's P2 program sector stated that 3 staff work on P2 programs, with approximately 20% of one staff member's time spent on mercury-related tasks (North, 2014).

Smaller facilities have smaller service areas, and thus, fewer sources to identify and target. Smaller facilities are also more likely to partner with large facilities that have already established P2 programs or organizations such as the Department of Health Services to reduce costs. Therefore, in-house labor requirements will most likely be less than those of a larger facility.

For example, an employee of the San Mateo wastewater treatment plant (WWTP) (design flow of 13.6 mgd) estimates that in-house labor for mercury P2-related tasks equals about 0.1 FTE. The level of effort is low because the City does not have a formal P2 program for mercury, and relies heavily on partnerships with the Department of Health and other larger P2 organizations (e.g., a county-wide stormwater P2 program) to develop the outreach and educational information needed to target local businesses and residents (San Mateo Public Works, 2005). The City anticipates that more in-house labor will be needed in the coming years as the program is expanded to target dentists and other potential source sectors (San Mateo Public Works, 2005). Similarly, the P2 coordinator at Mt. View Sanitation District (SD) (average flow of 2 mgd) only spends about one week per year on mercury-related P2 tasks. However, most of the sources in the service area have already been targeted, and the facility developed numerous partnerships with other organizations, making the district's P2 program for mercury virtually self-sustaining (Engler, 2005). If the district began additional activities such as fluorescent light bulb collection events or regulatory requirements for dentists, additional in-house labor would be needed (Engler, 2005).

To estimate costs of one FTE, we assumed employees meeting the BLS definition of environmental scientists or specialists (19-2041) would do most of the work.[6] Average wage

[6] BLS defines an environmental scientist or specialist as one that conducts research or performs investigation for the purpose of identifying, abating, or eliminating sources of pollutants or hazards that affect either the environment or the health of the population. Using knowledge of various scientific disciplines, they may collect, synthesize, study,

rates in California are $40.69 per hour; accounting for benefits using the BLS Employer Cost for Employee Compensation for state and local professional government workers (32.4% of total compensation is attributable to benefits), this rate is approximately $60.18 per hour. Thus, the cost for 1 FTE is approximately $125,000 per year (2,080 hours × $40.69 per hour).

Site Visits and Workshops

Municipal dischargers may also supplement their own employee labor with expertise from outside the municipality (e.g., consultants). For example, the Palo Alto RWQCP spends about $29,700 per year (escalated to 2016 dollars using the Consumer Price Index) on a private consultant to help them develop outreach materials and conduct mercury education workshops and seminars at schools throughout their service area (Bobel, 2005). Workshops can be used to provide target groups with sector-specific information on mercury sources, effective BMPs, and sources for alternative equipment. The need for additional assistance varies depending on the number of different sources of mercury to the plant and the size of the service area.

The Palo Alto RWQCP also hires a consultant to visit various sources and advise them on BMPs for reducing mercury or ensure that they are complying with sewer use ordinance requirements. Palo Alto spends about $19,800 year (2016 dollars) on this off-site consultant work (Bobel, 2005). Site-visits are useful to determine what BMPs, if any, are in place or could be employed at a particular site to reduce mercury discharges. Sources of mercury are usually easy to identify at dental offices. However, mercury sources at hospitals, medical centers, secondary schools, and universities are harder to identify because of the larger discharge volume and greater number of potential sources, and may require a greater amount of time.

Based on information from Palo Alto, we assumed that larger facilities may spend about $29,700 per year on tasks related to program maintenance and material development performed by persons not directly employed by the municipality, and $19,800 per year on site visits. Smaller facilities, due to the nature and size of their service areas would not likely have to spend as much. For example, San Mateo plans to spend about $23,000 (2013 dollars) on consultants to target dentists and conduct site visits (San Mateo Public Works, 2005). The facility may also need assistance in developing materials for those sources it has not yet targeted (e.g., hospitals).

Mercury-Free Products

Municipalities may need funds to provide mercury-free products to the public or commercial sectors. For example, many municipal dischargers hold collection events in which residents turn in mercury thermometers for recycling and receive either a free electronic thermometer or a coupon towards purchasing one. The Palo Alto RWQCP, EBMUD, and Mt. View SD have programs in which residents can exchange their mercury thermometers for digital thermometers free of charge. The cost to EBMUD for each digital thermometer is about $2.50, and mercury disposal costs are about $7 per pound of mercury waste through the local household hazardous waste facility (Mena, 2005). In 2005, EBMUD gave out approximately 800 digital thermometers

report, and recommend action based on data derived from measurements or observations of air, food, soil, water, and other sources.

and collected about 20 pounds of waste (Mena, 2005), and Mt. View SD exchanged about 200 thermometers (Engler, 2005). In current dollars, digital thermometers currently cost between $1 and $4 at wholesale prices, on average (DHGate, 2014).

However, municipal dischargers may also need to provide secondary schools or hospitals with mercury-free equipment to replace all or part of their mercury-containing equipment. The Minnesota Pollution Prevention Agency (MPPA) worked with schools to eliminate mercury. The schools often conducted the mercury inventory with guidance from the MPPA. Then, MPPA gave the schools a limited amount of free mercury-free equipment (including 40 laboratory thermometers, 2 digital fever thermometers, a blood pressure unit, and a digital barometer), lines up a proper recycling facility, and covers the mercury recycling costs. Total average costs were about $400 per school (Butler, 2002).

Costs vary based on the number of exchange/collection events and the volume of equipment collected. Note that over time, the discharger will collect most mercury-containing thermometers and replace all the mercury-containing equipment at schools. However, these costs would likely still be incurred annually because facilities would just refocus their efforts on other mercury-containing products (e.g., thermostats, fluorescent lights, and mercury switches) and sectors (e.g., hospitals, medical centers, and laboratories).

Advertising

Developing public service announcements (PSAs) and a website promoting mercury P2 efforts are relatively low-cost methods for distributing information. The PSA cost is for the time spent to prepare audio PSAs for radio broadcast use. For example, the price charged by Hispanic Communications Network to produce a 60 second Spanish or English PSA under a General Services Agreement for the federal government (GSA contract GS-23F-0307M) is $2,000. Due to a large service area, large dischargers could need a number of messages targeting different sources in different languages annually. Smaller municipal dischargers would likely have fewer sources to target. Thus, we assumed larger WWTPs would need four different PSA and small WWTPs would only need one.

Website

Municipal dischargers may target commercial, industrial, and residential customers through a website devoted to mercury source control efforts (e.g., post laws and orders, collection event dates and times, links to mercury fact sheets). The cost of a website depends on its function, number of pages, and security requirements. On average, a website with a customized template and content management system could cost between $1,500 and $2,200 (CA Web Design Inc., 2014). Due to the nature of P2 programs and the need to adapt efforts based on sampling and outreach results, frequent maintenance would be needed to keep the websites up to date. Thus, over the life of a program, website development and maintenance could average close to the development costs, or approximately $1,800 per year (midpoint of range). These costs do not include the cost of the website itself. Rather, facilities would likely add information on the P2 program to a preexisting website run by the municipality or sewer district.

Total Municipal P2 Program Costs

Exhibit C-2 summarizes potential P2 program components and costs, based on the experiences of relatively large (e.g., greater than 20 mgd) major municipal dischargers that have already implemented such programs.

Exhibit C-2: Mercury P2 Program Components and Potential Costs of Large WWTP (> 20 mgd)

Component	Annual Cost ($2016)[1]
Wastewater Characterization	$12,000
Program Development	$129,000
Site Visits and Workshops	$62,000
Mercury-Free Products	$4,000
Advertising	$8,000
Website Development	$2,000
Total	$217,000
1. Costs reflect experiences of large communities. Costs for a number of components (e.g., program development; site visits and workshops) may be proportionately less for smaller communities.	

With total potential costs for larger municipalities approximating $220,000 per year, costs for medium-sized municipal dischargers (e.g., 5 to 20 mgd) may be in the range of $170,000 annually, and for small municipal major dischargers (e.g., 1 to 5 mgd) in the range of $110,000 annually. Minor municipal dischargers serve much smaller areas and populations than major dischargers and have fewer mercury sources to target. Thus, cost may be substantially less (e.g., half) of that for small major WWTPs, or in the range of $60,000 annually. Actual costs will vary with community makeup and other factors including the ability to piggy-back off the efforts of other municipalities. For example, the Association of Metropolitan Sewerage Agencies (AMSA) estimated that implementing pollutant minimization programs range between $324,000 and $453,000 per facility per year ($2013; AMSA, 2002). Costs may also be greater in the startup period than costs in subsequent years as the program becomes more established; the estimates above represent average annual program expenditures. Dischargers will likely initially target the largest or most known sources of mercury to the treatment plant, such as dentists and hospitals, and then move on to other potential sources such as automobile service stations and secondary schools. The estimates for conducting site visits and workshops reflect this sequential targeting of an equal number of sources in a given year.

Source Control of Indirect Dischargers to Municipal Facilities

In addition to the cost of developing a P2 program, municipalities may require indirect dischargers to the sewer system to implement source controls. Municipalities would likely target dentists, hospitals and medical centers, secondary schools, universities, and industrial facilities. However, the program may not address all of these sectors immediately (i.e., in certain sectors, implementation of controls may not occur for several years).

Dental Offices

PMP costs for dentists would include the installation of an amalgam separator and implementation of BMPs. Costs for amalgam separators vary depending on removal efficiency, method of separation, and purchasing option (e.g., buy or lease), and annual maintenance costs vary based on the type of separator and size of dental practice.

Exhibit C-3 shows the costs associated with a number of amalgam separators. Capital costs range from $200 to $2,600, with an average of $900, and annual maintenance costs range from $50 to $580, with an average of approximately $300.

Exhibit C-3: Amalgam Separators Description and Costs

Amalgam Separator (Flow)	Number of Chairs	Purchase Cost	Maintenance Requirements	Maintenance Cost ($/yr)	Source:
Rasch 890-1500	1-12	$695	Replace canister every 18 mos. (includes shipping and recycle)	$400	AB Dental Trends (2014)
Rasch 890-6000 (4 L/min)	1-12	$525	Replace canister every 18 mos. (includes shipping and recycle)	$400	AB Dental Trends (2014)
Asdex As-9 11"	1	$210	Replace filter ever 6 mos.	$160	American Dental Accessories (2014)
Asdex As-9 23"	4	$300	Replace filter ever 9 mos.	$236	American Dental Accessories (2014)
SOLMETEX Hg5	10	$784	Replace filter ever 6 mos.	$584	American Dental Accessories (2014)
ECO II (2 L/min)	1-6	$499	Replace canister annually for 1 chair usage plus shipping/recycle	$279	PureLife Dental (2014)
The Amalgam Collector CH 12 (batch)	1	$625	No replacement costs; office responsible for sludge recycle	$50	R & D Services, Inc. (2014)
The Amalgam Collector CE 18 (batch)	2-5	$875	No replacement costs; office responsible for sludge recycle	$50	R & D Services, Inc. (2014)
The Amalgam Collector CE 24 (batch)	6-12	$1,295	No replacement costs; office responsible for sludge recycle	$50	R & D Services, Inc. (2014)
SOLMETEX Hg5-HV (1.5 L/min)	11-20	$2,613	Replace canister every 6-9 mos. (includes recycle)	$550	MS Air Online (2014)

BMPs for dentists usually include the following:

- Ensuring chairside traps, vacuum screens, or amalgam separator equipment are not rinsed in a sink
- Recycling chairside trap, vacuum screen, and amalgam separator wastes
- Training staff in proper handling and disposal of amalgam materials
- Ensuring bleach or chlorine-containing disinfectants are not used to clean vacuum lines system because these chemicals may dissolve mercury from amalgam
- Using only precapsulated dental amalgam
- Storing amalgam in accordance with recycler or hauler instructions
- Using mercury-free alternatives to amalgam, when appropriate
- Cleaning up any mercury spills with the proper mercury spill clean-up kit.

Other than minimal staff training, these BMPs would not impose additional costs for a dental office.

Hospitals and Medical Centers

P2 measures for hospitals and medical centers include BMPs such as eliminating the use and handling of mercury-containing products and equipment through the modification of purchasing practices. Mercury-free substitutes are available for most mercury-containing chemicals and equipment. Although mercury-free products may currently be more expensive than those containing mercury, there are savings associated with eliminating the costs of hazardous waste training, storage and disposal, clean up, and potential noncompliance, and potential health risks to staff, patients, and visitors. In the case of electronic thermometers, the mercury-free alternative also has time-saving benefits since an electronic thermometer gives a quicker temperature reading than a mercury thermometer (Pollution Probe, 1996). For example, comparison of a mercury-containing sphygmomanometer to a mercury-free aneroid sphygmomanometer shows that once staff training, spill cleanup, and administrative costs are taken into account, the mercury-free alternative is actually more cost effective (Pollution Probe, 1996).

The potential cost savings from using mercury-free equipment can be substantial. For example, the University of Minnesota-Duluth reports that phasing out mercury has significantly reduced costs due to hazardous spill cleanups (Second Nature, 2003). The average wage rate of spill team members is about $100 per hour, and it takes on average about 6 hours to clean up a spill (California DHS, 2000). Spill kits range in costs from $15 to $200. Using mercury also requires administrative costs to keep procedures up to date and staff trained. In 1998, Kaiser-Permanente, which owns and operates 30 hospitals and 360 clinics, began a mercury minimization policy aimed at switching to mercury-free thermometers and sphygmomanometers, and proper disposal of fluorescent lamps, through a contract with a recycler. Kaiser-Permanente indicated that they realized cost savings from the program through having less waste to dispose of, and eliminating the need to prepare for and clean up mercury spills (which cost $250,000 per incident) and avoided medical treatment costs from exposure (TPMG Forum, 2007)

Therefore, implementing P2 activities is not likely to impose incremental costs on hospitals and medical centers.

Laboratories

P2 measures for laboratories that may reduce the amount of mercury released to the environment as a result of daily operations are similar to those implemented by hospitals and medical centers. In addition to replacing mercury containing equipment (e.g., manometers and thermometers) and chemicals containing mercury with mercury-free alternatives, laboratories can also work to minimize the amount of waste generated during experiments and testing procedures. The University of Minnesota-Duluth instituted micro-scale projects in undergraduate labs that dramatically reduced the quantities of possible mercury-containing chemicals used, purchased, and discarded (Second Nature, 2003).

Because there is a cost savings associated with a decrease in mercury spill clean ups costs, and costs for mercury free alternatives are often about the same as costs of mercury-containing chemicals, implementing P2 programs is not likely to impose incremental costs on laboratories.

Universities and Secondary Schools

There are a number of BMPs schools can implement to reduce mercury in their wastewater:

Educate students, teachers and administrators about the health hazards and environmental fate of mercury (e.g., see the Mercury in Schools Pollution Prevention project, located at http://www.mercuryinschools.uwex.edu)

Promote proper management and recycling of mercury and mercury-containing products (e.g., educate teachers and maintenance personnel on items that may contain mercury such as thermometers and laboratory chemicals, and proper disposal techniques)

Eliminate the use of mercury wherever possible and promote the use of alternative products that do not contain mercury (e.g., schools may have mercury-containing thermostats, barometers, thermometers, and wall switches that can easily be replaced with mercury-free alternatives)

Clean out plumbing (e.g., mercury builds up in plumbing over the years resulting in a constant mercury discharge even after the use of mercury is eliminated).

Universities and secondary schools would most likely take an inventory of mercury and mercury containing equipment in each building, and replace each item with a mercury-free alternative, as well as set up an educational program for professors, teachers, maintenance personnel, and students on the health effects of mercury, its environmental fate, and proper handling and clean up procedures.

The EBMUD initiated a mercury reduction program with the University of California at Berkeley (UCB) through grant funding from U.S. EPA. The program focused on identifying all mercury-containing equipment and chemicals through the campus and replacing them with mercury-free alternatives. Another main component of the program focused on outreach and education targeting professors, students, and school administrators. EBMUD also developed a template to guide other institutions on implementation of a successful mercury reduction program. UCB spent about $36,000 from 2002 through 2005 on the program (an average of $9,000 per year) for mercury waste disposal and recycling ($6,000) and program development and implementation ($30,000). However, if other universities use the template developed as part of the program development and implementation, costs would be much less.

P2 program implementation costs for secondary schools are most likely minimal because the municipality conducting the program generally conducts the mercury equipment inventory and arranges for equipment replacement and disposal (already accounted for in the direct costs). For example, MPPA does not charge schools to participate in its Mercury Free Zone program. In addition, this Agency offers free lab and medical equipment to replace the schools' mercury-containing equipment and arranges for proper mercury disposal at a recycling facility (Butler, 2002). The Oregon Association of Clean Water Agencies (ACWA), in conjunction with ODEQ, also developed a pilot program for two local school districts to eliminate the use of mercury in schools. ODEQ spent approximately $27,800 of staff time inventorying 5 schools for mercury equipment and chemicals, and an additional $6,000 on mercury replacement and disposal. All of these costs were covered by donations, City of Corvallis, City of Eugene, ACWA, and CWA 319 Nonpoint Source Grants from ODEQ (Oregon ACWA, 2005).

Based on the above examples, it is likely that municipalities will conduct mercury inventories and supply mercury-free equipment for secondary schools. Therefore, the costs to secondary schools would be minimal.

Facility-Specific Incremental Cost Estimates

The following exhibits show incremental costs by facility for each of the objectives and implementation options based on numeric WQBELs.

Exhibit D-1: Incremental Costs by Facility

NPDES No.	Facility	Major/ Minor	Flow (mgd)	Existing Treatment Level	Proposed Treatment	Capital Cost (2016$)	O&M Cost (2016$)	Annual Cost (2016$)[1]
Municipal Dischargers								
CA0022977	Cloverdale City WWTP	Major	1	Secondary	Filtration	$1,142,444	$23,582	$115,255
CA0023345	Windsor Town WWTP	Major	2.25	Tertiary	P2	--	--	$110,000
CA0025135	Healdsburg City WWTP	Major	1.4	Tertiary	P2	--	--	$110,000
CA0049224	San Luis Obispo WWTP	Major	5.1	Tertiary	P2	--	--	$110,000
CA0053651	Ventura WRP	Major	14	Tertiary	P2	--	--	$170,000
CA0056227	Donald C. Tillman WRP	Major	80	Tertiary	P2	--	--	$220,000
CA0079651	Linda Cnty Water District WWTP	Major	5	Tertiary	P2	--	--	$110,000
CA0085235	Cottonwood WWTP	Major	2.8	Tertiary	P2	--	--	$110,000
CA0104477	Clovis WWTP	Major	8.5	Secondary	Filtration	$9,710,776	$200,447	$979,665
CA0104493	Valley SD WWTP	Major	2.4	Secondary	Filtration	$2,741,866	$56,597	$276,611
CA8000395	Coachella SD WWTP	Major	1	Tertiary	P2	--	--	$110,000

Exhibit D-1: Incremental Costs by Facility

NPDES No.	Facility	Major/ Minor	Flow (mgd)	Existing Treatment Level	Proposed Treatment	Capital Cost (2016$)	O&M Cost (2016$)	Annual Cost (2016$)[1]
CA8000409	Corona WWRF No. 3	Major	84.4	Tertiary	P2	--	--	$220,000
CA0081507	IEUA Regional Plant No. 1	Minor	0.43	Tertiary	P2	--	--	$60,000
Industrial Dischargers								
CA0000809	Aerojet Sacramento Facility	Major	5	Secondary	P2 or Filtration	$5,712,221	$117,910	$37,000 - $576,273
CA0001309*	I'SOT Geothermal Project	Major	168	Secondary	P2	--	--	$37,000
CA0055387	ExxonMobil Oil Corporation - Torrance Refinery	Major	10	Secondary	P2 or Filtration	$11,424,443	$235,820	$37,000 - $1,152,547
CA0057827	Inglewood Oil Field	Major	7.55	Secondary	P2 or Filtration	$8,625,454	$178,044	$37,000 - $870,173
CA0109169*	Naval Base San Diego	Major	NA	Secondary	P2	--	--	$37,000
CA0109185	Santa Susana Field Laboratory	Major	0.235	Secondary	P2 or Filtration	$268,474	$5,542	$27,085 - $37,000
CA0004111	Sierra Pacific Industries Quincy Division Sawmill	Minor	35.8	Secondary	P2 or Filtration	$40,899,506	$844,235	$37,000 - $4,126,117

Exhibit D-1: Incremental Costs by Facility

NPDES No.	Facility	Major/ Minor	Flow (mgd)	Existing Treatment Level	Proposed Treatment	Capital Cost (2016$)	O&M Cost (2016$)	Annual Cost (2016$)[1]
CA0080357*	Shell Oil Products US-Carson Distribution Facility	Minor	NA	Secondary	P2	--	--	$37,000
CA0082406	US Naval Base Coronado (NBC)	Minor	0.166	Secondary	P2 or Filtration	$189,646	$3,915	$19,132 -$37,000

-- = not applicable
WWTP = wastewater treatment plant
WRP = water reclamation plant
NA= not available
P2 = pollution prevention program
*Design flow not reported in NPDES permit or flow is attributable to industrial stormwater; costs represent P2 only.
1. Annualized costs based on 5 percent interest and a 20 year estimated project life.