Appendix B

Draft Economic Analysis of Proposed Sediment Quality Objectives in the State of California

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List of Exhibits

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
cy	cubic yard
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
mm	millimeters
MM	Management measures
MS4	Municipal separate storm sewer system
ng/L	nanograms per liter
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and maintenance
OEHHA	Office of Environmental Health Hazard Assessment
OMR	Office of Mine Reclamation

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 proposing an amendment to the state's Water Quality Control Plan for Enclosed Bays and Estuaries: Part 1 Sediment Quality. This report contains an economic analysis of the proposed amendment of the sediment quality objectives Plan (hereinafter Plan) for the protection of aquatic life, human health, wildlife, and finfish. Under 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 Sediment Quality Objectives (SQO) options, available methods to achieve compliance with these options, and the costs of those methods.

Baseline and Proposed Policy

In 2008, the State Water Board adopted SQOs and an implementation Plan for bays and estuaries in the state (Part 1). An amendment of Part 1 – Sediment Quality was proposed in 2011. Part 1 integrates chemical and biological measures to determine if the sediment dependent biota are protected or degraded as a result of exposure to toxic pollutants in sediment and to protect the benthic community, human health, and wildlife. Part 1 includes narrative SQOs for the protection of aquatic life, human health, wildlife and finfish; identification of the beneficial uses that these objectives are intended to protect; and a program of implementation that contains specific indicators, tools, and implementation provisions to determine if the sediment quality at a station or multiple stations meet the narrative objectives, description of appropriate monitoring programs, and a sequential series of actions that shall be initiated when a sediment quality objective is not met, including stressor identification and evaluation of appropriate targets.

The State Water Board is proposing amendments to the Plan to incorporate additional implementation Policy for the protection of human health, modification in 303(d) listing and delisting procedure for the 303(d) list, and change in regional monitoring frequency. In establishing water quality objectives, the State Water Board considers economic factors, among others. Specifically, these economic factors include whether the objectives and alternatives under consideration are currently being attained, the methods available to achieve compliance and the costs of those methods. The available compliance methods and costs depend on the sources of the pollutants bioaccumulating in sediments in bays and estuaries, which could include municipal and industrial wastewater and stormwater, agriculture, boats, and legacy sources. Baseline conditions include current SQOs (e.g., benthic community, human health, wildlife and finfish SQOs, and narrative Basin Plan criteria), water quality objectives and policies regulating activities and pollutant discharges that affect sediment quality (e.g., CTR, Basin Plans, waste discharge requirements, and other policies), ongoing cleanup and remediation activities, and planned or anticipated cleanup and remediation actions that have not yet been completed [e.g., total maximum daily load development (TMDL) and implementation schedules]. Currently, Regional Water Boards have listed 45 bays and estuaries as impaired for toxic pollutants in sediments or fish tissue and another 124 bays and estuaries as impaired for toxic pollutants for which the effects from sediment are uncertain. There are also some impairments of fish and wildlife beneficial uses that Regional Water Boards have not yet identified the source of the pollutants and which could be attributable, at least in part, to pollutant concentrations in sediments.

Incrementally Impaired Waters

Under the current Plan, for narrative sediment quality objectives, a water segment is identified as impaired if the tissue pollutant levels in organism samples exceed a pollutant-specific evaluation guideline using binomial distribution. However, according to the proposed Plan, a water segment will be placed on the impaired list if any station within the site is assessed as Clearly Impacted and the total percent area categorized as Possibly Impacted and/or Likely Impacted equals or exceeds 15 percent of the site area over the duration of a listing cycle. The determination of the impact category is dependent on the MLOE approach. Once the Plan is adopted, the new implementation approach would be used to determine impairments and assess human health criteria.

Incremental Impacts of Proposed Amendments

The incremental economic impacts of the Plan include the costs of activities above and beyond those that would be necessary in the absence of the Plan under baseline conditions, as well as any cost savings associated with actions that will no longer need to occur (e.g., through more accurate assessment procedures). Note that assessments of impairment, controls, and sediment cleanups to reduce pollution in waters impaired under baseline conditions would continue in the absence of the Plan amendments. Thus, these existing impairments are not incremental impacts associated with the proposed SQO amendments.

Three significant amendments in the proposed Plan can have an incremental impact on the current Policy: a new approach to interpret human health objectives, a change in 303(d) listing and delisting process, and a change in regional sediment quality monitoring frequency. For interpreting human health objectives the proposed Plan introduces a tiered framework to assess the level of detrimental effect that a contaminated sportfish can pose to human consumers. This new approach is likely to result in an additional cost. The proposed modification in the existing 303(d) listing and delisting process may also cause an additional cost. The change in regional sediment monitoring frequency is likely to result in reduced cost. Further detail on incremental cost is discussed in the following section.

Monitoring and Assessment Cost

Comprehensive compliance and assessment activities are ongoing to support the baseline framework which will continue in the absence of the Plan. Additional efforts will be undertaken under the proposed Plan, which includes assessing compliance with the proposed Plan. A sufficient amount of data is needed to determine whether the sediments are meeting existing objectives. Additionally, if the toxic substances in sediments exceed SQOs under baseline or proposed Policy, further evaluation is required to identify source, linkage and remediation of this impairment. These activities, which can include developing a work Plan/project management, collecting additional data, conducting Ecological Risk Assessment (ERA)s or Toxicity Identification Evaluations (TIEs), surface water modeling, and other analyses, may be conducted as part of developing a TMDL (SCCWRP, 2005; Parsons, et al., 2002, as cited in WSPA, 2007, SWRCB (2011)). These compliance activities will incur associated costs. While insufficient data exists to estimate costs associated with all activities, this document focuses on incremental cost (April-2017 dollars) associated with changes in monitoring requirements. Where available, information on other assessment and compliance costs is provided.

Monitoring is one component of compliance costs. The SWRCB (2008) and SWRCB (2011) provided unit costs for monitoring to assess the SQOs to protect the benthic community, human health, wildlife and finfish (direct effects). Monitoring efforts for ERAs to assess indirect effects on wildlife and finfish beyond the monitoring necessary to assess water quality criteria and the SQOs for direct effects could involve collecting finfish and documenting the presence of deformities, irregularities in size, or population effects, and collection and analysis of wildlife tissue or bird eggs. Sample collection costs may vary based on factors such as water depth, abundance of fish species, sediment characteristics (may cause unsuccessful grabs that need to be repeated), and distance between stations. Although data for some parameters may not be needed at each sampling site, the total costs per sampling event could be in the range of $10,820 to $17,040.

Under the proposed Plan, a substantial amount of cost savings are associated with the change in monitoring frequency in the regional monitoring program. The sediment quality monitoring frequency in the regional monitoring program is reduced from the frequency of "once per three years" to "once per five years" which leads to a significant amount of cost reduction in monitoring activities. The number of stations needed to assess attainment of the SQO for bays and estuaries will vary based on site-specific factors. Based on 5 to 30 sites per water body, depending on the area, the State Water Board estimates that statewide monitoring costs to assess attainment of the proposed SQO will be reduced by $0.33 million to $0.51 million each year. For convenience, all costs used in this analysis are represented as an annual cost.

The proposed amendments to 303(d) listing procedures may result in identification of more or less impairments. For bays and estuaries not currently on the 303(d) list for sediment toxicity that would exceed the SQO under the proposed Plan amendments, the next step under the Plan would be a sequential approach to manage the sediment appropriately, including developing and implementing a work plan to confirm and characterize pollutant-related impacts, identify pollutants, and identify sources and management actions (including adopting a TMDL, if appropriate). The cost of this sequential approach will vary depending on a number of factors, including the extent of baseline efforts and studies underway to address other impairment issues, and the number of potential stressors to the area. Note that in the absence of the Plan amendments, Regional Water Boards could identify these waters as exceeding the narrative objectives, and thus incremental impacts associated with TMDL development and pollution controls would be zero.

The State Water Board (2001) estimates that development of complex TMDLs (including an implementation Plan) may cost over $1 million. In addition, SWRCB (2003a) indicates that TMDL development and mercury reduction strategy cost for the San Francisco Bay could range from $10 million to $20 million. These estimates provide some indication of incremental costs that could be associated with sequential approaches to managing designated use impairments. Thus, the estimates provide an approximation of costs incurred on a per TMDL basis.

The proposed Policy will supersede the implementation requirements in existing applicable TMDLs except for some TMDLs that are specifically identified in the proposed Plan. This analysis demonstrates that a substantial amount of cost savings could be achieved under the implementation of the proposed Plan.

The annual cost savings associated with changing the monitoring requirements of TMDLs ranged between approximately $0.13 million to $0.21 million. However, as information regarding the number of sampling locations per TMDL is uncertain, it was assumed that each site contains at least one sampling station. In reality, TMDLs typically include more than one sample location, so the real cost savings would be higher than this estimate.

Cleanup and Control Costs

Various remediation actions as well as pollution source control programs will be needed to achieve SQO attainment of those water bodies that are identified as impaired by the Regional Water Board. Many bays and estuaries are already listed for sediment impairments or are exceeding the benthic community, human health, or wildlife SQOs and, therefore, would require controls under baseline conditions. When the controls implemented under baseline Policy are identical to the ones that would be implemented under proposed Policy, there is no incremental cost or cost savings associated with the Plan amendments. When the baseline controls differ, there is potential for either incremental costs or cost-savings associated with the Plan amendments.

Because strategies to meet current objectives at many impaired sites are still in the Planning stages and the overall effects of implementation strategies are unknown, estimates of incremental costs would be highly speculative. For incremental sediment remediation and/or cleanup activities to be required under the Plan, monitoring data would have to indicate adverse impacts to all communities attributable to sediments in areas that would not be designated for cleanup under existing objectives. However, it is likely that most sites with sediment conditions that would require cleanup and remediation under the Plan amendments would also exceed current objectives. To the extent that results differ, it is possible that the additional assessment activities under the Plan amendments could lead to cleanup strategies that are more cost effective compared to baseline activities. In addition, based on the implementation Plans for existing TMDLs, Regional Water Boards are likely to pursue source controls for ongoing sources and only require remediation activities for historical pollutants with no known, ongoing sources.

If incremental remediation activities are necessary, costs are likely to be very specific to the particular site and project. Sediment remediation and cleanup costs may range from less than

$1/cy to over $1000/cy for various alternatives with different feasibility and practicality considerations (SWRCB, 1998). Preliminary estimates for dredging sediments in San Diego Bay suggest that unit costs may range from $100/cy to $200/cy, depending on the volume of sediment removed (SDRWQCB, 2007b; SWRCB, 2011).

Incremental costs for controls may result from the identification of additional chemical stressors that are not included in the Phase I SQOs, Basin Plans, or CTR. Since many practices that may be employed under existing TMDLs are applicable for controlling the mobilization of pollutants in general, this situation is also difficult to estimate. For example, the TMDL for pesticides and PCBs in the Calleguas Creek watershed indicates that the BMPs needed to achieve the nutrient and toxicity TMDLs for the watershed would likely reduce pesticides and PCBs to necessary levels as well (LARWQCB, 2005c). Thus, without being able to identify the particular pollutants causing toxic effects to wildlife and finfish, and the development of discharge concentrations needed to achieve the objectives, the needed cleanups and/or controls to achieve those concentrations are site- and pollutant-specific, and therefore, difficult to estimate.

The proposed Plan may result in situations where point sources are specifically required to control toxic pollutants to levels that are lower than what would be necessary in the absence of the Plan. In these instances, it is likely that these facilities would implement source control to eliminate the pollutant from entering their treatment Plant or industrial process, or pursue regulatory relief (e.g., a variance), rather than install costly end-of-pipe treatment. However, it is uncertain whether such a situation would arise as a result of the Plan amendments.

For agriculture, Regional Water Boards regulate farmers primarily through conditional WDR waivers that require compliance with water quality standards. Regional Water Boards may also require farmers to meet more stringent criteria for specific pollutants where necessary (e.g., to meet a TMDL, site-specific objectives). All of the affected Regional Water Boards have narrative objectives that specifically prohibit the discharge of pesticides and/or toxic pollutants that cause detrimental effects in aquatic life or to animals and humans. Thus, even in the absence of the Plan amendments, farmers would be prohibited from causing or contributing to toxicity to wildlife and finfish. Potential means of compliance for stormwater sources include increased or additional nonstructural BMPs (e.g., institutional, educational, or pollution prevention practices designed to limit generation of runoff or reduce the pollutants load of runoff); and structural controls (e.g., engineered and constructed systems designed to provide water quantity or quality control). Improving the effectiveness of nonstructural BMPs could be on the order of $26 per household (CSU Sacramento, 2005). Caltrans (2001) reports a range of costs for structural controls based construction costs from several transportation departments and jurisdictions. For example, average detention basin costs are approximately $7,000 and wetlands are $13,000. However, Delaware sand filter costs are approximately $118,000, on average (Caltrans, 2001; SWRCB, 2011).

For marinas and boating activities, potential means of compliance may include use of less toxic paint on boats; performing all boat maintenance activities above the waterline or in a lined channel to prevent debris from entering the water; removing boats from the water and cleaning in a specified location equipped to trap debris and collect wastewater; prohibiting hull scraping or any process that removes paint from the boat hull from being conducted in the water; and developing a collection system for toxic materials at harbors. For example, one marina spent $14,500 on a pollution prevention program in 1999 (MBNEP, 2000), and Carson, et al. (2002) estimated the cost of remaining life hull maintenance for 40 foot length, 11 foot width boats to range from a savings of $1,354 (new boat with nontoxic coating, good performance, and lower prices) to a cost of $6,251 (2.5 year old boat requiring stripping, fair performance, and higher prices). In addition, the cost of a unit that collects water that may contain toxic materials from boating maintenance operations so that it may be sent to the sanitary sewer system could cost between $3,200 to $4,500 (Pressure Power Systems, 2007).

Wetland controls may include aeration, channelization, revegetation, sediment removal, levees, or a combination of these practices. The extent of controls needed and the types of controls are unknown. The Central Valley Regional Water Board (2005b) provides one example of the cost of efforts underway in Anderson Marsh wetland on Cache Creek. Capital costs for controlling methylmercury export from Anderson March may range from $200,000 to $1 million, and O&M costs from $20,000 to $100,000 per year (CVRWQCB, 2005b; SWRCB, 2011).

Summary

Exhibit ES-1 summarizes the estimated total annual decremental costs statewide under the proposed Policy. At this time, data limitations make it is infeasible to quantify costs for all discharge types included in the Policy.

Exhibit ES-1. Estimated Total Annual Decremental Compliance (monitoring) Cost under Proposed Policy Options in California Bays and Estuaries (April-2017$ per year)[1]

Monitoring Cost	Criteria Policy		Cost Reduction (%)
	Baseline	Proposed	
Low	$937,000	$612,000	34%
High	$1,475,000	$963,000	34%

Notes:
1 All costs presented in April-2017$ and annualized based on a 5% interest rate and 20 year expected project life.

Exhibit ES-2. Estimated Total Annual Decremental Monitoring Cost under Proposed Policy Options in Applicable TMDLs (April-2017$ per year)[1]

Monitoring Cost	Criteria Policy		Cost Reduction (%)
	Baseline	Proposed	
Low	$246,000	$111,000	55%
High	$387,000	$174,000	55%

Notes:
1 All costs presented in April-2017$ 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 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, all TMDL sites are assumed to have at least one sampling location and costs associated with TMDL monitoring were determined based on this assumption, while in reality, a waterbody subjected to a TMDL contains multiple monitoring locations. This assumption and associated data limitation could potentially result in an underestimation of costs.

1 Introduction

The California State Water Resources Control Board (State Water Board) is proposing amendments to the Water Quality Control Plan for Enclosed Bays and Estuaries - Part 1 Sediment Quality (hereinafter Plan) for the protection of aquatic life, human health, wildlife, and finfish. The proposed amendment includes implementation procedures for the human health objectives and modification in program specific implementation procedure. This report presents an analysis of economic factors related to the amendment proposal, including compliance with the sediment quality objectives (SQO) options, available methods to achieve compliance with these options, and the costs of those methods.

1.1 Need for the Proposed Rule

Under the Clean Water Act (CWA), states have primary authority for establishing designated uses for water bodies, and developing sediment quality criteria to protect those designated uses. In 1989, California amended the Porter-Cologne Water Quality Control Act (Porter-Cologne) which requires the State Water Board to develop SQOs as part of a comprehensive program to protect existing and future beneficial uses within enclosed bays and estuaries (Section 13393). The State Water Board prepared a Work Plan for the development of SQOs for enclosed bays and estuaries in 1991 which included a schedule and specific tasks to develop direct effects tools that would protect benthic communities, and an element to assess the human and ecological risk in bays and estuaries from pollutants in sediments (indirect effects).

However, due to significant delays of adopting proposed SQOs, in 1999, petitioners filed a lawsuit against the State Water Board. As a result, the Superior Court ordered the State Water Board to develop SQOs for toxic pollutants as part of the Bay Protection and Toxic Cleanup Program pursuant to California Water Code (CWC) Section 13393 in accordance with a compliance schedule. In 2008, the State Water Board adopted SQOs and an implementation Policy for bays and estuaries in the state (Part I of the Plan; hereafter referred to as the Plan). In 2011, several amendments were proposed for addition to Part 1, including a narrative sediment quality objective for wildlife and finfish, a proposed process for implementing these narrative objectives, and proposed definitions added to the glossary in support of the narrative objectives. These amendments were adopted by the Porter-Cologne Act.

Part 1 -

- integrates chemical and biological measures to determine the impacts on sediment dependent biota as a result of exposing to toxic pollutants in sediment.
- includes narrative SQOs for the protection of aquatic life, human health, wildlife, and finfish.
- identifies the beneficial uses that these objectives are intended to protect.
- includes an implementation program containing specific indicators, tools, and implementation provisions to determine compliance.

- includes description of appropriate monitoring programs and sequential series of actions that shall be initiated when a sediment quality objective is not met, including stressor identification and evaluation of appropriate targets.

Recently, U.S. EPA suggested that it is more appropriate to amend the existing implementation approach by introducing a tiered framework for the protection of human health criteria that can provide a disciplined framework to assess SQO objectives accurately. U.S. EPA also recommended several amendments to address adjustment to the 303(d) listing and delisting process and monitoring requirements in the regional sediment quality monitoring program. Thus, the State Water Board staff is developing sediment quality objectives consistent with the U.S. EPA's recommendation. The Policy also establishes procedures for implementing the objectives. The State Water Board is proposing amendments to the Plan to incorporate additional sections with detailed discussion in interpreting the objectives for the protection of aquatic health, human health, and implementation Policy.

1.2 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]

[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.

Economic factors are often considered and assessed when an environmental Plan is amended. Economic factors include, but are not limited to, the attainability of the newly proposed rule/ Plan, whether the objectives and proposed alternatives are currently being attained, assessing the appropriate method to achieve compliance, and the costs related to the compliance method. The California State Water Board is considering the same economic factors to analyze the economic impact of the SQO objectives amendment. This report will demonstrate and address whether the SQOs are currently being attained, the incremental economic impact of the amendment implementation, the preventive and remedial measures available to achieve compliance with amended SQOs, and the related cost of compliance. The outcome of this analysis could be positive or negative. The cost may decrease if the pollutant sources are accurately identified. The choice of compliance methods solely depends on the source type that may be affected by the proposed SQOs. Potentially affected sources could include industries and municipal facilities discharging wastewater and stormwater to surface waters (i.e., point sources). Compliance cost also includes monitoring cost and assessment cost.

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, incremental impacts under proposed Plan, likely incremental compliance actions, and costs for these entities under the proposed Policy.

1.3 Organization of this Report

This report is organized as follows:

- Chapter 2 – describes the current applicable objectives and requirements that provide the baseline for the analysis of the incremental impact of the Policy.
- Chapter 3 – describes the amendments in the proposed Policy.
- Chapter 4 – identifies whether the proposed objectives are currently being met and whether there are any incremental impacts of meeting the objectives.
- Chapter 5 – describes the compliance costs.
- Chapter 6 – provides estimates of potential incremental statewide costs of the proposed Plan.

Appendices provide detailed information on current narrative objectives applicable to sediment quality, current water quality objectives, nonpoint source Plan management measures, detailed compliance analysis, toxic hot spots for bays and estuaries, and control costs.

2 Baseline for the Analysis

This section describes the applicable baseline for identifying the potential economic impact of incremental costs incurred by the proposed Policy options. Baseline conditions include existing sediment objectives and plans, potential sources of sediment, pollutant discharges that affect sediment quality, current level of sediment impairment of inland surface waters, enclosed bays, and estuaries in California, ongoing cleanup and remediation activities, and Planned or anticipated cleanup and remediation actions that have not yet been completed [e.g., total maximum daily load development (TMDL) and implementation schedules].

2.1 Previous Sediment Quality Objectives

The 2009 Policy was amended under Resolution 2011-0017, which was approved and only applicable under the action of Porter-Cologne Act. In this economic analysis, 2011 Policy is used as a baseline scenario to capture the incremental impact of the proposed Policy. Prior to the 2011 Policy amendments, SQO Policy was adopted by the regional boards and EPA in 2009. At first, there were no specific sediment quality objectives except the narrative objectives where individual basin Plans of the nine Regional Water Quality Control Boards established sediment water quality objectives to protect ambient sediment quality. Although they have individual sediment quality objectives, none of them are numeric sediment quality objectives. The existing sediment quality objectives for the nine Regional Water Quality Control Boards are listed in Appendix A. These criteria apply to all enclosed bays and estuaries in the state, except in water bodies where site-specific objectives have been established or where a TMDL applies. This list excludes Region 6 and Region 7, as they do not contain any enclosed bays or estuaries. Therefore, these two regions are out of the scope of this economic analysis.

2.2 Sediment Quality Objectives Beneficial Uses

The existing 2011 Plan is applicable to following beneficial uses: Estuarine Habitat, Marine Habitat, Commercial and Sport fishing, Aquaculture, Shellfish Harvesting, Rare or Endangered Species, Preservation of Biological Habitats of Special Significance, Wildlife Habitat, and Spawning Reproduction and Early Development for the protection of benthic community, Human Health, wildlife and finfish.

2.3 Sediment Quality Objectives Applicability

In accordance with existing sediment Policy, proposed Part 1 applies to enclosed bays[2] and estuaries[3] only. It does not apply to ocean waters including Monterey Bay and Santa Monica

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[2] ENCLOSED BAYS are indentations along the coast which enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the narrowest distance between headlands or outermost harbor works is less than 75 percent of the greatest dimension of the enclosed portion of the bay. This definition includes, but is not limited to: Humboldt Bay, Bodega Harbor, Tomales Bay, Drakes Estero, San Francisco Bay, Morro Bay, Los Angeles Harbor, Upper and Lower Newport Bay, Mission Bay, and San Diego Bay.

Bay, or inland surface waters. Part 1 applies to subtidal surficial sediments that have been deposited or emplaced seaward of the intertidal zone. Part 1 is also applicable in its entirety to point source discharges.

2.4 Sediment Quality Objectives

Sediment quality objectives in the existing Plan are described as follows:

- Aquatic Life – Benthic Community Protection: Pollutants in sediments shall not be present in quantities that, alone or in combination, are toxic to benthic communities in bays and estuaries implemented using the integration of multiple lines of evidence (MLOE).
- Human Health: Pollutants shall not be present in sediments at levels that bioaccumulate in aquatic life to levels that are harmful to human health.
- Wildlife and Resident Finfish: Pollutants shall not be present in sediment at levels that alone or in combination are toxic to wildlife and resident finfish by direct exposure or bioaccumulate in aquatic life at levels that are harmful to wildlife or resident finfish by indirect exposure in bays and estuaries of California.

Also, the California Toxics Rule (CTR) contains criteria for toxic pollutants applicable to inland surface waters, enclosed bays, and estuaries in the state. However, Regional Water Boards may adopt more stringent criteria for specific pollutants where necessary (e.g., to meet a TMDL, site-specific objectives). **Appendix B** shows the CTR criteria, and indicates where a Regional Water Board may have more stringent criteria in its Basin Plan. Implementation Process

2.5 Implementation Process

The State Water Board considered adopting procedures for implementing the objectives, including general procedures for all enclosed bays and estuaries. The implementation options will supersede the implementation Plans of any existing TMDL with few exceptions.

[3] ESTUARIES AND COASTAL LAGOONS are waters at the mouths of streams that serve as mixing zones for fresh and ocean waters during a major portion of the year. Mouths of streams that are temporarily separated from the ocean by sandbars shall be considered as estuaries. Estuarine waters will generally be considered to extend from a bay or the open ocean to the upstream limit of tidal action but may be considered to extend seaward if significant mixing of fresh and salt water occurs in the open coastal waters. The waters described by this definition include, but are not limited to, the Sacramento-San Joaquin Delta as defined by Section 12220 of CWC, Suisun Bay, Carquinez Strait downstream to Carquinez Bridge, and appropriate areas of the Smith, Klamath, Mad, Eel, Noyo, and Russian Rivers.

2.5.1 Assessing Sediment Quality Objectives

2.5.1.1 Aquatic Life – Benthic Community Protection for Applicable Bays and Coastal Lagoons[4]

The Plan utilizes MLOE approach to interpret narrative objectives and assess compliance for the protection of Aquatic life - Benthic community. Multiple tools are used to assess the benthic community's condition relative to the potential exposure to sediment toxicity. When a benthic community is exposed to toxic pollutants in sediments, it results in a presence of sediment contamination, degradation in the benthic community, and elevated concentrations of pollutants in sediment. Therefore, sediment quality assessment is necessary. This assessment consists of measurement and synchronization of three lines of evidence (LOE). The LOE are sediment toxicity, benthic community condition, and sediment chemistry.

- Sediment toxicity is a measure of the invertebrate's response when exposed to surficial sediments under controlled laboratory conditions. Sediment toxicity tests (i.e., short-term lethal and sub lethal tests) are conducted to estimate LOE that is used to assess both pollutant related biological effects and exposure.
- Benthic community condition is a measure of the species composition, abundance, and diversity of the sediment-dwelling invertebrates inhabiting surficial sediments. Benthic Indices (e.g., Benthic Response Index (BRI), Index of Biotic Integrity (IBI), Relative Benthic Index (RBI), and River Invertebrate Prediction and Classification System (RIVPACS)) are calculated to estimate LOE that is used to assess impacts to the primary receptors targeted for protection.
- Sediment chemistry is the measurement of the concentration of chemicals of concern in surficial sediments. The chemistry LOE is used to assess the potential risk to benthic organisms from toxic pollutants in surficial sediments. The sediment chemistry LOE is intended only to evaluate overall exposure risk from chemical pollutants. This LOE does not establish causality associated with specific chemicals.

For compliance assessment of the aquatic life SQO, all test results from sediment toxicity are compared and classified according to the sediment toxicity categorization values. The final toxicity LOE is calculated by taking the average of all response categories (nontoxic, low, moderate, and high toxicity). Next, to calculate LOE for benthic community condition, four benthic indices are calculated and categorized according to the disturbance categories (reference, low disturbance, and moderate disturbance). Finally, all categories are integrated by taking the median of all categories to determine benthic condition LOE.

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[4] Estuaries and Coastal Lagoons are waters at the mouths of streams that serve as mixing zones for fresh and ocean waters during a major portion of the year. Mouths of streams that are temporarily separated from the ocean by sandbars shall be considered as estuaries. Estuarine waters will generally be considered to extend from a bay or the open ocean to the upstream limit of tidal action but may be considered to extend seaward if significant mixing of fresh and salt water occurs in the open coastal waters. The waters described by this definition include, but are not limited to, the Sacramento-San Joaquin Delta as defined by Section 12220 of CWC, Suisun Bay, Carquinez Strait downstream to Carquinez Bridge, and appropriate areas of the Smith, Klamath, Mad, Eel, Noyo, and Russian Rivers.

In the case of sediment chemistry LOE calculation, all samples are tested for certain analytes to assess associated exposure. Sediment chemistry exposure is assessed by two methods: 1) Chemical Score Index (CSI) and 2) California Logistic Integration Model (CA LRM). Each sediment chemistry guideline method is categorized according to the exposure category (minimal exposure, low, moderate, and high exposure) and all results are integrated to determine the final LOE for sediment chemistry.

The attainment of sediment quality objectives in a particular site or station is assessed by interpretation and integration of MLOE. Different combinations of MLOE are derived in this assessment framework. These MLOE combinations reflect the presence and severity of two characteristics: severity of biological effects and potential of chemically-mediated effects. The severity of biological effect is determined from the benthos and toxicity test results, where benthos is given greater weight for determining effects. Evidence of chemical exposure, or the potential that effects are chemically mediated, is determined from the sediment chemistry and toxicity test results. Note that benthos is not used to assess chemical exposure because benthic disturbance can be caused by nontoxic-related factors, such as grain size, temperature, and recruitment. The combination of intermediate classification for severity of biological effect and potential for chemically-mediated effect can be assessed by six categories of impact at the station level.

The framework for evaluating the MLOE classifies each site into one of the six categories of impact as described in **Exhibit 2-1** as follows:

Exhibit 2-1. Categories of Impact at the Station Level

Assessment Category	Description
Unimpacted	Confident that sediment contamination is not causing significant adverse impacts to aquatic life living in the sediment at the site.
Likely Unimpacted	Sediment contamination at the site is not expected to cause adverse impacts to aquatic life, but some disagreement among the LOE reduces certainty in classifying the site as unimpacted.
Possibly Impacted	Sediment contamination at the site may be causing adverse impacts to aquatic life, but these impacts are either small or uncertain because of disagreement among LOE.
Likely Impacted	Evidence for a contaminant-related impact to aquatic life at the site is persuasive, even if there is some disagreement among LOE.
Clearly Impacted	Sediment contamination at the site is causing clear and severe adverse impacts to aquatic life.
Inconclusive	Disagreement among the LOE suggests that either the data are suspect or that additional information is needed before a classification can be made.

The station assessment resulting from each possible combination of the three LOEs is shown in **Exhibit 2-2** as follows:

Exhibit 2-2. Station Assessment Category Resulting from each Possible MLOE Combination

LOE Category Combination	Sediment Chemistry Exposure	Benthic Community Condition	Sediment Toxicity	Station Assessment
1	Minimal	Reference	Nontoxic	Unimpacted
2	Minimal	Reference	Low	Unimpacted
3	Minimal	Reference	Moderate	Unimpacted
4	Minimal	Reference	High	Inconclusive
5	Minimal	Low	Nontoxic	Unimpacted
6	Minimal	Low	Low	Likely unimpacted
7	Minimal	Low	Moderate	Likely unimpacted
8	Minimal	Low	High	Possibly impacted
9	Minimal	Moderate	Nontoxic	Likely unimpacted
10	Minimal	Moderate	Low	Likely unimpacted
11	Minimal	Moderate	Moderate	Possibly impacted
12	Minimal	Moderate	High	Likely impacted
13	Minimal	High	Nontoxic	Likely unimpacted
14	Minimal	High	Low	Inconclusive
15	Minimal	High	Moderate	Possibly impacted
16	Minimal	High	High	Likely impacted

LOE Category Combination	Sediment Chemistry Exposure	Benthic Community Condition	Sediment Toxicity	Station Assessment
17	Low	Reference	Nontoxic	Unimpacted
18	Low	Reference	Low	Unimpacted
19	Low	Reference	Moderate	Likely unimpacted
20	Low	Reference	High	Possibly impacted
21	Low	Low	Nontoxic	Unimpacted
22	Low	Low	Low	Likely unimpacted
23	Low	Low	Moderate	Possibly impacted
24	Low	Low	High	Possibly impacted
25	Low	Moderate	Nontoxic	Likely unimpacted
26	Low	Moderate	Low	Possibly impacted
27	Low	Moderate	Moderate	Likely impacted
28	Low	Moderate	High	Likely impacted
29	Low	High	Nontoxic	Likely unimpacted
30	Low	High	Low	Possibly impacted
31	Low	High	Moderate	Likely impacted
32	Low	High	High	Likely impacted
33	Moderate	Reference	Nontoxic	Unimpacted
34	Moderate	Reference	Low	Likely unimpacted
35	Moderate	Reference	Moderate	Likely unimpacted
36	Moderate	Reference	High	Possibly impacted
37	Moderate	Low	Nontoxic	Unimpacted
38	Moderate	Low	Low	Possibly impacted
39	Moderate	Low	Moderate	Possibly impacted
40	Moderate	Low	High	Possibly impacted
41	Moderate	Moderate	Nontoxic	Possibly impacted
42	Moderate	Moderate	Low	Likely impacted
43	Moderate	Moderate	Moderate	Likely impacted
44	Moderate	Moderate	High	Likely impacted
45	Moderate	High	Nontoxic	Possibly impacted
46	Moderate	High	Low	Likely impacted
47	Moderate	High	Moderate	Likely impacted
48	Moderate	High	High	Likely impacted
49	High	Reference	Nontoxic	Likely unimpacted
50	High	Reference	Low	Likely unimpacted
51	High	Reference	Moderate	Inconclusive
52	High	Reference	High	Likely impacted
53	High	Low	Nontoxic	Likely unimpacted
54	High	Low	Low	Possibly impacted
55	High	Low	Moderate	Likely impacted
56	High	Low	High	Likely impacted
57	High	Moderate	Nontoxic	Likely impacted

LOE Category Combination	Sediment Chemistry Exposure	Benthic Community Condition	Sediment Toxicity	Station Assessment
58	High	Moderate	Low	Likely impacted
59	High	Moderate	Moderate	Clearly impacted
60	High	Moderate	High	Clearly impacted
61	High	High	Nontoxic	Likely impacted
62	High	High	Low	Likely impacted
63	High	High	Moderate	Clearly impacted
64	High	High	High	Clearly impacted

The Plan specifies that sites which possess categories designated as Unimpacted and Likely Unimpacted sediments, shall be considered as achieving the SQO, whereas sites with Clearly Impacted, Likely Impacted, and Possibly Impacted sediments exceed the SQO. In addition, a Regional Water Board shall designate the Possibly Impacted category as meeting the protective condition if studies demonstrate that the combination of effects and exposure measures are not responding to toxic pollutants in sediments and that other factors are causing these responses within a specific reach segment or water body. In this situation, the Regional and State Board will only consider the Likely Impacted and Clearly Impacted categories as degraded when making a determination on receiving water limits or impaired water bodies.

2.5.1.2 Aquatic Life – Benthic Community Protection for Other Bays[5] and Estuaries

Station assessments for other bays and estuaries will be conducted using same conceptual approach and similar tools that are used for assessing SQOs in applicable bays and estuaries. There must be evidence of both elevated chemical exposure and biological effects, and the categorization of each LOE should be based on numeric values or a statistical comparison. However, the categorization of each LOE will be based on a reference condition rather than an established index or score. Reference sites should be located in an area uninfluenced by the dischargers or pollutants of concern, and should be representative of other habitat characteristics of the assessment area (e.g., salinity, grain size). Sites are classified in only two impact categories:

- Unimpacted – no conclusive evidence of both high pollutant exposure and high biological effects present at the site; evidence of chemical exposure and biological effects may be within natural variability or measurement error.
- Impacted – confident that sediment contamination present at the site is causing adverse direct impacts to aquatic life.

2.5.1.3 Human Health Protection

Compliance with the human health narrative sediment quality objective will be assessed based on a human health risk assessment in accordance with the California Environmental Protection

[5] Other bays and estuaries include all bays and estuaries except Euhaline Bays and Coastal Lagoons south of Point Conception and Polyhaline San Francisco Bay that includes the Central and South Bay Areas defined in general by waters south and west of the San Rafael Bridge and north of the Dumbarton Bridge

Agency's (Cal/EPA) Office of Environmental Health Hazard Assessment (OEHHA) policies for fish consumption and risk assessment, Cal/EPA's DTSC Risk Assessment, and U.S. EPA Human Health Risk Assessment policies.

2.5.1.4 Wildlife and Resident Finfish Protection

Compliance with the wildlife and resident finfish objective will be assessed on a case-by-case basis. Compliance will be based upon an ecological risk assessment considering any applicable and relevant ecological risk information, including policies and guidance from different sources such as OEHHA, DTSC, California Department of Fish and Game, U.S. Environmental Protection Agency, National Oceanographic Atmospheric Administration, and U.S. Fish and Wildlife Service. When threatened or endangered species are present in enclosed bays and estuaries, the Water Boards shall consult with State and/or Federal Resource Trustee agencies to ensure that these species are adequately protected.

2.5.2 Program Specific Implementation

2.5.2.1 Dredge Material

Existing baseline sediment quality objectives shall not be applied for dredging material suitability determination. Also, an approval of dredging projects that might involve dredging the sediment and exceeding the sediment objectives is not allowed. However there is some exception to this rule, including consideration of a method to remove dredging material that would prevent or minimize water quality degradation, or if the polluted sediment is removed in a manner that prevents or minimizes water quality degradation.

Furthermore, only those dredging projects are approved by the Regional Water Board where the polluted sediment is not deposited in a location that may cause significant adverse effects to living species or beneficial uses of the receiving waters. Also, the polluted sediment should not be deposited in a location that does not create maximum benefit to the people of the State, or, will not cause significant adverse impacts upon a federal sanctuary, recreational area, or other waters of significant national importance.

2.5.2.2 NPDES Receiving Water and Effluent Limit

SQOs will be implemented as receiving water limits in NPDES permits where a Regional Water Board believes there is potential for the discharge to be causing or contributing to an exceedance of an applicable SQO based on the results of stressor identification studies.

Receiving water monitoring requirements in NPDES permits may be satisfied by a Permittee's participation in a regional SQO monitoring program. Effluent limits established to protect or restore sediment quality shall be developed only after the establishment of a clear relationship linking the discharge to the degradation, identification of a contributor pollutant, and appropriate loading studies.

According to the existing Plan, nothing in the Plan will limit a Water Board's authority to develop and implement waste load allocations for TMDLs. However, it is recommended that the Water Boards develop TMDL allocations using the methodology described herein, wherever possible.

2.5.2.3 Exceedance of Receiving Water Limit

The receiving water limit to protect aquatic life or human consumers of sportfish would be considered as exceeded when a binomial distribution demonstrates that the total number of stations are not meeting the protective condition; therefore, rejecting the null hypothesis (**Exhibit 2-3**). The stations included in this analysis will be those that are located in the vicinity of the discharge and identified in the permit. After identifying the discharge causing an exceedance, a stressor identification study is usually conducted. If studies by the Permittee demonstrate that other sources are also contributing to the degradation of sediment quality, the Regional Water Board shall, as appropriate, require the Discharger to initiate studies to assess the extent to which these sources are a contributing factor.

Exhibit 2-3. Minimum Number of Measured Exceedances Needed to Exceed the Direct Effects SQO as a Receiving Water Limit

Sample Size	List If the Number of Exceedances Equals or Is Greater Than
2 – 24	2*
25 – 36	3
37 – 47	4
48 – 59	5
60 – 71	6
72 – 82	7
83 – 94	8
95 – 106	9
107 – 117	10
118 – 129	11

Note:

[1] Null Hypothesis: Actual exceedance proportion ≤ 3 percent.
Alternate Hypothesis: Actual exceedance proportion > 18 percent.
The minimum effect size is 15 percent.

[2] Application of the binomial test requires a minimum sample size of 16. The number of exceedances required using the binomial test at a sample size of 16 is extended to smaller sample sizes

To determine compliance with receiving water limits, Phase I Stormwater Discharges and Major Discharges are required to do sediment monitoring not less frequently than twice per permit cycle. For stations that are consistently classified as Unimpacted or Likely Unimpacted the frequency may be reduced to once per permit cycle. The Water Board may limit receiving water monitoring to a subset of outfalls for Phase I Stormwater Permittees. Similarly, sediment monitoring shall not be required more often than twice per permit cycle or less than once per permit cycle for Phase II Stormwater and Minor Discharges. For stations that are consistently classified as Unimpacted or Likely Unimpacted, the number of stations monitored may be reduced at the discretion of the Water Board. The Water Board may limit receiving water monitoring to a subset of outfalls for Phase II Stormwater Permitees. The frequency of the monitoring for receiving water limits for other regulated discharges and waivers will be determined by the Water Board.

2.5.2.4 Sediment Monitoring

The objective of the sediment monitoring program is to ensure the data appropriately characterizes the water body which may be contaminated by the accumulation of pollutants from varied sources. The existing Plan directs Regional Water Boards to require permittees to monitor sediments if they discharge toxic or priority pollutants that may accumulate in sediments at levels that will cause, have the reasonable potential to cause, or contribute to an exceedance of applicable SQOs. The monitoring frequency required in the existing plan is not less than once every three years, prior to the issuance or re-issuance of a permit.

Monitoring may be performed by individual Permitees to assess compliance with receiving water limits, or through participation in a regional or water body monitoring coalition or both as determined by the Water Board. The Permittee is encouraged to participate in the regional monitoring program. Regional monitoring program is a coalition of the regulated community that supports to achieve maximum efficiency and economy of resources through sharing of technical resources, trained personal, and associated costs within each major waterbody. Sediment monitoring programs shall be designed to ensure that the aggregate stations are spatially representative of the sediment within the water body.

The design of sediment monitoring programs, whether site-specific or region-wide, shall be based upon a conceptual model that could be useful for identifying the physical and chemical factors that control the fate and transport of pollutants and receptors that could be exposed to pollutants in the sediment. The conceptual model serves as the basis for assessing the appropriateness of a study design. A design of a conceptual model considers different factors, such as points of discharge into the segment of the water body or region of interest, tidal flow and/or direction of predominant currents, historic and/or legacy conditions in the vicinity, nearby land and marine uses or action, beneficial uses, potential receptors of concern, etc. Sampling events at sampling stations should be conducted between the months of June and September, and need to be consistent with the benthic community condition index period.

2.5.2.5 Evaluate Waters for 303(d) Listing

Under the existing sediment quality Plan, the water segments are designated as “impaired’ for sediment toxicity and placed on a section 303(d) list based on toxicity alone or toxicity that is associated with a pollutant. Water segments shall be placed on the section 303(d) list for exceedance of the narrative sediment quality objective for aquatic life protection only if the number of stations designated as not achieving the protective condition supports rejection of the null hypothesis. Also, water segments that exhibit sediment toxicity but are not listed for an exceedance of the narrative sediment quality objective for aquatic life protection shall continue to be listed according to the State Water Board’s Water Quality Control Policy for Developing California’s Clean Water Act Section 303(d) List (2004) (Listing Policy). If a water segment is listed under the Listing Policy and the Regional Water Board later determines that the applicable water quality standard consists of the sediment quality objective of Part 1 and a bay or estuarine habitat beneficial use, the Regional Water Board shall re-evaluate the listing. Upon re-revaluation, if the Regional Water Board determines that the water segment does not meet the criteria in IV.4.e.i.a of the Plan, the Regional Water Board shall delist the water segment.

2.5.3 Stressor Identification

Where water bodies or segments contain sites with degraded sediments, confirmatory monitoring shall be conducted to determine whether the results are a response to toxic pollutants in sediments or due to other factors. If MLOE or confirmatory monitoring results leads to an exceedance of the narrative SQOs, the Plan requires a sequential approach to manage the sediment appropriately. The sequential approach consists of development and implementation of a work plan (i.e., stressor identification) to seek confirmation and characterization of pollutant-related impacts, pollutant identification, and source identification. The Plan directs Regional Water Boards to prioritize segments or reaches with the highest percentage of sites designated as Clearly Impacted and Likely Impacted for stressor identification. The Water Boards shall assign the highest priority for stressor identification to those segments or reaches with the highest percentage of sites designated as Clearly Impacted and Likely Impacted.

Where segments or reaches contain Possibly Impacted but no Clearly or Likely Impacted sites, confirmation monitoring shall be conducted prior to initiating stressor identification. The stressor identification work plan shall be submitted to the Regional Water Board for approval. Stressor identification consists of the studies described below:

Confirmation and Characterization of Pollutant Related Impacts – Exceedance of the direct effects SQO at a site indicates that pollutants in the sediment are the cause, but does not identify the specific contaminants responsible or rule out confounding factors (e.g., physical disturbance). Physical alterations such as reduced salinity, impacts from dredging, very fine or course grain size, and propeller wash from passing ships may produce a condition in the benthic community similar to that caused by toxic pollutants. If impacts to a site are purely due to physical disturbance, the LOE characteristics will likely show a degraded benthic community with little or no toxicity and low chemical concentrations. Other nontoxic pollutant related stressors include elevated levels of total organic carbon, nutrients, and pathogens. Chemical and microbiological analysis will be necessary to determine if these constituents are present. The LOE characteristics for this type of stressor would likely be a degraded benthic community with a possible indication of toxicity and low chemical concentrations.

To further assess a site that is impacted by toxic pollutants, the Plan allows for several studies to be considered and evaluated in the work Plan for the confirmation effort:

- Evaluate the spatial extent of the area of concern;
- Examination of body burden data from animals exposed to the site's sediment to indicate if pollutants are being accumulated and to what degree;
- Application of chemical-specific mechanistic benchmarks to interpret sediment chemistry concentrations;
- Examination of chemistry and biology data from the site to determine if there is a correlation between the two lines of evidence;
- Gather alternative biological effects data such as bioaccumulation experiments and pore water toxicity or chemical analysis; and

- Conduct other investigations commonly performed as part of a Phase I TIE.

If there is compelling evidence that the SQO exceedances contributing to a receiving water limit exceedance are not due to toxic pollutants, then the Plan indicates that the assessment area shall be designated as having achieved the receiving water limit.

Pollutant Identification Studies – Pollutant identification studies to identify the cause of the observed effects may be based on the following:

- Statistical methods: Correlations between individual chemicals and biological endpoints (toxicity and benthic community).
- Gradient analysis: Comparisons between samples taken at various distances from a chemical hotspot determine patterns in chemical concentrations and biological responses.
- Toxicity Identification Evaluation (TIE): Sediment samples are manipulated chemically or physically to remove classes of chemicals or render them biologically unavailable. Following the manipulations, biological tests determine if toxicity has been removed. TIEs should be conducted at a limited number of stations, and preferably those with strong biological effects.
- Bioavailability: Chemical and toxicological measurements on pore water may determine the availability of sediment contaminants. Measurement of acid volatile sulfides and extracted metals analysis determine if sufficient sulfides are present to bind metals. Solid phase micro extraction (SPME) or laboratory desorption experiments can be used to identify which organics are available to animals.
- Verification: Compare body burden measurements on animals exposed to the sediment to established toxicity thresholds. Spike sediments with the suspected chemicals to verify that they are toxic at the concentrations observed in the field. Alternately, transplant unaffected animals to suspected sites for in-situ toxicity and bioaccumulation testing.

To address source identification and management actions, the Plan requires:

- Determining if sources are ongoing or legacy;
- Determining the number and nature of ongoing sources;
- If a single discharger is found to be responsible for discharging the stressor pollutant at a loading rate that is significant, requiring the discharger to take all necessary and appropriate steps to address exceedances, including, but not limited to, reducing the pollutant loading into the sediment; and
- When multiple sources are present in the water body and the stressor pollutant is discharged at a loading rate that is significant, requiring the sources to take all necessary and appropriate steps to address exceedances, including adopting a TMDL, if appropriate.

2.5.4 Cleanup and Abatement

Cleanup and abatement actions are covered by Water Code section 13304 for sediments that exceed the sediment quality objectives. It shall comply with Resolution No. 92-49 (Policies and

Procedures for Investigation and Cleanup and Abatement of Discharges under Water Code Section 13304), Cal. Code Regs., tit. 23, §§ 2907, 2911.

2.5.5 Development of Site-specific Sediment Management Guide

Site-specific sediment management guidelines may be developed by the Regional Water Boards where appropriate. Development of site-specific sediment management guidelines is the process to estimate the level of the stressor pollutant that will meet the narrative sediment quality objective. The guidelines can serve as the basis for cleanup goals or revision of effluent limits.

Guidelines should be developed only under the scenario when the stressor causing the sediment impairment in a specific water body is identified. The specific intention of site-specific sediment management guidelines is to link organism exposure and the biological effect. Once the relationship is established, a pollutant specific guideline may be designated that corresponds with minimum biological effects. The following approaches can be applied to establish these relationships:

- Correspondence with sediment chemistry. An effective guideline can best be derived based upon the site-specific or reach-specific relationship between the stressor pollutant exposure and biological response. Therefore, the correspondence between the bulk sediment stressor concentration and biological effects should be examined.
- Correspondence with bioavailable pollutant concentration. The concentration of the bioavailable fraction of the stressor pollutants is likely to show a less variable relationship to biological effects that bulk sediment chemistry. Interstitial water analysis, SPME, desorption experiments, selective extractions, or mechanistic models may indicate the bioavailable pollutant concentration. The correspondence between the bioavailable stressor concentration and biological effects should be examined.
- Correspondence with tissue residue. The concentration of the stressor accumulated by a target organism may provide a measure of the stressor dose for some chemicals (e.g., those that are not rapidly metabolized). The tissue residue threshold concentration associated with unacceptable biological effects can be combined with a bioaccumulation factor or model to estimate the loading or sediment concentration guideline.
- Literature review. If site-specific analyses are ambiguous or unable to determine a guideline, then the results of similar development efforts for other areas should be reviewed. Scientifically credible values from other studies can be combined with mechanistic or empirical models of bioavailability, toxic potency, and organism sensitivity to estimate guidelines for the area of interest.

The chemistry LOE, including the threshold values (e.g. CSI and CALRM), shall not be used for setting cleanup levels or numeric values for technical TMDLs.

2.6 Regional Monitoring Program

There is a broad range of sediment monitoring programs under the existing Policy and SQOs. These programs help Regional Water Boards, dischargers, and other organizations to characterize effluent, ambient water, and sediment quality, and fish and wildlife health. These efforts include regional and coordinated programs, as well as discharger monitoring requirements. Regional programs include:

1. **Southern California Bight Regional Monitoring Survey:** This is the largest water quality monitoring program in the South Coast. The Bight program is a collaborative, integrated regional monitoring program with over 100 participating agencies, including locally-regulated agencies, state and federal regulatory agencies, and non-governmental and academic institutions. This survey is managed by the Southern California Coastal Water Research Project to assess the physical, chemical, and biological impacts to ocean waters, bays, and estuaries from Ventura to San Diego. The most recent project is "Bight 13 Regional Monitoring" which includes "Bight 13 Sediment Chemistry Assessment" which aims to determine (1) the extent and magnitude of direct impact from sediment contaminants; (2) the trend in extent and magnitude of direct impacts from sediment contaminants; and (3) the indirect risk of sediment contaminants to seabirds.

2. **San Francisco Bay Regional Monitoring Program (SFBRMP)**: The Regional Monitoring Program (RMP) is San Francisco Estuary Institute (SFEI)'s largest program and monitors contamination in the estuary providing water quality regulators with information they need to manage the estuary effectively. The RMP is an innovative collaborative effort between SFEI, the Regional Water Board, and the regulated discharger community. Monitoring performed in the RMP determines spatial patterns and long-term trends in contamination through sampling of water, sediment, bivalves, bird eggs, and fish, and evaluates toxic effects on sensitive organisms and chemical loading to the Bay. RMP has been collecting archive samples during each sampling event for sediment, bivalve, fish and birds since the early 1990's. These samples are available to SFEI researchers with RMP Program Manager Approval, and can be requested directly from the Contaminant Data Display and Download (CD3) tool. The RMP is an annual effort, though individual parameters may be monitored more or less frequently.

3. **Surface Water Ambient Monitoring Program (SWAMP): This** State Water Board program provides decision makers and the public with the information necessary to evaluate surface water quality throughout California. SWAMP supports the collection of high quality data in all regions for 303(d) listing and 305(b) reporting on impaired water bodies and waters supporting beneficial uses. SWAMP is a statewide monitoring effort designed to assess the conditions of surface waters throughout the State of California. The SWAMP program was first established in 2000 by the State Water Board. For the purposes of SWAMP, "ambient" monitoring refers to any activity in which information about the status of the physical, chemical, and/or biological characteristics of the environment is collected to answer specific questions about the status and trends in water quality and/or beneficial uses of water.

   One of the funded projects of SWAMP is the Stream Pollution Trends Monitoring Program (SPoT), which was initiated to monitor trends in sediment toxicity and sediment contaminant concentrations in selected large rivers throughout California, and relates contaminant concentrations and toxicity to watershed land uses. The overall goal of this long-term trends assessment is to detect meaningful change in the concentrations of contaminants and their biological effects in large watersheds at time scales appropriate to management decision making. Sediment toxicity and a suite of pesticides, trace metals, and industrial compounds have been analyzed from 100 sites annually since 2008. The program design was revised in 2015 to reflect observed trends in stream contaminants and toxicity. This will allow for monitoring of additional chemicals of emerging concern and toxicity indicator species appropriate for these chemicals.

4. **Mussel Watch Program**: National Oceanic and Atmospheric Administration program of national status and trends is the longest running contaminant monitoring program in the United States. Contaminant concentrations in mussel tissue are a direct measure of exposure for all similar filter feeders in those habitats where found, and are an indicator of dietary exposure for biota that feed on these filter feeders.

5. **Regional Harbors Monitoring Program (RHMP):** RHMP is a collaborative program initiated in response to a Regional Water Board request pursuant to CWC 13255 for water quality information for Dana Point Oceanside, Mission Bay, and San Diego Bay. The objectives of this program include assessing water and sediment quality to sustain healthy biota, and the long-term trends in harbor conditions (Weston, 2008). The Regional Harbor Monitoring Program was developed by the Port of San Diego, City of San Diego, City of Oceanside, and County of Orange to understand the general water quality and condition of marine life in San Diego Bay, Mission Bay, Oceanside Harbor, and Dana Point Harbor. The RHMP assesses the spatial distribution of pollutants and their impacts, the safety of the waters for human contact, the safety of fish for human consumption, the abilities of the waters and sediments to sustain healthy biota, and the long-term trends in the conditions in each of the harbors. This core monitoring program occurs every five years to assess the conditions found in the harbors.

6. **Central Coast Long-term Environmental Assessment Network (CCLEAN)**: CCLEAN satisfies the NPDES receiving water monitoring and reporting requirements of program participants. Concerns center on elevated concentrations of persistent organic pollutants (e.g., petroleum hydrocarbons, chlorinated pesticides, polychlorinated biphenyls) in fish from the Monterey Submarine Canyon, declines in sea otter populations, diseases in sea otters related to high concentrations of persistent organic pollutants, and bird and mammal deaths due to blooms of toxic phytoplankton.

   The CCLEAN is a cooperative long-term monitoring program that satisfies the NPDES receiving water monitoring and reporting requirements of five entities including the Cities of Santa Cruz and Watsonville, Duke Energy, the Monterey Regional Water Pollution Control Agency, and the Carmel Area Wastewater District. In addition to meeting permit requirements, this collaborative meets objectives contained in a 1992 Memorandum of Agreement that established the Monterey Bay National Marine Sanctuary's Water Quality Protection Program and subsequent Action Plan entitled Monitoring, Data Access, and Interagency Coordination. Within the framework of CCAMP (Central Coast Ambient

Monitoring Program), the goal of the CCLEAN program is to assist stakeholders in maintaining, restoring, and enhancing nearshore water and sediment quality and associated beneficial uses in the Central Coast Region. A few of the specific objectives of the program are as follows:

- Obtain high-quality data describing the status and long-term trends in the quality of nearshore waters, sediments, and associated beneficial uses;
- Determine whether nearshore waters and sediments are in compliance with the Ocean Plan;
- Determine sources of contaminants to nearshore waters;
- Provide legally defensible data on the effects of wastewater discharges in nearshore waters; and
- Develop a long-term database on trends in the quality of nearshore waters, sediments and associated beneficial uses.

7. **Western Environmental Monitoring and Assessment Program (WEMAP) and the National Coastal Condition Assessment (NCCA):** These projects aim to assess near-coastal ecosystem health of the West Coast (Alaska, Washington, Oregon, California, and Hawai'i) according to methods and procedures developed under U.S. EPA Environmental Monitoring and Assessment Program (EMAP). In California, a four-year multi-agency cooperative study is managed by the Southern California Coastal Water Research Project (SCCWRP) and includes partners from the State Water Board, the San Francisco Estuary Institute (SFEI), Marine Pollution Studies Laboratory (MPSL), Moss Landing Marine Laboratories (MLML), Department of Fish and Game (DFG), and University of California, Davis. Under this project, a special study was conducted in Morro Bay in late 2003 under which water, sediment, and fish tissue samples were collected. In 2004, another round of WEMAP sampling was conducted in California's bays and estuaries with water and sediment samples collected at 49 stations and trawling for fish occurring at 31 of those stations. Funds were allocated to conduct additional sampling in bays and estuaries in 2005 and 2006. Water and sediment samples (n=32) were collected each year with trawling for flatfish species conducted at each station. MPSL-MLML provided field and logistical support for the California surveys in 2010 and lead the field effort in 2015.

2.7 Municipal and Industrial Facilities

Under the supervision of the National Pollutant Discharge and Elimination System (NPDES) permit program, the State Water Board regulates toxic pollutants in the effluents of municipal and industrial wastewater treatment facilities. The NPDES permits are issued pursuant to section 402 of the Clean Water Act, which requires that all point source discharges of pollutants to waters of the United States be regulated under a permit. Both technology-based and water quality based effluent limits are included in an NPDES permit. Water quality based effluent limits (WQBELs) reflect applicable water quality standards, including those contained in Basin Plans and the California Toxics Rule. NPDES permits also reflect narrative objectives contained in Basin Plans. The NPDES permittees may contribute to and support the RMP through special studies to assess compliance with the receiving water limits. These studies often focus on exposure and effects to fish and wildlife.

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 2-4** provides a summary of these California dischargers by discharge type.

Exhibit 2-4. 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)

2.8 Stormwater Discharges

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 (SWMP), 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 pollutants are reduced to the appropriate levels. This iterative approach increases requirements until water quality objectives are met. As such, this is an ongoing process and 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 sediment.

2.8.1 Municipal Discharges

Stormwater discharges from municipal facilities are regulated under 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 under which 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. Usually, large or medium municipal facilities are required to conduct chemical monitoring while small facilities are excluded from the requirement.

These permits can include actions addressing sediment quality. For example, the Contra Costa Clean Water Program (CA0029912 and CA0083313) requires the permittees to pursue a mass emission strategy to reduce pollutant discharges from point and nonpoint sources and address accumulation of pollutants in organisms and sediments (SFRWQCB, 1999). In addition, there are 209 small MS4s that have submitted SWMPs to Regional Water Boards or the State Water Board for approval. However, it is not clear how many of those MS4s discharge to enclosed bays and estuaries.

There are 22 NPDES Phase I MS4 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. Chapter 5 includes a detailed description on California's SWAMP activities.

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.

2.8.2 Industrial Discharges

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 (BAT) economically achievable 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.

2.8.3 Construction

The construction program involves those dischargers of stormwater whose project disturbs one or more acres of soil, or whose projects disturb less than one acre but are part of a larger common Plan of development that in total disturbs one or more acres. These facilities are required to obtain coverage under the general permit for discharges of stormwater associated with construction activity.

The construction general permit involves the development and implementation of a SWPPP that lists BMPs that a discharger will use to control pollutants in stormwater runoff and the placement of those BMPs. Additionally, the SWPPP must contain a visual monitoring program, a chemical monitoring program for nonvisible pollutants to be implemented if there is a failure of BMPs, and a sediment monitoring plan if the site discharges directly to a water body impaired for sediment.

2.8.4 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).

2.9 Nonpoint Sources

Nonpoint source pollution, unlike pollution from industrial and sewage treatment Plants, comes from many different sources. Some nonpoint source pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, depositing them into lakes, rivers, wetlands, coastal waters, and groundwater. Nonpoint source pollution may originate from several sources including agricultural operations, forestry operations, urban areas, boating and marinas, active and historical mining operations, atmospheric deposition, and wetlands. Note that, in many cases, discharges from these sources can be regulated as point sources (i.e., discernible, confined, and discrete conveyances).

In 1999, California implemented its Fifteen-Year Program Strategy for the Nonpoint Source Pollution Control Program, as delineated in the Plan for California's Nonpoint Source Pollution Control Program (NPS Program Plan). The legal foundation for the NPS Program Plan is the Clean Water Act (CWA) and the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) (SWRCB, 2000). The agencies primarily responsible for the development and implementation of the NPS Program Plan are the State Water Board, the nine Regional Water Boards, and the California Coastal Commission (CCC). Various other federal, state, and local agencies have significant roles in the implementation of the NPS Program Plan. Federal approval and funding of the NPS Program Plan required assurance that the state had legal authority to implement and enforce the Plan. The state's Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program (NPS Policy) provides guidance regarding the implementation and enforcement of the NPS Program Plan. As stated in the NPS Policy, the Porter-Cologne Act provides the legal authority of the State Water Board and Regional Water Boards to regulate nonpoint sources in California under waste discharge requirements (WDRs), conditional waivers of WDRs, or basin Plan prohibitions or amendments (SWRCB, 2004b). However, all WDRs need not contain numeric effluent limits. The Regional Water Boards do not usually assign nonpoint sources numeric effluent limits; rather they primarily rely on implementation of BMPs to reduce pollution. The NPS Program Plan specifies management measures (MMs) and the corresponding management practices or BMPs for each of six source categories. MMs should be implemented where needed by 2013 using a combination of nonregulatory activities and enforceable policies and mechanisms (SWRCB, 2003a). **Appendix C** describes the MMs for each source category applicable to sediment toxicity reductions.

2.9.1 Agriculture

Agricultural activity may significantly impact sediment quality in various ways. These impacts can be caused by:

- Farming activities or style which involves excessive erosion;
- Improper and excessive usage of pesticides and fertilizers; or
- Over application of irrigation water resulting in runoff of sediments and pesticides (SWRCB, 2006b).

California Regional Water Boards have historically regulated discharges from irrigated land including stormwater runoff, irrigation tail water, and tile drainage through a discharge waiver. These waivers are authorized by CWC Section 13269, which allows Regional Water Boards to waive WDRs if it is in the public interest.

Although the majority of historical discharge waivers require that discharges not cause violations of water quality objectives; these waivers also do not require water quality monitoring, which may lead to a significant impairment of water quality through agricultural runoff. In 1999, Senate Bill 390 amended CWC section 13269 and required Regional Water Boards to review and renew their waivers, or replace them with WDRs. If Regional Water Boards did not reissue the waivers by January 1, 2003, they expired. The Central Coast, Los Angeles, Central Valley, and San Diego Regional Water Boards have established conditional waivers for agricultural discharges. The Santa Ana Regional Water Board is in the process of developing a conditional waiver for discharges from irrigated agricultural lands. While the North Coast and San Francisco Bay Regional Water Boards have no immediate Plans to adopt waivers for agricultural discharges, they may do so in the future in the context of TMDLs.

Regional Water Boards regulate agricultural discharges from cropland under nonpoint source programs concurrently with the conditional waivers that rely on BMPs to protect water quality. For instance, the State Water Board and the CCC oversee agricultural control programs, with assistance from the Department of Pesticide Regulation (DPR) for pesticide pollution and the Department of Water Resources for irrigation water management (SWRCB, 2006b). The pesticide MM 1D is likely to have the greatest impact on sediment toxicity. This MM reduces contamination of surface water and ground water from pesticides through procedures, strategies, practices, and other controls. Another management system is Integrated Pest Management (IPM), which is an effective and environmentally sensitive approach to pest management. IPM helps to reduce harmful impact of pest through:

- Set action threshold of pest control;
- Monitoring and identifying pest to adopt appropriate control decisions in conjunction with action threshold;
- Adopting different effective and cost efficient prevention methods; and
- Evaluating different control methods.

IPM strategies include evaluating pest problems in relation to cropping history and previous pest control measures, and applying pesticides only when an economic benefit will be achieved. Pesticides should be selected based on their effectiveness to control target pests and their potential environmental impacts such as persistence, toxicity, and leaching potential (SWRCB, 2006b).

There are many planned, on-going, and completed activities related to management of pesticides. However, as reported in the most recent NPS Program Plan progress report (SWRCB, 2004a), efforts to improve water quality impaired by agriculture activities are highly challenging because of the different perspectives that exist between the regulatory community and the agricultural community. As of 2003, the SWRCB (2004a) reports the following progress:

- 16 watershed working groups are actively developing farm water quality plans, with 19 new groups being formed;
- Of the over 90 farmers that attended a Farm Water Quality Course, half have developed comprehensive water quality plans for more than 10,700 acres of irrigated crops; and
- Over 750 farmers have attended 35 workshops designed to train farmers in specific conservation practices.

2.9.2 Forestry

Timber harvesting and associated activities can result in the discharge of chemical pollutants and petroleum products, in addition to other conventional pollutants. Pollutants can be discharged through runoff and drift. Potential sources of pollutants in runoff include roads that have been treated with oils or other dust suppressing materials and herbicide applications. Forest chemical management focuses on reducing pesticides that are occasionally used for pest management to reduce mortality of desired tree species, and improve forest production. Pesticide use on state or private forestry land is regulated by DPR. However, a large proportion of California's forested lands are owned or regulated by the federal government (SWQCB, 2004a) in which pesticide use is controlled by the USDA Forest Service Region 5. In addition to the NPS Program Plan MMs, forestry activities are also controlled through WDRs and conditional waivers. Recently, Regional Water Boards have adopted waivers for timber harvesting activities, provided that the activities comply with the general conditions listed in each waiver, including compliance with applicable requirements contained in each Region's Basin Plan.

The DPR regulates the sale and use of pesticides and, through county agricultural commissioners (CACs), enforces laws pertaining to pesticide use. CACs inspect pesticide applications to forests and ensure that applications do not violate pesticide laws and regulations. Landowners must also submit timber harvest plans (THPs) to the California Department of Forestry (CDF) outlining what timber will be harvested, how it will be harvested, and the steps that will be taken to prevent damage to the environment. CDF will only approve those THPs that comply with all applicable federal and state laws. The Forest Practices Act provides a conditional exemption from WDRs for timber operations (article 1. section 4514.3). The Forest Practice Rules establish responsible forest resource management practices which serve the demand for timber and other forest products, while giving consideration to the public's need for watershed protection, as well as fisheries, wildlife and recreational opportunities.

2.9.3 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.

2.10 Impaired Waters

A 2011 Policy established a structured regulatory procedure to determine those water segments that are impaired due to sediment toxicity. For narrative objectives based on the bioaccumulation of pollutants in tissue, or, in a water segment is impaired if the tissue pollutant levels in organisms exceed a pollutant-specific evaluation guideline using binomial distribution. Regional Water Boards may select evaluation guidelines published by U.S. EPA or OEHHA.

Under the CWA, section 303(d), states are required to develop a list of water quality limited segments, establish priority rankings for the segments, and develop action plans, or TMDLs, to improve water quality. The listing Policy identifies the factors and information that shall be used by the State and Regional Water Boards to list and delist a water body. The 2012 303(d) list for impaired bays and estuaries and applicable TMDLs are described in **Exhibit 2-5** and **Exhibit 2-6** as follows:

Exhibit 2-5. 2012 303(d) Listings for Bays and Estuaries in California

Water Body	2012 303(d) list
Region 1	
Eureka Plain HU, Humboldt Bay	Other organics: PCBs Other organics: Dioxin Toxics Equivalent
Bodega HU, Bodega Harbor HA	Miscellaneous: Invasive species
Region 2	
San Francisco Bay, Central Basin	Sediment: Mercury, PAHs Water: Chlordane, Dieldrin, DDT
San Francisco Bay, Oakland Inner Harbor	Sediment: Chlordane, Lead, Zinc, Copper, PCBs, PAHs, Dieldrin, Mercury, Sediment Toxicity Water: Chlordane, DDT, Dieldrin Tissue: Mercury, PCBs, Selenium
San Francisco Bay, Richardson Bay	Water: Chlordane, Dieldrin, DDT Tissue: Mercury, PCBs
San Francisco Bay, Lower	Water: Chlordane, DDT, Dieldrin Tissue: Mercury, PCBs
San Francisco Bay, South	Water: Chlordane, DDT, Dieldrin Tissue: Mercury, PCBs, Selenium
San Francisco Bay, San Leonardo Bay	Sediment: Lead, Mercury, PAHs, Pesticides, Zinc Water: Chlordane, Dieldrin, Mercury Tissue: Mercury
San Francisco Bay , San Pablo Bay	Water: Chlordane, DDT, Dieldrin Tissue: Mercury, PCBs, Selenium
Suisun Bay	Water: Chlordane, DDT, Dieldrin Tissue: Mercury, PCBs, Selenium
Tomales Bay	Sediment: Sedimentation Tissue: Mercury
Carquinez Strait	Water: Chlordane, DDT, Dieldrin Tissue: Mercury, PCBs, Selenium
Castro Cove, Richmond (San Pablo Basin)	Sediment: Mercury, Dieldrin, Selenium, PAHs
Islais Creek	Sediment: Chlordane, Dieldrin, PAHs, Sediment Toxicity
Mission Creek	Sediment: Chlordane, Dieldrin, Lead, Mercury, PCBs, Silver, Zinc Water: PAHs
Sacramento San Joaquin Delta	Water: Chlordane, DDT, Dieldrin Tissue: Mercury, PCBs, Selenium
Stege Marsh	Water: Chlordane, Dacthal, Dieldrin Tissue: Mercury, PCBs, Zinc, Copper
Suisun Slough	Water: Diazinon
Region 3	
Carpinteria Marsh (El Estero Marsh)	Water: Priority Organics
Elkhorn Slough	Sediment: Sedimentation/Siltation Water: Pesticides
Goleta Slough/Estuary	Water: Priority Organics
Monterey Harbor	Sediment: Sediment Toxicity Water: Metals
Moro Cojo Slough	Sediment: Sedimentation/Siltation Water: Pesticides
Morro Bay	Sediment: Sedimentation/Siltation
Moss Landing Harbor	Sediment: Sedimentation/Siltation, Toxicity Water: Pesticides, Diazinon, Chlorpyrifos, Nickel

Water Body	2012 303(d) list
Old Salinas River Estuary	Water: Pesticides
Salinas River Lagoon (North)	Water: Pesticides
Salinas River Refuge Lagoon (South)	Sediment: Turbidity
Soquel Lagoon	Sediment: Sedimentation/Siltation
Region 4	
Calleguas Creek Reach 1 (was Mugu Lagoon on 1998 303(d) list)	Sediment: DDT, Sedimentation, Siltation Water: Dieldrin, Toxaphene, Copper, Mercury, Nickel, Zinc Tissue: Chlordane, DDT, Endosulfan, PCBs
Dominguez Channel Estuary (unlined portion below Vermont Ave)	Sediment: DDT, Toxicity, Zinc, Benthic Community Effects Water: Benzo(a)anthracene, Benzo(a)pyrene (3,4-Benzopyrene -7-d), Chrysene (C1-C4), Phenanthrene, Pyrene Tissue: Chlordane, DDT, Dieldrin, Lead, PCBs (Polychlorinated biphenyls)
Los Angeles Harbor - Cabrillo Marina	Water: DDT, PCBs, Benzo(a)pyrene (3,4-Benzopyrene -7-d Tissue: PCBs
Los Angeles Harbor - Consolidated Slip	Sediment: Benthic Community Effects, Chlordane, Chromium, Copper, Cadmium, DDT, Lead, Mercury, PCBs, Zinc, Sediment toxicity Water: 2-Methylnaphthalene, Benzo(a)anthracene, Chrysene (C1-C4), Benzo(a)pyrene (3,4-Benzopyrene -7-d), Dieldrin, Phenanthrene, Pyrene Tissue: Chlordane, DDT,PCBs, Toxaphene
Los Angeles Harbor - Fish Harbor	Sediment: Toxicity, Copper, Lead, Mercury, PAHs, Zinc Water: Chlordane, DDT, PCBs
Los Angeles Harbor - Inner Cabrillo Beach Area	Water: DDT, PCBs
Los Angeles River Estuary (Queensway Bay)	Sediment: Chlordane, DDT, PCBs, Toxicity
Los Angeles/Long Beach Inner Harbor	Sediment: Toxicity, Benthic Community Effects Water: DDT, Copper, Zinc, PCBs
Los Angeles/Long Beach Outer Harbor (inside breakwater)	Sediment: Toxicity Water: DDT, PCBs
Malibu Lagoon	Sediment: Benthic Community Effects
Marina del Rey Harbor - Back Basins	Sediment: Toxicity, Zinc, PCBs, Lead, Copper, Chlordane Tissue: Chlordane, DDT, Dieldrin, PCBs
Port Hueneme Harbor (Back Basins)	Tissue: DDT, PCBs
San Pedro Bay Near/Off Shore Zones	Sediment: DDT, toxicity Water: Chlordane, PCBs Tissue: DDT
Santa Clara River Estuary	Water: Toxaphene, ChemA, Toxicity
Santa Monica Bay Offshore/Nearshore	Sediment: DDT, PCBs, Toxicity Tissue: DDT, PCBs
Region 5	
Delta Waterways (Stockton Ship Channel)	Water: Chlorpyrifos, DDT, Diazinon, Group A Pesticides, Toxicity, PCBs, Dioxin, Furans, Tissue: Mercury, PCBs
Delta Waterways	Water: Chlorpyrifos, Chlordane, DDT, Diazinon, Dieldrin, Group A Pesticides, Toxicity Tissue: Mercury, PCBs

Water Body	2012 303(d) list
Region 8	
Anaheim Bay	Sediment: Toxicity Water: Nickel Tissue: Dieldrin, PCBs
Huntington Harbour	Sediment: Toxicity Water: Chlordane, Copper, Lead, Nickel Tissue: PCBs
Newport Bay, Lower (entire lower bay, including Rhine Channel, Turning Basin and South Lido Channel to east end of H-J Moorings)	Sediment: Toxicity Water: Chlordane, Copper, DDT, PCBs, Pesticides
Newport Bay, Upper (Ecological Reserve)	Sediment: Sedimentation, Toxicity, Water: Chlordane, Copper, DDT, Metals, PCBs, Pesticides,
Rhine Channel	Sediment: Toxicity Water: Copper, Lead, Mercury, Zinc, PCBs
Region 9	
Buena Vista Lagoon	Sediment: Sedimentation
Dana Point Harbor	Water: Copper, Zinc, Toxicity
Los Penasquitos Lagoon	Sediment: Sedimentation
Mission Bay	Water: Lead, Copper
Oceanside Harbor	Water: Copper
San Diego Bay Shoreline, 32nd St San Diego Naval Station	Sediment: Toxicity, Benthic Community Effects
San Diego Bay Shoreline, Downtown Anchorage	Sediment: Toxicity, Benthic Community Effects
San Diego Bay Shoreline, North of 24th Street Marine Terminal	Sediment: Toxicity, Benthic Community Effects
San Diego Bay Shoreline, Seventh Street Channel	Sediment: Toxicity, Benthic Community Effects
San Diego Bay Shoreline, Vicinity of B St and Broadway Piers	Sediment: Toxicity, Benthic Community Effects
San Diego Bay Shoreline, at Americas Cup Harbor	Water: Copper
San Diego Bay Shoreline, at Coronado Cays	Water: Copper
San Diego Bay Shoreline, at Glorietta Bay	Water: Copper
San Diego Bay Shoreline, at Harbor Island (East Basin)	Water: Copper
San Diego Bay Shoreline, at Marriott Marina	Water: Copper
San Diego Bay Shoreline, between Sampson and 28th Streets	Water: Copper, Mercury, PAHs, PCBs, Zinc
San Diego Bay Shoreline, near Chollas Creek	Sediment: Toxicity, Benthic Community Effects
San Diego Bay Shoreline, near Coronado Bridge	Sediment: Toxicity, Benthic Community Effects
San Diego Bay Shoreline, near Switzer Creek	Water: Chlordane, PAHs
San Diego Bay Shoreline, near sub base	Sediment: Toxicity, Benthic Community Effects
San Diego Bay, Shelter Island Yacht Basin	Water: Copper
San Elijo Lagoon	Sediment: Sedimentation

Water Body	2012 303(d) list
Tijuana River Estuary	Sediment: Turbidity Water: Thallium, Nickel, Pesticides, Lead

Source: 2012 303 (d) list.

Exhibit 2-6. Summary of Toxics TMDLs in California Bays and Estuaries

TMDL	Numeric Basis for TMDL	Objective or Target
Region 2		
San Francisco Bay Mercury TMDL	Objective	Fish tissue: 0.2 mg/kg Hg, TL3 and TL4 fish (size specified for certain species) 0.03 mg/kg Hg, 3-5 cm fish Water: 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
San Francisco Bay PCBs TMDL	Targets	Fish Tissue 22 ng PCBs/g Sediment: 2.5 µg PCBs/kg
Tomales Bay Mercury TMDL	Targets	Fish tissue: 0.2 mg/kg MeHg, legal halibut (55 cm) 0.05 mg/kg MeHg, 5-15 cm TL3 fish
North San Francisco Bay Selenium TMDL	Targets	Fish tissue: 8.0 µg/g whole-body dry weight, fish tissue 11.3 µg/g muscle tissue dry weight, fish tissue Water: 0.5 µg/L dissolved total selenium
Region 3		
Lake Nacimiento and Las Tablas Creek (not approved by State Water Board or U.S.EPA)	Targets	Water: 0.050 µg/L total Hg Sediment: 0.486 mg/kg Hg
Arroyo Paredon Watershed Diazinon and Additive Toxicity TMDL	Targets	Water: 0.16 ppb, CMC, Diazinon 0.10 ppb, CCC, Diazinon
Region 4		
Ballona Creek Estuary Toxics TMDL	Targets	Sediment: 0.5 µg/kg Chlordane 1.58 µg/kg DDT 22.7 µg/kg PCBs 4,022 µg/kg PAHs 1.2 mg/kg Cadmium 34 mg/kg Copper 46.7 mg/kg Lead 1.0 mg/kg Silver 15 mg/kg Zinc

TMDL	Numeric Basis for TMDL	Objective or Target
Calleguas Creek Watershed Metals and Selenium TMDL	Targets	<u>Dry Weather Water:</u> Dissolved Copper 3.1 ×WER Dissolved Nickel 8.2 µg/L Total Mercury 0.051 µg/L <u>Wet Weather Water:</u> Dissolved Copper 4.8 ×WER Dissolved Nickel 74 µg/L Total Mercury 0.051 µg/L <u>Sediment:</u> Copper 34,000 µg /kg Nickel 20,900 µg /kg <u>Fish Tissue:</u> Methylmercury 0.3 mg/kg (human health) Methylmercury Trophic Level 3 <50 mm 0.03 mg/kg Methylmercury Trophic Level 3 50-150 mm 0.05 mg/kg Methylmercury Trophic Level 3 150-350 mm 0.1 mg/kg <u>Bird Egg:</u> Mercury 0.5 mg/kg
Calleguas Creek Watershed OC Pesticides and PCBs TMDL	Targets	<u>Fish Tissue:</u> Chlordane 0.83 µg /kg DDT 32 µg /kg Dieldrin 0.65 µg /kg PCBs 5.3 µg /kg; Toxaphene 9.8 µg /kg <u>Sediment:</u> Chlordane 0.5 µg /kg DDT 1 µg /kg Dieldrin 20 ng/kg PCBs 23 µg /kg <u>Water:</u> Chlordane 4 ng/L DDT 1 ng/L Dieldrin 1.9 ng/L PCBs 30 ng/L Toxaphene 0.2 ng/L
Calleguas Creek Watershed Mugu Lagoon Metals	Targets	<u>Fish Tissue:</u> 0.3 mg/kg MeHg 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 <u>Water:</u> 0.050 µg/L total Hg

TMDL	Numeric Basis for TMDL	Objective or Target
Marina Del Rey Harbor Toxics TMDL	Targets	Fish Tissue: PCBs 5.3 µg/kg Sediment: Chlordane 0.5 µg/kg PCBs 22.7 µg/kg Copper 34 mg/kg Lead 46.7 mg/kg Zinc 150mg/kg Water: PCBs 0.17 ng/L (interim) PCBs 30 ng/L (final)
Santa Monica Bay DDTs and PCBs	Targets	Fish tissue (based on a consumption rate of 116g/d and exposure risk of 10^{-5}): Total DDT 40 ng/g Total PCBs 7 ng/g Water: Total DDT 0.17 ng/L Total PCBs 0.019 ng/L Sediment (normalized for organic carbon): Total DDT 2.3 µg /g OC Total PCBs 0.7 ng/g µg /g OC
Machado Lake Pesticides and PCB Domoniquez channel	Targets	Fish Tissue (ng/g wet weight): Total PCBs 3.6 DDT (all congeners) no target DDE (all congeners) no target DDD (all congeners) no target Total DDT 21.0 Chlordane 5.6 Dieldrin 0.46 Water Column: Total PCBs 0.00017 µg/L 4,4’ DDT 0.00059 µg/L 4,4’ DDE 0.00059 µg/L 4,4’ DDD 0.00084 µg/L Chlordane 0.00059 µg/L Dieldrin 0.00014 µg/L Sediment(µg/kg dry weight): Total PCBs 59.8 DDT (all congeners) 4.16 DDE (all congeners) 3.16 DDD (all congeners) 4.88 Total DDT 5.28 Chlordane 3.24 Dieldrin 1.9

TMDL	Numeric Basis for TMDL	Objective or Target
Dominguez Channel and Greater Los Angeles and Long Beach Harbor Toxics	Targets	Fish tissue (µg/kg wet): Chlordane 5.6 Dieldrin 0.46 n/a Total DDT 21 Total PCBs 3.6 PAHs – total 5.47 Toxaphene 6.1 Sediment (mg/kg): Cadmium 1.2 Chromium 81 Copper 34 Lead 46.7 Mercury 0.15 Zinc 150 Sediment (µg/kg): Chlordane, total 0.5 Dieldrin 0.02 Toxaphene 0.10 Total PCBs 22.7 Benzo[a]anthracene 261 Benzo[a]pyrene 430 Chrysene 384 Pyrene 665 2-methylnaphthalene 201 Dibenz[a,h]anthracene 260 Phenanthrene 240 Hi MW PAHs 1700 Lo MW PAHs 552 Total PAHs 4,022 Total DDT 1.58 Birds (tissue residues): Total DDT n/a 0.3 ug/g lipid Total PCBs 2.2 ug/g in
Region 5		
Cache Creek and Bear Creek TMDL for Methylmercury	Objective	Fish tissue: 0.23 mg/kg MeHg, 25-35 cm TL4 fish 0.12 mg/kg MeHg, 25-35 cm TL3 fish
Sacramento – San Joaquin Delta Estuary TMDL for Methylmercury	Objective	Fish tissue: 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
Region 8		
Toxic Pollutants San Diego Creek and Newport Bay	Targets	Fish tissue: 0.3 mg/kg MeHg Sediment: 0.13 ppm dry weight Hg

TMDL	Numeric Basis for TMDL	Objective or Target
Upper and Lower Newport Bay (including Rhine Channel) Metals TMDL	Targets	Fish Tissue: Mercury 0.3 mg/kg Chromium 0.2 mg/kg Water (Acute): Cadmium 42 µg/L Copper 4.8 µg/L Lead 210 µg/L Zinc 90 µg/ Water (Chronic): Cadmium 9.3 µg/L Copper 3.1 µg/L Lead 8.1 µg/L Zinc 81 µg/L Sediment: Cadmium 0.67 mg/kg Copper 18.7 mg/kg Lead 30.2 mg/kg Zinc 124 mg/kg Mercury 0.13 mg/kg Chromium 52 mg/kg
Upper and Lower Newport Bay Organochlorine Compounds TMDL	Targets	Fish Tissue: Chlordane 30 µg/kg DDT 50 µg/kg PCBs 20 µg/kg Water Chlordane 0.59 ng/L DDT 0.59 ng/L PCBs 0.17 ng/L Sediment: Chlordane 2.26 µg/kg DDT 3.89 µg/kg PCBs 21.5 µg/kg
Newport Bay Copper TMDL	Targets	Water(CTR Saltwater criteria) Acute 4.8 µg/L Copper Chronic 3.1 µg/L Copper Sediment: 34 µg/g, effects range low, ERL sediment guidelines
Region 9		
Shelter Island Yacht Basin Copper TMDL	Targets	Water (Acute): 4.8 µg/L Copper Water (Chronic): 3.1µg/L Copper

Note:

Source: SWRCB (2016)

cm = centimeter
NA = not applicable
Hg = Inorganic mercury
MeHg = methylmercury
mm = millimeters
TL = trophic level
mg/kg = milligram per kilogram
μg/kg = microgram per kilogram

3 Description of the Amendments

This chapter describes the February 2017 draft proposed amendments to the Water Quality Control Plan for Enclosed Bays and Estuaries. It discusses the applicability of the regulation, beneficial uses, and implementation procedures including monitoring requirements.

3.1 Sediment Quality Objectives Beneficial Uses

There are no proposed amendments of sediment quality objectives beneficial uses in the proposed Policy.

3.2 Sediment Quality Objectives Applicability

As in the existing sediment Policy, proposed Part 1 applies to enclosed bays and estuaries only. It does not apply to the ocean waters including Monterey Bay and Santa Monica Bay, or inland surface waters. There are no proposed amendments to applicable waters, sediments, or discharges in the Plan.

3.3 Sediment Quality Objectives

There are no proposed amendments to the sediment quality objectives of the Plan.

3.4 Implementation Procedures

The State Water Board is considering adoption of a new approach to implement the sediment quality objectives to protect human health. While the approach to implement aquatic life criteria and wildlife & finfish criteria remains unchanged from the existing Plan, the proposed revised implementation procedures associated with the human health SQO are based on a tiered regulatory framework. The amendments are described as follows:

3.4.1 Assessing Human Health Protection SQOs

In the proposed Plan, the SQO for the protection of human health is interpreted based on two contaminant categories: chlorinated pesticides and PCBs, and contaminants other than the chlorinated pesticides and PCBs. Procedures to assess the latter category have not changed from the existing plan. For all contaminants except chlorinated pesticides and PCBs, human health risk assessment judgement on a specific case-by-case basis will be employed to implement the narrative human health objective. While conducting a risk assessment process, the Water Boards shall consider any applicable and relevant information, including OEHHA policies for fish consumption and risk assessment, DTSC Risk Assessment, and U.S. EPA Human Health Risk Assessment policies.

For chlorinated pesticides and PCBs, the State Water Board introduced a sequential approach that shall be used to interpret the sediment quality narrative objective protecting human consumers of locally caught sportfish. The purpose of this assessment framework is to evaluate the acceptability of pollutant concentrations in fish tissue which is exposed to human consumers and assess the contribution of site-specific sediment contamination of sportfish. Two indicators play a vital role in this framework: 1) chemical exposure indicator comparing the contamination exposure levels at the site with advisory thresholds and 2) site linkage indicator comparing sportfish contamination measurements to estimated sportfish concentrations that would result from site exposure. A site assessment framework is established by using a categorical decision matrix to integrate the chemical exposure and site linkage indicators. The assessment framework consists of three tiers:

Tier 1 is a screening assessment to address whether contaminants in sediments at a site pose a potential chemical exposure that warrants further evaluation. For contaminants that pose such a potential in site sediments, a Tier 2 evaluation is required.

Tier 2 is a complete site assessment to assess sediment quality relative to the sediment quality objective protecting human consumers of locally caught sportfish. Tier 2 requires site-specific information and data, including sediment and sportfish tissue chemistry, sediment organic carbon, and percent lipid in tissue. The data are used to calculate average chemical exposure from consumption and the probability distribution of linkage between contaminants in sediment and sportfish.

Tier 3 is a more complex and site-specific assessment intended to supplement the Tier 2 evaluation. Greater flexibility is provided to address unique site conditions, confounding factors, or other chemical exposure factors. Tier 3 may be employed only after the completion of Tier 2.

The Tiered assessment framework is focused on linking high quality data to the site-specific conditions and factors. A prerequisite of this framework data analysis is developing a conceptual site model (CSM). A study design and both sediment and tissue data must be consistent with the CSM.

This assessment framework applies only to specific nonpolar chlorinated hydrocarbons: DDTs, PCBs, chlordane and dieldrin. The framework may be applied to assess either the entire water body or a portion, provided that the site area is at least 1 km^2. A Tiered Assessment Framework also requires some additional testing to evaluate the level of chemical exposure and contribution of sites for the estimated contamination in sediment. Laboratory testing requirements by Tier is listed in following **Exhibit 3-1**:

Exhibit 3-1. Laboratory Testing Requirements by Tier

Tier	Organochlorine Pest/PCBs in Sediment[3]	Total Organic Carbon	Organochlorine Pest/PCBs in Tissue	Percent Lipid	Organochlorine Pest/PCBs in Water
1	Yes[1]	Yes[1]	Yes[2]	No	No
2	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes

Note:
[1] Necessary if using sediment data for the Tier 1 assessment.
[2] Necessary if using tissue for the Tier 1 assessment.

3.4.1.1 Tier 1 Screening Evaluation

Tier 1 is an optional screening assessment that utilizes conservative assumptions to evaluate potential chemical exposure to human consumers of sportfish. If the outcome of Tier 1 evaluation is below the threshold level, sediments are considered as not degraded and no more Tier evaluation (i.e., Tier 2 and Tier 3) is required. A Tier 1 assessment is comprised of two evaluation classes: sediment-based and tissue-based. The assessment may be performed using either sportfish tissue or sediment contaminant concentrations data and matching total organic carbon data, depending on data availability. Data for either type of assessment must be no older than 6 years. If both sediment and tissue contamination data are available, the Tier I assessment is performed using both data types.

The tissue-based or sediment-based chemical exposure evaluation is performed by comparing measured tissue or sediment concentration to screening thresholds. This comparison shall be based on tissue data from all the species identified in the CSM. Tissue concentration in sportfish species and sediment concentration can be calculated using a prescribed equation at Section IV.A.2.g of proposed Policy. Sediment screening thresholds are calculated for each contaminant evaluated at the site using the biota sediment accumulation factors (BSAFs) based on the contaminant, fish guild, and site total organic carbon. The exceedance of tissue screening thresholds or sediment screening thresholds indicates the potential for unacceptable chemical exposure and requires a Tier 2 evaluation.

Tier 1 assessment of subsistence fishers may be accomplished by applying thresholds based on OEHHA Advisory Tissue Levels based on 5-day consumption rate in lieu of those provided in **Exhibit 3-2**.

Exhibit 3-2. Tier 1 Tissue Screening Thresholds

Parameter	DDT (ng/g ww)	PCB (ng/g ww)	Chlordane (ng/g ww)	Dieldrin (ng/g ww)
Tier 1 Threshold[1]	>520	>21	>190	>15

Note:
1 Advisory Tissue Level based on three servings per week (OEHHA 2008).

If either tissue or sediment is applied in Tier 1 and the result exceeds the threshold for any constituent, Tier 2 is required for those constituents. If both tissue and sediment are applied, the possible decision criteria and potential outcomes are decided as follows:

Exhibit 3-3. Decision Criteria for Tier 1

Decision Criteria	Decision
Both tissue and sediment result falls below the threshold	Not Impacted
Tissue results fall below the threshold and sediment equals or exceeds the threshold	Not Impacted
Sediment results fall below the threshold and tissue equals or exceeds the threshold	Tier 2 assessment is required
Both sediment and tissue results equal or exceed the threshold	Tier 2 assessment is required

3.4.1.2 Tier 2 Assessment

Tier 2 assessment is focused on determining if the site-specific sediments meet SQOs to protect human consumers of resident sportfish from bioaccumulative contaminants in sediment. Both tissue concentration data and sediment data are required for Tier 2 analysis to assess chemical exposure. The results of Tier 2 evaluation are compared with the thresholds established by OEHHA.

Tier 2 utilizes a mechanical food web model to combine multiple site-specific fixed and optional variables with a varying sampling frequency. The fixed or constrained model parameters include proportion of sportfish species consumed, sportfish characteristics, contaminant characteristics and the bioaccumulation model constants. Chemical exposure is assessed by comparing average tissue contaminant concentration to thresholds that are based on different meal consumption frequencies over the course of a week. Tissue contaminant thresholds and potential chemical exposure categories are described in **Exhibit 3-4** and **Exhibit 3-5** as follows:

Exhibit 3-4. Tier 2 Tissue Contaminant Thresholds

Parameter	Tier 2 Contaminant Threshold			
	FCG[1] (ng/g ww)	ATL3[2] (ng/g ww)	ATL2[3] (ng/g ww)	ATL1[4] (ng/g ww)
Chlordane	5.6	190	280	560
DDTs	21	520	1,000	2100
Dieldrin	0.46	15	23	46
PCBs	3.6	21	42	120

Note:
1 FCG - Fish Contaminant Goal based on 1 meal per week
2 ATL3 - Tissue Advisory Level based on consumption of 3 meals per week
3 ATL2 - Tissue Advisory Level based on 2 meals per week
4 ATL1 - Tissue Advisory Level based on 1 meal per week

Exhibit 3-5. Tier 2 Chemical Exposure Categories

Tissue Contaminant Concentration	Threshold	Outcome
Average	< FCG	1. Very Low
Average	< ATL3	2. Low
Average	< ATL2	3. Moderate
Average	< ATL1	4. High
Average	> ATL1	5. Very High

Tissue contaminant concentration in species related to site sediments can be calculated using the measured sum contaminant concentration (sum PCBs, sum DDTs, sum chlordanes, or dieldrin) in sediment from the site, biota-sediment accumulation factor for species ($BSAF_i$), site area (km^2) or length across the site (km), and sportfish home range (km^2) or linear movement distance (km) for species (HR_i). BSAF is the ratio of the wet weight contaminant concentration in biota to dry weight contaminant concentration in sediment. Arnot and Gobas food web model (2004), modified by Gobas and Arnot (2010), is used to calculate the BSAF for each of the fish guild species. Using estimated and observed tissue contaminant concentration, the site linkage factor can be determined.

After calculating the site linkage factor, a Monte Carlo simulation is used to estimate the sediment linkage factor distribution to capture the variability and uncertainty in sediment concentration data, as well as the BSAF calculation. The Monte Carlo simulation is conducted using 10,000 random subsamples of the concentration and BSAF distributions on a log normal basis. Site sediment linkage is calculated for each set of subsamples. The results of the simulations are compiled to calculate a cumulative probability distribution of sediment linkage. The portion of the distribution less than the sediment linkage threshold is used to determine the site linkage category. **Exhibit 3-7** demonstrates the site linkage categories for Tier 2 evaluation.

Exhibit 3-7. Site Sediment Linkage Categories for Tier 2 Evaluation

Cumulative % of sediment linkage distribution	Linkage threshold	Outcome
75%	<0.5	1. Very Low
50%	<0.5	2. Low
25%	<0.5	3. Moderate
25%	≥0.5	4. High

The overall site assessment category is determined using the decision matrix presented in **Exhibit 3-8**. Site sediments categorized as Unimpacted or Likely Unimpacted meet the SQO protecting human consumers for the specific contaminant evaluated. Site sediments categorized as Possibly Impacted, Likely Impacted, or Clearly Impacted do not meet the SQO. This evaluation is performed separately for each chemical contaminant group.

Exhibit 3-8. Site Assessment Matrix

		Chemical Exposure				
		Very Low	Low	Moderate	High	Very High
Site Sediment Linkage	Very Low	Unimpacted	Unimpacted	Likely Unimpacted	Likely Unimpacted	Likely Unimpacted
	Low	Unimpacted	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted
	Moderate	Unimpacted	Likely Unimpacted	Likely Impacted	Likely Impacted	Clearly Impacted
	High	Unimpacted	Likely Unimpacted	Likely Impacted	Clearly Impacted	Clearly Impacted

3.4.1.3 Tier 3 Assessment

A Tier 3 assessment is conducted when Tier 1 and Tier 2 assessment is incapable of providing a complete evaluation of a site. Tier 3 is performed to improve accuracy and precision of the Tier 2 assessment, evaluate different risk-related assumptions, incorporate spatial and temporal factors into the assessment, and evaluate specific subareas, contaminant gradients or potential hotspots. Tier 3 utilizes the same framework, indicators, and decision criteria described in Tier 2, but is performed only after the Tier 2 assessment is completed and with concurrence from the Regional Water Board.

Presence of variability in factor or process, or changes in exposure factors that affect contamination bioaccumulation in sediment may trigger Tier 3 assessment for a site. These factors include but are not limited to:

- differences in the relationship between geochemical characteristics and contaminant bioavailability;
- differences in physiological processes affecting bioaccumulation model performance;
- measured sediment concentrations that are not representative of actual fish forage area due to spatial or temporal variations in sediment contaminant distribution, fate, or transport;
- differences in food web or forage range of target species; and
- use of selected alternate sportfish species.

Tier 3 assessment for subsistence consumers may be accomplished by adjusting the chemical exposure thresholds to provide an equivalent level of health protection as described in OEHHA 2008. If chemical exposure assessment requires evaluation of subsistence fishers, thresholds based on OEHHA Advisory Tissue Level for 4- or 5-day consumption rates shall be applied in lieu of those provided in Table 16, in consultation with OEHHA to ensure representative characterization of exposure. With approval of the Regional Board, a decision to conduct a Tier 3 evaluation may be made at any stage of the program. A change in any parameter or model from that used in Tier 2 must be justified based on site conditions, in comparison to Tier 2 assumptions and values, and approved by the Regional Water Board prior to performing the analysis.

3.4.2 Program Specific Implementation

3.4.2.1 Implementation of Sediment Quality Objectives

Implementation of Part 1 shall be conducted in accordance with the following provisions and must be consistent with the schematic process illustrated in **Exhibit G-1** and **G-2 (Appendix G)** of this document. Due to the difference in receptors, as well as pathways, sediments that meet one objective may not meet another objective. Therefore, each SQO is evaluated independently. The new policy proposes to determine compliance with the aquatic life objective based on the assessment of two or more stations within a site. However, compliance associated with the sportfish consumer objective is assessed on a site-by-site basis that encompasses multiple sediment and tissue samples from the site. As a result, a unique study design is required for the assessment of sediment quality relative to each objective; however, this does not imply that the same sediment chemistry samples and other data cannot be applied to both aquatic life and sportfish-based assessment frameworks.

3.4.2.2 Dredge Materials

There are no amendments associated with dredge materials implementation proposed in the SQO Plan.

3.4.2.3 NPDES Permit

3.4.2.3.1 Receiving Water and Effluent Limits for SQOs

The Water Board shall apply the objectives as receiving water limits if the discharge to bay or estuarine water poses a reasonable potential to cause or contribute to an exceedance. The proposed Plan is applicable for both toxic and bioaccumulative discharge.

3.4.2.3.2 Exceedance of Receiving Water Limits

An exceedance of receiving water limits is based on a few decisive criteria, which have been revised from the existing Policy. The proposed policy adds two new factors to determine exceedance of receiving water limits: Under the proposed plan a receiving water limit for the protection of aquatic life will be determined to be exceeded when:

- Any station within the site is assessed as Clearly Impacted; and
- The total percent area categorized as Possibly Impacted and/or Likely Impacted equals or exceeds 15 percent of the site area over the duration of a permit cycle. Calculation of percent area shall be based on data from spatially representative samples selected using a randomized study design or equivalent spatial analysis;

These factors are in addition to the factors in the existing plan described below:

- Stressor identification study should be followed, if the discharge demonstrates a reasonable potential for SQO exceedance.
- If studies by the Permittee demonstrate that other sources may also be contributing to the degradation of sediment quality, the Regional Water Board shall, as appropriate, require the other sources to initiate studies to assess the extent to which these sources are a contributing factor.

The proposed plan adds new procedures to determine exceedance of the receiving water limit to protect human consumers. Under the proposed plan, an exceedance is demonstrated if:

- The site sediments are categorized as Possibly Impacted, Likely Impacted or Clearly Impacted over the duration of a permit cycle;
- It is demonstrated that the discharge is causing or contributing to the SQO exceedance.

Upon exceedance of a receiving water limit the Permittee must perform stressor identification studies.

3.4.2.3.3 Receiving Water Limits Monitoring Frequency

The monitoring frequency for receiving water limits remains unchanged from the existing Plan. All dischargers (i.e., major and minor), including Phase I and II stormwater dischargers and other regulated dischargers and waivers, will have similar sediment monitoring frequency as described in the existing Plan.

3.4.2.4 Sediment Monitoring and Assessment

All components of the sediment monitoring program in the existing Policy remain unchanged except the additional consideration for conceptual model design, change in sampling method, and regional monitoring frequency.

- **Method:** Under the proposed Plan, fish tissue samples will be collected along with sediment samples from each station (or site), and will be tested and assessed utilizing the existing methods and metrics.
- **Design:** Both in the existing and proposed SQO Plan, the sediment monitoring program will be operated utilizing a conceptual model that serves as the basis for assessing the appropriateness of a study design. Besides general consideration prescribed in the existing Policy, additional considerations in design are proposed to be added for the sediment monitoring program. These considerations include:
    - Site boundaries and site size;
    - Sportfish consumer population characteristics (e.g. consumption rate);
    - Sportfish species to be monitored;
    - Food web associated with sportfish species to be monitored; and
    - Site-specific modifications to the bioaccumulation model parameters (e.g. sportfish movement range or diet), as needed.

  A definition of the site boundaries and site size is needed to aid in data collection and data reduction, in addition to being a key input for the sediment linkage indicator. Selection of sportfish species of interest should be based on the fishing and consumption practices of local consumers, as well as species known to reside in the site and representing predominant dietary guilds.
- **Regional Monitoring Frequency:** Under the new Policy, regional sediment quality monitoring is proposed to be conducted at a minimum of once every five years. This is one of the major changes from the existing Policy that will incur a significant reduction in monitoring cost.

3.4.2.5 Evaluating Waters for Placement on the Section 303(d) List

In the proposed amendments, sediment toxicity listing criteria for the protection of benthic communities are prescribed based on the categorization of impact posed by site area. Water segments shall be placed on the section 303(d) list for exceedance of the narrative SQO for aquatic life protection only if:

- Any station within the site is assessed as Clearly Impacted; or
- The total percent area categorized as Possibly Impacted and/or Likely Impacted equals or exceeds 15 percent of the site area over the duration of a listing cycle. Calculation of percent area shall be based on data from multiple spatially representative samples selected using a randomized study design or equivalent spatial analysis.

Data to be evaluated shall include all relevant data collected from monitoring programs conducted over the duration of the listing cycle (6 years).

Similarly, water segments shall be placed on the section 303(d) list for exceedance of the narrative SQO for human health protection of Part 1 if:

- The site sediments are categorized as Possibly Impacted, Likely Impacted or Clearly Impacted over the duration of the listing cycle (6 years);

Site sediment evaluation shall use the methods and meet the following requirements:

- Data used in the evaluation must be obtained from multiple spatially representative stations.
- Data used in the evaluation must be obtained from multiple surveys over a span of at least one year.

Water segments shall be removed from the section 303(d) list if the listing thresholds are not exceeded over the duration of the listing cycle and satisfy the requirements.

3.4.2.6 Stressor Identification

There is no amendment to the stressor identification guideline language in the proposed Plan.

3.4.2.7 Development of Site-Specific Sediment Management Guidelines

The new proposed SQO Policy includes management guidelines for human health which are based on site-specific bioaccumulation factors for sportfish and are derived by utilizing bioaccumulation modeling. The overall goal behind these management guidelines is to determine contaminant concentration in site sediment that will result in acceptable contaminant levels in sportfish tissue.

The approach involves developing the guidelines by calculating sediment concentration (Cs) corresponding to attainment of acceptable sportfish contaminant concentration based on the biota-sediment accumulation factor ($BSAF_{95}$), where $BSAF_{95}$ is the highest upper 95th percentile of BSAF derived from bioaccumulation model for species used in the assessment.

Calculation of sediment guidelines is based on the assumption that site sediment contamination is the primary determinant of tissue contamination. However, in situations where other contamination sources are important, such as water column contamination from offsite areas or watershed inputs, these approaches may not achieve the desired tissue contaminant levels. In such situations, these additional sources should be considered in deriving management guidelines. Regional background contamination should be taken into account when establishing management guidelines or actions. Regional background contamination is defined as the concentration of contaminant that is primarily attributable to diffuse sources, not attributable to a specific source or release. It is not feasible to establish management guidelines for a site that is below regional background contamination of surrounding water, as objectives cannot be met within a defined timeframe. Instead, the objectives should be regarded as management goals to inform watershed-based management Plans. The assessment categorical results of Unimpacted and Likely Unimpacted may be used as alternative sediment management guidelines in lieu of numeric targets.

4 Incremental Impact of the Plan

This section contains an evaluation of compliance with the SQOs based on available discharge data and the potential impacts to dischargers of sediment toxicity.

4.1 Incrementally Impaired Waters

There is not enough information available at this time to predict changes in impairment status that would result from proposed changes to the Plan. Therefore it is not feasible at this time to estimate the associated compliance costs.

4.2 List of Bays and Estuaries in California

The list of applicable enclosed bays and estuaries that will be covered under the proposed Policy has not changed due to proposed amendments. **Exhibits 4-1** and **4-2** list the enclosed bays and estuaries covered under both plans. Apart from this list, there are hundreds of additional small estuaries, draining coastal streams, and small rivers that are not identified; however, most of these are in undeveloped or sparsely developed areas.

Exhibit 4-1. List of Enclosed Bays in California Covered under Proposed Policy

Name of the Bay/Harbor	Size (Acres)
Regional Board 1	
Crescent City Harbor	374
Humboldt Bay	16,000
Bodega Harbor	822
Regional Board 2	
Tomales Bay	1240
Drakes Estero Bay	12,780
San Francisco Bay, Richardson Bay	2,439
Half Moon Bay	355
Regional Board 3	
Moss Landing Harbor	79
Monterey Harbor	76
Morro Bay	6,605
Santa Barbara Harbor	266
Regional Board 4	
Ventura Harbor	179
Channel Islands Harbor	166
Port Hueneme	65
Marina del Rey	931
King Harbor	105
Alamitos Bay	499
Los Angeles and Long Beach Harbors consolidated slip	36
Dominguez Channel Estuary	70,400
Los Angeles and Long Beach Harbors Cabrillo beach	156
Regional Board 8	
Anaheim Bay	248
Bolsa Bay	116

Name of the Bay/Harbor	Size (Acres)
Newport Bay	1,853
Regional Board 9	
Mission Bay	2,032
San Diego Bay, Shoreline, at Marriott Marina	32
San Diego Bay, Shoreline, Chula Vista Marina	49

Source: SWRCB (2016)

Exhibit 4-2. List of Enclosed Estuaries in California Covered under Proposed Policy

Name of the Bay/Harbor[1]	Size (Acres)
Regional Board 1	
Lake Earl and Lake Tolowa Lagoons	2,191
Stone Lagoons	896
Big Lagoons	1,470
Mad River Estuary	3,18,080
Regional Board 2	
Bolinas Lagoon	988
Carqinez Strait	1,415
Regional Board 3	
Elkhorn Slough Estuary	741
Regional Board 9	
Los Penasquitos Lagoon	37

Note:
[1] There are more estuaries in the state of California. Due to lack of available data, those estuaries are not listed in this table.

4.3 Identifying Incremental Impact

There is a variety of pollution control, cleanup, and remediation activities currently in place to protect bays and estuaries from further impairment due to sediment toxicity. These activities are assumed to be continued in the absence of Plan. Therefore, this analysis is focused on those potential changes or costs that are likely to occur under the proposed Plan.

All Regional Water Boards currently follow SQOs defined and described in the Water Quality Control Plan for Enclosed Bays and Estuaries-Part 1 Sediment Quality. A water body could be listed as impaired for toxic substances for multiple reasons. Under the baseline (existing) Plan, Regional Water Boards would list sediment as exceeding the objectives only if multiple lines of evidence (with sufficient data) indicate impairment. In the proposed Plan, the MLOE approach is still implemented to assess impairment, but more diligently and accurately. The proposed amendments could potentially increase or decrease the number of water bodies that would be incorrectly listed as impaired for toxic substances, however it is infeasible to predict. Potential costs or cost savings associated with implementing the SQOs depends on the relative stringency of the objectives.

A few proposed amendments in monitoring requirements and the implementation procedure may lead to additional cost or cost reduction. The amendments are found in the following sections:

1. Regional Sediment Quality Monitoring Requirement Frequency
2. Listing/Delisting Policy of the 303(d) List
3. Implementation Method for Assessing Human Health Criteria

The lines of evidence, tools for assessing impairment, monitoring methods, inflation factors, stressor thresholds, and thus, potential costs vary for the aquatic life, human health, and wildlife SQOs for bays and estuaries. However, the possible outcomes based on a comparison of existing objectives and implementation of the Plan are similar. **Exhibit 4-3** indicates the possible outcomes.

Exhibit 4-3. Potential Incremental Impacts Associated with the Proposed Plan Amendments

Assessment of Attainment of Existing Beneficial Uses under Existing Plans	Assessment under Proposed SQO	
	Impairment not attributable to sediments	Impairment attributable to sediments
Impairment not attributable to sediments	• No change in sediment quality. • Potential incremental assessment costs	• Sediment quality improvement. • Potential incremental assessment and control costs.
Impairment attributable to sediments	• Sediment quality remains the same, which may be lower than under implementation of baseline narrative objective. • Potential incremental assessment costs, but will avoid unnecessary control costs.	• Change in sediment quality if better data lead to change in control strategies • Potential incremental assessment costs; potential incremental costs or cost-savings depending on differences in control strategies

Source: SWRCB (2011)

4.3.1 Sediment Monitoring and Assessment

Significant modification of sediment quality monitoring frequency and design considerations are included in the proposed Plan. A sediment monitoring program is designed based on a conceptual model which has certain requirements, such as model parameter or input. The conceptual model is used for identifying the physical and chemical factors that control the fate and transport of pollutants and receptors. The proposed Policy modifies the current model requirement and adds some new components to input parameters, including:

- Site boundaries and site size;
- Sportfish consumer population characteristics (e.g. consumption rate);
- Sportfish species to be monitored;
- Food web associated with sportfish species to be monitored; and
- Site-specific modifications to the bioaccumulation model parameters (e.g. sportfish movement range or diet) as needed.

Additional costs can be incurred from collection of information/data regarding site boundaries size, surveying the site and consumers, monitoring for sportfish species and food web associated with the sportfish, etc. Information on costs associated with collecting this additional information is not readily available, therefore, the cost associated with model evaluation is not included in this study.

The amendment of the sediment Policy proposes a change in the regional monitoring program's monitoring frequencies listed in **Exhibit 4-4**, below.

Exhibit 4-4. Sediment Monitoring Frequency in Current and Proposed Plan

Sediment Monitoring Frequency	
Existing Policy	**Proposed Policy**
Minimum once every three years	Minimum once every five year

The new sediment monitoring requirement under the regional sediment quality monitoring program will lead to a reduction of monitoring costs in applicable bays and estuaries. This is the only compliance cost that can be reasonably estimated at this time and is the focus of this cost analysis.

4.3.2 Evaluating Waters for Placement on the Section 303(d) List

Under the existing Plan, the decision of placing a water segment on the section 303(d) list was dependent on null hypothesis testing. However, in the proposed Policy, the decision criteria has been changed. Water segments will be declared as impaired for aquatic life criteria and human health criteria when any station within the site is assessed as Clearly Impacted, Possibly Impacted, or Likely Impacted (in case of human health criteria). The assessment will be conducted based on the total percentage area classified as Clearly, Likely or Possibly Impacted.

The entire assessment framework for identifying segments impaired by sediment toxicity involves multiple costs, including monitoring cost, evaluation cost, and compliance cost. However, adequate information and data is not available to estimate these costs.

4.3.3 Implementation Framework for Assessing Human Health

Under the existing Plan, the narrative human health objective in section IV.B. of Part 1 shall be implemented on a case-by-case basis, based upon a human health risk assessment where the Water Boards shall consider any applicable and relevant information, including OEHHA policies for fish consumption and risk assessment, DTSC Risk Assessment, and U.S. EPA Human Health Risk Assessment policies.

According to the proposed Plan, implementation procedures for assessing human health criteria are divided in to two classes of contaminants:

- Chlorinated pesticides and PCBs; and
- Contaminants other than chlorinated pesticides and PCBs.

Contaminants other than chlorinated pesticides and PCBs will follow the existing implementation Plan guideline for assessing human health criteria. However, for chlorinated pesticides and PCBs, the methods and procedures associated with the Tiered Assessment Framework shall be used to interpret the narrative objective to protect human consumers of locally caught sportfish. This framework utilizes available sportfish data and involves field sampling, laboratory testing, Tiered (1, 2, and 3) Assessment Framework, Tier screening evaluation, and site linkage analysis. Although the proposed Policy contains procedures to perform this regulatory assessment, we do not have sufficient information to predict whether this would result in more or less stringent implementation of objectives. Therefore, the cost associated with human health criteria compliance assessment cannot be estimated in this analysis.

4.3.4 Exceedance of Receiving Water Limit

The existing sediment quality Policy utilizes a categorized binomial distribution and minimum number of measured exceedances to demonstrate the potential of exceeding receiving water limits. In the proposed Plan, existing criteria used to identify exceedance are modified and proposed based on the total percent area categorized as different level of impact. In protection of human health, exceedance of receiving water limits is demonstrated based on the category of site sediments (Possibly Impacted, Likely Impacted, Clearly Impacted) over the duration of a permit cycle. Currently, not enough information is available to estimate changes in the frequency of exceedance of receiving water limits under proposed Policy. As follows, cost estimates associated with new procedures for determining exceedance of receiving water limits are not performed at this time.

4.3.5 TMDL Monitoring Cost

Under the proposed Plan, nothing shall limit a Water Board's authority to develop and implement waste load allocations for Total Maximum Daily Loads. However, it is recommended that the Water Boards develop TMDL allocations using the methodology described herein, wherever possible. Sediment monitoring requirements for the TMDL will be superseded by the monitoring requirement described in the proposed Policy. **Exhibit 4-5** presents the list of applicable TMDLs associated with Enclosed Bays and Estuaries of California:

Exhibit 4-5. Applicable TMDLs Associated with Sediment Toxicity Impairment in Enclosed Bays and Estuaries of California

Regional Board	Name of the TMDL
2	North San Francisco Bay Selenium
	SF Bay Mercury
	SF Bay PCB
	Tomales Bay Mercury TMDL
3	Diazinon and Additive Toxicity in Arroyo Paredon Watershed
4	Ballona Creek Estuary Toxics TMDL
	Marina Del Rey Toxics TMDL
	Calleguas creek watershed pesticides and PCB TMDL
	Santa Monica Bay DDTs and PCBs
	Machado lake pesticides and PCB Domoniquez channel

	Dominguez Channel and Greater Harbors Toxics TMDL
5	Sacramento – San Joaquin Delta Estuary TMDL for Methylmercury
	Cache creek mercury TMDL
8	Copper-metal TMDLs for Newport bay
	Organochlorine Compounds TMDLs for San Diego Creek, Upper and Lower Newport Bay
9	San Diego Bay - Shelter Island Yacht Basin Total Maximum Daily Load

Source: SWRCB (2016)

However, in some water bodies TMDLs would take precedence over the SQO amendments. This includes:

- San Francisco Bay Region - San Francisco Bay PCB TMDL
- Los Angeles Region - Ballona Creek and Estuary Toxics TMDL
- Los Angeles Region - Dominguez Channel and Greater Harbors Toxics TMDL
- Los Angeles Region - Marina Del Rey Toxics TMDL
- Santa Ana Region - Organochlorine Compounds TMDLs for San Diego Creek, Upper and Lower Newport Bay.

5 Compliance Costs

5.1 Compliance Assessment

Under the proposed Plan, changes in methods to assess objectives and carry out implementation procedures may result in either increased or decreased instances where further regulatory action (e.g., addition of receiving water limits, additions/deletions to the 303(d) list, etc.) is required. Until actual site sediment and tissue data are monitored and assessed according to the proposed Plan, it is impracticable to predict associated compliance costs. In addition, for individual dischargers, reasonable potential for exceeding objectives or receiving water limits cannot be determined in this analysis because there is insufficient data available to predict the incremental differences in SQO exceedances that would occur. As a result, costs associated with assessing objectives and implementation procedures have not been estimated. In order to provide an indication of potential compliance costs, this Section presents unit costs associated with potential control measures and activities that may be necessary for compliance with fish tissue and water quality objectives. For the cost estimation under proposed policy, all 2011 costs were converted to April-2017 dollars using the Engineering News Record (ENR) and Construction Cost Index (CCI).

The proposed Plan includes changes in monitoring requirements. As these tend to be static and predictable, they easily translate into cost estimates. Additionally, monitoring cost data from previous rulemaking and ongoing monitoring efforts is readily available. This section therefore focuses on the estimated costs associated with changes in monitoring requirements.

5.1.1 Monitoring and Assessment for Bays

Monitoring is an important part of the compliance assessment of baseline regulatory framework. Under baseline regulatory framework, extensive monitoring and assessment activities are in operation. In the absence of the proposed Plan, these activities will continue, and additional efforts will be undertaken (e.g., as Regional Boards assess compliance with existing objectives for sediment toxicity, and address sites currently impaired for sediment toxicity). However, a significant amount of data is needed to determine whether sediments are in compliance with existing narrative objectives for sediment toxicity related to aquatic life, human health, and wildlife. Similarly, in instances in which sediments exceed baseline objectives for sediment toxicity, assessment of the causes and sources will be needed in order to identify means of compliance with the objectives. These activities, which can include developing a work Plan/project management, collecting additional data, conducting Ecological Risk Assessments (ERAs) or toxicity identification evaluations (TIEs), surface water modeling, and other analysis, may be conducted as part of developing a TMDL (SCCWRP, 2005; Parsons, et al., 2002, as cited in WSPA, 2007).

The objective of ERA is to evaluate the potential for biological effects to occur as a result of exposure to one or more stressors in the environment. ERA is a flexible iterative process that can be used for any site segment or water body either prospectively to assess future conditions or retrospectively to assess risk associated with spills or releases, or existing degradation (U.S.

EPA, 1998). ERAs may be relatively simple or extremely complex depending upon the site conditions, number of pollutants, exposure pathways, and receptors. In all cases, a variety of expertise is needed to ensure that the results of the ERA are relevant for the species exposure pathways and pollutants associated with the site segment or water body.

SWRCB (2008) and SWRCB (2011) provided unit costs for monitoring to assess the SQOs to protect the benthic community, human health, wildlife, and finfish. The costs are presented as a unit cost for per sampling event which includes from survey, sample collection, laboratory testing, and any activities that are associated with preparing the samples for transport to the analysis laboratory. A unit sampling event cost for a bay or estuary was estimated by calculating the number of sampling station per sites and multiplying it with a unit sampling cost per station. Finally the annual monitoring cost under a baseline sediment Plan was obtained by multiplying the unit sampling event cost per bay with an annual regional monitoring frequency under baseline Plan. Similarly, the annual monitoring cost under proposed Plan can be calculated by multiplying the unit sampling event cost per bay with an annual regional monitoring frequency under baseline Plan. However, to calculate potential monitoring cost under proposed Plan, the 2011 unit costs are escalated to April-2017 dollar to reflect the current economy.

Monitoring efforts for ERAs to assess indirect effects to wildlife and finfish beyond the monitoring necessary to assess water quality criteria and the SQOs for direct effects could involve collecting finfish and documenting the presence of deformities, irregularities in size, or population effects, and collection and analysis of wildlife tissue or bird eggs. **Exhibit 5-1** provides unit costs for these types of analyses. Sample collection costs may vary based on factors such as water depth, abundance of fish species, sediment characteristics (may cause unsuccessful grabs that need to be repeated), and distance between stations. Although data for some parameters may not be needed at each sampling site, the total costs per sampling event could be in the range of $10,820 to $17,040.

Exhibit 5-1. Unit Cost for Sampling Event[1]

Parameter	Unit Cost	Number per Event	Total Cost
Sediment and fish collection (for sampling or observation)	$1,500 - $1,800 per site	1	$1,500 - $1,800
Benthic Survey	$800 - $1,200 per site	1	$800 - $1,200
Metals suite (tissue)	$175 - $225 per sample	6	$1,050 - $1,350
Metal Suite (Sediment and Water)	$175 - $225 per sample	1	$175 - $225
Mercury (tissue)	$30 - $80 per sample	6	$180 - $480
Total Mercury	$65 - $135 per sample	1	$65 - $135
PAH Suite	$400	1	$400
Chlorinate pesticides (tissue)	$200 - $575 per sample	6	$1,200 - $3,450
Chlorinate pesticides (Sediment and Water sample)	$200 - $575 per sample	1	$200 - $575
Sediment toxicity (acute lethal)	$800 per sample	1	$800
Sediment toxicity (sublethal)	$800-$1400 per sample	1	$800 - $1,400
PCBs suite (tissue)	$575 - $775 per sample	6	$3,450 - $4,650
PCB cogeners (not coplanar)	$200 - $575 per sample	1	$200 - $575
Total Cost per Sampling Event	**NA**	**NA**	**$10,820 - $17,040**

Note:

Source: SCCWRP (2011), SWRCB (2011a), Source: SWRCB (2011)

[1] Incremental to sampling requirements to assess attainment of SQOs for direct effects in bays and estuaries, SWRCB(2008)
[2] Includes boat, materials, and labor for observing fish communities or collecting fish for sampling.
[3] Three fish per species and two species per site are considered for this estimation.
[4] The unit cost are the sampling cost for 2011. These values are converted to April-2017 dollars for the calculation under proposed Plan.

To assess attainment of the proposed SQO, the number of stations from which data should be collected will vary based on water body-specific factors including:

- Area;
- Tidal flow and/or direction of predominant currents;
- Historic and or legacy conditions in the vicinity of the water body;
- Nearby land and marine uses or actions;
- Beneficial uses;
- Potential receptors of concern;
- Changes in grain size, salinity, water depth, and organic matter; and
- Other sources or discharges in the immediate vicinity of the water body.

Exhibit 5-2. Number of Sampling Locations Based on the Bay Size

Bay Size (acres)	Number of Sites
<500	5
500-5000	12
>5000	30

Exhibit 5-3 shows a range of potential costs to obtain data for the bays for which no or insufficient data are available for assessing SQO compliance. These estimates represent the product of the potential number of samples (**Exhibit 5-2**) and the cost per sample of $10,820 to $17,040 (**Exhibit 5-1).**

Exhibit 5-3. Potential Compliance (monitoring) Cost Reduction under the Proposed Plan

Regional Board	Water Body	Size (Acres)	Number of Samples	Total Monitoring Costs Reduction (Low)	Total Monitoring Costs Reduction (High)
1	Crescent City Harbor	374	5	$6,253	$9,848
	Humboldt Bay	16,000	30	$37,519	$59,088
	Bodega Harbor	822	12	$15,008	$23,635
2	Tomales Bay	9,600	30	$37,519	$59,088
	Drakes Estero Bay	12,780	30	$37,519	$59,088
	San Francisco Bay, Richardson Bay	2,439	12	$15,008	$23,635
	Half moon Bay	355	5	$6,253	$9,848
3	Moss Landing Harbor	79	5	$6,253	$9,848
	Monterey Harbor	76	5	$6,253	$9,848
	Morro Bay	6,605	30	$37,519	$59,088

Regional Board	Water Body	Size (Acres)	Number of Samples	Total Monitoring Costs Reduction (Low)	Total Monitoring Costs Reduction (High)
	Santa Barbara Harbor	266	5	$6,253	$9,848
4	Ventura Harbor	179	5	$6,253	$9,848
	Channel Islands Harbor	166	5	$6,253	$9,848
	Port Hueneme	65	5	$6,253	$9,848
	Marina del Rey	931	12	$15,008	$23,635
	King Harbor	105	5	$6,253	$9,848
	Alamitos Bay	499	5	$6,253	$9,848
	Los Angeles and Long Beach Harbors consolidated slip	36	5	$6,253	$9,848
	Los Angeles and Long Beach Harbors Cabrillo beach	156	5	$6,253	$9,848
8	Anaheim Bay	248	5	$6,253	$9,848
	Bolsa Bay	116	5	$6,253	$9,848
	Newport Bay	1853	12	$15,008	$23,635
	Mission Bay	2032	12	$15,008	$23,635
	San Diego Bay San Diego Bay, Shoreline, at Marriott Marina	32	5	$6,253	$9,848
	San Diego Bay, Shoreline, Chula Vista Marina	49	5	$6,253	$9,848
Total	--	--	--	**$325,168**	**$512,094**

Notes:

[1] Costs are represented as annual monitoring cost.

In addition to the need for monitoring to conduct MLOE for segments with no data or insufficient data, confirmatory monitoring would also be required in instances where existing data indicate Possibly Impacted sites with no Clearly or Likely Impacted results. Due to lack of data to predict the number of these instances, cost associated with confirmatory monitoring could not be estimated.

5.1.2 Costs Associated With TMDLs

The proposed changes to the Plan may result in new 303(d) listings and/or delisting's. In turn, costs may be incurred for new TMDL requirements or costs savings may result where a lowered impairment status obviates a TMDL requirement. There is insufficient data to predict the overall effect of proposed Plan changes on the number of 303(d) category 5 listings; however information on the cost of TMDLs is available from the 2011 rulemaking. The State Water Board (2001) estimates that development of complex TMDLs (including an Implementation Plan) may cost over $1 million. In addition, SWRCB (2003a) indicated that TMDL development and mercury reduction strategy costs for the San Francisco Bay could range from $10 million to $20 million. These estimates provide some indication of costs that can be associated with sequential approaches to managing designated use impairments. Thus, the estimates provide an approximation of the potential magnitude of both costs associated with new or elevated listings and cost savings where additional information to accurately identify the cause of the impairment leads to downgrading or delisting. Assuming monitoring cost is the only cost associated with the TMDL and there is no new TMDL development is required under proposed policy, there could be a potential savings of $0.13 million to $0.21 million in TMDL monitoring COST under the proposed policy. Thus, assuming that assessments of SQOs would be based on the number of sites per water body, the net decremental cost associated with compliance with the Plan could range from approximately $0.13 million to $0.21 million. For the cost estimation under proposed Plan, all 2011 costs were converted to April-2017 dollars using the Engineering News Record (ENR) and Construction Cost Index (CCI).

5.1.3 Monitoring and Assessment for Estuaries

The State Water Board is collecting estuary data throughout California as a part of the Phase II effort. The focus of Phase II of the National Estuary Program is to gather and summarize the existing knowledge concerning the state of the estuary as well as the physical, chemical, and biological factors controlling spatial and temporal changes. According to the program, data will be collected to develop appropriate tools for implementing SQOs for estuaries in California. These data can also be used to assess compliance with the final SQO. Thus, additional monitoring might be required for estuarine water bodies that are not already considered under this effort. However, costs of these monitoring efforts cannot be estimated until the data collection effort is complete. Otherwise, the sampling efforts already underway could be double counted.

5.1.4 Monitoring and Assessment for TMDLs

The proposed Policy would supersede implementation Plans of existing TMDLs except for the few water bodies where existing monitoring requirements associated with TMDLs will remain unchanged.

Those water bodies include:

- San Francisco Bay Region - San Francisco Bay PCB TMDL
- Los Angeles Region - Ballona Creek and Estuary Toxics TMDL
- Los Angeles Region - Dominguez Channel and Greater Harbors Toxics
- Los Angeles Region - Marina Del Rey Toxics TMDL
- Santa Ana Region - Organochlorine Compounds TMDLs for San Diego Creek, Upper and Lower Newport Bay

Exhibit 5-4 shows the existing applicable TMDLs associated with enclosed bays and estuaries of California. The number of stations per TMDL sites varies, but for illustrative purposes and simplicity, the costs are presented on a per station basis.

Exhibit 5-4. Potential Monitoring Cost Reduction (low) in Existing Applicable TMDLs Associated with Enclosed Bays and Estuaries

Regional Board	Name of the TMDL	Annual existing monitoring cost (low)[1,2]	Monitoring cost under proposed Plan (low)	Change in cost
2	North San Francisco Bay Selenium	$11,762	$2,352	$9,410
	SF Bay Mercury	$11,762	$2,352	$9,410
	SF Bay PCB[3]	$11,762	$11,762	$0
	Tomales Bay Mercury TMDL	$2,352	$2,352	$0
3	Diazinon and Additive Toxicity in Arroyo Paredon Watershed	$11,762	$2,352	$9,410
4	Ballona Creek Estuary Toxics TMDL[3]	$23,524	$23,524	$0
	Marina Del Rey Toxics TMDL[3]	$23,524	$23,524	$0
	Calleguas creek watershed pesticides and PCB TMDL	$23,524	$2,352	$21,172
	Santa Monica Bay DDTs and PCBs	$2,352	$2,352	$0
	Machado lake pesticides and PCB Dominguez Channel	$3,529	$2,352	$1,176
	Dominguez Channel and Greater Harbors Toxics TMDL[3]	$2,352	$2,352	$0
5	Sacramento – San Joaquin Delta Estuary TMDL for Methylmercury	$47,048	$2,352	$44,696
	Cache creek mercury TMDL	$11,762	$2,352	$9,410
8	Copper-metal TMDLs for Newport bay	$23,524	$2,352	$21,172
	Organochlorine Compounds TMDLs for San Diego Creek, Upper and Lower Newport Bay[3]	$23,524	$23,524	$0
9	San Diego Bay - Shelter Island Yacht Basin Total Maximum Daily Load	$11,762	$2,352	$9,410
Total Cost	--	--	--	**$135,264**

Note:

1 Only low costs are presented in the table.

2 The number of stations per TMDL sites varies, but for illustrative purposes and simplicity, the costs are presented on a per station basis.

3 Total Maximum Daily Loads would take precedence over the SQO amendments in these waterbodies.

Assuming all existing applicable TMDLs will conduct monitoring under the monitoring requirements specified in proposed Policy amendment, there could be a potential cost savings ranging from approximately $135,000 to $213,000.

5.2 Potential Controls

The next step under the proposed Plan would be to manage impaired sediment appropriately, which includes establishing a regulatory framework to identify pollutants of concern, source identification, assessing level of impacts associated with impaired sediment, management actions, etc. Different factors can affect potential management and control cost, including other efforts and studies to assess impairment issues and number of potential stressors in the area. It is important to note that, if the Regional Water Board is already addressing the impairment issue under a different study or project, or as a result of other regulatory measures then incremental costs associated with pollution controls will be zero.

Remedial management actions are required to achieve compliance when a sediment sample or water segment is declared as impaired due to failure to meet SQO objectives. Although there are three different SQO objectives to meet (i.e., aquatic, human health and wildlife), baseline controls could be identical for each scenario. If there is already an established baseline control assigned to evaluate compliance for an objective, and controls identified as appropriate to meet the other objectives are identical to these, there will be no incremental costs with the Plan amendments.

Plan amendments may result in incremental pollution control cost associated with new instances of nonattainment of SQOs. An increase in potential control cost may also arise from the identification of additional chemical stressors that are not included in the CTR or Basin Plans. For example, in Ballona Creek, the Regional Water Board identified pyrethoid pesticides as the cause of sediment toxicity, and not metals and other toxic pollutants for which CTR criteria and sediment TMDL targets already existed (City of Los Angeles WPD, 2010). Since many practices that may be employed under existing TMDLs are applicable for controlling the mobilization of pollutants in general, pollutant specific costs are difficult to differentiate. Another example is from the TMDL for pesticides and PCBs in the Calleguas Creek Watershed. The TMDL indicates that the BMPs needed to achieve the nutrient and toxicity TMDLs for the watershed would likely reduce pesticides and PCBs to necessary levels as well (LARWQCB, 2005c).

In this particular analysis, the identification of the pollutants that cause toxicity to aquatic life and humans could not be performed due to the data uncertainty, which leads to an inability to develop discharge concentrations needed to achieve the objectives. Therefore, the required controls to achieve those concentrations are difficult to identify. The following sections discuss these issues with respect to the program areas of municipal and industrial wastewater, NPDES stormwater, Caltrans, industrial stormwater, marinas and boating activities, cleanup and remediation activities, wetlands, and dredging activities. **Appendix F** provides additional information on unit costs.

5.2.1 Municipal and Industrial Wastewater

Municipal and Industrial dischargers affected by Plan amendments would be regulated through the general statewide program implementation procedures (general permits) or individual NPDES permit program. For sediment objectives, the permit writer may assign an effluent limit only if conditions described in Section IV.4.c.i of the proposed Policy are met. In some cases, effluent limits necessary to achieve water column water quality objectives may also be necessary or may already be in place. A well planned and designed pollution control measure can address both types of limits if the focus is to identify the source and eliminate the pollutant from entering their treatment plant or industrial process. Alternatively, the Discharger may pursue regulatory relief (e.g., a variance). For the Discharger these approaches may be preferable to installing costly end-of-pipe treatment. Currently, it is challenging to assess whether the Plan amendments would result in additional controls beyond those necessary to meet effluent limits protective of the water column. Therefore, incremental cost associated with additional controls cannot be estimated at this time.

5.2.2 NPDES Stormwater

For stormwater sources, an incremental cost associated with new controls may or may not be required to achieve compliance with proposed Policy. As in the case for municipal and industrial wastewater, controls protective of water column objectives may also provide sufficient protection of sediment objectives. If Plan amendments do result in additional requirements to reduce pollutants in stormwater then additional control measures might include:

- Increased or additional non-structural BMPs – institutional, education, or pollution prevention practices designed to limit generation of runoff or reduce the pollutant load in runoff; and
- Structural controls – engineered and constructed systems designed to provide water quantity or quality control.

While there is insufficient information to predict how often additional controls would be required due to the Plan amendments, a brief discussion on different pollution control structures and their associated cost are discussed below.

5.2.2.1 Non-Structural BMPs

Non-structural BMPs can be very effective in controlling pollution generation at the source, which in turn can reduce or eliminate the need for costly end-of-pipe treatment or structural controls. They are designed to reduce the amount of stormwater runoff or pollutants that can be generated in a watershed. Usually most municipal stormwater monitoring programs implement non-structural BMPs to meet existing permit requirements. Additional compliance factors can necessitate modification or expansion of existing BMPs. For example, additional cost may come from expanding an existing outreach and education program to a larger or new target audience, refocusing source control efforts on pollutants and sources of concern (e.g., pesticide/herbicide use or integrated pest management program). Similarly, incremental costs may result from increasing program compliance efforts, and increasing frequency, duration, or efficiency of maintenance practices, such as street sweeping.

Costs are not easily quantified for the non-structural BMPs primarily because there are no design standards for these practices (SWRCB, 2006c). Also, many have been education-oriented with high up-front costs to develop outreach materials. Non-structural BMPs include public education and outreach, illicit discharge detection and elimination, construction site stormwater runoff control, post construction stormwater management in new development and redevelopment, and pollution prevention and good housekeeping for municipal operations, such as street sweeping. CSU Sacramento (2005), estimates that the aforementioned requirements, when implemented through a SWMP, cost $26 per household per year. The establishment of a public education program might seem expensive depending on the baseline program, the incremental activities, municipality size, and degree of coordination with other municipalities, but once a baseline program is established, expanding the program to other regions would not be as costly as starting a similar program from scratch. **Appendix F** provides additional examples of non-structural BMP cost estimates.

5.2.2.2 Structural BMPs

There are a variety of structural means to control the quantity and quality of stormwater runoff, including infiltration systems, detention systems, retention systems, constructed wetlands, filtration systems, and vegetated systems. There are also types of structural BMPs that rely upon natural systems, including vegetation and soils. The cost for any particular structure depends on the type of control, the quantity of water treated, and site-specific factors such as land cost. Incremental costs or cost-savings associated with the Plan amendments cannot be estimated without information on differences, if any, in structural control strategies between baseline and Plan conditions. The focus of structural BMPs is not meant to replace the use of non-structural BMPs, but rather to work in tandem with these Planning and design-based approaches to minimize unavoidable impacts. Appendix F provides examples of cost estimates for individual structures.

5.2.2.3 MS4s

Under the Policy, the State Water Board and Regional Water Boards must include permit provisions requiring Phase I and Phase II MS4s to implement monitoring requirements for dischargers to waters subject to the proposed Policy. In addition, MS4s would be required to implement pollution prevention measures.

If the Phase I and Phase II MS4s were required to augment their existing pollution prevention programs we would expect them to incur significant costs. However, this likely represents a substantial overestimate since the actual number of Phase II MS4s with existing sediment toxicity control programs are unknown. In addition, there may already be controls required but not fully implemented under an existing NPDES MS4 permit, which would also reduce sediment toxicity. This could negate the need for enhanced controls under the proposed Policy. The monitoring requirements for MS4 permits under the proposed Plan remain unchanged from the 2011 SQOs Plan that states:

"Phase I Stormwater Discharges and Major Discharges—Sediment Monitoring shall not be required less frequently than twice per permit cycle. For Stations that are consistently classified as Unimpacted or Likely Unimpacted the frequency may be reduced to once per permit cycle. The Water Board may limit receiving water monitoring to a subset of outfalls for Phase I Stormwater Permitees [sic].

Phase II Stormwater and Minor Discharges—Sediment Monitoring shall not be required more often than twice per permit cycle or less than once per permit cycle. For stations that are consistently classified as Unimpacted or Likely Unimpacted, the number of stations monitored may be reduced at the discretion of the Water Board. The Water Board may limit receiving water monitoring to a subset of outfalls for Phase II Stormwater Permitees [sic]."

As shown in **Exhibit 5-5**, there are already six large MS4s with requirements to implement sediment source control programs. Thus, municipalities in the remaining 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 sediment source control program under the proposed Policy.

Exhibit 5-5. Permit Requirements and SWMP Activities Specific to Sediment 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 Toxicity in bedded sediment (fine grained) a total of one sample per year during April-June coordinated with surface water ambient monitoring program (SWAMP). • Develop and implement programs to prevent pollution of the Estuary by other harmful pollutants like sediments, and nutrients • The Permittees shall implement and require contractors to implement BMPs for erosion and sediment control during and after construction for maintenance activities on rural roads, particularly in or adjacent to stream channels or wetlands. • Develop a strong estimate of the amount of sediment entering the Bay from local tributaries and urban drainages. By July 1, 2011, Permittees shall develop a design for a robust sediment delivery estimate/sediment budget in local tributaries and urban drainages. • Evaluate the effectiveness of the control measures implemented, evaluate attainment of pesticide concentration and toxicity targets for water and sediment from monitoring data and identify improvements to existing control measures and/or additional control measures, if needed, to attain targets with an implementation time schedule. • The Permittees shall implement appropriate BMPs for erosion and sediment controls for all
Region 4 – Ventura County (CAS004002)	Ventura River, Santa Clara River, Calleguas Creek, Malibu Creek	• Meet interim sediment concentration (WLAs) ranging from 1.1 ng/g to 25,700 ng/g depending on constituent, location and flow. • Conduct a source control study, develop, and submit an Urban Water

Exhibit 5-5. Permit Requirements and SWMP Activities Specific to Sediment for Large MS4s in California

MS4 Name (NPDES No.)	Affected Water Bodies	Permit Requirements and SWMP Activities
Region 5 - Sacramento County (CAS082597)	Sacramento-San Joaquin Delta	• Require BMP to control sediment • Sediment toxicity is monitored regularly in coordination with SWAMP program
Region 5 – East Contra Costa (CAS083313)	Sacramento-San Joaquin Delta	• Implement pollution prevention measures and BMPs to minimize sediment discharges
Region 5 – City of Stockton and San Joaquin County (CAS083470)	Sacramento-San Joaquin Delta	• Develop and implement a sediment quality monitoring program that includes components of the 2009 SWAMP • Identification, development, implementation and assessment of BMPs to address controllable discharges of sediment-bound contaminants that may be linked to sediment toxicity to the MEP.
Region 5 - Port Stockton (CAS0084077)	Central Delta and San Joaquin River	• The Central Valley Regional Water Board is currently developing a Delta Regional Monitoring Program ("RMP") for the Sacramento-San Joaquin Delta, which will involve collection of data on pollutants and toxicity in sediment.
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	• 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.

Notes:
BMP = best management practice
Hg = Inorganic mercury
MeHg = methylmercury
WLA = wasteload allocation
TMDL = total maximum daily load

5.2.3 Caltrans

Under the proposed Policy, all NPDES permits are subjected to implementation requirements. Therefore, Caltrans are expected to experience incremental impacts or incur incremental costs as a consequence of the proposed Plan.

5.2.4 Industrial Stormwater

Under the proposed Plan, industrial stormwater may experience incremental or decremental impacts in costs as a consequence of the proposed Plan, but it is infeasible to predict it due to data unavailability. For industrial storm water discharges with existing sediment monitoring requirements, the cost might decrease due to the change in required monitoring frequency. The proposed Plan may result in requirements for the Permittee to implement additional structural and non-structural controls, similar to those discussed in Section 5.2.2. In some instances, the Permittee may provide new or additional treatment technologies. Due to the site-specific nature of stormwater control and treatment, we are unable to develop specific cost estimates associated with the incremental control activities.

5.2.5 Marinas and Boating Activities

Marinas and boating activities are a significant source of toxic pollutants which can cause significant impairment in sediment. Control measures that address toxic pollutants from marinas and boating activities include:

- Use of biocide-free paint on boats or more frequent boat hull cleaning to prevent leaching of toxic paints;
- Performing above waterline boat maintenance activities in a lined channel to prevent debris from entering the water;
- Performing below waterline boat maintenance on land in area with runoff (and dust) controls; and
- Developing a collection system for toxic materials at harbors.

Although water quality controls for marinas are less common than controls for urban stormwater, information on TMDL and toxic hotspot cleanups indicates that they may be included in baseline strategies for impaired sites. However, there may also be incremental costs or cost savings at these sites as a result of the Plan amendments. Sites that are not exceeding current objectives, but would experience the proposed changes in human health objectives implementation methods could incur incremental control costs. Also, Incremental costs or cost savings will depend on the pollutants of concern, the types of activities undertaken, and, in some cases, the number of boats affected. **Appendix F** provides examples of the types of activities that may be included in incremental costs (or cost savings if baseline activities are not necessary).

5.2.6 Cleanup and Remediation Activities

Due to data unavailability, it is difficult to determine whether incremental cleanup and remediation activities will be required as a result of the Plan amendments. Additionally, according to the implementation plans of existing TMDLs, Regional Water Boards conduct remedial activities only for those pollutants that are historically present in the water body with an unknown and unidentified source. However, the possibility of implementing different cleanup and remedial activities depend on the feasibility of different strategies (e.g., capping, removal and disposal, removal and treatment and disposal), the proximity of source material (for capping) or to appropriate treatment and disposal facilities, whether disposal facilities exist or whether new facilities must be built, as well as other factors. Costs for any sediment remediation actions necessary as a result of the Plan could be similar to those estimated by the Regional Water Board for hot spot cleanup. **Appendix F** provides additional discussion regarding potential costs.

5.2.7 Wetlands

Wetlands may be used to control pollutants in wastewater and/or storm water. To achieve compliance with proposed SQOs, incremental improvements in wetland controls may or may not be necessary. Moreover, the location and extent of any controls needed and the types of controls are unknown at this time. Possible wetland control factors might include aeration, channelization, revegetation, sediment removal, levees, or a combination of these practices. Wetland protection measures might also include land use planning, land conservation, erosion and sediment control, stormwater treatment, watershed stewardship, etc.

One example of wetland control efforts underway is the Tulare Lake, drainage district, California. A flow-through experimental wetland system has been under investigation since 1996 to remove selenium (Se) from agricultural drainage water in the Tulare Lake Drainage District at Corcoran, California. In 1999, the wetland cells reduced Se from inflow water by 32 to 65% in concentration and 43 to 89% in mass. Additional controls mentioned above can be implemented to further reduce the concentration of selenium. Another example of wetland pollution control is Anderson Marsh wetland on Cache Creek. This wetland is located within a 1,000-acre park comprising oak woodlands and riparian areas. Various management practices have been implemented in this wetland to reduce the concentration of methylmercury, and other practices may reduce the downstream transport of methylmercury formed in the wetland. The extent of new wetland controls and costs that would stem from the proposed Plan amendments is currently unknown; however, the Central Valley Regional Water Board (2005b) provides capital cost estimates for controlling methylmercury export from Anderson March ranging from $200,000 to $1 million, and O&M costs ranging from $20,000 to $100,000 per year.

5.2.8 Dredging Activities

The existing and proposed Plan does not apply to dredge material suitability determinations. According to the existing and proposed Plan, the Water Boards shall not approve a dredging project that involves the dredging of sediment that exceeds the objectives in Part 1, unless the Water Boards determine that:

- The polluted sediment is removed in a manner that prevents or minimizes water quality degradation;
- The polluted sediment is not deposited in a location that may cause significant adverse effects to aquatic life, fish, shellfish, or wildlife or may harm the beneficial uses of the receiving waters, or does not create maximum benefit to the people of the State; and/or
- The activity will not cause significant adverse impacts upon a federal sanctuary, recreational area, or other waters of significant national importance.

Changes to SQO implementation procedures may affect Regional Water Board determinations of whether a sediment proposed for removal exceeds human health objectives. The impact on the number of permitting dredging project approvals or requirements associated with the dredging projects cannot be estimated at this time due to lack of data.

6 Statewide Costs

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

6.1 Sediment Quality and Costs in the Absence of Plan

The State's 2012 303(d) list currently has 127 segments of bays and estuaries impaired for toxic pollutants among which 88 segments are listed for sediment quality and 48 sites are known as toxic hot spots according to the State Water Board's BPTCP. There are an additional 8 bays that might be impaired based on the direct effect on aquatic life. These impaired segments need significant attention, and efforts should be made to control this impairment. Substantial resources are required to be spent over the next decades for additional monitoring, pollution control, pollution prevention, source identification, sediment cleanup and remediation activities. These resources include an estimated $87.6 million to $1.03 billion for cleanup and remediation of toxic hot spots that are of high priority (SWRCB, 2003b; SWRCB, 2011). These conditions require substantial resources to be spent over the next decades for monitoring, assessment, TMDL development, pollution controls, and sediment cleanup and remediation. These resources include an estimated $87.6 million to $1.03 billion for cleanup and remediation of toxic hot spots that are of high priority (SWRCB, 2003b; SWRCB, 2011).

In the absence of SQOs, all Regional Water Boards currently have narrative objectives for toxic substances, toxicity, bioaccumulation, pesticides, or a combination of these categories in their respective Basin Plan. Although these narrative objectives are subject to interpretation and are implemented according to each Regional Water Board’s Policy, sediments can be impaired for adverse physiological responses in animal and aquatic life, bioaccumulation in biota or fish resulting in adverse effects to aquatic life and wildlife, sediment toxicity, or high concentrations of toxic substances (especially pesticides) in sediments. However, it is not certain whether the developed or development of TMDLs would help to restore beneficial uses. Indeed, TMDLs are often phased such that evaluation of early actions can result in changes or redirection of future actions. Thus, cost might be reduced in the future due to the decreased frequency of the sediment quality monitoring program.

6.2 Sediment Quality and Costs under the Proposed Plan

As shown in the section 5.1.1, $0.32 million to $0.51 million in monitoring costs could be reduced due to the decreased monitoring frequency in the sediment quality monitoring program in California Bays and Estuaries. Although this cost only includes reduction associated with the decreased sediment quality monitoring, there might be an additional cost associated with ERA evaluation, TMDL development, implementation costs, and remedial actions.

These actions could also occur in the absence of the Plan based on existing monitoring and assessment practices. For example, Anchor Environmental (2006) performed an ERA for the Rhine Channel sediment remediation feasibility study. The Rhine Channel is a toxic hotspot under the Water Boards Bay Protection Program and on the 303(d) list for copper, pesticides, chlordane, DDT, PCBs, and sediment toxicity in lower Newport Bay. The ERA focused on risks associated with bioaccumulation and trophic transfer from sediment into fish and wildlife (including benthic and pelagic forage fish and higher trophic level species such as California halibut, harbor seal, and brown pelican) for copper, mercury, selenium, DDE, and PCBs. The purpose of the ERA was to assess and characterize existing risks to aquatic life and biota associated with contaminants in sediment. Anchor Environmental (2006) used the results to evaluate potential management actions. There are an unknown number of efforts such as this that already reflect requirements of the Proposed Plan. Thus, incremental costs associated with the proposed Plan amendments are highly uncertain.

The annual reduction in monitoring costs under the proposed Plan is approximately $0.32 million to $0.51 million per year for all the dischargers in applicable bays and estuaries. These costs are included in the costs summarized for the Policy in **Exhibit 6-1**. Reasonable potential for exceeding SQOs based on the modified implementation procedure cannot be assessed due to unavailable data. Therefore, cost associated with additional monitoring resulting from exceedances, associated control cost, and pollution prevention cost cannot be estimated. Additionally, costs to stormwater dischargers, dischargers of abandoned mines, dredging, wetlands, and other nonpoint sources cannot be estimated at this time due to data limitations. These costs would be in addition to the costs summarized for the Policy in **Exhibit 6-1**. **Exhibit 6-1** shows the detailed estimated cost for each discharger needing reductions under the proposed Plan.

Exhibit 6-1. Estimated Total Annual Decremental Compliance (monitoring) Cost under Proposed Policy for California Bays

Monitoring cost	Criteria Policy		Cost reduction (%)
	Baseline	Proposed	
Low	$936,795.60	$611,627	34%
High	$1,475,323.20	$963,228	34%
1. All costs presented in April-2017$ and annualized based on a 5% interest rate and 20 year expected project life.			

Notes:
[1] All costs presented in April-2017$ and annualized based on a 5% interest rate and 20 year expected project life.

Similarly, the annual reduction in monitoring costs under the proposed Plan is approximately $0.13 million to $0.21 million per year for all TMDLs applicable to proposed SQO amendments. These costs are summarized for the Policy in **Exhibit 6-2**.

Exhibit 6-2. Estimated Total Annual Decremental Monitoring Cost under Proposed Plan for Applicable TMDLs (April-2017$ per year)[1]

Monitoring Cost	Criteria Policy		Cost Reduction (%)
	Baseline	Proposed	
Low	$245,827	$110,563	55%
High	$387,143	$174,122	55%

6.3 Limitations and Uncertainties

The lack of data precludes estimation of potential costs associated with compliance assessment in the proposed Plan amendments. Additionally, uncertainties in the baseline scenario also may affect the cost analysis of proposed amendments of the Plan. For example, existing TMDLs and hot spot cleanup and remediation actions are planned, but have yet to be fully implemented, and the sediment quality that would result without the Plan is unknown. Baseline control scenarios are relevant because many practices can reduce loadings for a wide variety of pollutants. For example, the TMDL for pesticides and PCBs in the Calleguas Creek watershed indicates that the BMPs needed to achieve the nutrient and toxicity TMDLs for the watershed would likely reduce pesticides and PCBs to necessary levels as well (LARWQCB, 2005c). Thus, controls to address existing impairments (for water or sediment) could alter the assessment of compliance with the objectives.

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 6-2** provides a summary of these uncertainties and the potential impact on the cost estimates.

Exhibit 6-3. Summary of Limitations and Uncertainties of the Analysis

Assumption/Uncertainty	Potential Impact on Costs	Explanation
Unable to assess reasonable potential of sediment toxicity present in an existing water body under the proposed Plan amendments.	?	Sediment toxicity data was not available or accessible for the period of concern. Therefore, it is difficult to decide whether the dischargers discharging to applicable bays and estuaries are able to comply with newly proposed Plan amendments of the SQO.
Unable to assign additional monitoring cost based on compliance with amendments.	-	At this time, insufficient information exists regarding which water bodies will be exceeding SQO under proposed Policy.
Assumed and calculated monitoring frequency annually or "per year" basis. Therefore, all the costs are represented as annual monitoring cost.	-	The monitoring frequency for regional sediment quality control program is described as "once every five year" or "once every three year" term. to make the cost estimation associated with monitoring convenient, all monitoring frequencies are calculated as annual instead of three or five year term.
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.
Assumed a lack of existing stormwater controls despite a prevalence of existing pollution prevention programs at MS4s	+	Due to a lack of site-specific data, incremental estimates are likely a substantial overestimate since many of the costed controls are already being implemented.
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.

Exhibit 6-3. Summary of Limitations and Uncertainties of the Analysis

Assumption/Uncertainty	Potential Impact on Costs	Explanation
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.

Notes:
Key:
"+" = potential costs likely overestimated
"-" = potential costs likely underestimated
"?" = impact on cost unknown

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Appendix A. Current Narrative Objectives Applicable to Sediment Quality

This Appendix lists the current narrative Regional Water Board Basin Plan objectives that relate to sediment quality.

North Coast Regional Water Board (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. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the Regional Water Board.
- Pesticides – No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. There shall be no bioaccumulation of pesticide concentrations found in bottom sediments or aquatic life.

San Francisco Bay Regional Water Board (Region 2)

- Bioaccumulation – Many pollutants can accumulate on particles, in sediment, or bioaccumulate in fish and other aquatic organisms. Controllable water quality factors shall not cause a detrimental increase in concentrations of toxic substances found in bottom sediments or aquatic life. Effects on aquatic organisms, wildlife, and human health will be considered.
- 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. Detrimental responses include, but are not limited to, decreased growth rate and decreased reproductive success of resident or indicator species. There shall be no acute toxicity in ambient waters. There shall be no chronic toxicity in ambient waters.

The health and life history characteristics of aquatic organisms in waters affected by controllable water quality factors shall not differ significantly from those for the same waters in areas unaffected by controllable water quality factors.

Central Coast Regional Water Board (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. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, toxicity bioassays of appropriate duration, or other appropriate methods as specified by the Regional Water Board.

- Pesticides – No individual pesticide or combination of pesticides shall reach concentrations that adversely affect beneficial uses. There shall be no increase in pesticide concentrations found in bottom sediments or aquatic life.

Los Angeles Regional Water Board (Region 4)

- Pesticides – No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. There shall be no increase in pesticide concentrations found in bottom sediments or aquatic life.
- 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. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the Regional Water Board.

Central Valley Regional Water Board (Region 5)

- No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses; discharges shall not result in pesticide concentrations in bottom sediments or aquatic life that adversely affect beneficial uses; total identifiable persistent chlorinated hydrocarbon pesticides shall not be present in the water column at concentrations detectable within the accuracy of analytical methods approved by EPA or the Executive Officer; and pesticide concentrations shall not exceed the lowest levels technically and economically achievable.
- 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. Compliance with this objective will be determined by analyses of indicator organisms, species diversity, population density, growth anomalies, and biotoxicity tests of appropriate duration or other methods as specified by the Regional Water Board.

Santa Ana Regional Water Board (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 Regional Water Board (Region 9)

- Pesticides – No individual pesticide or combination of pesticides shall be present in the water column, sediments or biota at concentrations that adversely affect beneficial uses. Pesticides shall not be present at levels which will bioaccumulate in aquatic organisms to levels which are harmful to human health, wildlife, or aquatic organisms.
- 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. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the Regional Water Board.

Appendix B. Current Water Quality Objectives

This Appendix lists the current water quality objectives for toxic pollutants under the California Toxics Rule (CTR).

Exhibit B-1. CTR Priority Toxic Pollutant Criteria (concentrations in µg/L)

Pollutant	Freshwater		Saltwater		Human Health for consumption of:	
	Acute	Chronic	Acute	Chronic	Water & Organisms	Organisms Only
Antimony					14	4300
Arsenic	340	150	69	36		
Beryllium						
Cadmium	4.3	2.2	42	9.3		
Chromium (III)	550	180				
Chromium (VI)	16	11	1100	50		
Copper	13	139.0	4.8	3.1	1300	
Lead	65	652.5	210	8.1		
Mercury (303d listed)					0.05	0.051
Nickel	470	47052	74	8.2	610	4600
Selenium (303d listed)		5.0	290	71		
Silver	3.4	3.4	1.9			
Thallium					1.7	6.3
Zinc	120	120	90	81		
Cyanide	22	5.2	1	1	700	220000
Asbestos					7,000,000	
2,3,7,8-TCDD (Dioxin) (303d listed)					0.000000013	0.000000014
Acrolein					320	780
Acrylonitrile					0.059	0.66
Benzene					1.2	71
Bromoform					4.3	360
Carbon Tetrachloride					0.25	4.4
Chlorobenzene					680	21000
Chlorodibromomethane					0.401	34

Pollutant	Freshwater		Saltwater		Human Health for consumption of:	
	Acute	Chronic	Acute	Chronic	Water & Organisms	Organisms Only
Chloroethane						
2-Chloroethylvinyl Ether						
Chloroform						
Dichlorobromomethane					0.56	46
1,1-Dichloroethane						
1,2-Dichloroethane					0.38	99
1,1-Dichloroethylene					0.057	3.2
1,2-Dichloropropane					0.52	39
1,3-Dichloropropylene					10	1700
Ethylbenzene					3100	29000
Methyl Bromide					48	4000
Methyl Chloride						
Methylene Chloride (Dichloromethane)					4.7	1600
1,1,2,2-Tetrachloroethane					0.17	11
Tetrachloroethylene					0.8	8.85
Toluene					6800	200000
1,2-Trans-Dichloroethylene					700	140,000
1,1,1-Trichloroethane						
1,1,2-Trichloroethane					0.60	42
Trichloroethylene					2.7	81
Vinyl Chloride					2	525
Chlorophenol					120	400
2,4-Dichlorophenol					93	790
2,4-Dimethylphenol					540	2300
2-Methyl-4,6-Dinitrophenol					13.4	765
2,4-Dinitrophenol					70	14000
2-Nitrophenol						
4-Nitrophenol						
3-Methyl-4-Chlorophenol						
Pentachlorophenol					0.28	8.2
Phenol					21000	4600000
2,4,6-Trichlorophenol					2.1	6.5

Pollutant	Freshwater		Saltwater		Human Health for consumption of:	
	Acute	Chronic	Acute	Chronic	Water & Organisms	Organisms Only
Acenaphthene					1200	2700
Acenaphthylene						
Anthracene					9600	110000
Benzidine					0.00012	0.00054
Benzo(a)Anthracene					0.0044	0.049
Benzo(a)Pyrene					0.0044	0.049
Benzo(b)Fluoranthene					0.0044	0.049
Benzo(ghi)Perylene						
Benzo(k)Fluoranthene					0.0044	0.049
Bis(2-Chloroethoxy)Methane						
Bis(2-Chloroethyl)Ether					0.031	1.4
Bis(2-Chloroisopropyl)Ether					1400	170000
Bis(2-Ethylhexyl)Phthalate					1.8	5.9
4-Bromophenyl Phenyl Ether						
Butylbenzyl Phthalate					3000	5200
2-Chloronaphthalene					1700	4300
4-Chlorophenyl Phenyl Ether						
Chrysene					0.0044	0.049
Dibenzo(a,h)Anthracene					0.0044	0.049
1,2-Dichlorobenzene					2700	17000
1,3-Dichlorobenzene					400	2600
1,4-Dichlorobenzene					400	2600
3,3-Dichlorobenzidine					0.04	0.077
Diethyl Phthalate					23000	120000
Dimethyl Phthalate					313000	2900000
Di-n-Butyl Phthalate					2700	12000
2,4-Dinitrotoluene					0.11	9.1
2,6-Dinitrotoluene						
Di-n-Octyl Phthalate						
1,2-Diphenylhydrazine					0.040	0.54
Fluoranthene					300	370
Fluorene					1300	14000

Pollutant	Freshwater		Saltwater		Human Health for consumption of:	
	Acute	Chronic	Acute	Chronic	Water & Organisms	Organisms Only
Hexachlorobenzene					0.00075	0.00077
Hexachlorobutadiene					0.44	50
Hexachlorocyclopentadiene					240	17000
Hexachloroethane					1.9	8.9
Indeno(1,2,3-cd) Pyrene					0.0044	0.049
Isophorone					8.4	600
Naphthalene						
Nitrobenzene					17	1900
N-Nitrosodimethylamine					0.00069	8.1
N-Nitrosodi-n-Propylamine					0.005	1.4
N-Nitrosodiphenylamine					5.0	16
Phenanthrene						
Pyrene					960	11,000
1,2,4-Trichlorobenzene						
Aldrin	3		1.3		0.00013	0.00014
alpha-BHC					0.0039	0.013
beta-BHC					0.014	0.046
gamma-BHC (Lindane)	0.95		0.16		0.019	0.063
delta-BHC	2.4					
Chlordane (303d listed)	1.1	0.0043	0.09	0.004	0.00057	0.00059
4,4-DDT (303d listed)		0.001	0.13	0.001	0.00059	0.00059
4,4-DDE					0.00059	0.00059
4,4-DDD	0.24				0.00083	0.00084
Dieldrin (303d listed)	0.22	0.056	0.71	0.0019	0.00014	0.00014
alpha-Endosulfan	0.22	0.056	0.034	0.0087	110	240
beta-Endosulfan		0.056	0.034	0.0087	110	240
Endosulfan Sulfate					110	240
Endrin	0.086	0.036	0.037	0.0023	0.76	0.81
Endrin Aldehyde	0.52				0.76	0.81
Heptachlor	0.52	0.0038	0.053	0.0036	0.00021	0.00021
Heptachlor Epoxide		0.0038	0.053	0.0036	0.00010	0.00011
PCBs sum (303d listed)	0.73	0.014		0.03	0.00017	0.00017

Pollutant	Freshwater		Saltwater		Human Health for consumption of:	
	Acute	Chronic	Acute	Chronic	Water & Organisms	Organisms Only
Toxaphene		0.0002	0.21	0.0002	0.00073	0.00075

Appendix C. Nonpoint Source Plan Management Measures

This appendix provides a description of the management measures (MMs) applicable to sediment toxicity control from California's Nonpoint Source Management Program Plan. There are five MMs in the NPS Program Plan relevant to sediment toxicity control for agriculture (Exhibit C-1).

Exhibit C-1. Agricultural Management Measures

MM Code	Agriculture MM Title	Description
1A	Erosion and Sediment Control	Where erosion and sedimentation from agricultural lands affects coastal waters and/or water bodies listed as impaired by sediment, landowners must design and install or apply a combination of practices to reduce solids and associated pollutants in runoff during all but the larger storms. Alternatively, landowners may apply the erosion component of a Resource Management System as defined in the U.S. Department of Agriculture Natural Resources Conservation Service Field Office Technical Guide.
1D	Pesticide Management	Implementation will occur through cooperation with the Department of Pesticide Regulation by development and adoption of reduced risk management strategies (including reductions in pesticide use); evaluation of pest, crop, and field factors; use of Integrated Pest Management (IPM); consideration of environmental impacts in choice of pesticides; calibration of equipment; and use of anti-backflow devices. IPM strategies are key and include evaluating pest problems in relation to cropping history and previous pest control measures, and applying pesticides only when an economic benefit will be achieved. Pesticides should be selected based on their effectiveness to control target pests and environmental impacts such as their persistence, toxicity, and leaching

MM Code	Agriculture MM Title	Description
		potential.
1F	Irrigation Water Management	Irrigation water would be applied uniformly based on an accurate measurement of crop water needs and the volume of irrigation water applied, considering limitations raised by such issues as water rights, pollutant concentrations, water delivery restrictions, salt control, wetland, water supply, and frost/freeze temperature management. Additional precautions would apply when chemicals are applied through irrigation.
1G	Education/Outreach	Implement pollution prevention and education programs such as: activities that cause erosion and loss of sediment on agricultural land; activities that cause discharge from confined animal facilities (excluding Concentrated Animal Feeding Operations) to surface water; activities that cause excess delivery of nutrients and/or leaching of nutrients; activities that cause contamination of surface water and ground water from pesticides; grazing activities that cause physical disturbance to sensitive areas and the discharge of sediment, animal waste, nutrients, and chemicals to surface and ground waters; irrigation activities that cause nonpoint source pollution of surface waters.

Source: SWRCB (2000), SWRCB (2011)

There are 11 MMs that address the various forestry operations and practices (**Exhibit C-2**). The Forest Practice Rules (FPRs) also closely reflect these silvicultural MMs.

Exhibit C-2. Forestry Management Measures

MM Code	Forestry MM Title	Description
2A	Pre-Harvest Planning	Silvicultural activities should be planned to reduce potential delivery of pollutants to surface waters by addressing the timing, location, and design of harvesting and road construction; site preparation;

MM Code	Forestry MM Title	Description
		identification of sensitive or high-erosion risk areas; and the potential for cumulative water quality impacts.
2B	Streamside Management Areas (SMAs)	Protect against soil disturbance and reduce sediment and nutrient delivery to waters from upland activities. Intended to safeguard vegetated buffer areas along surface waters to protect the water quality of adjacent streams.
2C	Road Construction/Reconstruction	Road construction/reconstruction should be conducted so as to reduce sediment generation and delivery by following preharvest plan layouts and designs for road systems, incorporating adequate drainage structures, properly installing stream crossings, avoiding road construction in SMAs, removing debris from streams, and stabilizing areas of disturbed soil such as road fills.
2D	Road Management	Management of roads to prevent sedimentation, minimize erosion, maintain stability, and reduce the risk that drainage structures and stream crossings will fail or become less effective. Implementation includes inspections and maintenance actions to prevent erosion of road surfaces and to ensure the effectiveness of stream-crossing structures. Also address appropriate methods for closing roads that are no longer in use.
2E	Timber Harvesting	Addresses skid trail location and drainage, management of debris and petroleum, and proper harvesting in SMAs. Timber harvesting practices that protect water quality and soil productivity also have economic benefits by reducing the length of roads and skid trails, reducing equipment and road maintenance costs, and providing better road protection.
2F	Site Preparation and Forest Regeneration	Impacts of mechanical site preparation and regeneration operations— particularly in areas that

MM Code	Forestry MM Title	Description
		have steep slopes or highly erodible soils, or where the site is located in close proximity to a water body—can be reduced by confining runoff onsite. This measure addresses keeping slash material out of drainage ways, operating machinery on contours, timing of activities, and protecting ground cover in ephemeral drainage areas and SMAs. Careful regeneration of harvested forestlands is important in protecting water quality from disturbed soils.
2H	Revegetation of Disturbed Areas	Addresses the rapid revegetation of areas disturbed during timber harvesting and road construction—particularly areas within harvest units or road systems where mineral soil is exposed or agitated (e.g., road cuts, fill slopes, landing surfaces, cable corridors, or skid trails) with special priority for SMAs and steep slopes near drainage ways.
2I	Forest Chemical Management	Application of pesticides, fertilizers, and other chemicals used in forest management should not lead to surface water contamination. Pesticides must be properly mixed, transported, loaded, and applied, and their containers disposed of properly. Fertilizers must also be properly handled and applied since they also may be toxic depending on concentration and exposure. Includes applications by skilled workers according to label instructions, careful prescription of the type and amount of chemical to be applied, use of buffer areas for surface waters to prevent direct application or deposition, and spill contingency Planning.
2J	Wetlands Forest Management	Forested wetlands provide many beneficial water quality functions and provide habitat for aquatic life. Activities in wetland forests should be conducted to protect the aquatic functions of forested wetlands.

MM Code	Forestry MM Title	Description
2K	Postharvest Evaluation	Incorporate postharvest monitoring, including (a) implementation monitoring to determine whether the operation was conducted according to specifications, and (b) effectiveness monitoring after at least one winter period to determine whether the specified operation prevented or minimized discharges.
2L	Education/Outreach	Implement pollution prevention and education programs to reduce NPS pollutants generated by applicable silvicultural activities.

Source: SWRCB (2000), SWRCB (2011)

California's 15 urban MMs (**Exhibit C-3**) are organized to parallel the land use development process to address the prevention and treatment of pollution during all phases of urbanization; this strategy relies primarily on pollution prevention or source reduction practices.

Exhibit C-3. Urban Management Measures

MM Code	Urban MM Title	Description
3.1 A	Developing Areas – Watershed Protection	Encourage land use and development Planning on a watershed scale that takes into consideration sensitive areas that, by being protected, will maintain or improve water quality.
3.1B	Developing Areas – Site Development	Aims to protect areas that provide important water quality benefits and limit land disturbance.
3.1C	Developing Areas – New Development	Addresses increased pollutant loads associated with developed lands, and the hydrologic alterations resulting from development that affects runoff volume and timing. Developers can use innovative site planning techniques or incorporate runoff management practices to reduce the hydrologic impact of development on receiving waters.
3.2A	Construction Sites – Construction Site Erosion and Sediment Control	Aims to reduce erosion through implementation of erosion and sediment control practices.

MM Code	Urban MM Title	Description
3.2B	Construction Sites – Chemical Control	Implement a chemical control plan to: limit application, generation, and migration of toxic substances; ensure proper storage and disposal of toxic materials; and apply nutrients to establish and maintain vegetation.
3.3A	Existing Development	Includes the implementation of nonstructural controls to reduce pollutant loads and volume of stormwater runoff.
3.4A	On-site Disposal Systems (OSDS) – New OSDSs	Includes comprehensive Planning by the regulatory authority, including measures to protect sensitive areas, such as nutrient-limited waters and shellfish harvest areas. Measures might include prohibitions, setbacks, or requirements for the use of innovative treatment systems to effect greater treatment of sewage. Also includes performance-based requirements for the siting, design, and installation of systems, and inspection of newly installed systems.
3.4B	On-site Disposal Systems (OSDS) – Operating OSDSs	Addresses the programmatic aspects of OWTS management to ensure that systems that are installed as designed are inspected and maintained regularly to prevent failures. Public education about proper sewage treatment system use and maintenance is an important part of this measure, as is development and enforcement of policies to prevent or minimize the impacts of OWTS failures.
3.5A	Transportation Development Planning, Siting, and Developing Roads and Highways	Aims to protect areas that provide important water quality benefits and limit land disturbance.
3.5B	Transportation Development – Bridges	Aims to design bridges to minimize damage to riparian or wetland habitats and treating runoff from bridge decks before it is allowed to enter watercourses. Bridge maintenance activities should be conducted using containment practices

MM Code	Urban MM Title	Description
		to prevent pollutants from entering the water or riparian habitat below. Restoration of damaged riparian or instream habitats should be done after bridge construction, maintenance, and demolition.
3.5C	Transportation Development – Construction Projects	Implement a chemical control Plan to: limit application, generation, and migration of toxic substances; ensure proper storage and disposal of toxic materials; and apply nutrients to establish and maintain vegetation.
3.5D	Transportation Development – Chemical Control	Implement a chemical control Plan to: limit application, generation, and migration of toxic substances; ensure proper storage and disposal of toxic materials; and apply nutrients to establish and maintain vegetation.
3.5E	Transportation Development – Operation and Maintenance	Incorporate pollution prevention procedures into the operation and maintenance of roads, highways, and bridges to reduce pollutant loadings to surface waters.
3.5F	Transportation Development – Road, Highway, and Bridge Runoff Systems	Acknowledges the fact that roads built in the past may not have the same level of runoff control and treatment that is expected today, and these older roads may be contributing to pollution problems in receiving waters. Municipalities responsible for road and bridge rights-of-way should undertake an assessment of the roads' and bridges' contribution to surface waters and identify opportunities for installing new treatment practices. Based on water quality priorities and the availability of staff and funding resources, a schedule should be devised to implement these practices.
3.6A	Education/Outreach – Pollution Prevention: General Sources	Used to reduce the amount of pollutants generated or allowed to be exposed to runoff.

Source: SWRCB (2000), SWRCB (2011)

There are 16 MMs to address marina and boating sources of nonpoint pollution (**Exhibit C-4**). Effective implementation of these MMs can ensure appropriate operation and maintenance practices and encourage the development and use of effective pollution control and education efforts. The MMs cover the following operations and facilities:

- Any facility that contains 10 or more slips, piers where 10 or more boats may tie up, or any facility where a boat for hire is docked
- Any residential or Planned community marina with 10 or more slips
- Any mooring field where 10 or more boats are moored
- Public or commercial boat ramps
- Boat maintenance or repair yards on or adjacent to the water (typically, boat yards are separate entities from marinas and are regulated under NPDES stormwater permits).

Exhibit C-4. Marinas and Boating Management Measures

MM Code	Marinas MM Title	Description
4.1A	Assessment, Siting and Design – Marina Flushing	Provides for maximum flushing and circulation of surface waters through marina siting and designs. These practices can reduce the potential for water stagnation, maintain biological productivity, and reduce the potential for toxic accumulation in bottom sediment.
4.1D	Assessment, Siting and Design – Shoreline Stabilization	Use of vegetative stabilization methods is preferred over the use of structural stabilization methods where shoreline erosion is a pollution problem.
4.1E	Assessment, Siting and Design – Stormwater Runoff	Involves implementing runoff control strategies to remove at least 80 percent of suspended solids from stormwater runoff coming from boat maintenance areas (some boat yards may conform to this provision through NPDES permits).
4.1F	Assessment, Siting and Design – Fueling Station Design	Requires that fueling stations be located and designed to contain accidental fuel spills in a limited area, and that fuel containment equipment and spill contingency Plans be provided to ensure quick spill response.

MM Code	Marinas MM Title	Description
4.1H	Assessment, Siting and Design – Waste Management Facilities	Requires that facilities be installed at new and expanding marinas where needed for the proper recycling or disposal of solid wastes (e.g., oil filters, lead acid batteries, used absorbent pads, spent zinc anodes, and fish waste as applicable) and liquid materials (e.g., fuel, oil, solvents, antifreeze, and paints).
4.2A	Operation and Maintenance – Solid Waste Control	Involves properly disposing of solid wastes produced by the operation, cleaning, maintenance, and repair of boats to limit entry of these wastes to surface waters.
4.2C	Operation and Maintenance – Liquid Material Control	Promotes sound fish waste management through a combination of fish cleaning restrictions, education, and proper disposal.
4.2D	Operation and Maintenance – Petroleum Control	Requires provision and maintenance of the appropriate storage, transfer, containment, and disposal facilities for liquid materials commonly used in boat maintenance, as well as encouraging the recycling of these materials.
4.2E	Operation and Maintenance – Boat Cleaning and Maintenance	Aimed at reducing the amount of fuel and oil that leaks from fuel tanks and tank air vents during the refueling and operation of boats.
4.2G	Operation and Maintenance – Boat Operation	Involves prevention of turbidity and physical destruction of shallow-water habitat resulting from boat wakes and prop wash.
4.3A	Education and Outreach – Public Education	Requires that public education, outreach, and training programs be instituted to prevent and control improper disposal of pollutants into State waters.

Source: SWRCB (2000), SWRCB (2011)

State Water Resources Control Board (SWRCB). 2000. Nonpoint Source Program Strategy and Implementation Plan, 1998-2013. January.

Appendix D. Municipal and Industrial Discharger Estimated Compliance Costs

Exhibit D-1: Estimated Compliance Cost (low) with Proposed Policy by Water Body (California Bays)

Regional Board	Name of Bay/Harbor	Size (Acres)	Number of Stations (active)	Regional Sediment Quality Monitoring Frequency (2011) (per year)[1]	Low monitoring cost under baseline	Low monitoring cost under proposed Plan	Change in cost (Reduction)
1	Crescent City Harbor	374	5	0.333	$18,015.30	$11,762.07	$6,253
	Humboldt Bay	16000	30	0.333	$108,091.80	$70,572.41	$37,519
	Bodega Harbor	822	12	0.333	$43,236.72	$28,228.96	$15,008
2	Tomales Bay	9,600	30	0.333	$108,091.80	$70,572.41	$37,519
	Drakes Estero Bay	12780	30	0.333	$108,091.80	$70,572.41	$37,519
	San Francisco Bay, Richardson Bay	2439	12	0.333	$43,236.72	$28,228.96	$15,008
	Half moon Bay	355	5	0.333	$18,015.30	$11,762.07	$6,253
3	Moss Landing Harbor	79	5	0.333	$18,015.30	$11,762.07	$6,253
	Monterey Harbor	76	5	0.333	$18,015.30	$11,762.07	$6,253
	Morro Bay	6605	30	0.333	$108,091.80	$70,572.41	$37,519
	Santa Barbara Harbor	266	5	0.333	$18,015.30	$11,762.07	$6,253
4	Ventura Harbor	179	5	0.333	$18,015.30	$11,762.07	$6,253
	Channel Islands Harbor	166	5	0.333	$18,015.30	$11,762.07	$6,253
	Port Hueneme	65	5	0.333	$18,015.30	$11,762.07	$6,253
	Marina del Rey	931	12	0.333	$43,236.72	$28,228.96	$15,008
	King Harbor	105	5	0.333	$18,015.30	$11,762.07	$6,253
	Alamitos Bay	499	5	0.333	$18,015.30	$11,762.07	$6,253
	Los Angeles and Long Beach Harbors consolidated slip	36	5	0.333	$18,015.30	$11,762.07	$6,253
	Los Angeles and Long Beach Harbors Cabrillo beach	156	5	0.333	$18,015.30	$11,762.07	$6,253
8	Anaheim Bay	248	5	0.333	$18,015.30	$11,762.07	$6,253
	Bolsa Bay	116	5	0.333	$18,015.30	$11,762.07	$6,253
	Newport Bay	1853	12	0.333	$43,236.72	$28,228.96	$15,008

9	Mission Bay	2032	12	0.333	$43,236.72	$28,228.96	$15,008
	San Diego Bay San Diego Bay, Shoreline, at Marriott Marina	32	5	0.333	$18,015.30	$11,762.07	$6,253
	San Diego Bay, Shoreline, Chula Vista Marina	49	5	0.333	$18,015.30	$11,762.07	$6,253
Total Monitoring Cost		--	--	--	**$936,795.60**	**$611,627.51**	**$325,168.09**

Notes:
[1] Under 2011 SQO Policy, Regional sediment quality monitoring will occur once every three year.

Exhibit D-2: Estimated Compliance Cost (high) with Proposed Policy by Water Body (California Bays)

Regional Board	Name of Bay/Harbor	Size (Acres)	Number of Stations (active)	Regional Sediment Quality Monitoring Frequency (2011) (per year)[1]	High monitoring cost under baseline	High monitoring cost under proposed Plan	Change in cost (Reduction)
1	Crescent City Harbor	374	5	0.333	$28,371.60	$18,523.63	$9,848
	Humboldt Bay	16000	30	0.333	$170,229.60	$111,141.76	$59,088
	Bodega Harbor	822	12	0.333	$68,091.84	$44,456.70	$23,635
2	Tomales Bay	9,600	30	0.333	$170,229.60	$111,141.76	$59,088
	Drakes Estero Bay	12780	30	0.333	$170,229.60	$111,141.76	$59,088
	San Francisco Bay, Richardson Bay	2439	12	0.333	$68,091.84	$44,456.70	$23,635
	Half moon Bay	355	5	0.333	$28,371.60	$18,523.63	$9,848
3	Moss Landing Harbor	79	5	0.333	$28,371.60	$18,523.63	$9,848
	Monterey Harbor	76	5	0.333	$28,371.60	$18,523.63	$9,848
	Morro Bay	6605	30	0.333	$170,229.60	$111,141.76	$59,088
	Santa Barbara Harbor	266	5	0.333	$28,371.60	$18,523.63	$9,848
4	Ventura Harbor	179	5	0.333	$28,371.60	$18,523.63	$9,848
	Channel Islands Harbor	166	5	0.333	$28,371.60	$18,523.63	$9,848
	Port Hueneme	65	5	0.333	$28,371.60	$18,523.63	$9,848
	Marina del Rey	931	12	0.333	$68,091.84	$44,456.70	$23,635
	King Harbor	105	5	0.333	$28,371.60	$18,523.63	$9,848

	Alamitos Bay	499	5	0.333	$28,371.60	$18,523.63	$9,848
	Los Angeles and Long Beach Harbors consolidated slip	36	5	0.333	$28,371.60	$18,523.63	$9,848
	Los Angeles and Long Beach Harbors Cabrillo beach	156	5	0.333	$28,371.60	$18,523.63	$9,848
8	Anaheim Bay	248	5	0.333	$28,371.60	$18,523.63	$9,848
	Bolsa Bay	116	5	0.333	$28,371.60	$18,523.63	$9,848
	Newport Bay	1853	12	0.333	$68,091.84	$44,456.70	$23,635
9	Mission Bay	2032	12	0.333	$68,091.84	$44,456.70	$23,635
	San Diego Bay San Diego Bay, Shoreline, at Marriott Marina	32	5	0.333	$28,371.60	$18,523.63	$9,848
	San Diego Bay, Shoreline, Chula Vista Marina	49	5	0.333	$28,371.60	$18,523.63	$9,848
Total Monitoring Cost		--	--	--	**$1,475,323.20**	**$963,228.54**	**$512,094.66**

Notes:
[1] Under 2011 SQO Policy, Regional sediment quality monitoring will occur once every three year.

Exhibit D-3: Monitoring Cost Summary under Baseline and Proposed Policy

	Criteria	Baseline Policy	Proposed Policy	Cost Reduction	Cost Reduction (%)
Monitoring Cost	Low	$936,795.60	$611,627.51	**$325,168.09**	**34.71%**
	High	$1,475,323.20	$963,228.54	**$512,094.66**	**34.71%**

Exhibit D-4: TMDL Monitoring Cost Summary under Baseline and Proposed Policy

Name of the TMDL	Cost Reduction (Low)	Cost Reduction (High)
North San Francisco Bay Selenium	$9,410	$14,818.90
SF Bay Mercury	$9,410	$14,818.90
SF Bay PCB	No change in cost	No change in cost
Tomales Bay Mercury TMDL	No change in cost	No change in cost
Diazinon and Additive Toxicity in Arroyo Paredon Watershed	$9,410	$14,818.90
Ballona Creek Estuary Toxics TMDL	No change in cost	No change in cost
Marina Del Rey Toxics TMDL	No change in cost	No change in cost

Name of the TMDL	Cost Reduction (Low)	Cost Reduction (High)
Callegua creek watershed pesticides and PCB TMDL	$21,172	$33,342.53
Santa Monica Bay DDTs and PCBs	No change in cost	No change in cost
Machado lake pesticides and PCB Domoniquez channel	$1,176	$1,852.36
Dominguez Channel and Greater Harbors Toxics TMDL	No change in cost	No change in cost
Sacramento – San Joaquin Delta Estuary TMDL for Methylmercury	$44,696	$70,389.78
Cache creek mercury TMDL	$9,410	$14,818.90
Copper-metal TMDLs for Newport bay	$21,172	$33,342.53
Organochlorine Compounds TMDLs for San Diego Creek, Upper and Lower Newport Bay	No change in cost	No change in cost
San Diego Bay - Shelter Island Yacht Basin Total Maximum Daily Load	$9,410	$14,818.90
Total Cost Reduction under Proposed Policy	**$135,264**	**$213,022**

Notes:

1. Monitoring requirements under proposed policy will not supersede the existing monitoring plan of TMDLs.

Appendix E. Toxic Hot Spots for Bays and Estuaries

This appendix provides additional information on the enclosed bays listed as known toxic hot spots in the Consolidated Plan. **Exhibit E-1** summarizes the information in the Consolidation Plan for bays.

Rank	Site Identification	Reason for Listing	
		Definition Trigger	Pollutants
High	Delta Estuary, Cache Creek watershed including Clear lake	Human health impacts	Mercury
High	Delta Estuary	Aquatic life impacts	Diazinon
High	Delta Estuary - Morrison Creek, Mosher Slough, 5 Mile Slough, Mormon Slough & Calaveras River	Aquatic life impacts	Diazinon & Chlorpyrifos
High	Delta Estuary - Ulatis Creek, Paradise Cut, French Camp & Duck Slough	Aquatic life impacts	Chlorpyrifos
High	Humboldt Bay Eureka Waterfront H Street	Bioassay toxicity	Lead, Silver, Antimony, Zinc, Methoxychlor, PAHs
High	Los Angeles Inner Harbor Dominguez Channel, Consolidated slip	Human health, aquatic life impacts	DDT, PCBs, PAH, Cadmium, Copper, Lead, Mercury, Zinc, Dieldrin, Chlordane
High	Los Angeles Outer Harbor Cabrillo Pier	Human health, aquatic life impacts	DDT, PCBs, Copper
High	Lower Newport Bay Rhine Channel	Sediment toxicity, exceeds objectives	Arsenic, Copper, Lead, Mercury, Zinc, DDE, PCB, TBT
High	Moss Landing Harbor and Tributaries	Aquatic life & human health concerns – Sediment chemistry, Toxicity, Bioaccumulation and exceedances of NAS and or FDA guidelines	Pesticides, PCBs, Nickel, Chromium, TBT
High	Mugu Lagoon/ Calleguas Creek tidal prism, Eastern Arm, Main Lagoon, Western Arm	Aquatic life impacts	DDT, PCBs, metals, Chlordane, Chlorpyrifos
High	San Diego Bay Seventh St. Channel, Paleta Creek, Naval Station	Sediment toxicity and benthics community impacts	Chlordane, DDT, PAHs and Total Chemistry
High	San Francisco Bay Castro Cove	Aquatic life impacts	Mercury, Selenium, PAHs, Dieldrin
High	San Francisco Bay Entire Bay	Human health impacts	Mercury, PCBs, Dieldrin, Chlordane, DDT, Dioxin Site listing was based on Mercury and PCB health advisory
High	San Francisco Bay Islais Creek	Aquatic life impacts	PCBs, Chlordane, Dieldrin, Endosulfan Sulfate, PAHs, Anthropogenically enriched H2S and NH3
High	San Francisco Bay Mission Creek	Aquatic life impacts	Silver, Chromium, Copper Mercury, Lead, Zinc, Chlordane, Chlorpyrifos, Dieldrin, Mirex, PCBs, PAHs, anthropogenically enriched H2S and NH3

Rank	Site Identification	Reason for Listing	
		Definition Trigger	Pollutants
High	San Francisco Bay Peyton Slough	Aquatic life impacts	Silver, Cadmium, Copper, Selenium, Zinc, PCBs, Chlordane, ppDDE, Pyrene
High	San Francisco Bay Point Potrero/ Richmond Harbor	Human health impacts	Mercury, PCBs, Copper, Lead, Zinc
High	San Francisco Bay Stege Marsh	Aquatic life impacts	Arsenic, Copper, Mercury, Selenium, Zinc, Chlordane, Dieldrin, ppDDE, Dacthal, Endosulfan 1, Endosulfan sulfate, Dichlorobenzophenone, Heptachlor epoxide, Hexachlorobenzene, Mirex, Oxidiazon, Toxaphene,PCBs
High	San Joaquin River at City of Stockton	Exceedances of water quality objective	Dissolved oxygen
High	Santa Monica Bay Palos Verdes Shelf	Human health, aquatic life impacts	DDT, PCBs
Moderate	Anaheim Bay, Naval Reserve	Sediment toxicity	Chlordane, DDE
Moderate	Ballona Creek Entrance Channel	Sediment toxicity	DDT, Zinc, Lead, Chlordane, Dieldrin, Chlorpyrifos
Moderate	Bodega Bay-10006 Mason’s Marina	Bioassay toxicity	Cadmium, Copper, TBT, PAH
Moderate	Bodega Bay-10028 Porto Bodega Marina	Bioassay toxicity	Copper, Lead, Mercury, Zinc, TBT, DDT, PCB, PAH
Moderate	Bodega Bay-10007 Spud Point Marina	Bioassay toxicity	NA
Moderate	Delta Estuary Delta	Aquatic life impacts	Chlordane, Dieldrin, Lindane, Heptachlor, Total PCBs, PAH, DDT
Moderate	Delta Estuary Delta	Human health impacts	Chlordane, Dieldrin, Total DDT, PCBs, Endosulfan, Toxaphene
Moderate	Los Angeles River Estuary	Sediment toxicity	DDT, PAH, Chlordane
Moderate	Upper Newport Bay Narrows	Sediment toxicity, Exceeds Water Quality Objectives	Chlordane, Zinc, DDE
Moderate	Lower Newport Bay Newport Island	Exceeds Water Quality Objectives	Copper, Lead, Mercury, Zinc, Chlordane, DDE, PCB, TBT
Moderate	Marina del Rey	Sediment toxicity	DDT, PCB, Copper, Mercury, Nickel, Lead, Zinc, Chlordane
Moderate	Monterey Harbor	Aquatic life impacts, Sediment toxicity	PAHs, Cu, Zn, Toxaphene, PCBs, Tributyltin
Moderate	San Diego Bay Between “B” Street & Broadway Piers	Benthic community impacts	PAHs, Total Chemistry
Moderate	San Diego Bay Central Bay Switzer Creek	Sediment toxicity	Chlordane, Lindane, DDT, Total Chemistry
Moderate	San Diego Bay Chollas Creek	Benthic community impacts	Chlordane, Total Chemistry
Moderate	San Diego Bay Foot of Evans & Sampson Streets	Benthic Community Impacts	PCBs, Antimony, Copper, Total Chemistry
Moderate	San Francisco Bay Central Basin, San Francisco Bay	Aquatic life impacts	Mercury, PAHs
Moderate	San Francisco Bay Fruitvale (area in front of storm drain)	Aquatic life impacts	Chlordane, PCBs

Rank	Site Identification	Reason for Listing	
		Definition Trigger	Pollutants
Moderate	San Francisco Bay Oakland Estuary. Pacific Drydock #1 (area in front of stormdrain)	Aquatic life impacts	Copper, Lead, Mercury, Zinc, TBT, ppDDE, PCBs, PAHs, Chlorpyrifos, Chlordane, Dieldrin, Mirex
Moderate	San Francisco Bay, San Leandro Bay	Aquatic life impacts	Mercury, Lead, Selenium, Zinc, PCBs, PAHs, DDT, pesticides
Low	Bolsa Chica Ecological Reserve	Sediment toxicity	DDE
Low	Huntington Harbor Upper Reach	Sediment toxicity	Chlordane, DDE, Chlorpyrifos

Source: SWRCB (2003).

State Water Resources Control Board (SWRCB). 2003. Consolidated Toxic Hot Spots Cleanup Plan: Volumes I and II. August.

Appendix F. Control Cost

This appendix provides a description of the types of control costs that might be incurred as incremental costs of the Plan amendments should entities need to implement controls that would not be necessary in the absence of the Plan.

F.1 Stormwater Nonstructural BMP

One of the most expensive nonstructural BMP programs is the street sweeping program that accounts for approximately 11% to 64% of SWMP costs incurred by municipalities responding to a recent survey (CSU Sacramento, 2005). More intensive sweeping could include incremental costs for equipment purchase and operation. The type and operation of the equipment, sweeping frequency and number of passes, and climate determines the efficiency of street sweeping (FHWA, 2002). Thus, increasing the frequency of sweeping or changing the type of sweeper used may result in decreases in pollutant loads.

California State University (CSU) Sacramento conducted a stormwater cost survey for the State Water Board to document costs incurred by select municipalities in implementing SWMPs as part of their MS4 NPDES permits. **Exhibit F-1** shows street sweeping costs for several California municipalities, with costs ranging from $12 to $61 per curb mile. Incremental costs for more extensive sweeping would depend on a municipality's current sweeping practices and the extent of the increase needed to reduce toxic loadings (e.g., the incremental curb miles and whether new sweepers need to be purchased).

Exhibit F.1: Examples of Street Sweeping Costs

Municipality	Street Sweeping Costs ($)[1]	Annual Curb Miles Swept	Costs per Curb Mile Swept ($/curb mile)	Estimated Annual Frequency
Fremont	$1,915,000	31,405	$61	12
Sacramento	$1,322,748	26,450	$50	12
Encinitas	$117,962	5,832	$20	12
Corona	$414,215	20,877	$20	26
Fresno-Clovis	$2,193,296	142,411	$15	12
Santa Clarita	$557,443	46,800	$12	50

Notes:
Source: CSU Sacramento (2005); SWRCB (2011)
[1] Costs are in 2002/2003 fiscal year dollars

Most municipalities use mechanical/brush model sweepers (Minton, 2007), which are generally only half as effective as vacuum sweepers with respect to pollutant loading reduction. Vacuum sweepers are much more effective at removing fine sediments, silts and clays where much of the pollution resides. There are two types of vacuum sweepers: wet and dry. The dry vacuum sweepers remove a greater percentage of small particulates and sediments than the wet vacuum sweepers. Thus, depending on the load reductions needed, switching to either a wet or dry vacuum sweeper could increase pollutant load reductions to surface waters.

Conventional mechanical sweepers cost approximately $69,000 (1995 dollars), whereas wet vacuum sweepers cost around $127,000 (1995 dollars) (FHWA, 2002). The useful life span of these sweepers is between 4 and 7 years, and the operating cost associated with these sweepers is about $70 per hour (1996 dollars) (FHWA, 2002). The capital cost of vacuum-assisted dry sweepers is on the order of $170,000 (1996 dollars) with a projected useful life span of about 8 years, and operating costs of approximately $35 per hour (1996 dollars) (FHWA, 2002).

F.2 Stormwater Structural Controls

There are a variety of structural means to control the quantity and quality of stormwater runoff including infiltration systems, detention systems, retention systems, constructed wetlands, filtration systems, and vegetated systems. The cost of constructing stormwater controls depends on site conditions and drainage area. Furthermore, there are often economies of scale, making it difficult to develop a unit construction cost.

Caltrans conducted a stormwater control retrofit pilot program to acquire experience in the installation and operation of a wide range of structural controls and to evaluate the performance and costs of these devices (Caltrans, 2004). As part of this program, Caltrans compared the construction costs incurred during the program to costs collected from several other transportation departments and jurisdictions (Caltrans, 2001). Caltrans obtained cost data from the following entities: Maryland State Highway Administration, Texas Department of Transportation, City of Austin (Texas), King County (Washington), Florida Department of Environmental Quality, Maryland and Virginia BMP data collected by the Center for Watershed Protection, and City of Santa Monica (California). **Exhibit F-2** presents Caltrans' unit cost estimates for these municipalities.

Exhibit F.2: Unit Cost Estimate by Municipality

Control Type	Number of Projects	Approximate Unit Cost ($/acre)			
		Median	Average	Max	Min
Detention Basin	23	$4,901	$6,983	$32,336	$470
Retention Basin (Wet Pond)	23	$8,287	$13,122	$55,883	$1,625
Wetland	25	$4,807	$7,859	$37,641	$271
Infiltration Trench	8	$15,395	$24,626	$65,737	$7,127
Austin Sand Filter	15	$24,307	$40,737	$171,438	$1,828
Delaware Sand Filter	4	$118,933	$117,938	$193,484	$40,404
Bio retention	2	$60,498	$60,498	$95,582	$25,414

Notes:

Source: Caltrans (2001); SWRCB (2011), escalated to 2007 dollars (from 1999 dollars) using the CCI.

1 Does not include Caltrans pilot program costs. Caltrans adjusted all costs for difference in regional economics and date of construction using RS Means Heavy Construction Cost Data and the CCI, respectively.

However, the costs incurred by Caltrans for BMPs constructed during their retrofit program are, in general, substantially higher than costs reported by the other entities Caltrans used for comparison. Caltrans (2001) indicated several reasons for these higher costs, including:

- Experience and efficiency in Planning and design can contribute significantly to savings; Caltrans had relatively little experience and a relatively short Planning horizon;
- BMP retrofit work was not combined with any ongoing construction projects; and
- Pilot program did not reflect lowest cost technology for a given site.

Caltrans estimated that the retrofit program costs could be lowered by between 41% and 76%. Therefore, although the retrofit program provides valuable information related to stormwater controls, the costs are likely to overstate those that would be incurred by other entities for the same practices.

The Westside Water Quality Improvement (WWQI) Project is an example of a structural stormwater control project designed and constructed in California. The WWQI Project is a system designed to treat, to the maximum extent possible, dry weather and stormwater runoff from eastern parts of Santa Monica and parts of west Los Angeles. The system is capable of treating dry weather runoff up to 3 cubic feet per second (cfs) and stormwater runoff up to 33 cfs in a 24-hour period. The runoff comes from approximately 220 acres within Santa Monica's Centinela Sub-Watershed area and 2,280 acres from parts of west Los Angeles (CSM, No Date).

The facility utilizes three separate processes to treat and improve the quality of runoff: screening, sedimentation, and direct filtration. Direct filtration takes place in the Contech Stormwater Management StormFilter® unit which removes oil and grease, dissolved heavy metals, herbicides and pesticides. Removal of trash and other floatables, and suspended particulates by sedimentation occurs in the StormFilter, Bio Clean Nutrient Separating Baffle Box™, and at the transverse diversion weir (CSM, No Date). The facility operates totally on a gravity flow basis. Isolation gate valves may be closed for maintenance or to protect the system from being overloaded during heavy storm events (typically once or twice in a season) (CSM, No Date). The estimated cost of this project was approximately $2 million (ACC, 2007).

F.3 Controls for Marinas

Coastal Boat works in Morro Bay, California completed a pollution prevention project in 1999 to reduce the amount of heavy metals and toxic pollutants that reached the bay from the marina. In addition to distributing 500 pamphlets to various agencies and organizations promoting pollution prevention along the waterfront, the facility also purchased new cleaning equipment including dustless sanders and a Vacu-boom system (used to prevent runoff from washing operations) for boaters to use during maintenance operations (MBNEP, 2000). The marina spent approximately $14,500 on the program (includes $5,400 in funding from the MBNEP) (MBNEP, 2000).

The Vacu-boom system is a hollow, flexible tube placed directly on a hard surface to form a downslope side dam or to completely encircle the wash or containment area. During use, the boom is connected by a portable wet vacuum recovery unit (Pressure Power Systems, 2007). When the wet vacuum system is turned on, the Vacu-Boom tightly seals itself to the surface to form an impervious liquid barrier and water is extracted into the boom into the vacuum unit (Pressure Power Systems, 2007). The water is discharged from the vacuum unit through a discharge hose into a holding tank, filter unit, or sanitary sewer (Pressure Power Systems, 2007). **Exhibit F-3** shows costs for various size units.

Exhibit F-3: Capital Costs for Vacu-Boom System (2007 dollars)

Tube Size	Capital Cost
20 feet	$3,200
25 feet	$3,350
30 feet	$3,600
40 feet	$4,100
50 feet	$4,500

Source: SWRCB (2011)

The Los Angeles Regional Water Board, among others, has identified copper-based antifouling paints as a source of copper pollution in marinas and bays (LARWQCB, 2005a; 2005b). Reduction or elimination of this pollution may require the transition to alternatives. Few, if any, areas in California have begun the transition to less toxic alternatives. The San Diego Regional Water Board (2005) provides information on the potential costs associated with the use of nontoxic paints on boats, based on findings in Carson, et al. (2002). **Exhibit F-4** provides a comparison between copper-based antifouling paints and nontoxic epoxy coatings. Boat owners may save small amounts of money on nontoxic hull coatings and maintenance over the life of the boat. In some situations, individual boat owners could spend slightly more money on nontoxic coating maintenance but the amount will be small compared to hull maintenance cost over the life of the boat (SDRWQCB, 2005).

Exhibit F.4: Comparison between Copper-based Antifouling Paint and Nontoxic Epoxy Coating

Copper-based Antifouling Paints	Nontoxic Epoxy Coatings
Initially less expensive to apply ($30 per foot)	Initially more expensive to apply ($30 - $50 per foot)
Not needed to be clean as often (14 times per year)	Needed to be cleaned more often (22 times per year)
Needed to be reapplied more often (every 2.5 years)	Not needed to be re-applied very often (every 5 years to 10 years)
Needed to be stripped about 6th application (every 15 years if paint reapplied every 2.5 years)	Do not need to be stripped (in first 30-60 years)

Source: SDRWQCB (2005); SWRCB (2011)

1. Based on a typical stylized 40-foot long boat with 11-foot beam width and 375 square feet of wetted hull surface.

Variability in costs from this transition depends primarily on whether stripping for a boat is required prior to application of the nontoxic alternative. Stripping is not needed for new, unpainted boats. For older boats (approximately 15 years old), stripping is required for both application of nontoxic epoxy coatings, and continued application of copper-based paints. Thus, only boats less than 15 years old would have the option of stripping prior to applying the new paint. Stripping costs are approximated at $120/foot (Carson, et al., 2002). Long term cost estimates for transitioning from copper-based antifouling paints to nontoxic coatings also vary depending on assumptions regarding the performance of the nontoxic coatings and their price (SDRWQCB, 2005).

For example, Carson, et al. (2002) estimated the cost of remaining life hull maintenance for 40 foot length, 11 foot width boats to range from a savings of $1,354 (new boat with nontoxic coating, good performance, and lower prices) to a cost of $6,251 (2.5 year old boat requiring stripping, fair performance, and higher prices). Carson, et al. (2002) estimated that the least costly alternative for the transition to nontoxic paint (i.e., allowing boat owners to convert when the epoxy-copper cost differential is most favorable) would cost the boating community (about 7,000 boats) in San Diego Bay approximately $1.5 million over 15 years (2002 year dollars). If all boat owners were required to convert to nontoxic paints immediately, costs to boaters would be approximately $33.8 million (Carson, et al., 2002).

F.4 Sediment Remediation and Cleanup

There are a number of limitations associated with estimates of unit costs for sediment remediation and cleanup. Unit costs are generally only applicable to the conditions and constraints of the site remediated (Myers, 2005). Factors such as project scale, beneficial use opportunities, and the need for land are highly site-specific and greatly influence project costs (Myers, 2005). Myers (2005) also points out that unit costs for a one time remediation job will generally be greater than unit costs of a long term project in which a specific amount of sediment is treated each year over many years, due to economies of scale.

The types of remedial or cleanup activities implemented and their effectiveness are also highly site-specific. For example, sediment capping may be feasible in a deep water area but not feasible in a shallower area through which large ships have to pass. Also, dredging may be cost-effective where only the top layer of sediment is contaminated. However, where contamination exists beneath the top layer of sediment, dredging may not be feasible or cost-effective. Thus, information on the extent of contamination and water body uses is important in determining feasible cleanup options.

Another limitation to most unit cost estimates is a lack of detail on how the costs were derived. Tetra Tech and Averett (1994) (as cited in Myers, 2005) estimate that unit costs for a thermal gas phase reduction process range from $426/cy to $506/cy. This estimate reflects the buildup of costs in a number of categories, including site preparation, permitting, capital equipment, pretreatment, labor, consumables, supplies, and utilities, effluent treatment and disposal, monitoring, maintenance, site demobilization and cleanup, dredging, construction of and transportation to temporary storage facility, land leases, and disposal of residual material. However, due to site-specific conditions in another area (e.g., lack of available space to construct a temporary storage facility), these particular estimates may not be applicable. If documentation regarding the buildup of costs for each category is available, the estimates could potentially be modified to take site-specific conditions into account.

In 1997, the National Academy of Sciences (NAS) published comparison unit cost and cost-effectiveness information for a number of remediation strategies (**Exhibit F-5**). NAS (1997) ranked the alternatives based on feasibility, effectiveness, practicality, and cost (<$1/cy to $1,000/cy). The lowest cost option (natural recovery) does not rank high in feasibility or practicality. In comparison, the highest cost option (thermal ex situ treatment) ranks high in feasibility, effectiveness, and practicality.

Exhibit F-5. Cost-Effectiveness of Sediment Remediation Approaches

Approach	Feasibility	Effective	Practicality	Cost
Interim Control				
Administrative	0	4	2	4
Technological	1	3	1	3
In Situ Treatment				
Natural Recovery	0	4	1	4
Capping	2	3	3	3
Treatment	1	1	2	2
Sediment Removal and Transport	2	4	3	2
Ex Situ Treatment				
Physical	1	4	4	1
Chemical	1	2	4	1
Thermal	4	4	3	0

Biological	0	1	4	1
Ex Situ Containment	2	4	2	2

Scoring	Feasibility	Effective	Practicality	Cost
0	<90%	Concept	Not acceptable, very uncertain	$1,000/cy
1	90%	Bench		$100/cy
2	99%	Pilot		$10/cy
3	99.9%	Field		$1/cy
4	99.99%	Commercial	Acceptable, certain	<$1/cy

Notes:
Source: SWRCB (1998), SWRCB (2011), as adapted from and reprinted with permission from Contaminated Sediments in Ports and Waterways Cleanup Strategies and Technologies. Copyright 1997 by the National Academy of Sciences. Courtesy of the National Academy Press, Washington, D.C.

Comparable to the NAS estimates from 1997, USACE (2001) indicates that sediment treatment costs can range from around $50/cubic meter ($65/cy) for a process such as stabilization to over $1,000/cubic meter ($1,300/cy) for high temperature thermal processes. These estimates are based on project costs throughout the United States. However, preliminary estimates from USACE (1999) for capping sediments in the Palos Verdes Shelf in California range from $1.79/cy to $5.06/cy, which is greater than the $1/cy estimate in the exhibit.

As part of a cleanup and abatement order, the San Diego Regional Water Board developed unit cost estimates for dredging contaminated sediments in the San Diego Bay based on preliminary cost estimates from Exponent (2003). **Exhibit F-6** shows these unit costs. All of the estimates are for dredging with a mechanical dredge and do not include the sediment volume from areas beneath piers or within 10 feet of structures because of stability concerns.

Exhibit F.6: Unit Cost Estimates for Dredging Contaminated Sediments in San Diego Bay

Cleanup Alternative	Approximate Dredge Volume (cubic yards)	Approximate Total Cost	Approximate Cost per Cubic Yard
LAET	75,000	$15,000,000	$200
5x Background	754,000	$88,000,000	$117
Background	1,200,000	$120,000,000	$102

Notes:
Sources: SDRQWCB (2007)
LAET = lowest apparent effects threshold

F.5 References

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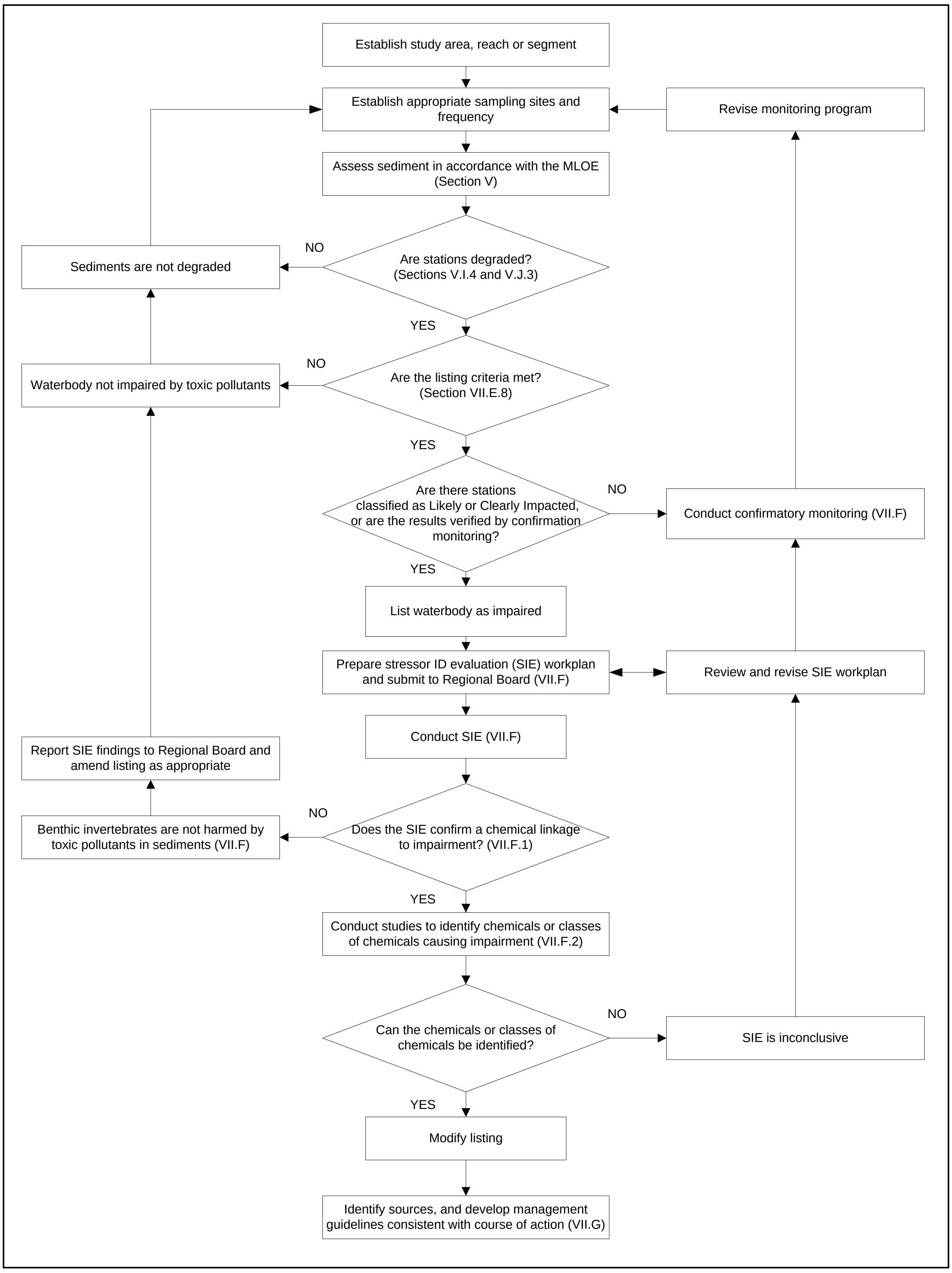
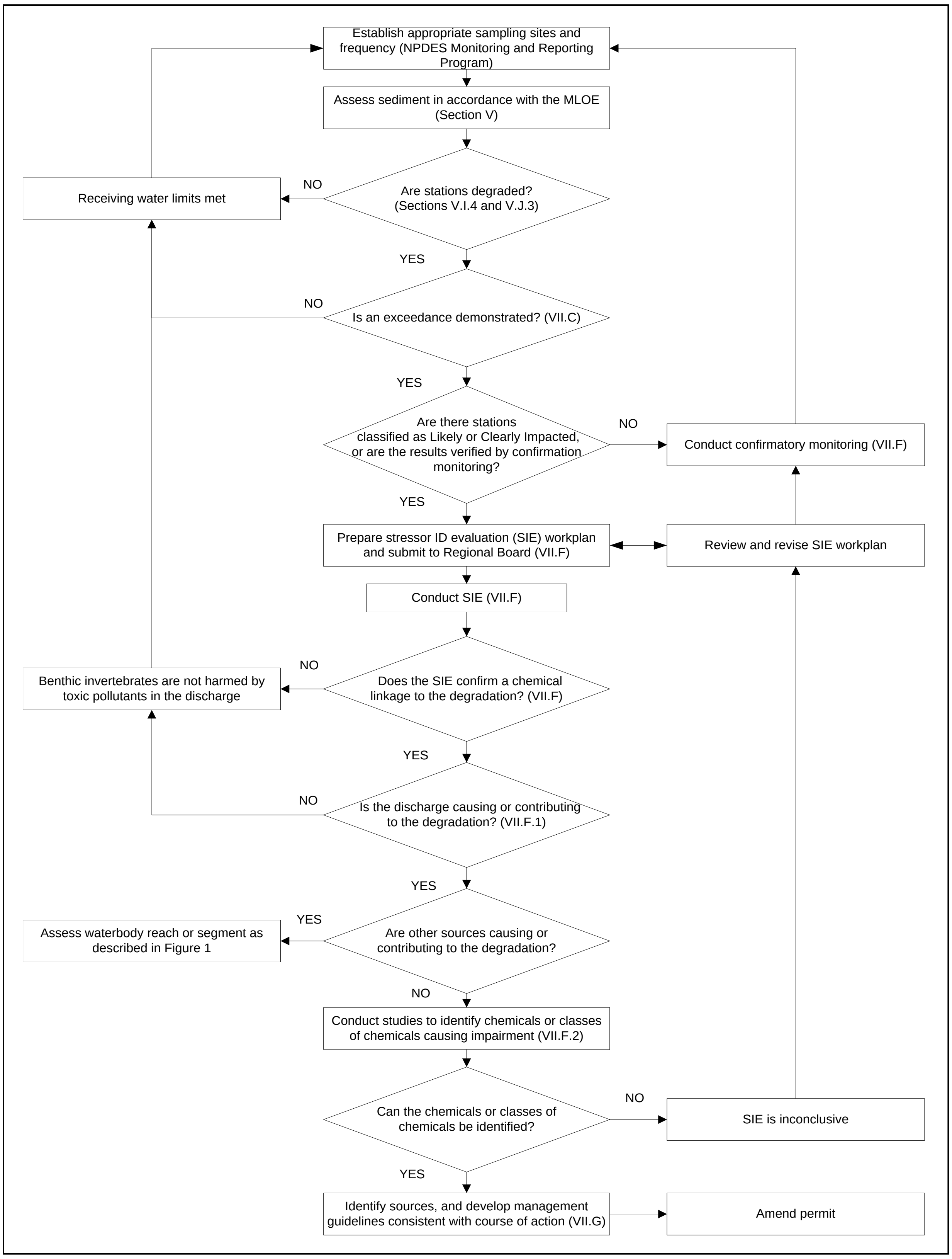
Appendix G. Flow Charts and Schematics

Exhibit G-1. Waterbody Assessment Process



Source: SWRCB (2011)

Exhibit G-2. Point Source Assessment Process



Source: SWRCB (2011)

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