Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California

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STATE OF CALIFORNIA
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2014

Amendments to the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California

Amendment	Date of Adoption	Resolution Number	Effective Date
Sediment Quality Objectives	February 19, 2008	2008-0070	August 25, 2009
Toxicity Water Quality Objectives			

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I. INTRODUCTION AND RELATIONSHIP TO OTHER WATER QUALITY CONTROL PLANS

This Water Quality Control Plan for INLAND SURFACE WATERS, ENCLOSED BAYS, and ESTUARIES of California (Plan) establishes provisions for water quality and sediment quality that apply to all inland surface waters, enclosed bays, and estuaries of the state, including both waters of the United States and surface waters of the state. These provisions do not apply to ocean waters, including Monterey Bay and Santa Monica Bay. All terms in capital letters are defined in Appendix A.

In accordance with Water Code section 13170, except where otherwise noted, this Plan supersedes any Regional Water Quality Control Plans (Basin Plans) for the same waters to the extent of any conflict.

II. BENEFICIAL USES

Water body-specific beneficial use designations contained in the Basin Plans and other state-wide plans, including future amendments to those plans, are incorporated by reference into this Plan.

III. WATER QUALITY OBJECTIVES

A. Toxicity

1. Applicable Beneficial Uses

The following numeric water quality objectives for chronic and acute TOXICITY establish minimum requirements to protect AQUATIC LIFE beneficial uses including, but not limited to, warm freshwater habitat (WARM), cold freshwater habitat (COLD), WILDLIFE habitat (WILD), estuarine habitat (EST), commercial and sport fishing (COMM), marine habitat (MAR), inland saline water habitat (SAL), and wetland habitat (WET).

2. Toxicity Water Quality Objectives

The toxicity water quality objectives provided in this chapter apply to all inland surface waters, enclosed bays, and estuaries of the state. The toxicity water quality objectives do not supersede narrative toxicity water quality objectives in the Basin Plans.

As with all water quality objectives, these objectives apply to the quality of the receiving water, not the effluent. Therefore, the water quality objectives are not to be directly applied as effluent limits unless the INSTREAM WASTE CONCENTRATION (IWC) equals 100 percent.

Chronic Toxicity
The chronic toxicity water quality objective is expressed as a NULL HYPOTHESIS and a REGULATORY MANAGEMENT DECISION (RMD) of 0.75, where the following null hypothesis shall be used:

H_o: Mean RESPONSE (ambient receiving water) ≤ 0.75 • mean response (control)

Attainment of the water quality objective is demonstrated by rejecting this null hypothesis in accordance with the statistical approach described in Chapter IV., Section A.4.

Acute Toxicity
The acute toxicity water quality objective is expressed as a null hypothesis and an RMD of 0.80, where the following null hypothesis shall be used:

H_o: Mean response (ambient receiving water) ≤ 0.80 • mean response (control)

Attainment of the water quality objective is demonstrated by rejecting this null hypothesis in accordance with the statistical approach described in Chapter IV., Section A.4.

3. Interaction with Regional Water Quality Control Plans

The toxicity provisions in Section A. of this chapter, and Section A. of Chapter IV. supersede Basin Plan toxicity provisions to the extent that:

1) The Basin Plan provisions apply to the implementation of water quality objectives for acute and chronic toxicity, and

2) The Basin Plan provisions regard toxicity testing and/or interpretation of toxicity results.

The toxicity provisions in Section A. of this chapter, and Section A. of Chapter IV. do not supersede the narrative toxicity water quality objectives or site-specific toxicity water quality objectives established in the Basin Plans.

The toxicity provisions in Section A of this Chapter, and Section A. of Chapter IV. do not supersede any Total Maximum Daily Loads, including their implementation provisions, adopted by a Regional Water Board prior to the effective date of these toxicity provisions.

IV. IMPLEMENTATION OF WATER QUALITY OBJECTIVES

A. Toxicity

Implementation procedures for NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) WASTEWATER DISCHARGERS and POINT SOURCE WASTE DISCHARGE REQUIREMENTS (WDR) DISCHARGERS are contained in Section A.1. of this chapter. Implementation procedures for storm water dischargers regulated pursuant to NPDES permits are contained in Section A.2. of this chapter. Implementation procedures for nonpoint source dischargers required to monitor toxicity are contained in Section A.3. of this chapter.

1. NPDES Wastewater Dischargers and Point Source WDR Dischargers

a. Reasonable Potential Analyses and Species Sensitivity Screening

Except as otherwise provided in Section A.1., subsection f. of this chapter, and excluding publicly owned or privately owned wastewater treatment facilities that are authorized to discharge at a rate equal to or greater than five million gallons per day (MGD), all NPDES wastewater dischargers and point source WDR dischargers shall conduct a REASONABLE POTENTIAL analysis for chronic toxicity, pursuant to the procedures established in this section, to determine if their waste discharge has the reasonable potential to cause or contribute to an excursion above the toxicity water quality objectives established in Section A.2. of Chapter III. A reasonable potential analysis shall be conducted prior to every permit issuance, reissuance, or reopening (to address toxicity requirements) that occurs after the effective date of these toxicity provisions. The PERMITTING AUTHORITY may also require NPDES wastewater dischargers and point source WDR dischargers to conduct reasonable potential analyses for acute toxicity. Reasonable potential analyses for acute toxicity are not recommended for wastewater treatment facilities. If, however, the Permitting Authority determines that a reasonable potential analysis for acute toxicity is necessary, this decision must be substantiated in the NPDES fact sheet or WDR information sheet (or equivalent document).

In accordance with Code of Federal Regulations, title 40, section 122.44(d)(1)(i) (48 FR 14153, Apr. 1, 1983), the State Water Board has determined that wastewater treatment facilities that are authorized to discharge at a rate equal to or greater than five MGD have reasonable potential to cause or contribute to an excursion above the toxicity water quality objectives established in Section A.2. of Chapter III. Accordingly, the Permitting Authority shall ensure that these wastewater treatment facilities use the procedures of this subsection only to identify or confirm the most sensitive test species for routine monitoring use.

Test method selection is determined by salinity and tier classification (refer to Table 1 in Section A.4. of this chapter). Freshwater test methods shall be used for receiving waters with salinity less than 1,000 milligrams per liter (mg/L), and marine test methods shall be used for receiving waters with salinity equal to or greater than 1,000 mg/L. However, NPDES wastewater dischargers and point source WDR dischargers that discharge freshwater effluent to marine waters may use freshwater test methods as determined by the Permitting Authority. Tier I test species are preferred for marine test methods, but the Permitting Authority may allow the use of Tier II test species for marine test methods if Tier I species are not available.

At a minimum, reasonable potential analyses and species sensitivity screenings for chronic toxicity shall include one vertebrate, one invertebrate and one aquatic plant. If the Permitting Authority requires a reasonable potential analysis/species sensitivity screening for acute toxicity, one vertebrate and one invertebrate shall be used. A minimum of four single-concentration toxicity tests utilizing the IWC and control shall be performed for each test species used. Reasonable potential analyses shall be conducted over a time span that is representative of the discharge. Toxicity tests conducted during species sensitivity screenings shall be done so concurrently, or with discharge samples collected at the same time, or during overlapping times.

Test results shall be calculated using the TEST OF SIGNIFICANT TOXICITY (TST), as described in Section A.4. of this chapter. Toxicity test data generated during a permit

term active on or after the effective date of these toxicity provisions, or any valid data submitted for permit renewal may be used for reasonable potential analyses/species sensitivity screening, provided that the data meet all of the requirements established in this section. Reasonable potential is demonstrated if the effluent, at the IWC, produces a test result of "fail" as described in Section A.1., subsection e.(2) of this chapter. Toxicity test data that produce a test result of "pass" shall be further evaluated by the NPDES wastewater discharger or point source WDR discharger to determine both reasonable potential and the single most sensitive test species for use in routine monitoring. This evaluation shall be carried out by calculating the PERCENT EFFECT at the IWC (step 6 in Section A.4.).

Based upon the foregoing, a wastewater discharge has reasonable potential to cause or contribute to an excursion above the toxicity water quality objectives established in Section A.2. of Chapter III. if any of the four tests result in a "fail" or if any of the four tests produces an effect at the IWC greater than 10 percent. A wastewater discharge does not have reasonable potential to cause or contribute to an excursion above the toxicity water quality objectives established in Section A.2. of Chapter III. if the IWC passes each toxicity test and exhibits an effect at or below 10 percent.

b. Effluent Limitations in Permits

If reasonable potential is demonstrated for chronic toxicity, in accordance with the provisions established in Section A.1., subsection a. of this chapter, the Permitting Authority shall include a narrative MAXIMUM DAILY EFFLUENT LIMITATION (MDEL) and a numeric MEDIAN MONTHLY EFFLUENT LIMITATION (MMEL) for chronic toxicity, in accordance with Code of Federal Regulations, title 40, section 122.45, subsections (d)(1)-(2) (as amended at 65 FR 30909, May 15, 2000), in any NPDES wastewater permit or point source WDR issued, reissued, or reopened (to address toxicity requirements) after the effective date of these toxicity provisions. The Permitting Authority shall also include an MDEL and MMEL for chronic toxicity in any NPDES wastewater permit or point source WDR issued, reissued, or reopened (to address toxicity requirements) for wastewater treatment facilities that are authorized to discharge at a rate equal to or greater than five MGD. MDELs and MMELs are not required for NPDES wastewater dischargers or point source WDR dischargers that discharge at a rate less than five MGD if reasonable potential is not demonstrated. If reasonable potential is demonstrated for acute toxicity, in accordance with the discretionary provisions established in Section A.1., subsection a. of this chapter, an MDEL and an MMEL for acute toxicity shall be included in the NPDES wastewater permit or point source WDR, and the Permitting Authority shall document the need for these acute limitations in the NPDES fact sheet or WDR information sheet (or equivalent document).

The MDEL for chronic and acute toxicity shall be expressed as the outcome of the TST approach and the resulting percent effect. The MMEL for chronic and acute toxicity shall be expressed as the median result of a maximum of three independent toxicity tests completed no later than 20 days from the date of the initial toxicity test result of "fail." Compliance with the MDEL and MMEL shall be determined using the TST approach, as described in Section A.4. of this chapter.

Appropriate monitoring frequencies for chronic toxicity are established in Section A.1., subsection d.(1) of this chapter. MIXING ZONES and dilution credits, as determined by the applicable Regional Water Board per conditions specified in section 1.4.2 in the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and

Estuaries of California (State Implementation Policy), may be applied to these numeric effluent limitations.

c. Test Methods

NPDES wastewater dischargers and point source WDR dischargers shall use the test species in Table 1 in Section A.4. of this chapter, and shall follow the methods for CHRONIC TOXICITY TESTS as established in the following United States Environmental Protection Agency (U.S. EPA) method manuals: Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, Fourth Edition (EPA-821-R-02-013); Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms, Third Edition (EPA-821-R-02-014); and Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms, First Edition (EPA-600-R-95-136). Dischargers required to monitor acute toxicity shall follow the ACUTE TOXICITY TEST methods established in Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition (EPA-821-R-02-012). A two-concentration test design shall be used for all toxicity monitoring required under Sections A.1.-3. of this chapter. For the acute *Pimephales promelas*, *Oncorhynchus mykiss*, *Cyprinodon variegatus*, and *Menidia beryllina* toxicity test methods, a minimum of four replicate chambers shall be used for all toxicity monitoring required under Sections A.1.-3. of this chapter.

d. Routine Monitoring

NPDES wastewater dischargers and point source WDR dischargers that demonstrate reasonable potential, as determined in Section A.1., subsection a. of this chapter, and wastewater treatment facilities that are authorized to discharge at a rate equal to or greater than five MGD are required to conduct routine chronic toxicity monitoring at a frequency no less than that established in Section A.1., subsection d.(1) of this chapter in order to determine compliance with the MDEL and MMEL. If the Permitting Authority determines that a discharger demonstrates reasonable for acute toxicity, and that monitoring solely for chronic toxicity will not be sufficiently protective, the discharger shall conduct routine acute toxicity monitoring in addition to chronic toxicity monitoring. The single test species (vertebrate, invertebrate, or aquatic plant) that exhibits the highest percent effect at the IWC during a reasonable potential analysis/species sensitivity screening (i.e. the most sensitive species) shall be utilized for routine monitoring during the permit cycle. Routine toxicity test design shall, at a minimum, include a single-concentration analysis of the IWC compared to a control. In the absence of reasonable potential, the Permitting Authority has the discretion to require NPDES wastewater dischargers and point source WDR dischargers to conduct periodic monitoring for chronic or acute toxicity. The rationale for requiring toxicity monitoring, absent reasonable potential, must be documented in the NPDES fact sheet or WDR information sheet (or equivalent document).

(1) Monitoring Frequency

CONTINUOUS NPDES WASTEWATER DISCHARGERS AND POINT SOURCE WDR DISCHARGERS that are authorized to discharge at a rate equal to or greater than five MGD shall initiate one chronic toxicity test every calendar month for the duration of the permit. NON-CONTINUOUS NPDES WASTEWATER DISCHARGERS AND POINT SOURCE WDR DISCHARGERS that are authorized to discharge at a rate equal to or greater than five MGD shall initiate one chronic toxicity test, every calendar month during which a period of discharge lasts 15 or more days, for the duration of the permit. If

required, acute toxicity monitoring shall be conducted at intervals determined by the Permitting Authority for these dischargers.

Continuous NPDES wastewater dischargers and point source WDR dischargers that are authorized to discharge at a rate less than five MGD shall conduct one chronic toxicity test each CALENDAR QUARTER (e.g. January–March, April–June, etc.), for the duration of the permit. Non-continuous NPDES wastewater dischargers and point source WDR dischargers that are authorized to discharge at a rate less than five MGD shall conduct one chronic toxicity test, every calendar quarter during which a period of discharges lasts 15 or more days, for the duration of the permit. If required, acute toxicity monitoring shall be conducted at intervals determined by the Permitting Authority for these dischargers.

The Permitting Authority shall have the discretion to require continuous and non-continuous NPDES wastewater dischargers and point source WDR dischargers to conduct more chronic or acute toxicity monitoring than that which is prescribed in this subsection. The rationale for requiring additional toxicity monitoring must be documented in the NPDES fact sheet or WDR information sheet (or equivalent document).

Wastewater treatment facilities authorized to discharge at a rate equal to or greater than five MGD, on either a continuous or non-continuous basis, are eligible to reduce their monitoring frequency to one chronic toxicity test per calendar quarter. The Permitting Authority will have the discretion to grant this chronic toxicity monitoring reduction to eligible wastewater treatment facilities upon reissuance of an NPDES wastewater permit or point source WDR, provided that in the prior 10 consecutive years:

a) Neither the MDEL nor MMEL has not been exceeded;

b) A procedural violation has not accrued;

c) A treatment process change or facility upgrade has not occurred; and,

d) An additional industrial discharger has not been added to an approved wastewater treatment facility Pretreatment Program, as defined in Code of Federal Regulations, title 40, section 403.3(d) (as amended 70 FR 60191, Oct. 14, 2005).

Pursuant to Code of Federal Regulations, title 40, section 122.63(b) (as amended 73 FR 70485, Nov. 20, 2008), the Permitting Authority shall require eligible wastewater treatment facilities to return to a routine monitoring schedule, consisting of one chronic toxicity test per month, if the requirements listed above are not met. Upon returning to a monthly chronic toxicity monitoring schedule, eligible wastewater treatment facilities will need to, once again, meet the requirements listed above in order to be granted another discretionary chronic toxicity monitoring reduction.

e. Compliance Determination

NPDES wastewater dischargers and point source WDR dischargers shall report the results of reasonable potential analyses, species sensitivity screenings, routine toxicity tests, and toxicity tests conducted during an accelerated monitoring schedule to the Permitting Authority as either a “pass” or a “fail” at the IWC, and provide the calculated percent effect at the IWC in accordance with the TST approach (refer to Appendix B for examples of compliance determination).

(1) Pass

A test result indicating a "pass" is interpreted as meeting the MDEL and MMEL. If a test results in a "pass," dischargers shall continue routine monitoring in accordance with the provisions of Section A.1., subsection d.(1) of this chapter.

(2) Fail

A chronic toxicity test result indicating a "fail" with a percent effect at or above 50 percent is an exceedance of the chronic MDEL. An acute toxicity test result indicating a "fail" and a percent effect at or above 40 percent is an exceedance of the acute MDEL. Exceeding either MDEL requires the implementation of an accelerated monitoring schedule.

If a routine toxicity test results in a "fail," but the percent effect is below the MDEL, the discharger shall initiate a maximum of two additional toxicity tests in order to determine compliance with the MMEL. The first additional test must be completed within 10 days of the initial toxicity test result of "fail," and the second additional test must be completed within 10 days of the first additional toxicity test result of "pass." If the first of these two additional tests results in a "fail," the second additional test is waived as the median monthly result is "fail" and the MMEL is exceeded. If the first of these two additional tests results in "pass," the discharger shall conduct the second additional test to determine compliance with the MMEL. Exceeding an MMEL will result in a violation and will require the implementation of an accelerated monitoring schedule for continuous dischargers, in accordance with the provisions of Section A.1., subsection e.(3) of this chapter. The Permitting Authority shall determine the necessary actions for non-continuous dischargers that fail a verification toxicity test or exceed an MMEL.

(3) Accelerated Monitoring

Continuous discharger NPDES wastewater permits and point source WDRs issued, reissued, or reopened (to address toxicity requirements) after the effective date of these toxicity provisions shall include an accelerated monitoring schedule to be implemented following an exceedance of a chronic or acute MDEL or MMEL. Continuous NPDES wastewater dischargers and point source WDR dischargers with both chronic and acute effluent limitations shall conduct accelerated monitoring using chronic toxicity tests if both the chronic and acute effluent limitations are exceeded.

An accelerated monitoring schedule shall be implemented within seven days of the exceedance and shall be concluded within 45 days of the exceedance and shall consist of three toxicity tests completed in 10-day intervals. If an exceedance of an MDEL triggers an accelerated monitoring schedule, an exceedance of the MMEL can occur if a subsequent accelerated toxicity test, conducted within the same calendar month as the exceedance, also results in a "fail."

A test that results in a "fail" during accelerated monitoring will require initiation of a TOXICITY REDUCTION EVALUATION (TRE), as described in Section A.1., subsection e.(4) of this chapter. If a test result of "fail" occurs before the three chronic toxicity tests required in an accelerated monitoring schedule have been completed, the remaining tests shall be waived and a TRE shall be initiated. If no test results in a "fail," the discharger shall return to their routine monitoring schedule as identified in Section A.1., subsection d.(1) of this chapter.

(4) Toxicity Reduction Evaluation

Any toxicity test conducted by a continuous NPDES wastewater discharger or point source WDR discharger during accelerated monitoring that results in a "fail," will be required to conduct a TRE. A discharger shall conduct a TRE in accordance with a TRE Work Plan developed pursuant to the requirements of the Permitting Authority. When TREs are required of multiple facilities that discharge to the same water body, the facilities may coordinate the TREs with the approval of the Permitting Authority. Dischargers shall discontinue their accelerated monitoring schedule and conduct a maximum of three toxicity tests each month in accordance with the provisions of Section A.1., subsection d. of this chapter, for the duration of the TRE. The Permitting Authority shall determine when non-continuous dischargers must submit and implement a TRE Work Plan. NPDES wastewater dischargers and point source WDR dischargers are required to take all reasonable steps to control toxicity once the source of the toxicity is identified and to complete the TRE as soon as practicable.

(5) Violations

Any exceedance of an MMEL is a violation. An exceedance of an MDEL shall not constitute a violation.

Any toxicity test that results in a "fail" at the IWC (at any percent effect) during an accelerated monitoring schedule initiated after an exceedance of the MMEL, or during a TRE, will not constitute additional violations, provided that:

a) The discharger proceeds with accelerated monitoring and a TRE (if required) in a timely manner; and

b) The discharger completes the TRE (if required) within six months from the date of TRE initiation, or demonstrates, to the Permitting Authority's satisfaction, that additional time to complete the TRE is necessary.

Additionally, a discharger's failure to initiate an accelerated monitoring schedule or conduct a TRE, as required by an NPDES wastewater permit or point source WDR, will result in all exceedances being considered violations of the MMEL and may also result in the initiation of an enforcement action.

f. Exceptions

(1) Small Disadvantaged Communities

The Water Boards are authorized to exempt PUBLICLY OWNED TREATMENT WORKS (POTW) only serving SMALL DISADVANTAGED COMMUNITIES from some or all of the provisions of Section A.1. of this chapter if the Permitting Authority makes a finding that the discharge will have no reasonable potential to cause or contribute to an exceedance of the toxicity water quality objectives. Regardless of exemption status, POTWs only serving small disadvantaged communities must comply with the toxicity water quality objectives established in Chapter III., Section A.2, and the Permitting Authority will have the discretion to assign routine monitoring and mitigation measures as necessary. Routine monitoring schedules for POTWs only serving small disadvantaged communities shall not exceed the applicable frequency established in Section A.1., subsection d.(1) for the facility's authorized rate of discharge.

(2) Insignificant Discharges

The Water Boards are authorized to exempt certain NPDES wastewater discharges and point source WDR discharges from some or all of the provisions of Section A.1. of this chapter if the Permitting Authority makes a finding that the discharge will have no reasonable potential to cause or contribute to an exceedance of the toxicity water quality objectives. To be eligible for the INSIGNIFICANT DISCHARGE exception, dischargers must discharge less than one MGD on a non-continuous basis. Insignificant discharges must comply with the toxicity water quality objectives established in Chapter III., Section A.2, and the Permitting Authority will have the discretion to assign routine monitoring and mitigation measures as necessary. Routine monitoring for insignificant discharges shall not exceed one toxicity test per calendar quarter.

(3) Categorical Exceptions

The Permitting Authority may, after compliance with the CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA), allow short-term or seasonal exceptions from meeting the toxicity water quality objectives established in Section A.2 of Chapter III., and the provisions established in Section A.1. of this chapter if it is determined to be necessary in order to implement control measures either:

a) For resources or pest management (e.g. vector or weed control, pest eradication, or fishery management) conducted by public entities or mutual water companies to fulfill statutory requirements including, but not limited to, those in the California Fish and Game, Food and Agriculture, Health and Safety, and Harbors and Navigation codes; or

b) Regarding drinking water conducted to fulfill statutory requirements under the federal Safe Drinking Water Act or the California Health and Safety Code. Such categorical exceptions may also be granted for draining water supply reservoirs, canals, and pipelines for maintenance; draining municipal storm water conveyances for cleaning or maintenance; or draining water treatment facilities for cleaning or maintenance.

For each project in either category, the discharger shall notify potentially affected public and governmental agencies. Also, the discharger shall submit to the Executive Officer or Executive Director of the Permitting Authority for approval:

a) A detailed description of the proposed action, including the proposed method of completing the action;

b) A time schedule;

c) A discharge and receiving water quality monitoring plan (before project initiation, during the project, and after project completion, with the appropriate quality assurance and quality control procedures);

d) CEQA documentation;

e) Contingency plans;

f) Identification of alternate water supply (if needed); and

g) Residual waste disposal plans.

Additionally, upon completion of a project, the discharger shall provide certification by a qualified biologist that the receiving water beneficial uses have been restored. To prevent unnecessary delays in taking emergency actions or to expedite the approval process for expected or routine activities that fall under categorical exceptions, the discharger should submit to the Executive Officer of the Permitting Authority, in advance of seeking approval, the required documentation to the extent possible.

(4) Case-By-Case Exceptions

Where site-specific conditions in individual water bodies or watersheds differ sufficiently from statewide conditions and those differences cannot be addressed through other provisions of this Plan, the State Water Board may, in compliance with CEQA, subsequent to a public hearing, and with the concurrence of the U.S. EPA, grant an exception to meeting the toxicity water quality objectives established in Chapter III., Section A.2, and the provisions established in Section A.1. of this chapter where the State Water Board determines:

a) The exception will not compromise protection of enclosed bay, estuarine, and/or inland surface waters for aquatic life beneficial uses; and

b) The public interest will be served.

(5) Flow-Through Acute Toxicity Testing Systems

For industrial NPDES wastewater dischargers that are required to conduct weekly ACUTE FLOW-THROUGH TOXICITY TESTING prior to the effective date of these toxicity provisions, the Permitting Authority may require alternative approaches to the provisions established in Section A.1., subsections a.-e. of this chapter as they apply to acute toxicity. Flow-through acute toxicity testing systems constructed after the effective date of these toxicity provisions shall be designed to facilitate TST analyses. These industrial NPDES wastewater dischargers must still comply with the toxicity water quality objectives established in Chapter III., Section A.2. and all chronic toxicity testing provisions established in this chapter.

2. Storm Water Dischargers Regulated Pursuant to NPDES Permits

This section applies to storm water dischargers regulated under general and individual NPDES storm water discharge permits.

Within one year of the effective date of these toxicity provisions, the Permitting Authority shall issue Water Code section 13383 letters to storm water dischargers with existing toxicity monitoring requirements. These section 13383 letters shall require all toxicity data collected within one year from the date of the letter to be analyzed using the TST approach, as described in Section A.4. of this chapter.

If, after the effective date of these toxicity provisions, the Permitting Authority requires toxicity monitoring within new or reissued general or individual NPDES storm water permits, then the Permitting Authority shall also require the use of the TST approach for toxicity data analyses.

Results obtained from toxicity tests shall be reported to the Permitting Authority as either a "pass" or a "fail." Dischargers that lack toxicity monitoring requirements in their general or

individual NPDES storm water discharge permit shall be exempt from the provisions of this section.

3. Nonpoint Source Dischargers Required to Monitor Toxicity

This section applies to nonpoint source discharging entities in California required to monitor toxicity under existing WDRs, Conditional Waivers of WDRs, or Conditional Prohibitions.

Within one year of the effective date of these toxicity provisions, the Permitting Authority shall issue Water Code section 13267 letters to all nonpoint source dischargers identified under this section. These section 13267 letters shall require all toxicity data collected within one year from the date of the letter to be analyzed using the TST approach, as described in Section A.4. of this chapter.

If, after the effective date of these toxicity provisions, the Permitting Authority requires toxicity monitoring within a new or reissued WDR, Conditional Waiver of WDR, or Conditional Prohibition, then the Permitting Authority shall also require the use of the TST approach for toxicity data analyses.

4. Statistical Method

Results obtained from single-concentration chronic and acute toxicity tests shall be analyzed using the TST approach.

For each test endpoint, follow Steps 1 through 6.

Step 1: Prior to analysis: if the measured response is reported as a percentage (e.g. percent survival, percent fertilization) it must be transformed using the arc sine square root transformation below. If the measured response is not reported as a percentage, skip Step 1 and proceed to Step 2.

Calculate the response proportion (RP) for each REPLICATE:

$$RP = \frac{\text{Number of Surviving or Unaffected Organisms}}{\text{Number Exposed}}$$

Transform each RP to arc sine based on the following scenarios:

For $0 < RP < 1$

Angle (in radians) = arc sine $\sqrt{(RP)}$

For RP = 0

Angle (in radians) = arc sine $\sqrt{1/4n}$
Where n = number of organisms used for each replicate

For RP = 1

Angle = 1.5708 rad – (radians for RP = 0)

Step 2: Conduct Welch's t-test using the following equation:

$$t = \frac{\overline{Y}_t - b \bullet \overline{Y}_c}{\sqrt{\frac{S_t^{\,2}}{n_t} + \frac{b^2 S_c^{\,2}}{n_c}}}$$

where:

$\overline{Y}_c$	=	Mean response for the control
$\overline{Y}_t$	=	Mean response for the IWC
S_c^2	=	Estimate of the variance for the control
S_t^2	=	Estimate of the variance for the IWC
n_c	=	Number of replicates for the control
n_t	=	Number of replicates for the IWC
b	=	0.75 for chronic tests; 0.80 for acute tests

Step 3: Adjust the degrees of freedom, v, using the following equation:

$$v = \frac{\left(\frac{S_t^{\,2}}{n_t} + \frac{b^2 S_c^{\,2}}{n_c}\right)^2}{\frac{\left(\frac{S_t^{\,2}}{n_t}\right)^2}{n_t - 1} + \frac{\left(\frac{b^2 S_c^{\,2}}{n_c}\right)^2}{n_c - 1}}$$

For tests using Welch's t-test, the degrees of freedom are obtained from v in the equation above. Since v is most likely a non-integer, round v to the next lowest integer. Note: if the variance is zero for both the control and the IWC or ambient water, then go to Step 6.

Step 4: Using the calculated t-value from Step 2, compare the calculated t-value with the critical t-value in Table 2 using the test method-specific alpha (α) values shown in Table 1. To obtain the critical t-value, look across the table for the α error value that corresponds to the toxicity test method and then look down the table for the appropriate degrees of freedom.

Step 5: If the calculated t-value is less than the critical t-value, the test result is a "fail" at the IWC. If the calculated t-value is greater than the critical t-value, the result is a "pass" at the IWC.

Step 6: Calculate the percent effect at the IWC using untransformed data and the following equation:

$$\%\,\text{Effect at IWC} = \frac{\text{Mean Control Response} - \text{Mean IWC Response}}{\text{Mean Control Response}} \bullet 100$$

Note:

a) If the variance is zero for both the control and IWC or ambient water, then the percent effect in the IWC treatment is compared directly with the RMD for unacceptable toxicity (20% effect for acute and 25% effect for chronic tests). If the percent effect is less than the RMD, then the test result is a "pass." If not, then the test result is a "fail."

b) Adding test replicates can increase test power to a level necessary to reject the null hypothesis of the TST.

Table 1. Summary of alpha (α) levels for toxicity test methods.

EPA Toxicity Test Method	*b* Value	Tier	False Negative (α Error)
Chronic Freshwater Methods			
Ceriodaphnia dubia (water flea) survival and reproduction	0.75	I	0.20
Pimephales promelas (fathead minnow) survival and growth	0.75	I	0.25
Selenastrum capricornutum (green alga) growth	0.75	I	0.25
Chronic West Coast Marine Methods			
Atherinops affinis (topsmelt) survival and growth	0.75	I	0.25
Dendraster excentricus (sand dollar); ***Strongylocentrotus purpuratus*** (purple urchin) fertilization	0.75	I	0.05
Dendraster excentricus (sand dollar); ***Strongylocentrotus purpuratus*** (purple urchin) larval development	0.75	I	0.05
Haliotis rufescens (red abalone) larval development	0.75	I	0.05
Mytilus sp. (mussels); ***Crassostrea gigas*** (oyster) larval development	0.75	I	0.05
Macrocystis pyrifera (giant kelp) germination and germ-tube length	0.75	I	0.05
Chronic East Coast Marine Methods			
Menidia beryllina (inland silverside) survival and growth	0.75	II	0.25
Americamysis bahia (mysid) survival and growth	0.75	II	0.15
Acute Freshwater Methods			
Ceriodaphnia dubia (water flea); ***Daphnia magna*** (water flea); ***Daphnia pulex*** (water flea); ***Hyalella azteca*** (amphipod) survival	0.80	I	0.10
Pimephales promelas (fathead minnow); ***Oncorhynchus mykiss*** (rainbow trout); ***Salvelinus fontinalis*** (brook trout) survival	0.80	I	0.10
Acute Marine Methods			
Atherinops affinis (topsmelt) survival	0.80	I	0.10
Americamysis bahia (mysid) survival	0.80	II	0.10
Menidia beryllina (inland silverside) survival	0.80	II	0.10

Note:

a) The false positive rate (β error) is 0.05 for all test methods

b) The *Ceriodaphnia dubia* chronic toxicity test design for the survival endpoint is not amenable to a Welch's t-test so the survival endpoint will be determined as a percent effect using the TST approach. A percent effect less than 25 percent will be

considered a "pass," and a percent effect equal to or greater than 25 percent will be considered a "fail."

c) For acute toxicity test methods, the test result will be considered a "pass," regardless of a TST determination of "fail" if the percent survival in the IWC is equal to or greater than 90 percent.

Table 2. Critical values of the t-distribution; one tail probability is assumed.

α Error					
Degrees of Freedom (v)	**0.25**	**0.20**	**0.15**	**0.10**	**0.05**
1	1	1.3764	1.9626	3.0777	6.3138
2	0.8165	1.0607	1.3862	1.8856	2.92
3	0.7649	0.9785	1.2498	1.6377	2.3534
4	0.7407	0.941	1.1896	1.5332	2.1318
5	0.7267	0.9195	1.1558	1.4759	2.015
6	0.7176	0.9057	1.1342	1.4398	1.9432
7	0.7111	0.896	1.1192	1.4149	1.8946
8	0.7064	0.8889	1.1081	1.3968	1.8595
9	0.7027	0.8834	1.0997	1.383	1.8331
10	0.6998	0.8791	1.0931	1.3722	1.8125
11	0.6974	0.8755	1.0877	1.3634	1.7959
12	0.6955	0.8726	1.0832	1.3562	1.7823
13	0.6938	0.8702	1.0795	1.3502	1.7709
14	0.6924	0.8681	1.0763	1.345	1.7613
15	0.6912	0.8662	1.0735	1.3406	1.7531
16	0.6901	0.8647	1.0711	1.3368	1.7459
17	0.6892	0.8633	1.069	1.3334	1.7396
18	0.6884	0.862	1.0672	1.3304	1.7341
19	0.6876	0.861	1.0655	1.3277	1.7291
20	0.687	0.86	1.064	1.3253	1.7247
21	0.6864	0.8591	1.0627	1.3232	1.7207
22	0.6858	0.8583	1.0614	1.3212	1.7171
23	0.6853	0.8575	1.0603	1.3195	1.7139
24	0.6849	0.8569	1.0593	1.3178	1.7109
25	0.6844	0.8562	1.0584	1.3163	1.7081
26	0.684	0.8557	1.0575	1.315	1.7056
27	0.6837	0.8551	1.0567	1.3137	1.7033
28	0.6834	0.8546	1.056	1.3125	1.7011
29	0.683	0.8542	1.0553	1.3114	1.6991
30	0.6828	0.8538	1.0547	1.3104	1.6973
inf	0.6745	0.8416	1.0364	1.2816	1.6449

Figure 1. Reasonable potential analysis for wastewater dischargers.

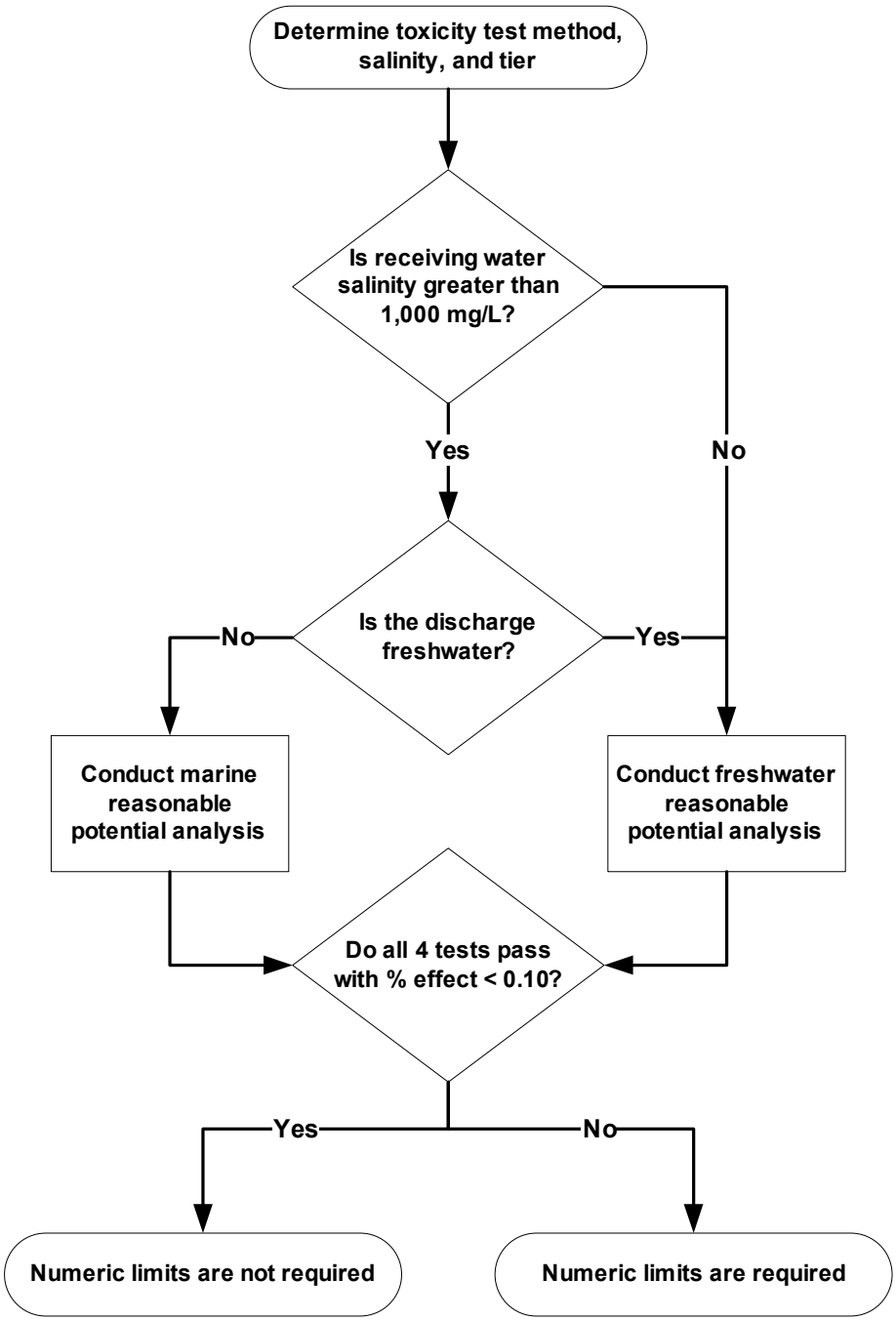
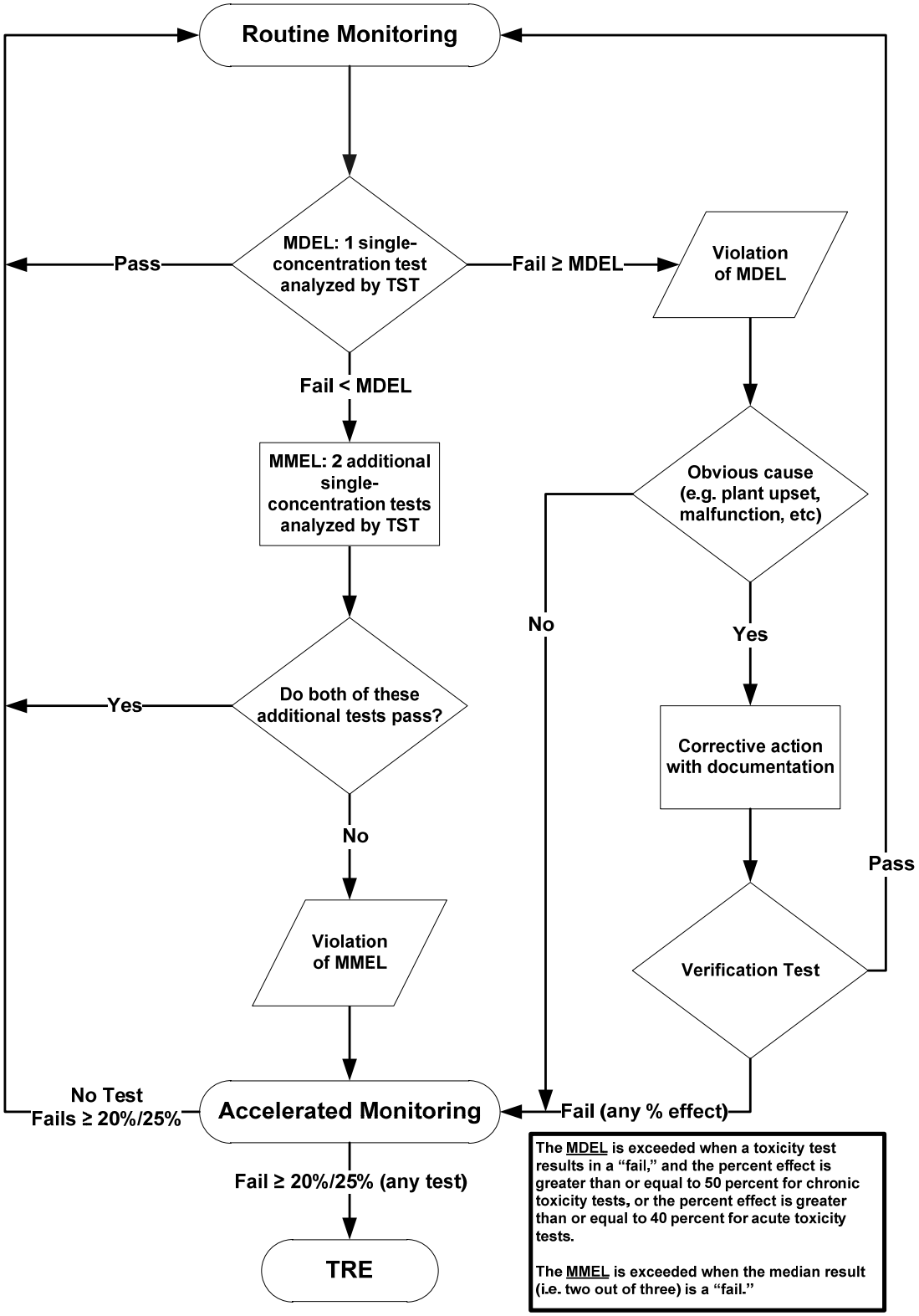


Figure 2. Compliance determination for wastewater dischargers.



V. SEDIMENT QUALITY OBJECTIVES AND IMPLEMENTATION

A. Intent and Summary

1. Intent of Chapter V.

It is the goal of the State Water Board to comply with the legislative directive in Water Code section 13393 to adopt sediment quality objectives (SQOs). This chapter 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 in order to protect BENTHIC communities in ENCLOSED BAYS and ESTUARIES, human health, WILDLIFE, and RESIDENT FINFISH. This chapter is not intended to address low dissolved oxygen, pathogens, or nutrients including ammonia. The State Water Board will continue to refine benthic community protection indicators for estuarine waters and improve the approach to address sediment quality-related human health risk associated with consumption of fish tissue.

2. Summary of Chapter V.

Chapter V. includes:

1) Narrative SQO for the protection of aquatic life.

2) Narrative SQO for the protection of human health.

3) Narrative SQO for the protection of wildlife and resident finfish.

4) Identification of the beneficial uses that these SQOs are intended to protect.

5) A program of implementation for each SQO that contains:

    a) Specific indicators, tools and implementation provisions to determine if the sediment quality at a station or multiple stations meets the narrative objectives;

    b) A description of appropriate monitoring programs; and

    c) A sequential series of actions that shall be initiated when an SQO is not met, including stressor identification and evaluation of appropriate targets.

B. Use and Applicability of SQOs

1. Ambient Sediment Quality

The SQOs and supporting tools shall be utilized to assess ambient sediment quality.

2. Relationship to other narrative objectives

1) Except as provided in paragraph 3 below, this chapter supersedes all applicable narrative water quality objectives and related implementation provisions in Basin Plans, to the extent that the objectives and provisions are applied to protect bay or estuarine benthic communities from toxic pollutants in sediments.

2) Except as provided in paragraph 3 below, this chapter also supersedes all applicable narrative water quality objectives and related implementation provisions in Basin Plans, to the extent that the objectives and provisions are applied to protect wildlife and resident finfish from toxic pollutants in sediments, unless the State Water Board approves amendments to a Basin Plan to incorporate new, more stringent narrative water quality objectives or implementation provisions.

3) The supersession provisions in paragraphs 1 and 2 above do not apply to existing sediment cleanup activities where a site assessment was completed and submitted to the Regional Water Board by February 19, 2008.

3. Applicable Waters

This chapter applies to enclosed bays and estuaries only. This chapter does not apply to OCEAN WATERS including Monterey Bay and Santa Monica Bay, or INLAND SURFACE WATERS.

4. Applicable Sediments

This chapter applies to subtidal SURFICIAL SEDIMENTS that have been deposited or emplaced seaward of the intertidal zone. This chapter does not apply to:

1) Sediments characterized by less than five percent of fines or substrates composed of gravels, cobbles, or consolidated rock.

2) Sediment as the physical pollutant that causes adverse biological response or community degradation related to burial, deposition, or sedimentation.

5. Applicable Discharges

This chapter is applicable in its entirety to POINT SOURCE discharges. NONPOINT SOURCES of toxic pollutants are subject to Sections B, C, D, E, and F of this chapter.

C. Beneficial Uses

Beneficial uses protected by this chapter and corresponding target receptors are identified in Table 3.

Table 3. Beneficial uses and target receptors.

Beneficial Uses	Target Receptors
Estuarine Habitat	Benthic Community/finfish/wildlife
Marine Habitat	Benthic Community/finfish/wildlife
Commercial and Sport Fishing	Human Health
Aquaculture	Human Health
Shellfish Harvesting	Human Health
Rare, Threatened, or Endangered Species	Finfish/Wildlife
Preservation of Biological Habitats of Special Significance	Finfish/Wildlife
Wildlife Habitat	Wildlife
Spawning Reproduction and Early Development	Finfish

D. Sediment Quality Objectives

1. 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 of California. This narrative objective shall be implemented using the integration of multiple lines of evidence (MLOE) as described in Section E of this chapter.

2. Human Health

Pollutants shall not be present in sediments at levels that will bioaccumulate in aquatic life to levels that are harmful to human health in bays and estuaries of California. This narrative objective shall be implemented as described in Section G.1. of this chapter.

3. 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. This narrative objective shall be implemented as described in Section G.2. of this chapter.

E. Implementation for Assessing Benthic Community Protection

1. MLOE Approach to Interpret the Narrative Objective

The methods and procedures described below shall be used to interpret the Narrative Objective described in Section D.1. These tools are intended to assess the condition of benthic communities relative to potential for exposure to toxic pollutants in sediments. Exposure to toxic pollutants at harmful levels will result in some combination of a degraded benthic community, presence of toxicity, and elevated concentrations of pollutants in sediment. The assessment of sediment quality shall consist of the measurement and integration of three lines of evidence (LOE). The LOE are:

1) Sediment Toxicity—Sediment toxicity is a measure of the response of invertebrates exposed to surficial sediments under controlled laboratory conditions. The sediment toxicity LOE is used to assess both pollutant-related biological effects and exposure. Sediment toxicity tests are of short durations and may not duplicate exposure conditions in natural systems. This LOE provides a measure of exposure to all pollutants present, including non-traditional or unmeasured chemicals.

2) Benthic Community Condition—Benthic community condition is a measure of the species composition, abundance, and diversity of the sediment-dwelling invertebrates inhabiting surficial sediments. The benthic community LOE is used to assess impacts to the primary receptors targeted for protection under Section D.1. Benthic community composition is a measure of the biological effects of both natural and anthropogenic stressors.

3) Sediment Chemistry—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.

2. Limitations

None of the individual LOE are sufficiently reliable when used alone to assess sediment quality impacts due to toxic pollutants. Within a given site, the LOEs applied to assess exposure as described in Section E.1. may underestimate or overestimate the risk to benthic communities and do not indicate causality of specific chemicals. The LOEs applied to assess biological effects can respond to stresses associated with natural or physical factors, such as sediment grain size, physical disturbance, or organic enrichment.

Each LOE produces specific information that, when integrated with the other LOEs, provides a more confident assessment of sediment quality relative to the narrative objective. When the exposure and effects tools are integrated, the approach can quantify protection through effect measures and also provide predictive capability through the exposure assessment.

3. Water Bodies

1) The tools described in Sections E.4. through E.9. are applicable to 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.

2) For all other bays and estuaries where LOE measurement tools are unavailable, station assessment will follow the procedure described in Section E.10.

4. Field Procedures

1) All samples shall be collected using a grab sampler.

2) Benthic samples shall be screened through:

   a) A 0.5 millimeter (mm)-mesh screen in San Francisco Bay and the Sacramento-San Joaquin Delta.

   b) A 1.0 mm-mesh screen in all other locations.

3) Surface sediment from within the upper 5 centimeter (cm) shall be collected for chemistry and toxicity analysis.

4) The entire contents of the grab sample, with a minimum penetration depth of 5 cm, shall be collected for benthic community analysis.

5) Bulk sediment chemical analysis will include at a minimum the pollutants identified in Table 18 (page ___).

5. Laboratory Testing

All samples will be tested in accordance with U.S. EPA or American Society for Testing and Materials (ASTM) methodologies where such methods exist. Where no U.S. EPA or ASTM methods exist, the State Water Board or Regional Water Boards shall approve the use of other methods. Analytical tests shall be conducted by laboratories certified by the California Department of Health Services in accordance with Water Code section 13176.

6. Sediment Toxicity

1) Short-Term Survival Tests—A minimum of one short-term survival test shall be performed on sediment collected from each station. Acceptable test organisms and methods are summarized in Table 4.

Table 4. Acceptable short term survival sediment toxicity test methods.

Test Organism	Exposure Type	Duration	ENDPOINT
Eohaustorius estuarius	Whole Sediment	10 days	Survival
Leptocheirus plumulosus	Whole Sediment	10 days	Survival
Rhepoxynius abronius	Whole Sediment	10 days	Survival

2) Sublethal Tests—A minimum of one sublethal test shall be performed on sediment collected from each station. Acceptable test organisms and methods are summarized in Table 5.

Table 5. Acceptable sublethal sediment toxicity test methods.

Test Organism	Exposure Type	Duration	Endpoint
Neanthes arenaceodentata	Whole Sediment	28 days	Growth
Mytilus galloprovincialis	Sediment-water Interface	48 hours	Embryo Development

3) Assessment of Sediment Toxicity—Each sediment toxicity test result shall be compared and categorized according to responses in Table 6. The response categories are:

a) Nontoxic—Response not substantially different from that expected in sediments that are uncontaminated and have optimum characteristics for the test species (e.g. control sediments).

b) Low Toxicity—A response that is of relatively low magnitude; the response may not be greater than test variability.

c) Moderate Toxicity—High confidence that a statistically significant toxic effect is present.

d) High Toxicity—High confidence that a toxic effect is present and the magnitude of response includes the strongest effects observed for the test.

Table 6. Sediment toxicity categorization values.

Test Species/ Endpoint	Statistical Significance	Nontoxic (Percent)	Low Toxicity (Percent of Control)	Moderate Toxicity (Percent of Control)	High Toxicity (Percent of Control)
Eohaustorius Survival	Significant	90 to 100	82 to 89	59 to 81	< 59
Eohaustorius Survival	Not Significant	82 to 100	59 to 81		<59
Leptocheirus Survival	Significant	90 to 100	78 to 89	56 to 77	<56
Leptocheirus Survival	Not Significant	78 to 100	56 to 77		<56
Rhepoxynius Survival	Significant	90 to 100	83 to 89	70 to 82	< 70
Rhepoxynius Survival	Not Significant	83 to 100	70 to 82		< 70
Neanthes Growth	Significant	90 to 100[1]	68 to 90	46 to 67	<46
Neanthes Growth	Not Significant	68 to 100	46 to 67		<46
Mytilus Normal	Significant	80 to 100	77 to 79	42 to 76	< 42
Mytilus Normal	Not Significant	77 to 79	42 to 76		< 42

[1] Expressed as a percentage of the control

4) Integration of sediment Toxicity Categories—The average of all test response categories shall determine the final toxicity LOE category. If the average falls midway between categories it shall be rounded up to the next higher response category.

7. Benthic Community Condition

1) General Requirements:

   a) All benthic invertebrates in the screened sample shall be identified to the lowest possible taxon and counted.

   b) Taxonomic nomenclature shall follow current conventions established by local monitoring programs and professional organizations (e.g. master species list).

2) Benthic Indices—The benthic condition shall be assessed using the following methods:

   a) Benthic Response Index (BRI), which was originally developed for the southern California mainland shelf and extended into California's bays and estuaries. The BRI is the abundance-weighted average POLLUTION tolerance score of organisms occurring in a sample.

   b) Index of Biotic Integrity (IBI), which was developed for freshwater streams and adapted for California's bays and estuaries. The IBI identifies community measures that have values outside a reference range.

   c) Relative Benthic Index (RBI), which was developed for embayments in California's Bay Protection and Toxic Cleanup Program. The RBI is the weighted sum of: (a) several community parameters (total number of species, number of crustacean species, number of crustacean individuals, and number of mollusc species), and abundances of (b) three positive, and (c) two negative indicator species.

   d) River Invertebrate Prediction and Classification System (RIVPACS), which was originally developed for British freshwater streams and adapted for California's bays and estuaries. The approach compares the assemblage at a site with an expected species composition determined by a multivariate predictive model that is based on species relationships to habitat gradients.

3) Assessment of Benthic Community Condition—Each benthic index result shall be categorized according to disturbance as described in Table 7. The disturbance categories are:

   a) Reference—A community composition equivalent to a least affected or unaffected site.

   b) Low Disturbance—A community that shows some indication of stress, but could be within measurement error of unaffected condition.

   c) Moderate Disturbance—Confident that the community shows evidence of physical, chemical, natural, or anthropogenic stress.

   d) High Disturbance—The magnitude of stress is high.

4) Integration of Benthic Community Categories—The median of all benthic index response categories shall determine the benthic condition LOE category. If the median falls between categories it shall be rounded up to the next higher effect category.

Table 7. Benthic index categorization values.

Index	Reference	Low Disturbance	Moderate Disturbance	High Disturbance
Southern California Marine Bays				
BRI	< 39.96	39.96 to 49.14	49.15 to 73.26	> 73.26
IBI	0	1	2	3 or 4
RBI	> 0.27	0.17 to 0.27	0.09 to 0.16	< 0.09
RIVPACS	> 0.90 to < 1.10	0.75 to 0.90 or 1.10 to 1.25	0.33 to 0.74 or > 1.25	< 0.33
Polyhaline Central San Francisco Bay				
BRI	< 22.28	22.28 to 33.37	33.38 to 82.08	> 82.08
IBI	0 or 1	2	3	4
RBI	> 0.43	0.30 to 0.43	0.20 to 0.29	< 0.20
RIVPACS	> 0.68 to < 1.32	0.33 to 0.68 or 1.32 to 1.67	0.16 to 0.32 or > 1.67	< 0.16

8. Sediment Chemistry

1) All samples shall be tested for the analytes identified in Table 18—This list represents the minimum analytes required to assess exposure. In water bodies where other toxic pollutants are believed to pose risk to benthic communities, those toxic pollutants shall be included in the analysis. Inclusion of additional analytes cannot be used in the exposure assessment described below. However, the data can be used to conduct more effective stressor identification studies as described in Section H.6.

2) Sediment Chemistry Guidelines—The sediment chemistry exposure shall be assessed using the following two methods:

   1) Chemical Score Index (CSI), that uses a series of empirical thresholds to predict the benthic community disturbance category (score) associated with the concentration of various chemicals (Table 8). The CSI is the weighted sum of the individual scores (Equation 1).

      Equation 1. $CSI = \Sigma(w_i \times cat_i)/\Sigma w$

      Where: cat_i = predicted benthic disturbance category for chemical I;
      w_i = weight factor for chemical I;
      Σw = sum of all weights.

   2) California Logistic Regression Model (CA LRM), that uses logistic regression models to predict the probability of sediment toxicity associated with the concentration of various chemicals (Table 9 and Equation 2). The CA LRM exposure value is the maximum probability of toxicity from the individual models (P_{max}).

Equation 2. $p = e^{B0+B1(x)} / (1 + e^{B0+B1(x)})$

Where: p = probability of observing a toxic effect;
B0 = intercept parameter;
B1 = slope parameter; and
x = concentration of the chemical.

Table 8. Category score concentration ranges and weighting factors for the CSI.

Chemical	Units	Weight	Score (Disturbance Category)			
			1 Reference	2 Low	3 Moderate	4 High
Copper	mg/kg	100	≤52.8	> 52.8 to 96.5	> 96.5 to 406	> 406
Lead	mg/kg	88	≤ 26.4	> 26.4 to 60.8	> 60.8 to 154	> 154
Mercury	mg/kg	30	≤ 0.09	> 0.09 to 0.45	> 0.45 to 2.18	> 2.18
Zinc	mg/kg	98	≤ 112	> 112 to 200	> 200 to 629	> 629
PAHs, total high MW	µg/kg	16	≤ 312	> 312 to 1325	> 1325 to 9320	>9320
PAHs, total low MW	µg/kg	5	≤ 85.4	> 85.4 to 312	> 312 to 2471	> 2471
Chlordane, alpha-	µg/kg	55	≤ 0.50	> 0.50 to 1.23	> 1.23 to 11.1	>11.1
Chlordane, gamma-	µg/kg	58	≤ 0.54	> 0.54 to 1.45	> 1.45 to 14.5	> 14.5
DDDs, total	µg/kg	46	≤ 0.50	> 0.50 to 2.69	> 2.69 to 117	> 117
DDEs, total	µg/kg	31	≤ 0.50	> 0.50 to 4.15	> 4.15 to 154	> 154
DDTs, total	µg/kg	16	≤ 0.50	> 0.50to 1.52	> 1.52 to 89.3	> 89.3
PCBs, total	µg/kg	55	≤11.9	> 11.9 to 24.7	> 24.7 to 288	> 288

Table 9. CA LRM regression parameters.

Chemical	Units	B0	B1
Cadmium	mg/kg	0.29	3.18
Copper	mg/kg	-5.59	2.59
Lead	mg/kg	-4.72	2.84
Mercury	mg/kg	-0.06	2.68
Zinc	mg/kg	-5.13	2.42
PAHs, total high MW	µg/kg	-8.19	2.00
PAHs, total low MW	µg/kg	-6.81	1.88
Chlordane, alpha	µg/kg	-3.41	4.46
Dieldrin	µg/kg	-1.83	2.59
Trans nonachlor	µg/kg	-4.26	5.31
PCBs, total	µg/kg	-4.41	1.48
p,p' DDT	µg/kg	-3.55	3.26

3) Assessment of Sediment Chemistry Exposure—Each sediment chemistry guideline result shall be categorized according to exposure as described in Table 10. The exposure categories are:

   a) Minimal Exposure—Sediment-associated CONTAMINATION may be present, but exposure is unlikely to result in effects.

   b) Low Exposure—Small increase in pollutant exposure that may be associated with increased effects, but magnitude or frequency of occurrence of biological impacts is low.

c) Moderate Exposure—Clear evidence of sediment pollutant exposure that is likely to result in biological effects; an intermediate category.

d) High Exposure—Pollutant exposure highly likely to result in possibly severe biological effects; generally present in a small percentage of the samples.

Table 10. Sediment chemistry guideline categorization values

Guideline	Minimal Exposure	Low Exposure	Moderate Exposure	High Exposure
CSI	< 1.69	1.69 to 2.33	2.34 to 2.99	>2.99
CA LRM	< 0.33	0.33 to 0.49	0.50 to 0.66	> 0.66

4) Integration of Sediment Chemistry Categories—The average of all chemistry exposure categories shall determine the final sediment chemistry LOE category. If the average falls midway between categories it shall be rounded up to the next higher exposure category.

9. Interpretation and Integration of MLOE

Assessment as to whether the aquatic life sediment quality objective has been attained at a station is accomplished by the interpretation and integration of MLOE. The categories assigned to the three LOE, sediment toxicity, benthic community condition and sediment chemistry are evaluated to determine the station level assessment. The assessment category represented by each of the possible MLOE combinations reflects the presence and severity of two characteristics of the sample: severity of biological effects, and potential for chemically-mediated effects.

1) Severity of Biological Effects—The severity of biological effects present at a site shall be determined by the integration of the toxicity LOE and benthic condition LOE categories using the decision matrix presented in Table 11.

2) Potential for Chemically-Mediated Effects—The potential for effects to be chemically-mediated shall be determined by the integration of the toxicity LOE and chemistry LOE categories using the decision matrix presented in Table 12.

Table 11. Severity of biological effects matrix.

		Toxicity LOE Category			
		Nontoxic	Low Toxicity	Moderate Toxicity	High Toxicity
Benthic Condition LOE Category	Reference	Unaffected	Unaffected	Unaffected	Low Effect
	Low Disturbance	Unaffected	Low Effect	Low Effect	Low Effect
	Moderate Disturbance	Moderate Effect	Moderate Effect	Moderate Effect	Moderate Effect
	High Disturbance	Moderate Effect	High Effect	High Effect	High Effect

Table 12. Potential for chemically mediated effects matrix

		Toxicity LOE Category			
		Nontoxic	Low Toxicity	Moderate Toxicity	High Toxicity
Sediment Chemistry LOE Category	Minimal Exposure	Minimal Potential	Minimal Potential	Low Potential	Moderate Potential
	Low Exposure	Minimal Potential	Low Potential	Moderate Potential	Moderate Potential
	Moderate Exposure	Low Potential	Moderate Potential	Moderate Potential	Moderate Potential
	High Exposure	Moderate Potential	Moderate Potential	High Potential	High Potential

3) Station Level Assessment—The station level assessment shall be determined using the decision matrix presented in Table 13. This assessment combines the intermediate classifications for severity of biological effect and potential for chemically-mediated effect to result in six categories of impact at the station level:

   a) Unimpacted—Confident that sediment contamination is not causing significant adverse impacts to aquatic life living in the sediment at the site.

   b) 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.”

   c) 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.

   d) Likely Impacted—Evidence for a contaminant-related impact to aquatic life at the site is persuasive, even if there is some disagreement among LOE.

   e) Clearly Impacted—Sediment contamination at the site is causing clear and severe adverse impacts to aquatic life.

   f) Inconclusive—Disagreement among the LOE suggests that either the data are suspect or that additional information is needed before a classification can be made.

Table 13. Station assessment matrix.

		Severity of Effect			
		Unaffected	Low Effect	Moderate Effect	High Effect
Potential For Chemically-Mediated Effects	Minimal Potential	Unimpacted	Likely Unimpacted	Likely Unimpacted	Inconclusive
	Low Potential	Unimpacted	Likely Unimpacted	Possibly Impacted	Possibly Impacted
	Moderate Potential	Likely Unimpacted	Possibly Impacted or Inconclusive[1]	Likely Impacted	Likely Impacted
	High Potential	Inconclusive	Likely Impacted	Clearly Impacted	Clearly Impacted

[1] Inconclusive category when chemistry is classified as minimal exposure, benthic response is classified as reference, and toxicity response is classified as high.

The station assessment resulting from each possible combination of the three LOE is shown in Table 19 (page). As an alternative to Tables 11, 12 and 13, each LOE category can be applied to Table 19 to determine the overall condition of the station. The results will be the same regardless of the tables used.

4) Relationship to the Aquatic Life—Benthic Community Protection Narrative Objective.

   a) The categories designated as "Unimpacted" and "Likely Unimpacted" shall be considered as achieving the protective condition at the station. All other categories shall be considered as degraded except as provided in b) below.

   b) The Water Board shall designate the category "Possibly Impacted" as meeting the protective condition if the studies identified in Section G.6. 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 Water Board will consider only the categories "Likely Impacted" and "Clearly Impacted" as degraded when making a determination on receiving water limits and impaired water bodies described in Section G.

10. MLOE Approach to Interpret the Narrative Objective in Other Bays and Estuaries

Station assessments for water bodies identified in Section E.3.2. will be conducted using the same conceptual approach and similar tools to those described in Sections E.4.–8. Each LOE will be evaluated by measuring a set of readily available indicators in accordance with Tables 14 and 15.

1) Station Assessment—Station assessment shall be consistent with the following key principles of the assessment approach described in Sections E.4. through E.9.:

   a) Results for a single LOE shall not be used as the basis for an assessment.

b) Evidence of both elevated chemical exposure and biological effects must be present to indicate pollutant-associated impacts.

c) The categorization of each LOE shall be based on numeric values or a statistical comparison.

2) LOE and Measurement Tools—Sediment chemistry, toxicity, and benthic community condition shall be measured at each station. Table 14 lists the required tools for evaluation of each LOE. Each measurement shall be conducted using standardized methods (e.g. U.S. EPA or ASTM guidance) where available.

3) Categorization of LOEs—Determination of the presence of an LOE effect (i.e. biologically significant chemical exposure, toxicity, or benthic community disturbance) shall be based on a comparison to a numeric response value or a statistical comparison to reference stations. The numeric values or statistical comparisons (e.g. confidence interval) used to classify an LOE as "Effected" shall be comparable to those specified in Sections E.6.–8. to indicate High Chemical Exposure, High Toxicity, or High Disturbance. Reference stations shall be located in an area expected to be uninfluenced by the discharge or pollutants of concern in the assessment area and shall be representative of other habitat characteristics of the assessment area (e.g. salinity, grain size). Comparison to reference shall be accomplished by compiling data for appropriate regional reference sites and determining the reference envelope using statistical methods (e.g. tolerance interval).

Table 14. Tools for use in evaluation of LOEs.

LOE	Tools	Metrics
Chemistry	Bulk sediment chemistry to include existing list (Table 18) plus other chemicals of concern	CA LRM Pmax Concentration on a dry weight basis
Sediment Toxicity	10-Day amphipod survival using a species tolerant of the sample salinity and grain size characteristics. (e.g. *Hyalella azteca* or *Eohaustorius estuarius*)	Percent of control survival
Benthic Community Condition	Invertebrate species identification and abundance	SPECIES RICHNESS Presence of sensitive indicator taxa Dominance by tolerant indicator taxa Presence of diverse functional and feeding groups Total abundance

Table 15. Numeric values and comparison methods for LOE categorization.

Metric	Threshold value or Comparison
CA LRM	Pmax > 0.66
Chemical Concentration	Greater than reference range or interval
Percent of Control Survival	*E. estuarius*: < 59 *H. azteca*: < 62 or SWAMP criterion
Species Richness	Less than reference range or interval
Abundance of Sensitive Indicator Taxa	Less than reference range or interval
Abundance of Tolerant Indicator Taxa	Greater than reference range or interval
Total Abundance	Outside of reference range or interval

4) Station Level Assessment—The station level assessment shall be determined using the decision matrix presented in Table 16. This assessment combines the classifications for each LOE to result in two categories of impact at the station level:

   a) 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.

   b) Impacted—Confident that sediment contamination present at the site is causing adverse direct impacts to aquatic life.

Table 16. Station assessment matrix for other bays and estuaries.

Chemistry LOE Category	Toxicity LOE Category	Benthic Condition LOE Category	Station Assessment
No effect	No effect	No effect	Unimpacted
No effect	No effect	Effect	Unimpacted
No effect	Effect	No effect	Unimpacted
No effect	Effect	Effect	Impacted
Effect	No effect	No effect	Unimpacted
Effect	No effect	Effect	Impacted
Effect	Effect	No effect	Impacted
Effect	Effect	Effect	Impacted

5) Relationship to the Aquatic Life—Benthic Community Protection Narrative Objective—The category designated as "Unimpacted" shall be considered as achieving the protective condition at the station.

F. Implementation for Assessing Human Health, Wildlife and Resident Finfish Protection

1. Human Health

The narrative human health objective in Section D.2. of this chapter shall be implemented on a case-by-case basis, based upon a human health risk assessment. In conducting a risk assessment, the Water Boards shall consider any applicable and relevant information, including California Environmental Protection Agency's (Cal/EPA) Office of Environmental Health Hazard Assessment policies for fish consumption and risk assessment, Cal/EPA's Department of Toxic Substances Control Risk Assessment, and U.S. EPA Human Health Risk Assessment policies.

2. Wildlife and Resident Finfish

The narrative wildlife and resident finfish objective in Section D.3. of this chapter shall be implemented on a case-by-case basis, based upon an ecological risk assessment. In conducting an ecological risk assessment, the Water Boards shall consider any applicable and relevant ecological risk information, including policies and guidance from the following sources:

1) Cal/EPA's Office of Environmental Health Hazard Assessment

2) Cal/EPA's Department of Toxic Substances Control

3) California Department of Fish and Game

4) U.S. Environmental Protection Agency

5) National Oceanographic Atmospheric Administration

6) 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.

G. Program Specific Implementation

1. Dredge Materials

1) This chapter shall not apply to dredge material suitability determinations.

2) The Water Boards shall not approve a dredging project that involves the dredging of sediment that exceeds the objectives in this chapter, unless the Water Boards determine that:

a) The polluted sediment is removed in a manner that prevents or minimizes water quality degradation.

b) 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.

c) The activity will not cause significant adverse impacts upon a federal sanctuary, recreational area, or other waters of significant national importance.

2. NPDES Receiving Water and Effluent Limits

1) If a Water Board determines that discharge of a toxic pollutant to bay or estuarine waters has the reasonable potential to cause or contribute to an exceedance of the SQOs, the Water Board shall apply the objectives as receiving water limits.

2) The Permittee shall be in violation of such limits if it is demonstrated that the discharge is causing or contributing to the SQO exceedance as defined in Section G.3.

3) Receiving water monitoring required by an NPDES permit may be satisfied by a Permitee's participation in a regional SQO monitoring program described in Section G.5.

4) The sediment chemistry guidelines shall not be translated into or applied as effluent limits. Effluent limits established to protect or restore sediment quality shall be developed only after:

a) A clear relationship has been established linking the discharge to the degradation,

b) The pollutants causing or contributing to the degradation have been identified, and

c) Appropriate loading studies have been completed to estimate the reductions in pollutant loading that will restore sediment quality.

These actions are described further in Sections G.6. and G.7. Nothing in this section shall limit a Water Board's authority to develop and implement WASTE LOAD ALLOCATIONS for Total Maximum Daily Loads (TMDL). However, it is recommended that the Water Boards develop TMDL allocations using the methodology described herein, wherever possible.

3. Exceedance of Receiving Water Limit

Exceedance of a receiving water limit is demonstrated when:

1) Using a BINOMIAL DISTRIBUTION, the total number of stations designated as not meeting the protective condition as defined in Sections E.9.4. or E.10.4. supports rejection of the NULL HYPOTHESIS as presented in Table 17. The stations included in this analysis will be those located in the vicinity of the discharge and identified in the permit, and

2) It is demonstrated that the discharge is causing or contributing to the SQO exceedance, following the completion of the stressor identification studies described in Section G.6.

3) 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.

Table 17. 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[1]
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: Null Hypothesis: Actual exceedance proportion < 3 percent. Alternate Hypothesis: Actual exceedance proportion > 18 percent. The minimum effect size* is 15 percent.

[1] 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.

Exceedance will require the Permittee to perform additional studies as described in Sections G.6. and G.7.

4. Receiving Water Limits Monitoring Frequency

1) Phase I Storm Water 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 storm water Permitees.

2) Phase II Storm Water 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 storm water Permitees.

3) Other Regulated Discharges and Waivers—The frequency of the monitoring for receiving water limits for other regulated discharges and waivers will be determined by the Water Board.

5. Sediment Monitoring

1) Objective—Bedded sediments in bays contain an accumulation of pollutants from a wide variety of past and present sources discharged either directly into the bay or indirectly into waters draining into the bay. Embayments also represent highly disturbed or altered habitats as a result of dredging and physical disturbance caused by construction and maintenance of harbor works, boat and ship traffic, and development of adjacent lands.

Due to the multitude of stressors and the complexity of the environment, a well-designed monitoring program is necessary to ensure that the data collected adequately characterizes the condition of sediment in these water bodies.

2) Permitted Discharges—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 as described under G.5.3., or both as determined by the Water Board.

3) Monitoring Coalitions—To achieve maximum efficiency and economy of resources, the State Water Board encourages the regulated community in coordination with the Regional Water Boards to establish water body-monitoring coalitions. Monitoring coalitions enable the sharing of technical resources, trained personnel, and associated costs and create an integrated sediment-monitoring program within each major water body. Focusing resources on regional issues and developing a broader understanding of pollutants effects in these water bodies enables the development of more rapid and efficient response strategies and facilitates better management of sediment quality.

    a) If a regional monitoring coalition is established, the coalition shall be responsible for sediment quality assessment within the designated water body and for ensuring that appropriate studies are completed in a timely manner.

    b) The Water Board shall provide oversight to ensure that coalition participants are proactive and responsive to potential sediment quality related issues as they arise during monitoring and assessment.

    c) Each regional monitoring coalition shall prepare a work plan that describes the monitoring, a map of the stations, participants and a schedule that shall be submitted to the Water Board for approval.

4) Methods—Sediments collected from each station shall be tested or assessed using the methods and metrics described in Section E.

5) Design:

    a) The design of sediment monitoring programs, whether site-specific or region wide shall be based upon a conceptual model. A conceptual model is 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. The detail and complexity of the conceptual model is dependent upon the scope and scale of the monitoring program. A conceptual model shall consider:

- 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 actions
- Beneficial uses
- Potential receptors of concern
- Changes in grain size salinity water depth and organic matter
- Other sources or discharges in the immediate vicinity

b) Sediment monitoring programs shall be designed to ensure that the aggregate stations are spatially representative of the sediment within the water body.

c) The design shall take into consideration existing data and information of appropriate quality.

d) Stratified random design shall be used where resources permit to assess conditions throughout a water body.

e) Identification of appropriate strata shall consider characteristics of the water body including sediment transport, hydrodynamics, depth, salinity, land uses, inputs (both natural and anthropogenic) and other factors that could affect the physical, chemical, or biological condition of the sediment.

f) Targeted designs shall be applied to those Permitees that are required to meet receiving water limits as described in Section G. 2.

6) Index Period—All stations shall be sampled between the months of June through September to be consistent with the benthic community condition index period.

7) Regional Monitoring Schedule and Frequency:

a) Regional sediment quality monitoring will occur at a minimum of once every three years.

b) Sediments identified as exceeding the narrative objective will be evaluated more frequently.

8) Evaluating waters for Placement on the Section 303(d) List—In California, water segments are placed on the section 303(d) list for sediment toxicity based either on toxicity alone or toxicity that is associated with a pollutant. The listing criteria are contained in the State Water Board's Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (2004) (Listing Policy). This chapter adds an additional listing criterion that applies only to listings for exceedances of the narrative sediment quality objective for aquatic life protection in Section D.1. The criterion under this chapter is described in subsection a. below, and the relationship between the sediment toxicity listing criteria under the Listing Policy and the criterion under this chapter is described in subsections b. and c., below.

a) Water segments shall be placed on the section 303(d) list for exceedance of the narrative SQO for aquatic life protection in Section D.1.

of this chapter only if the number of stations designated as not achieving the protective condition as defined in Sections E.9. and E.10. supports rejection of the null hypothesis, as provided in Table 3.1 of the State Water Board's Listing Policy.

b) Water segments that exhibit sediment toxicity but that are not listed for an exceedance of the narrative SQO for aquatic life protection in Section D.1. shall continue to be listed in accordance with Section 3.6 of the Listing Policy.

c) If a water segment is listed under Section 3.6 of the Listing Policy and the Regional Water Board later determines that the applicable water quality standard that is impaired consists of the SQO in Section D.1. of this chapter and a bay or estuarine habitat beneficial use, the Regional Water Board shall reevaluate the listing in accordance with Sections E.9 and E.10. If the Regional Water Board reevaluates the listing and determines that the water segment does not meet the criteria in subsection a. above, the Regional Water Board shall delist the water segment.

6. Stressor Identification

If sediments fail to meet the narrative SQOs in accordance with Sections E. and F. the Water Boards shall direct the regional monitoring coalitions or Permittees to conduct 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 approach consists of development and implementation of a work plan to seek confirmation and characterization of pollutant-related impacts, pollutant identification and source identification. The work plan shall be submitted to the Water Board for approval. Stressor identification consists of the following studies:

1) Confirmation and Characterization of Pollutant Related Impacts—Exceedance of the direct effects SQO at a site indicates that pollutants in the sediment are the likely cause but does not identify the specific pollutant responsible. The MLOE assessment establishes a linkage to sediment pollutants; however, the lack of confounding factors (e.g. physical disturbance, non-pollutant constituents) must be confirmed. There are two generic stressors that are not related to toxic pollutants that may cause the narrative to be exceeded:

   a) Physical Alteration—Examples of physical stressors include reduced salinity, impacts from dredging, very fine or coarse grain size, and prop wash from passing ships. These types of stressors may produce a non-REFERENCE CONDITION in the benthic community that is similar to that caused by 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.

b) Other Pollutant Related Stressors—These constituents, which include elevated total organic carbon, ammonia, nutrients and pathogens, may have sources similar to chemical pollutants. 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 possibly an indication of toxicity, and low chemical concentrations.

To further assess a site that is impacted by toxic pollutants, there are several lines of investigation that may be pursued, depending on site-specific conditions. These studies may be considered and evaluated in the work plan for the confirmation effort:

a) Evaluate the spatial extent of the area of concern. This information can be used to evaluate the potential risk associated with the sediment, distinguish areas of known physical disturbance or pollution and evaluate the proximity to anthropogenic source gradient from such inputs as outfalls, storm drains, and industrial and agricultural activities.

b) Body burden data may be examined from animals exposed to the site's sediment to indicate if pollutants are being accumulated and to what degree.

c) Chemical-specific MECHANISTIC BENCHMARKS may be applied to interpret sediment chemistry concentrations.

d) Chemistry and biology data from the site should be examined to determine if there is a correlation between the two LOEs.

e) Alternate biological effects data may be pursued, such as BIOACCUMULATION experiments and pore water toxicity or chemical analysis.

f) Other investigations that may commonly be performed as part of a Phase 1 TOXICITY IDENTIFICATION EVALUATION (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 assessment area shall be designated as having achieved the receiving water limit.

2) Pollutant Identification—Methods to help determine cause may be statistical, biological, chemical, or a combination. Pollutant identification studies should be structured to address site-specific conditions, and may be based upon the following:

a) Statistical Methods—Correlations between individual chemicals and biological endpoints (toxicity and benthic community).

b) Gradient Analysis—Comparisons are made between different samples taken at various distances from a chemical hotspot to examine patterns in chemical concentrations and biological responses. The concentrations of causative agents should decrease as biological effects decrease.

c) Additional TIE Efforts—A toxicological method for determining the cause of impairments is the use of

TIEs. Sediment samples are manipulated chemically or physically to remove classes of chemicals or render them biologically unavailable. Following the manipulations, biological tests are performed to determine if toxicity has been removed. TIEs should be conducted at a limited number of stations, preferably those with strong biological or toxicological effects.

d) BIOAVAILABILITY—Chemical pollutants may be present in the sediment but not biologically available to cause toxicity or degradation of the benthic community. There are several measures of bioavailability that can be made. Chemical and toxicological measurements can be made on pore water to determine the availability of sediment pollutants. Metal compounds may be naturally bound up in the sediment and rendered unavailable by the presence of sulfides. Measurement of acid volatile sulfides and simultaneously extracted metals analysis can be conducted to determine if sufficient sulfides are present to bind the observed metals. Similarly, organic compounds can be tightly bound to sediments. Measurements of sediment organic carbon and other binding phases can be conducted to determine the bioavailable fraction of organic compounds. Solid phase microextraction (SPME) or laboratory desorption experiments can also be used to identify which organics are bioavailable to benthic organisms.

e) Verification—After specific chemicals are identified as likely causes of impairment, analysis should be performed to verify the results. Sediments can be spiked with the suspected chemicals to verify that they are indeed toxic at the concentrations observed in the field. Alternately, animals can be transplanted to suspected sites for in situ toxicity and bioaccumulation testing.

When stressor Identification yields inconclusive results for sites classified as "Possibly Impacted," the Water Board shall require the Permittee or regional monitoring coalition to perform a one-time augmentation to that study or, alternatively, the Water Board may suspend further stressor identification studies pending the results of future routine SQO monitoring.

3) Sources Identification and Management Actions.

a) Determine if the sources are ongoing or legacy sources.

b) Determine the number and nature of ongoing sources.

c) If a single discharger is found to be responsible for discharging the stressor pollutant at a loading rate that is significant, the Regional Water Board shall require the discharger to take all necessary and appropriate steps to address exceedance of the SQO, including but not limited to reducing the pollutant loading into the sediment.

d) When multiple sources are present in the water body that discharge the stressor pollutant at a loading rate that is significant, the Regional Water Board shall require the sources to take all necessary and appropriate steps to address exceedance of the SQO. If appropriate, the Regional Water Board may adopt a TMDL to ensure attainment of the sediment standard.

7. Cleanup and Abatement

Cleanup and abatement actions covered by Water Code section 13304 for sediments that exceed the objectives in this chapter 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.

8. Development of Site-Specific Sediment Management Guidelines

The Regional Water Boards may develop site-specific sediment management guidelines where appropriate; for example, where toxic stressors have been identified and controllable sources of these stressors exist or remedial goals are desired.

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 guideline can serve as the basis for cleanup goals or revision of effluent limits described in 2.4. above, depending upon the situation or sources. All guidelines when applied for cleanup, must comply with 92-49.

Guideline development should only be initiated after the stressor has been identified. The goal is to establish a relationship between the organism's exposure and the biological effect. Once this 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:

1) 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.

2) 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.

3) 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.

4) 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.

5) The chemistry LOE of Section E.8.2., including the threshold values (e.g. CSI and CALRM), shall not be used for setting cleanup levels or numeric values for technical TMDLs.

Figure 3. Water body assessment process.

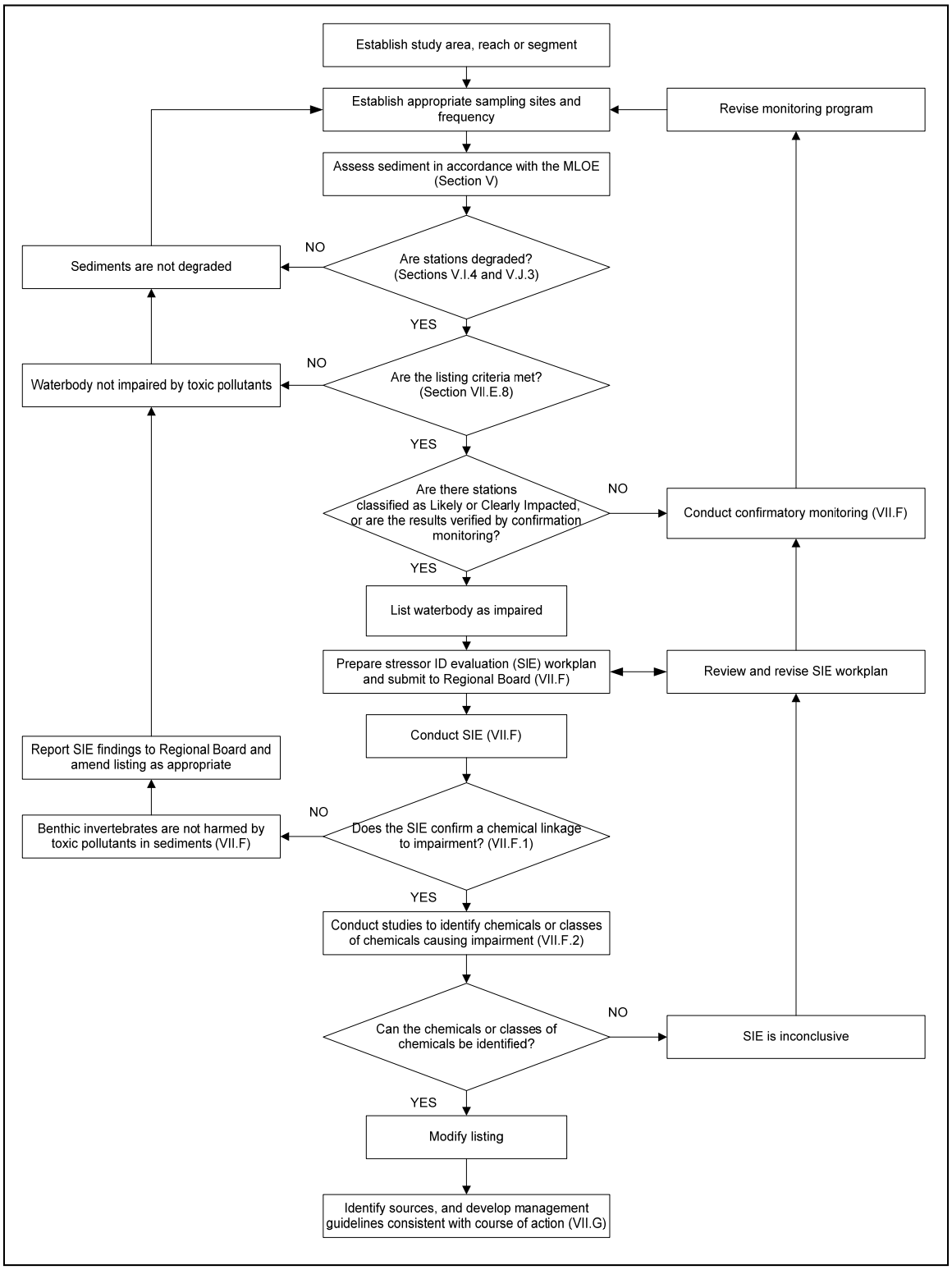


Figure 4. Point source assessment process.

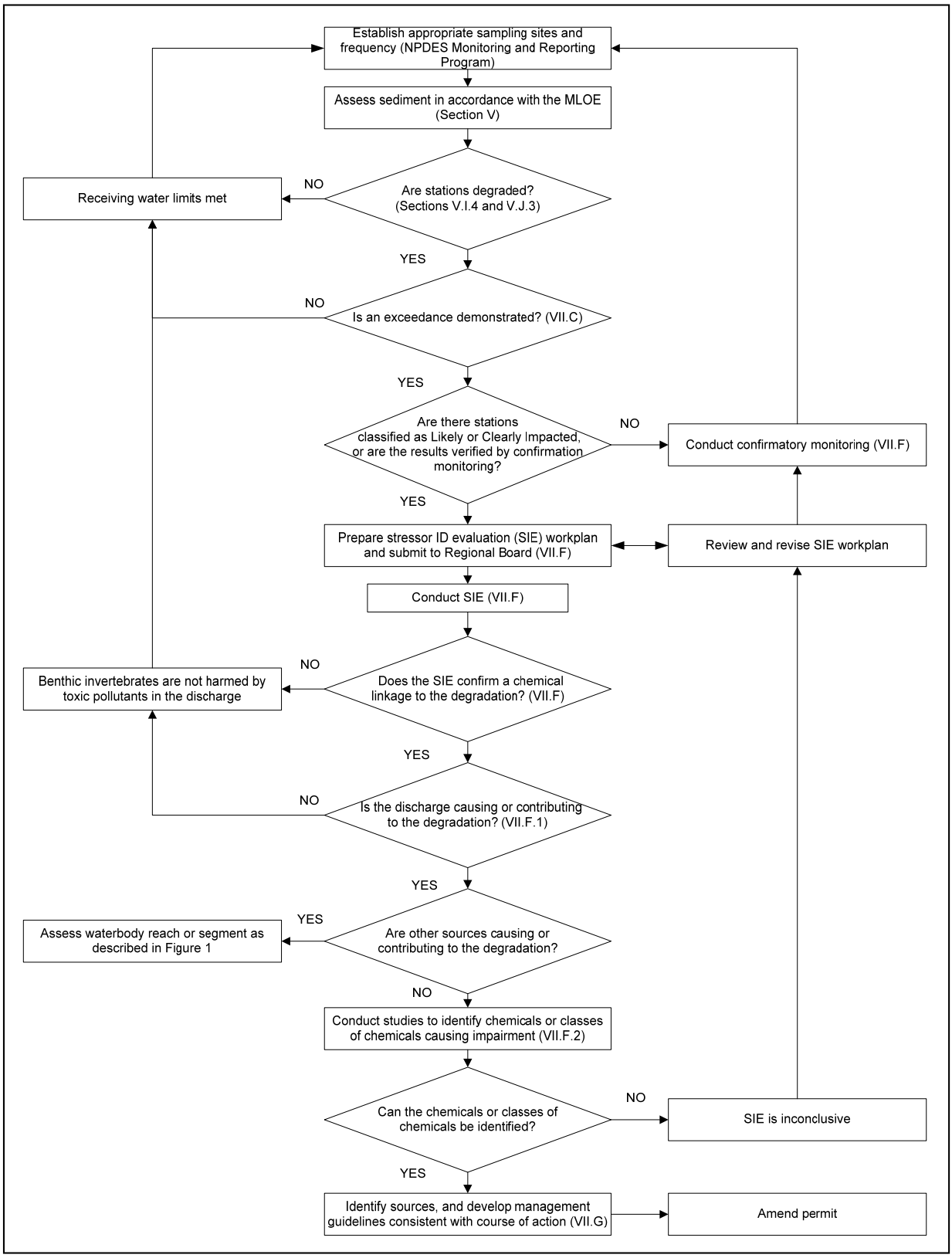


Table 18. List of chemical analytes needed to characterize sediment contamination exposure and effect.

Chemical Name	Chemical Group	Chemical Name	Chemical Group
Total Organic Carbon	General	Alpha Chlordane	Pesticide
Percent Fines	General	Gamma Chlordane	Pesticide
		Trans Nonachlor	Pesticide
Cadmium	Metal	Dieldrin	Pesticide
Copper	Metal	o,p'-DDE	Pesticide
Lead	Metal	o,p'-DDD	Pesticide
Mercury	Metal	o,p'-DDT	Pesticide
Zinc	Metal	p,p'-DDD	Pesticide
		p,p'-DDE	Pesticide
		p,p'-DDT	Pesticide
Acenaphthene	PAH	2,4'-Dichlorobiphenyl	PCB congener
Anthracene	PAH	2,2',5-Trichlorobiphenyl	PCB congener
Biphenyl	PAH	2,4,4'-Trichlorobiphenyl	PCB congener
Naphthalene	PAH	2,2',3,5'-Tetrachlorobiphenyl	PCB congener
2,6-dimethylnaphthalene	PAH	2,2',5,5'-Tetrachlorobiphenyl	PCB congener
Fuorene	PAH	2,3',4,4'-Tetrachlorobiphenyl	PCB congener
1-methylnaphthalene	PAH	2,2',4,5,5'-Pentachlorobiphenyl	PCB congener
2-methylnaphthalene	PAH	2,3,3',4,4'-Pentachlorobiphenyl	PCB congener
1-methylphenanthrene	PAH	2,3',4,4',5-Pentachlorobiphenyl	PCB congener
Phenanthrene	PAH	2,2',3,3',4,4'-Hexachlorobiphenyl	PCB congener
Benzo(a)anthracene	PAH	2,2',3,4,4',5'-Hexachlorobiphenyl	PCB congener
Benzo(a)pyrene	PAH	2,2',4,4',5,5'-Hexachlorobiphenyl	PCB congener
Benzo(e)pyrene	PAH	2,2',3,3',4,4',5-Heptachlorobiphenyl	PCB congener
Chrysene	PAH	2,2',3,4,4',5,5'-Heptachlorobiphenyl	PCB congener
Dibenz(a,h)anthracene	PAH	2,2',3,4',5,5',6-Heptachlorobiphenyl	PCB congener
Fluoranthene	PAH	2,2',3,3',4,4',5,6-Octachlorobiphenyl	PCB congener
Perylene	PAH	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	PCB congener
Pyrene	PAH	Decachlorobiphenyl	PCB congener

Table 19. 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
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
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

APPENDICES

APPENDIX A: Glossary

ACUTE TOXICITY TEST: A test to determine the concentration of effluent or ambient waters that causes an adverse effect (usually mortality) on a group of test organisms during a short-term exposure (e.g. 24, 48, or 96 hours).

AQUATIC LIFE: For the purpose of Chapter V., aquatic life refers to benthic invertebrates, shellfish sport fish and finfish.

BENTHIC: Living on or in bottom of the ocean, bays, and estuaries, or in the streambed.

BINOMIAL DISTRIBUTION: Mathematical distribution that describes the probabilities associated with the possible number of times particular outcomes will occur in a series of observations (i.e. samples). Each observation may have only one of two possible results (e.g. standard exceeded or standard not exceeded).

BIOACCUMULATION: A process in which an organism's body burden of a pollutant exceeds that in its surrounding environment as a result of chemical uptake through all routes of chemical exposure; dietary and dermal absorption and transport across the respiratory surface.

BIOAVAILABILITY: The fraction of a pollutant that an organism is exposed to that is available for uptake through biological membranes (e.g. gut, gills).

CALENDAR MONTH: A period of time, identified by the Permitting Authority that reflects the corresponding number of days in each month of the year.

CALENDAR QUARTER: A period of time defined as three successive calendar months.

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA): The statute set forth in Public Resources Code section 21000 et seq.

CHEMICALS OF CONCERN: Pollutants that occur in environmental media at levels that pose a risk to ecological receptors or human health.

CHRONIC TOXICITY TEST: A short-term aquatic test in which sublethal effects (e.g. reduced growth or reproduction) are usually measured in addition to lethality.
CONTAMINATION: An impairment of the quality of the waters of the state by waste to a degree that creates a hazard to the public health through poisoning or through the spread of disease. "Contamination" includes any equivalent effect resulting from the disposal of waste whether or not waters of the state are affected (CWC section 13050(k)).

CONTINUOUS NPDES WASTEWATER DISCHARGERS AND POINT SOURCE WDR DISCHARGERS: Facilities that discharge without interruption throughout its operating hours, except for infrequent shutdowns for maintenance, process changes, or other similar activities.

EFFECT SIZE: The maximum magnitude of exceedance frequency that is tolerated.

ENCLOSED BAYS: Indentations along the coast that 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.

ENDPOINT: A measured response of a receptor to a stressor. An endpoint can be measured in a toxicity test or in a field survey.

ESTUARIES AND COASTAL LAGOONS: 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 the California Water Code, Suisun Bay, Carquinez Strait downstream to Carquinez Bridge, and appropriate areas of the Smith, Klamath, Mad, Eel, Noyo, and Russian Rivers.

EUHALINE: Waters ranging in salinity from 25–32 practical salinity units (psu).

FLOW-THROUGH ACUTE TOXICITY TESTING SYSTEMS: A toxicity testing system where an effluent sample is either pumped continuously from the sampling point directly to a dilutor system; or collected and placed in a tank adjacent to the test laboratory and pumped continuously from the tank to a dilutor system.

INLAND SURFACE WATERS: All surface waters of the state that do not include the ocean, enclosed bays, or estuaries.

INSIGNIFICANT DISCHARGES: NPDES wastewater discharges and point source WDR discharges that are deemed a very low threat to water quality by the Permitting Authority.

INSTREAM WASTE CONCENTRATION (IWC): The concentration of a toxicant or effluent in the receiving water after mixing (the inverse of the dilution ratio) as determined by the Permitting Authority..

LOAD ALLOCATION (LA): The portion of a receiving water's total maximum daily load (TMDL) that is allocated to one of its nonpoint sources of pollution or to natural background sources.

MAXIMUM DAILY EFFLUENT LIMIT (MDEL): For the purposes of chronic and acute aquatic toxicity, an MDEL is an effluent limit based on the outcome of the Test of Significant Toxicity (TST) approach and the resulting percent effect at the IWC. The MDEL is exceeded when a toxicity test results in a “fail,” and the percent effect is equal to, or greater than 50 percent for chronic toxicity tests or the percent effect is equal to, or greater than 40 percent for acute toxicity tests.

MECHANISTIC BENCHMARKS: Chemical guidelines developed based upon theoretical processes governing bioavailability and the relationship to biological effects.

MEDIAN MONTHLY EFFLUENT LIMIT (MMEL): For the purposes of chronic and acute aquatic toxicity, an MMEL is an effluent limit based on the median result of three independent toxicity

tests, conducted within the same calendar month, and analyzed using the TST. The MMEL is exceeded when the median result (i.e. two out of three) is a "fail."

MIXING ZONE: A limited zone within a receiving water that is allocated for mixing with a wastewater discharge where water quality criteria can be exceeded without causing adverse effects to the overall water body.

NON-CONTINUOUS NPDES WASTEWATER DISCHARGERS AND POINT SOURCE WDR DISCHARGERS: Facilities that do not discharge in a continuous manner (e.g. intermittent and seasonal dischargers).

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES): Dischargers that are subject to NPDES permitting requirements, but are not in the storm water program including, but not limited to, publicly owned treatment works.

NONPOINT SOURCES: Sources that do not meet the definition of a point source, as defined below.

NULL HYPOTHESIS: A statement used in statistical testing that has been put forward either because it is believed to be true or because it is to be used as a basis for argument, but has not been proved.

OCEAN WATERS: Territorial marine waters of the state, as defined by California law, to the extent these waters are outside of enclosed bays, estuaries, and coastal lagoons. Discharges to ocean waters are regulated in accordance with the State Water Resources Control Board's California Ocean Plan.

PERCENT EFFECT: The value that denotes the difference in response between the IWC and the control, divided by the mean response, and multiplied by 100.

PERMITTING AUTHORITY: The State Water Resources Control Board or Regional Water Quality Control Board that issues an NPDES permit, Waste Discharge Requirements (WDR), Conditional Waiver of WDRs, Conditional Prohibition, Water Quality Certification, or other authorization for the discharge or proposed discharge of waste.

POINT SOURCE: Any discernible, confined and discrete conveyance including, but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural storm water discharges and return flows from irrigated agriculture.

POINT SOURCE WDR DISCHARGERS: Entities that discharge from industrial or wastewater treatment facilities into surface waters of the state, pursuant to WDRs that do not serve as NPDES permits.

POLLUTANT: Defined in section 502(6) of the CWA as "dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water."

POLLUTION: defined in section 502(19) of the CWA as the "the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water." Pollution is

also defined in Water Code section 13050(1) as an alternation of the quality of the waters of the State by waste to a degree that unreasonably affects either the waters for beneficial uses or the facilities that serve these beneficial uses.

POLYHALINE: Waters ranging in salinity from 18–25 psu.

PUBLICLY OWNED TREATMENT WORKS (POTW): Facilities owned by a state or municipality that store, treat, recycle, and reclaim municipal sewage or industrial wastes of a liquid nature.

REASONABLE POTENTIAL: A designation used for a waste discharge that is projected or calculated to cause or contribute to an excursion above a water quality standard. For the purposes of chronic and acute aquatic toxicity, reasonable potential is demonstrated when the IWC of a discharge produces a test result of "fail" or when the percent effect at the IWC is greater than 0.10.

REFERENCE CONDITION: The characteristics of water body segments least impaired by human activities. As such, reference conditions can be used to describe attainable biological or habitat conditions for water body segments with common watershed/catchment characteristics within defined geographical regions.

REGULATORY MANAGEMENT DECISION (RMD): The decision that represents the maximum allowable error rates and thresholds for chronic and acute aquatic toxicity (and non-toxicity) that would result in an acceptable risk to aquatic life.

REPLICATES: Two or more independent organism exposures of the same treatment (i.e. effluent concentration) within an aquatic toxicity test. Replicates are typically conducted with separate test chambers and test organisms, each having the same effluent concentration.

RESIDENT FINFISH: Any species of bony fish or cartilaginous fish (sharks, skates and rays) whose home range occupies all or part of the water body, but does not extend into other water bodies.

RESPONSE: The measured biological endpoint(s) (e.g. survival, growth, and reproduction) used in an aquatic toxicity test method. The responses from the control and the IWC are quantified using statistical approaches to determine if toxicity is present.

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

SPECIES RICHNESS: The number of species in a sample.

SURFICIAL SEDIMENTS: Those sediments representing recent depositional materials and containing the majority of the benthic invertebrate community.

STATISTICAL SIGNIFICANCE: When it can be demonstrated that the probability of obtaining a difference by chance only is relatively low.

TEST OF SIGNIFICANT TOXICITY (TST): A statistical approach used to analyze aquatic toxicity test data. The TST incorporates a restated null hypothesis, Welch's t-test, and biological effect thresholds for chronic and acute toxicity.

TOXICITY: The aggregate toxic effect of a waste discharge measured directly by a chronic or acute aquatic toxicity test. This aggregate effect is frequently referred to as "whole effluent toxicity."

TOXICITY IDENTIFICATION EVALUATION (TIE): Techniques used to identify the unexplained cause(s) of toxic events. TIE involves selectively removing classes of chemicals through a series of sample manipulations, effectively reducing complex mixtures of chemicals in natural waters to simple components for analysis. Following each manipulation, the toxicity of the sample is assessed to see whether the toxicant class removed was responsible for the toxicity.

TOXICITY REDUCTION EVALUATION (TRE): A study conducted in a step-wise process designed to identify the causative agents of effluent or ambient toxicity, isolate the sources of toxicity, evaluate the effectiveness of toxicity control options, and then confirm the reduction in toxicity. A TIE may be required as part of the TRE, if appropriate.

WILDLIFE: All tetrapod vertebrates, including amphibians, reptiles, birds, and mammals, (inclusive of marine mammals).

APPENDIX B: Examples of Compliance Determination for Toxicity Effluent Limitations

Chronic *Ceriodaphnia dubia* reproduction test

Replicate/Statistic	Control	IWC
1	29	31
2	38	28
3	31	25
4	34	28
5	36	22
6	35	21
7	30	27
8	31	26
9	36	29
10	34	30
Mean	33.4	26.7
Standard Deviation	2.989	3.268
# of Replicates (n)	**10**	**10**

1) Transform data with arcsine square root transformation if applicable (not necessary for this type of data).

2) Conduct Welch's t-test.

$$t = \frac{\overline{Y_t} - b \times \overline{Y_c}}{\sqrt{\frac{S_t^2}{n_t} + \frac{b^2 S_c^2}{n_c}}} = \frac{26.7 - (0.75 \times 33.4)}{\sqrt{\frac{10.68}{10} + \frac{(0.75)^2\ (8.93)}{10}}} = 1.32$$

3) Adjust the degrees of freedom.

$$v = \frac{\left(\frac{S_t^2}{n_t} + \frac{b^2 S_c^2}{n_c}\right)^2}{\frac{\left(\frac{S_t^2}{n_t}\right)^2}{n_t - 1} + \frac{\left(\frac{b^2 S_c^2}{n_c}\right)^2}{n_c - 1}} = \frac{\left(\frac{10.68}{10} + \frac{(0.75)^2 (8.93)}{10}\right)^2}{\frac{\left(\frac{10.68}{10}\right)^2}{10 - 1} + \frac{\left(\frac{(0.75)^2\ (8.93)}{10}\right)^2}{10 - 1}} = 15$$

4) Compare the calculated t-value with the critical t-value:

Given 15 degrees of freedom and an alpha level set at 0.20, the critical t-value = 0.87 (obtained from Table 2 in this Policy).

5) 1.32 > 0.87 = pass

6) Calculate the percent effect at the IWC

$$\%\,\text{Effect at IWC} = \frac{33.4 - 26.7}{33.4} \bullet 100 = 20.1\%$$

Conclusion: This test result would be in compliance with the MDEL and the MMEL.

Acute fish survival test

Replicate/Statistic	Control	IWC
1	10	10
2	10	8
3	10	9
4	10	8
Mean	10	8.75
Standard Deviation	0.000	0.958
# of Replicates (n)	**4**	**4**

1) Transform data with arcsine square root transformation if applicable.

Replicate/Statistic	Control	Treatment
1	1.412	1.412
2	1.412	1.107
3	1.412	1.249
4	1.412	1.107
Mean	1.412	1.219
Standard Deviation	0.000	0.145
# of Replicates (n)	**4**	**4**

2) Conduct Welch's t-test.

$$t = \frac{\overline{Y_t} - b \times \overline{Y_c}}{\sqrt{\frac{S_t{}^2}{n_t} + \frac{b^2 S_c{}^2}{n_c}}} = \frac{1.219 - (0.80 \times 1.412)}{\sqrt{\frac{0.021}{4} + \frac{(0.80)^2\ (0.00)}{4}}} = 1.23$$

3) Adjust the degrees of freedom.

$$v = \frac{\left(\frac{S_t^2}{n_t} + \frac{b^2 S_c^2}{n_c}\right)^2}{\frac{\left(\frac{S_t^2}{n_t}\right)^2}{n_t - 1} + \frac{\left(\frac{b^2 S_c^2}{n_c}\right)^2}{n_c - 1}} = \frac{\left(\frac{0.021}{4} + \frac{(0.80)^2(0.00)}{4}\right)^2}{\frac{\left(\frac{0.021}{4}\right)^2}{4-1} + \frac{\left(\frac{(0.80)^2\ (0.00)}{4}\right)^2}{4-1}} = 3$$

4) Compare the calculated t-value with the critical t-value:

Given 3 degrees of freedom and an alpha level set at 0.10, the critical t-value = 1.64 (obtained from Table 2in this Policy).

5) 1.23 < 1.64 = fail

6) Calculate the percent effect at the IWC.

$$\%\,\text{Effect at IWC} = \frac{10 - 8.75}{10} \bullet 100 = 12.5\%$$

Conclusion: This test result did not exceed the MDEL, but the discharger would need to conduct two additional tests to determine compliance with the MMEL. Dischargers that do not conduct these two additional tests would be in violation of the MMEL.