STATE OF CALIFORNIA
S.B. 469 TMDL GUIDANCE

A PROCESS FOR ADDRESSING IMPAIRED WATERS IN CALIFORNIA

California State Water Resources Control Board
1001 I Street
Sacramento, California 95814

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Companion Documents:

Categorical TMDL Module—Bacteria (draft available)
Categorical TMDL Module—Pesticides (under development)

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FIGURES

1. INTRODUCTION

Section 303(d) of the Clean Water Act (CWA) contains backstop provisions designed to ensure that all state water quality standards are met. The water quality of many waters of the state is currently unacceptable. The Total Maximum Daily Load (TMDL) program was created by the State Board to implement the requirements of these backstop provisions, consistent with state and federal law, for the purpose of ensuring that water quality standards are attained. The TMDL program is the primary program responsible for achieving clean water where traditional controls on point sources have proven inadequate to do so. The program thus is charged with creating plans that consider all sources and causes of impairment, and allocating responsibility for corrective measures, regardless of sources or cause, that will attain water quality standards.

The goal of this guidance document is to assist the California State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards (RWQCBs) in addressing impaired waters through actions that are consistent with both national and regional United States Environmental Protection Agency (USEPA) regulations and guidance as well as with state technical, regulatory, and legislative requirements. The guidance should also facilitate a greater understanding of expectations, which can result in improved coordination, consistency, and information exchange among RWQCBs. This document is also intended to provide the public with a better understanding of the process and products associated with the assessment of impaired waters and development of implementation plans to improve them.

Impaired Water: A waterbody that has been determined under state policy and federal law to be not meeting water quality standards. An impaired water is a water that has been listed on the California 303(d) list or has not yet been listed but otherwise meets the criteria for listing. A water is a portion of a surface water of the state, including ocean, estuary, lake, river, creek, or wetland. The water currently may not be meeting state water quality standards or may be determined to be threatened and have the potential to not meet standards in the future. The State of California's 303(d) list can be found at http://www.swrcb.ca.gov/quality.html.

As required by the Clean Water Act (CWA), states are to identify and report to USEPA their water quality-limited waters. These waters are to be identified according to the provisions established in USEPA's Water Quality Management and Planning Regulation at 40 CFR 130.7(b). The identified waters should include those impaired due to point and/or nonpoint sources of pollution and may include threatened good-quality waters. Section 303(d) of the CWA requires each state to maintain a list of impaired waterbodies and revise the list every 2 years. The 2002 list, which is the most current approved list for California, requires the development of plans for addressing impaired waters in over 1,800 waterbody/pollutant combinations. (One waterbody can be listed for numerous pollutants.)

Federal TMDL-related Links

40 CFR 130.7(b)—
http://www.access.gpo.gov/nara/cfr/cfrhtml_00/Title_40/40cfr130_00.html
Section 303(d) of the CWA—
http://www4.law.cornell.edu/uscode/33/1313.html

To support the development of plans for addressing impaired waters, this document includes a description of the recommended phases for identifying actions that will lead to restoration of waterbody conditions and the ultimate removal of the impaired water designation. The phases, which are consistent with current state and regional tracking methods, are:

1. Project Definition (Chapter 2)
2. Project Planning (Chapter 3)
3. Data Collection (Chapter 4)
4. Project Analyses (Chapter 5)
5. Regulatory Action Selection (Chapter 6)
6. Regulatory Process (Chapter 6)
7. Approval
8. Implementation (Chapter 7)

References to Additional Information in the Appendices

Throughout the document, icons are included to identify areas relating to additional information contained in appendices.

Areas where templates are available are identified by:

Areas where an issue paper provides expanded discussion are denoted by:

Topics with relevant legal memos are denoted by:

At each phase, the suite of options available to address impaired waters can be considered by following the iterative decision process presented in this document. The process for addressing impaired waters is presented as a science-based methodology, beginning with the formulation of a conceptual model that serves as the technical plan for projects and as the baseline from which the technical approach can be adapted as scientific investigations provide new data and information. Throughout this process the focus is on identifying actions that can result in the successful restoration of impaired waters, while continuously adapting to new information and evolving science. The concept of adaptive management is recognized in the impaired waters process, and new data, analysis results, and post-implementation monitoring can result in recommendations for reassessment, revised TMDL calculations, and updated implementation plans. Although the specifics of each project will vary, the analyst should recognize that each phase in the process has the potential to become incrementally more detailed and focused and that circumstances may arise that will dictate the need for further examination of data, analyses, and input from involved and interested parties. To better communicate these concepts, the information in this document is presented as discrete prescriptive steps. In reality, each of the RWQCBs will have wide latitude and numerous options, as well as some legal constraints, when determining how to address impaired waters.

Delist. To remove an impaired water from the state's 303(d) list through a formal action and approval by USEPA. The process typically involves submitting the state list to USEPA.
Total Maximum Daily Load (TMDL). A numerical calculation of the loading capacity of a water body to assimilate a certain pollutant and still attain all water quality standards. The sum of the individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources and natural background, and a margin of safety (MOS). TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standards.
Site-Specific Objectives (SSO). Objectives that reflect site-specific conditions. An SSO may be appropriate when it is determined that promulgated water quality standards or objectives are not protective of beneficial uses or when site-specific conditions warrant more or less stringent effluent limits than those based on promulgated water quality standards or objectives, without compromising the beneficial uses of the receiving water.
Use Attainability Analysis (UAA). A structured scientific assessment of the factors affecting the attainment of a water's designated use, including physical, chemical, biological, and economic factors (e.g., naturally occurring pollutant concentrations, human-caused conditions or sources of pollution, hydrologic modifications, and physical conditions related to the natural features of the waterbody).

1.1. Regulatory Background

Section 13001 of the California Water Code identifies the SWRCB and all RWQCBs as the principal state agencies responsible for the coordination and control of water quality. The SWRCB and RWQCBs are expected to conform to and implement the policies of the Water Code and coordinate their respective activities to achieve a unified and effective water quality control program in the state. The Water Code also authorizes the SWRCB to adopt statewide water quality control plans and requires each RWQCB to develop and adopt Basin Plans that address all areas in the region and conform to state water quality policy. (Appendix A includes additional information on basin planning).

Each regional Basin Plan includes:

- Identification of existing and potential beneficial uses.
- Identification of water quality objectives (WQOs).
- Implementation programs to achieve the WQOs.

Senate Bill 469 was enacted in April 2002 to add Section 13191.3 to the Water Code. The addition requires the SWRCB, on or before July 1, 2003, to prepare guidelines to be used by the SWRCB and the RWQCBs for the purpose of listing and delisting waters and developing and implementing the Total Maximum Daily Load (TMDL) program and calculating TMDLs pursuant to Section 303(d) of the federal CWA. In general, Section 303(d) of the CWA requires each state to establish TMDLs for waters within its boundaries for which certain effluent limitations are not stringent enough to achieve applicable water quality standards. A TMDL is the maximum amount of a pollutant that a waterbody can assimilate while still meeting water quality standards. While the implementation plan for a TMDL may involve a modification of the applicable water quality standards, a TMDL itself is not a component of California's water quality standards. (Appendix B includes a legal memo concerning the difference between WQOs and a numeric target used in a TMDL.)

Regulatory Links

California Water Code—http://www.leginfo.ca.gov/cgi-bin/calawquery?codesection=wat&codebody=&hits=20

Porter-Cologne Water Quality Control Act (California Water Code, Division 7. Water Quality [CWC Sections 13000–14958])—http://www.swrcb.ca.gov/water_laws/docs/portercologne2003.pdf

Regulatory Actions

RWQCBs have wide latitude, numerous options, and some legal constraints that apply when determining how to address impaired waters. Irrespective of whether Section 303(d) of the CWA requires a TMDL, the process for addressing waters that do not meet applicable standards will be accomplished through existing regulatory tools and mechanisms. Chapter 6 provides a more detailed discussion of regulatory action options.

A summary of the regulatory options for addressing impaired waters is provided in Figure 1-1. In most cases, it will require implementation of a pollution reduction strategy of some sort. However, if a listed waterbody is neither impaired nor threatened, the appropriate regulatory response would be to remove the waterbody from the list (to delist). Likewise, if the water quality standards is are not being achieved because the applicable standards are not appropriate, an appropriate regulatory response may be to correct the standards through mechanisms such as use attainability analysis (UAA), a site-specific objective (SSO), or other modification of the water quality standard. In addition, an antidegradation finding may authorize the lowering of water quality to some degree, which may address the impairment. What constitutes an inappropriate standard is discussed more fully in Appendix C, but the discussion here should not be construed as implying that standards may be changed as a convenient means of "restoring" waterbodies. To the contrary, federal and state law contain numerous detailed requirements that in many cases would prevent modification of the standards especially if it would result in less stringent controls. Modification of standards may be appropriate however, to make uses more specific, to manage conflicting uses, to address site-specific conditions, and for other such reasons. If, subsequent to evaluation of standards, the water does not meet revised WQOs, a TMDL calculation might be required.

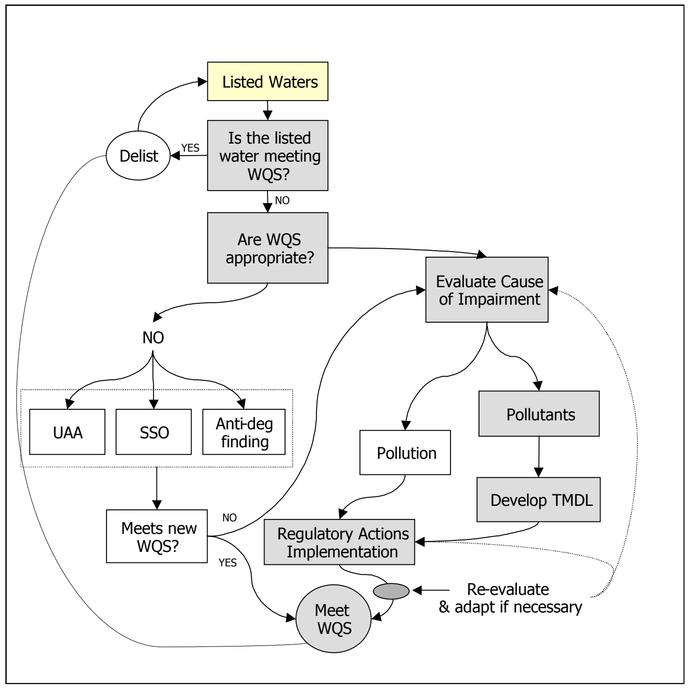


Figure 1-1. Regulatory Options Summary

Common causes or categories of impairment are related to anthropogenic factors. They include waters impaired by certain USEPA-designated pollutants and waters impaired by other forms of pollution. The Porter-Cologne Water Quality Control Act charges the SWRCB and the RWQCBs with the responsibility of protecting the beneficial uses and quality of all waters of the state, irrespective of the cause of the impairment. The federal requirement to calculate TMDLs for listed waters is limited to those pollutants that USEPA determines are suitable for such calculation. Although USEPA's current position is that all pollutants are suitable under proper technical conditions, as the complexity of many pollutant-based impairments becomes more apparent, it is possible that USEPA will exclude certain pollutants from the TMDL requirement in the future (see definitions in box below).

Pollutants. The term *pollutant* is defined in Section 502(6) of the CWA as "dredged spoil, solid waste, incinerator residue, 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" (http://www4.law.cornell.edu/uscode/33/1362.html).

Pollution. The term *pollution* is defined in Section 502(19) of the CWA as the "man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water" (http://www4.law.cornell.edu/uscode/33/1362.html). The term *pollution* thus includes impairments caused by discharges of pollutants. *Pollution* is also defined in Section 13050(l) of the California Water Code as an alteration 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 (http://www.leginfo.ca.gov/cgi-bin/displaycode?section=wat&group=13001-14000&file=13050-13051).

Subject to available resources, all violations of standards may be addressed using any combination of existing regulatory tools. Existing regulatory tools include individual or general waste discharge requirements (whether they are National Pollutant Discharge Elimination System [NPDES] permits or requirements solely under California law), individual or general waivers of waste discharge requirements, enforcement actions, interagency agreements, regulations, Basin Plan amendments, and other policies for water quality control. Basin Plan amendments can include implementing a specific water quality control plan, adopting prohibitions, or (where appropriate) modifying standards. The priority ranking assigned to an impaired water will help the RWQCBs determine priorities for addressing the impairments. Some of the key factors in determining the most appropriate regulatory option(s) are listed below. (For specific details see Chapter 6.)

- *Multiple actions of the RWQCB*: If multiple actions by the RWQCB are required, the solution must be implemented through a Basin Plan amendment or other regulation.
- *Single Vote of the RWQCB*: If the solution can be implemented with a single vote of the RWQCB, it may be implemented by that vote. When an implementation plan can be adopted in a single regulatory action, such as a permit, a waiver, or an enforcement order, there is no legal requirement to first adopt the plan through a Basin Plan amendment.
- *Regulatory Action of Another State, Local, or Federal Agency*: If the RWQCB finds that a proposed solution will correct the impairment, the RWQCB may certify that the regulatory action will correct the impairment and, if applicable, implement the assumptions of the TMDL, in lieu of adopting a redundant program.
- *Nonregulatory Action of Another Entity*: If the RWQCB finds that the action will correct the impairment, the RWQCB may certify that the nonregulatory action will correct the impairment and, if applicable, implement the assumptions of the TMDL, in lieu of adopting a redundant program.
- *Voluntary Actions by Nonregulatory Entities*: Such actions are appropriate if the RWQCB makes findings, supported by substantial evidence in the project record, that a program being implemented by a nonregulatory entity will be adequate to correct the impairment.

Process for Calculating TMDLs in California

TMDLs are generally adopted at the time programs are instituted to implement actions to correct an impairment. TMDLs may be adopted in any of the following ways: as part of a Basin Plan amendment, in the assumptions underlying a permitting action, in an enforcement action, or in another single regulatory action that is designed by itself to correct the impairment. The TMDL is adopted with the regulatory action that implements it. The manner of SWRCB review of the plan or program will depend upon and be consistent with the manner in which the RWQCB has adopted the TMDL. The TMDL is transmitted to the USEPA with a Request for Approval.

1.2. Structure of this Document

This guidance document has been organized to be consistent with water quality regulations in California and current tracking of state progress in addressing impaired waters. Figure 1-2 identifies the key phases and associated major sections of the document. The remainder of this document is organized into the following chapters:

- ***Chapter 2*** describes the development of the Project Definition, the first step in planning a strategy for addressing impaired waters.
- ***Chapter 3*** provides guidance on the development of the Project Plan, including a scope of work, identifying and allocating adequate resources to complete the project, scheduling interim and final milestones and important dates, assessing constraints, and reviewing ongoing activities and stakeholders in the analysis area.
- ***Chapter 4*** discusses the planning and collection of monitoring information in support of the project.
- ***Chapter 5*** provides guidance on the Project Analyses phase, including selection of technical approach, analysis of data, options for presentation and interpretation of analyses, documentation, and report preparation.
- ***Chapter 6*** provides guidance on the decision process for selecting regulatory actions that can be initiated to address the impaired water. The legislative and administrative requirements associated with regulatory actions are described.

TMDL Definitions

The following definitions are drawn from 40 CFR Part 130 (http://www.access.gpo.gov/nara/cfr/cfrhtml_00/Title_40/40cfr130_00.html).

Loading Capacity (LC). The greatest amount of loading that a water can receive without violating water quality standards (40 CFR 130.2(f)). The LC equals the TMDL.
Load Allocation (LA). The portion of a receiving water's loading capacity that is attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources (40 CFR 130.2(g)).
Waste Load Allocation (WLA). The portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality-based effluent limitation (40 CFR 130.2(h)).
Margin of Safety (MOS). A required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving waterbody (40 CFR 130.7(c)(1)).

- ***Chapter 7*** discusses the development of implementation plans and provides information on including adaptive implementation concepts into implementation monitoring and tracking.
- ***Appendix A*** presents a checklist of the steps in the Basin Planning process.
- ***Appendix B*** provides copies of TMDL-related legal memorandums issued by SWRCB's Office of Chief Counsel.
- ***Appendix C*** presents an issue paper on UAAs and SSOs.
- ***Appendix D*** provides report templates for a Delisting Memo, Project Plan, Report Tracking Sheet, and TMDL Report.
- ***Appendix E*** presents case studies to highlight different approaches for addressing impaired waters. (Case studies will be added as relevant TMDLs are approved by the SWRCB.)
- ***Appendix F*** contains guidance on stakeholder involvement in the impaired waters process.

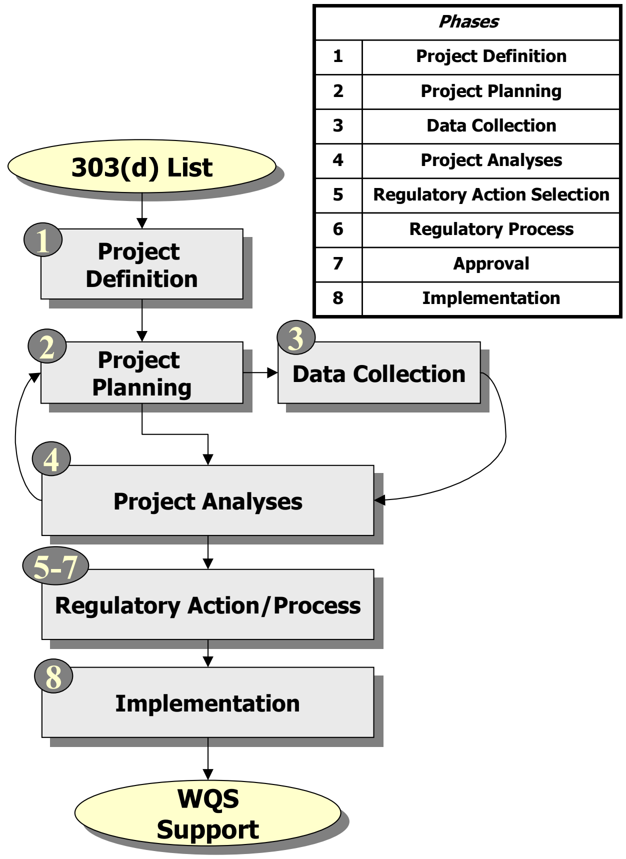


Figure 1-2. Impaired Water Assessment Phases

Each section of the document builds on the previous sections to highlight the incremental process of building on evaluations and more detailed data analysis. Supplementing this document are a series of more in-depth issue papers and categorical (i.e., pollutant-specific) technical guidances. As the list of supporting documents will continue to expand over time, readers are encouraged to check the Web link periodically. http://www.waterboards.ca.gov/tmdl/tmdl.htmlPractitioners should always look ahead to the regulatory and implementation actions (and even beyond, e.g., implementation plans) that might be employed in achieving the goal of restoring waters and meeting water quality standards.

2. PROJECT DEFINITION

> ***Project Scope.*** One or more impaired waters and one or more causes grouped in a geographic area, typically within one drainage area or watershed. The grouping of multiple impaired waters facilitates the development and execution of a plan to address the impaired waters.

The goal of the Project Definition stage is to outline a strategy for addressing one or more impaired waters. The strategy identifies the key activities that will be performed in subsequent stages of the analyses. The project definition is based on a *preliminary* review of available information describing the nature of the impairment. This abbreviated review is used to develop an *initial* hypothesis of the causative factors and a strategy for the analysis and ultimate management approach. The hypothesis might be revised at any time during the impaired waters process based on new information or analysis. Ultimately, the project definition not only supports understanding of the impairment; it also provides an essential precursor to the design of the project plan, which will establish the project scope, additional data gathering needs, analysis approaches, and stakeholder involvement techniques.

Data compilation and review are focused on the information relevant to building an understanding of the water quality impairment of the waterbody. The time spent on the project definition development process will also depend on the complexity and size of the project (number of water(s), cause(s)). Consideration of this information can better guide impaired waters planning, analysis, assumptions, and expected outcomes. The examination of information can be organized into three general steps, as shown in Figure 2-1 and described below:

- Compile basic information
- Analyze data
- Develop the preliminary project definition

Preliminary Data Compilation

- Types (monitoring, geographic, qualitative, other)
- Sources (academic, private, public)
- Quality (quality assurance/quality control, Quality Assurance Project Plan, recent, historical, incomplete)

Preliminary Data Analysis

- WQS/uses
- Conditions of impairment (summer, low flows)
- Potential sources/causes
- Data gaps/recommendations
- Basic statistics/regression
- Potential pollutant relationships (correlations)

Preliminary Project Definition

- 303(d) listing/basis
- Location
- Specific impairment, data source and justification
- Initial source/cause relationship
- Data sufficiency
- Recommended approach

Figure 2-1. Steps in Derivation of Project Definition

2.1. Preliminary Data Compilation

This step entails a preliminary examination of what relevant data are available to describe the nature of the impairment. Consideration should be given to organizing the data and information inventory using a spreadsheet or database. The following lists of questions and data needs are intended to provide a basic understanding of the types of information often used in the analyses of impaired waters. They do not represent the minimum elements for a given project type, nor are they intended to be comprehensive.

□ *Why is the water listed?*
- Determine the water quality standards impairment that placed the water on the state 303(d) list

- Identify data sources and rationale supporting the determination of a standards violation
- Consider whether the conditions leading to listing have changed (e.g., remediation, restoration, new data collection)

What types of data and information are available?

Monitored:
- Current/historical chemical, biological, and physical monitoring data
- Previous watershed or water quality analyses
- Flow and runoff information
- Meteorological data
- Point source monitoring data
- Flow alteration or diversion information

Geographic:
- Maps of the watershed, point and nonpoint sources (See sample project map in Figure 2-2.)
- Waterbody size and shape information
- Tributary locations and characteristics
- Current, historical, and potential future land uses
- Soil surveys and geologic information
- Topographic information
- Monitoring locations
- Point source locations

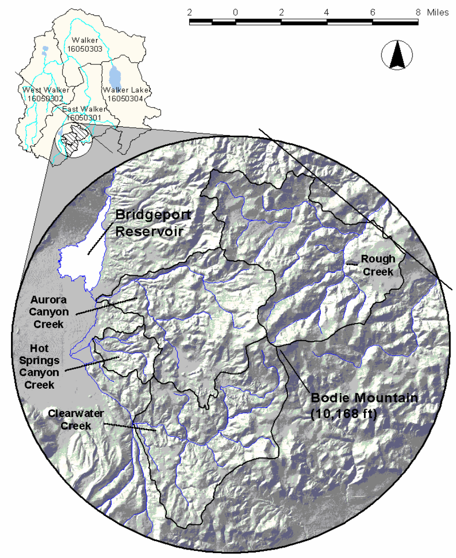


Figure 2-2. Sample Project Location Map

Regulatory:
- Existing programs
- Applicable water quality standards
- Discharge permits
- Past enforcement actions
- Existing regulatory and voluntary pollutant control programs

Qualitative:
- Agency personnel or local contacts who may have an initial understanding or hypothesis regarding the causes or sources of impairment
- Anecdotal information on the waterbody conditions (e.g., citizen complaints)
- Stakeholder meetings as a means to support information gathering and to brief the public on project

What are the sources for gathering available data?
- Public agencies (e.g., USEPA, U.S. Geological Survey [USGS], RWQCB, 319-funded group, volunteers, local contacts)
- Academic institutions
- Private (e.g., utilities, industry, citizens' groups)
- Published peer-reviewed scientific literature and gray literature produced by other agencies (e.g., U.S. Forest Service)

- *What are the data quality considerations?*
  - Were the available data collected under a Quality Assurance Project Plan (QAPP)
  - Is the data set complete/incomplete?
  - When were the data collected?

2.2. Data Analysis

In Step 2 a brief analysis is performed to support the formulation of the analyst's understanding of the waterbody conditions and the potential sources of impairment. The level of effort dedicated to this analysis should be commensurate with the desired product—a basic understanding of the conditions. As a general rule, no more than 2 weeks should be invested in this step. Questions considered in the Step 2 analysis are

- *What are the designated use(s) and impairment(s) associated with the listing?*
  - List the beneficial use(s) for the impaired segment(s), describe the designated uses being affected, and document the WQOs (narrative or numeric) or antidegradation concerns related to the identified impairment. (Appendix B includes a legal memo concerning the difference between WQOs and a numeric target used in a TMDL.)

- *Under what conditions is the impairment observed?*
  - Dry or wet season?
  - Rain on snow events?
  - High- or low-flow seasons?
  - Uniform throughout the year?

- *What are the potential sources contributing to the impairment?*
  - Pollutant source summary (nonpoint and point sources).
  - When does loading occur?
  - How do pollutants enter the waterbody (i.e., runoff, point sources, contaminated ground water, land uses, ineffective point source treatment, pipe failures, or bypasses around a sewer line)?
  - If possible, create a schematic conceptual model—visual guide—of watershed processes and sources.

- *What are the major data gaps?*
  - Are the data sufficient for the expected analysis (i.e., to evaluate current conditions and spatial and temporal trends, to use in model development)?
  - Is the data set relatively complete for all constituents?
  - Will additional data need to be collected?
  - What recommendations should be made for additional data collection?

- *Does examination of the data show any obvious relationships?*
  - Are there any obvious correlations? Performance of selected statistical analysis in key locations may identify problem areas and clarify the degree of impairment.

- *What characteristics of the waterbody and/or watershed could be affecting the impairment?*
  - Current/future growth, increases in industrial areas, future NPDES permits, residence time, reservoir/lake depth, mixing zones, seasonal cottage/home use (i.e., increased use in septic systems).

- *What types of management measures might be considered to restore the impaired water?*
  - Types of management measures and management practices for point and/or nonpoint sources.
  - Considerations for uncontrollable sources—UAA, SSO, variance in standards (seasonality), finding to authorize allowable degradation.
  - Ongoing watershed protection efforts (e.g., current mine reclamation projects or close-out plans).
  - Potential coordination with other agencies or related watershed studies.
  - Potential issues associated with constraints on water supply and water rights in the watershed or potential implementation measures.

2.3. Preliminary Project Definition

Based on the preliminary data review and analysis, a project definition is drafted describing the following:

- **303(d) listing location and pollutant(s):** Brief description of the location of the watershed, the extent of the listing, the appropriate standards, and the pollutants to be addressed.
- **Basis of listing:** Brief narrative of the data and information used as the basis for listing the waterbody as impaired.
- **Key pollutant sources:** Narrative on known and expected pollutant sources in the watershed.
- **Working hypothesis regarding cause of impairment:** If known, identify the likely causes of the impairment.
- **Analysis strategy:** Brief description of the strategy, if known, for assessing the impairment. For example, state whether the analysis will be limited to low-flow conditions and a spreadsheet model will be used.
- **Management techniques:** Discussion of potential management practices and additional investigation that might be required.

As new information is gathered in subsequent stages of the impaired waters process, the project definition should be revised accordingly. The box below provides an example of a project definition that was subsequently revised based on additional data collection and analysis.

Project Definition Example

The following provides a hypothetical example of a situation where the project definition was revised as new information provided a better understanding of the sources and impairment conditions. The example illustrates the dynamic nature of the problem definition, with its revision and enhancement occurring throughout the ongoing analytical process.

The Canyon Creek watershed is approximately X mi^2 and is dominated by rangeland and forest. The watershed is almost entirely Forest Service lands (99%), with very little privately held lands (<1%). Canyon Creek is listed on the 303(d) list of waters not meeting water quality standards because of nuisance growths of algae. The coldwater aquatic life designated use is not fully supported because of excess plant growths (algal growth). The creek appears to be experiencing elevated nutrient concentrations resulting in nuisance growths of algae. This appears to violate the narrative water quality objective for nutrients, which prohibits discharges of biostimulatory substances in concentrations that cause nuisance or adversely affect beneficial uses. Based on historical monitoring, the primary sources of excess nutrients causing the impairment were identified as grazing, removal of riparian vegetation, and streambank destabilization. Additional data gathering is recommended to verify the impairment and quantify the source contributions.

The project plan was developed and implemented. Additional monitoring data were collected in Canyon Creek during late spring and summer to verify the impairment listing, evaluate the potential sources, and determine the level of current algal growth in the stream. Since there were no numeric standards for plant nutrients, an assessment for nutrient overenrichment was made, including an algal bioassay. Using this information, a numeric target for algal productivity was established for this stream. This target was based on a USEPA moderate level productivity criterion for algal growth based on algal bioassays.

Analysis of the data indicated that a naturally occurring source, a spring, was the largest contributor of nutrient loading to the stream. Road maintenance/runoff was identified as another source in addition to the expected sources of rangeland, removal of riparian vegetation, and streambank destabilization.

The project definition was revised in the final project report as follows (the revised text is underlined):

The Canyon Creek watershed is approximately X mi^2 and is dominated by rangeland and forest. The watershed is almost entirely Forest Service lands (99%), with very little privately held lands (<1%). Canyon Creek is listed on the 303(d) list of waters not meeting water quality standards because of nuisance growths of algae. The coldwater aquatic life designated use is not fully supported because of excess plant growths (algal growth). <Revised text> This violates the narrative water quality objective for nutrients, which prohibits discharges of biostimulatory substances in concentrations that cause nuisance or adversely affect beneficial uses. <u>Creek has high nutrient concentrations resulting in nuisance growths of algae. Excessive algae growth is impairing the high quality coldwater fishery use. The nutrient concentrations in the creek are naturally high due to a spring, but anthropogenic sources identified in the 2001 monitoring provide additional nutrient inputs that stimulate algal growth. Management of road maintenance/runoff, rangeland, removal of riparian vegetation, and streambank destabilization is expected to meet the moderate level productivity criterion for the algal growth target in the creek, which will result in meeting water quality objectives.</u>

The new project definition resulted from the technical analysis that identified the presence of a naturally occurring source, as well as road maintenance/runoff issues. The resulting TMDL recognizes natural conditions and road maintenance/runoff in the allocation of nonpoint sources.

3. PROJECT PLAN

Once the project definition phase has been completed, a clear and coherent plan to complete the project must be designed. The objective of the project plan is to map the project from start to finish, detailing specific objectives, available resources, constraints, project tasks, interim milestones, and project deadlines. The scope of work (or project plan) will guide project efforts through completion of the project. The project plan will need to be updated if new information or analysis requires modifying the course of action.

3.1. Project Task Selection

Before planning the project, the project definition should be reviewed to gain familiarity with the location, the nature of the waterbody impairment, the watershed characterization, the basis for the 303(d) listing, the preliminary data assessment, and the preliminary objective of the project. The goal of the review of the project definition should be to determine whether the waterbody is attaining water quality standards or whether more data collection is needed to make this determination. In support of the project planning phase, a slightly more detailed compilation and review of data can be performed so that the scope of the project can be more accurately defined. Based on the findings of the data review, the analysis may follow a path consistent with one of the three regulatory tracks listed below and in Figure 3-1:

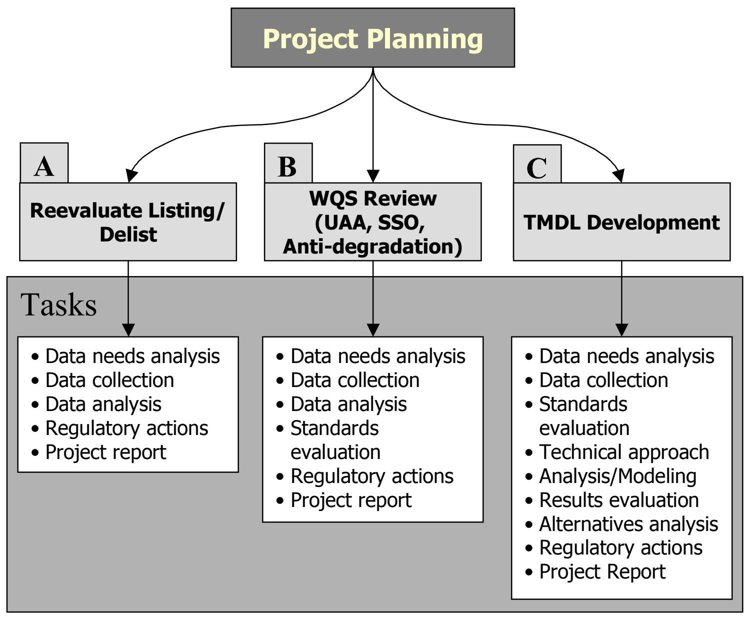


Figure 3-1. Task Selection Process

A. Water quality standards (WQS) may currently be supported, or a determination of the condition cannot be made, and further data collection is needed.
B. Additional data review or observations subsequent to listing indicate that a standards-related action will be needed (UAA, SSO, Anti-degradation). Appendix C includes an issue paper on UAAs and SSOs.
C. A corrective action, such as a TMDL, will be required.

Other tracks or combination of tracks might be desired depending on the circumstances. As data are collected and analyzed, or more detailed modeling analyses are performed, the initial selection of the regulatory track can be revised accordingly. Selection of regulatory track A, B, or C will likely dictate the types of analytical tasks needed. Table 3-1 lists the typical tasks and their relevance to each of the regulatory tracks. These generalized tracks are intended to provide some structure to these analyses, but they should not be accepted as the only or even the preferred tracks. It is likely that many analyses will start as Track A and will end up as Tracks B, C, or a combination.

Table 3-1. Typical Subtasks in the Project Analyses Phase

Track A	Track B	Track C
• Statistical analysis of monitoring data • Collection of additional monitoring data • Interpretation and assessment of the existing standards	• Statistical analysis of monitoring data • Evaluation of monitoring methods, detection limits, and laboratory analysis • Evaluation of multiple endpoints • Interpretation and assessment of the existing standards	• Watershed delineation • Watershed loading assessment/modeling • Watershed calibration/validation • Receiving water model setup • Bathymetry input • Receiving water model calibration/validation

Track A has an abbreviated task list, because the focus is on confirmation of the impairment through monitoring and/or additional or more detailed data analyses. One possible reason for pursuing this track is that management of sources or illicit discharges might have resulted in restoration of water quality standards. If the data collection or analysis confirms that the waterbody is in compliance with WQS, the appropriate regulatory action may be the delisting of the waterbody. If the additional data or analyses confirm that the impairment still exists, the Project Plan should be modified to reflect the need to follow Track B, C, or both.

Although all tracks share similar tasks, the specific analyses recommended will vary depending on the goal of the analyses or the type of regulatory action pursued. In Track C (development of a plan to correct the impairment), the analyses will be specifically defined by the technical approach selected. If a TMDL is required for the project, it will be calculated by following Track C.

3.2. Evaluation of Needs

Performance of each identified task will require investment of staff or contractor resources, specialized skills, and time. Examination of each task can help identify the full list of supporting resources that would be needed to achieve project objectives. Preparing a full list of potential needs can help in formulating options when realistic constraints are imposed by schedules and budget limitations. It is important to recognize that the level of effort required for each project might vary considerably based on factors such as watershed/waterbody complexity, source types, stakeholder and public interest, and cost of implementation.

An example of a needs analysis for a single pollutant (bacteria) TMDL project (Track C) is shown in Table 3-2. Note that the staff expertise listed in the table represents the optimal mix of skills for a TMDL analysis project and that in reality very few projects will have access to these skills. The purpose of the table is to help anticipate the typical level of effort and the need to build a multidisciplinary team to support the analysis. In most cases, RWQCBs will not need these skills for each project, but consideration of the technical resource pool (within the RWQCB or statewide) might prove useful when questions or technical needs arise.

Table 3-2. Sample Needs Analysis for a Bacteria TMDL Project

Task (Phase)	Desired Skills for Analyses	Level of Effort[a] Hours	Products
Project Definition (1)	Scientist/Engineer	20-60	Project Definition Statement
Project Plan (2)	Scientist/Engineer Biologist Statistician Monitoring expert	8-16 8-16 4-40 0-60	Project Plan
Stakeholder Involvement	Public outreach specialist Various technical staff as needed	80+ TBD	Ongoing Meetings/Briefing Materials
Data Collection & Analysis (3)[a]	Scientist/Engineer GIS technician	40-100 20-40	Progress Report Study Reports
Technical Approach (4)	Scientist/Engineer	32	Preliminary Project Report(s)
Analysis/Modeling (4)	Scientist/Engineer GIS technician	240-320 20-40	
Alternatives Analysis (4)	Scientist/Engineer	60	
Regulatory Actions (5)	Scientist/Engineer Legal reviewer[b]	16 16	Project Report
Regulatory Process (6)	Scientist/Engineer Public outreach specialist Legal reviewer[b]	TBD	Basin Plan Amendment or Other Regulatory Action
Regulatory Approvals (7)	Scientist/Engineer Legal reviewer[b]	TBD	SWRCB, Office of Administrative Law, USEPA Approval
Implementation (8)	NPS/Agricultural policy expert Scientist/Engineer	80 40	Ongoing Progress Reports (Post-Approval)

TBD = To be determined.
[a] Assumptions: No additional monitoring.
Available bacteria sampling and flow gauging.
Hydrologic Simulation Program-FORTRAN (HSPF)-based modeling approach.
Limited-complexity watershed (10 to 20 subwatersheds).
[b] Legal review will depend on type of regulatory option selected.

3.3. Assessment of Available Resources and Constraints

After specifying the needs to complete the identified tasks and actions, an assessment of the available resources and potential constraints must be made. Determining the available resources and potential constraints can significantly impact the scope of work and the specific tasks and technical approaches identified. Figure 3-2 illustrates the relationship between the needs (objectives/tasks) and the resources and constraints. The project needs will be reevaluated based on evaluation of the resources and constraints and the final project plan will reflect the resolution of the needs and constraints analyses. The checklist below provides categories of resources and constraints that should be considered in defining the project plan:

- **Data**
  - What amount and types of data are appropriate?
  - Do additional data need to be collected?

- How will additional data collection impact the project schedule?
- Do the data need to be converted from hard copy, manipulated, or re-formatted?
- Will existing data be difficult to compile?

Technical

- What is the level of complexity associated with the technical approach?
- Are the technical resources available in-house?
- Does the technical approach require specialized computer hardware or software?
- Can the technical approach demonstrate that the action will result in meeting applicable water quality standards?
- Have similar projects been completed? If so, can these be used as examples?

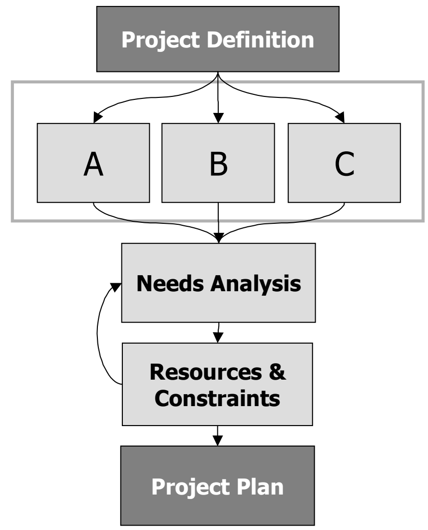


Figure 3-2. Iterative Planning Process

Monetary

- Given the necessary level of effort expected to complete the project, what is the cost in terms of person-years (PYs)?
- If expertise outside the agency is needed, what is the expected cost?
- What is the estimated cost of the project?
- What is the budget for the project?
- Can all tasks identified for the project be completed using the existing budget?

Staff

- How many staff members are potentially available to work on the project?
- What current obligations do staff members have?
- What skills do existing staff members have? Are these consistent with the project requirements?
- Is outside expertise needed?

Time

- Are there Consent Decree or lawsuit-related deadlines?
- What is the state's scheduled date for completion of the impaired waters analyses?
- What length of time is required for the review and approval process for the anticipated regulatory options? How will this impact the project?

Stakeholders

- What level of stakeholder involvement is appropriate?
- What are the key milestones where stakeholder meetings are needed or recommended?
- How can stakeholder resources be leveraged to assist the project?

Depending on the scenario, the specific resources and constraints may vary; however, the objective should be to determine what level of complexity is achievable given the level of resources and constraints. For instance, if more data collection is needed, funding resources may limit the extent of the effort. Or, perhaps data are not sufficient to support using a very complicated watershed/water quality model to calculate TMDLs or determine corrective actions. The above questions should help specify resources and constraints.

3.4. Identification of Interim Milestones, Project Timeline, and Tracking Options

To effectively control the project and ultimately ensure the project's success, a project performance timeline should be developed. In addition, interim milestones should be identified to provide a means for tracking the progress of the project. At a minimum, milestones should be consistent with the phases identified in Table 3-3.

Table 3-3. Phases of California's Impaired Water Process

Phase	Description	Product(s)
1	Definition of project, pollutant(s)/waterbody(s), justification.	Project Definition
2	Compile existing information, identify data needs, develop study plans, and engage stakeholders.	Project Plan
3	Data collection and analyses	Progress Report(s) Study Report(s)
4	Project report(s) w/ data and analysis findings. May include impairment assessment, source and loading analysis, implementation alternatives.	Preliminary Project Report(s)
5	Develop recommendations for regulatory action and compile results/findings.	Project Report (Phases 2-4 Inclusive)
6	RWQCB regulatory action process. May include workshop(s), hearing(s), and referral back to staff.	Basin Plan Amendment or Other Regulatory Action (e.g., Permit)
7	Regulatory approval	SWRCB, Office of Administrative Law, USEPA Approval
8	Implementation	Clean water

Interim milestones can be based on the specific tasks and actions that must take place to complete the project. For instance, the first milestone could occur following completion of the data compilation, analysis, and gap assessment. The second milestone could occur once the watershed/water quality model has been developed. Tracking milestones then provide a basis on which to judge the progress of the report and time needed to complete the project.

The project timetable specifies the overarching time period during which the project tasks occur. The interim milestones ensure that specific tasks are being accomplished. Interim milestones may need to be periodically revised. Together, the project timeline and interim milestones can also help to determine budget and resource requirements.

To construct the project timeline, the project's start and completion dates should be determined. Specific dates for the tasks, objectives, and interim milestones can be determined by working backwards from the completion date. Based on the intended regulatory action, sufficient time for unanticipated challenges can be built into the process. Multiple timelines can be developed if the specific regulatory action is not yet determined. A sample schedule for a Track C project is shown in Table 3-4 below.

Table 3-4. Sample 2-Year Schedule for Simplified Track C Project

Task (Phase)	Quarters (3-month increments)							
	1	2	3	4	5	6	7	8
Project Definition (1)								
Project Plan (2)								
Stakeholder (All) Involvement [a]	✓		✓		✓	**TBD**		
Data collection and analysis (3)[b]								
Technical Approach (4)								
Analysis/Modeling (4)								
Alternatives Analysis (4)			*Draft Reports*					
Regulatory Actions (5)	*Final Report*				TBD			
Regulatory Process (6)					TBD			
Regulatory Approvals (7)					TBD			
Implementation (8)					Follow-up TBD			

[a] Minimum recommended stakeholder meetings; remaining meetings dictated by regulatory options selected.
[b] Assumes no monitoring or additional data collection.

3.5. Development of the Project Plan

The product of this phase is the Project Plan document. Development of the final project plan requires resolving the needs (section 3.2), resources and constraints (section 3.3), and the project timetable (section 3.4.) Figure 3-2 illustrates the iterative process of reconciling the needs and the constraints placed on the project. The constraints often require a reassessment of the needs and the project approach. Several strategies can be employed to increase efficiency or optimize the use of available resources to meet the needs of the project.

- **Staff Sharing.** Identify and allocate staff resources for specialty skills across RWQCBs, and other state and federal agencies.
- **Outsourcing.** Identify key tasks that can be performed by technical experts or specialists in academia or the private sector.
- **Other sponsors**. Identify stakeholders willing to commit technical staff resources or financial resources to support data gathering or analysis. Other sponsors may include industry, specialty groups, and nonprofit agencies. Crafting an agreement with a local sponsor should consider the level and timing of commitment and the protection of the unbiased scientific and policy decision process of the RWQCB.

In reconciling needs and resources, another consideration is the phasing of the project in relation to other projects. While examining strategies for performing the project analysis, options for sharing common tasks between projects can also be considered. Analysis efficiencies can be realized by a larger grouping of projects within watersheds or regions, sharing specific tasks between projects, phasing projects to build technical skills or libraries, or identifying common technical and research needs that can benefit multiple projects. Some general efficiency ranges are shown in Table 3-5—these ranges represent estimates based on past experience developing and reviewing TMDLs and national costing studies conducted to support state and federal regulation development.

Grouping within a watershed is more efficient because data compilation and outreach activities are shared. Similar pollutants (e.g., nutrients) are likely to result in combined modeling techniques (e.g., nutrient, algal modeling). Unrelated pollutants are less likely to provide significant saving since their behavior is different, sources may vary, and analysis cannot be efficiently combined. Adjacent watersheds may offer some logistical efficiency (e.g., meetings). Note that the actual benefits of clustering are highly dependent on site-specific conditions and that clustering can have the effect of increasing analytical complexity. Therefore, site-specific conditions should be considered and weighed against the potential benefits of streamlining the process.

Table 3-5. Sample Efficiencies (as percentage of project cost)[a]

Type of Clustering	Efficiency Range (Percent)
Watershed	25—35
Additional related pollutant, same water	30—45
Additional unrelated pollutant, same water	10—30
Adjacent watersheds, similar pollutants/methods	10—20

[a]Typical clustering efficiencies are based on Tetra Tech's experience

The final project plan provides a summary of the project definition; data compilation and analysis, data gap assessment; specific tasks to be undertaken during the project; technical and monetary resources needed; staff or contract personnel who will complete the project; potential constraints; budget; and expected timeline, interim milestones, and completion date. A sample Track C Project Plan outline is shown in Figure 3-3 and a sample template is provided in Appendix D.

Sample Project Plan Outline—Track C

I. Introduction

II. Summary of Requirements
- a. Project Definition
- b. Objectives

III. Preliminary Data Review/Background
- a. Geographic Setting
- b. Sources
- c. Monitoring

IV. Project Tasks
- a. Public Participation
- b. Data Gap Evaluation
- c. Data Collection
- d. Data Analysis
- e. Model Selection
- f. Model Application and Testing
- g. Results
- h. Alternatives Analysis
- i. Technology Transfer
- j. Regulatory Options
- k. Implementation Plan
- l. Final Report
- m. Administrative Record

V. Personnel and Level of Effort
- a. Project Organization
- b. Staff Assignment
- c. Level of Effort

VI. Schedule and Products (by Task)
- a. Timeline
- b. Milestones

VII. Cost Estimate
- a. Assumptions
- b. Allocations by Task

Tables

California 1998 303(d) Listed Waterbodies
Relevant Water Quality Objectives
Existing and Potential Beneficial Uses
Available Geographic or Location Information
Available Monitoring Data
NPDES Discharges
Land Ownership Percentages
Land Cover Distribution
Approach Advantages and Disadvantages

Figures

Watershed Location
Location and Topography
Digital Elevation Map
Land Ownership
Land Use Coverage
Project Schedule

Figure 3-3. Sample Project Plan Outline

4. DATA COLLECTION AND MONITORING

Data gaps identified during the data analysis might be significant enough to delay the technical analysis phase until additional data are collected. Additional monitoring might be needed to

- Confirm impairment
- Evaluate criteria
- Support the project analyses
- Calibrate and validate models
- Identify or eliminate possible sources
- Test or evaluate management options

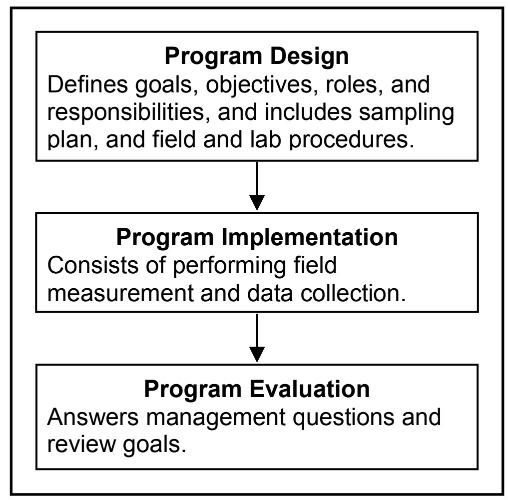


Figure 4-1. Key Phases in Development of a Monitoring Program

When additional data are needed, a monitoring plan should be developed that outlines the objectives of the monitoring effort, the methods of collecting and storing the data (including all quality assurance [QA] procedures), and how the data will be used in the analysis. The monitoring plan (see Figure 4-1) should include

1. A **program design** component that identifies key management questions to be answered by the monitoring program; defines the data quality requirements; details the technical aspects of field sampling; defines standard operating procedures, methods for laboratory analysis and quality control, and chain of custody; and includes a data management plan.
2. A **program implementation** phase that consists of performing field measurements and data collection, laboratory analysis, and processing and storage of program data. Program implementation should be performed according to the standard operating procedures and quality assurance plan developed during the program design step.
3. A **program evaluation** phase in which the data collected from the monitoring program are assessed for accuracy and sufficiency and are used to support analyses that answer the management questions defined in the program design.
4. The monitoring plan should also be checked to ensure it is consistent with the guidance and requirements of the Water Boards' Surface Water Ambient Monitoring Program (SWAMP).

Each step of the monitoring process consists of a set of elements that provides a structured approach for ensuring that all monitoring considerations are addressed and coordinated in an effective manner. Monitoring builds on the existing framework of state monitoring (e.g., Surface Water Ambient Monitoring Program [SWAMP]—see box below), as well as related state, federal, local, and nonpoint and private efforts

Monitoring programs developed for collection of additional data for TMDLs must be consistent with current SWAMP procedures and guidelines. SWAMP has established guidelines for field sampling (including standard operating procedures), a performance-based system for laboratory analyses, a Quality

Surface Water Ambient Monitoring Program (SWAMP)

The SWRCB recently created the Surface Water Ambient Monitoring Program (SWAMP) as a first step toward developing a long-term ambient monitoring program. SWAMP serves as an umbrella program for Water Board monitoring activities, including the TMDL Program. SWAMP provides a framework for producing consistent and comparable high quality data that is easily accessible via the internet. (SWAMP is intended to meet four goals:

- Identify specific problems preventing the SWRCB, RWQCBs, and the public from realizing beneficial uses in targeted watersheds.
- Create an ambient monitoring program that addresses all HUs of the State using consistent and objective monitoring, sampling and analysis methods; consistent data quality assurance protocols; and centralized data management.
- Document ambient water quality conditions in potentially clean and polluted areas.
- Provide the data to evaluate the effectiveness of water quality regulatory programs in protecting beneficial uses of waters of the State.

Because SWAMP is a relatively new program, it is still being developed and refined. Each Regional Board has a SWAMP Coordinator that can provide the most current information on the program.

Management Plan that details quality assurance and quality control requirements and minimum data quality objectives. SWAMP also has an internet accessible database and requirements on database architecture, data standards, and water quality data elements. SWAMP guidelines and requirements are refined annually. The most up-to-date information can be found.

4.1. Monitoring Program Design

The design step will result in the development of an overall framework for designing and implementing an effective sampling plan with well-defined criteria and specifications along with associated laboratory analyses and data quality control procedures. Before the monitoring program is designed, an appropriate plan should be developed. Planning a successful monitoring program relies on (1) collecting and properly processing all programmatic and technical information relevant to characterizing the intended use of the data; (2) defining the relationships between the various planning components, including management questions to be answered, available resources, and site conditions; and (3) deriving a set of monitoring objectives and guidelines for final design of the program. Figure 4-2 illustrates the important planning elements to consider prior to design and implementation of data collection.

The design step of the monitoring program involves development of (1) data quality and monitoring objectives; (2) a sampling design plan, including detailed specifications for standard operating procedures, and a logistical and training program; (3) a data management plan; and (4) a Quality Assurance Project Plan (QAPP). The monitoring design provides complete documentation of the data collection procedures and the rationale or justification supporting the various planning and design conditions.

SWRCB's *Proposal for a Comprehensive Ambient Surface Water Quality Monitoring Program* includes information on

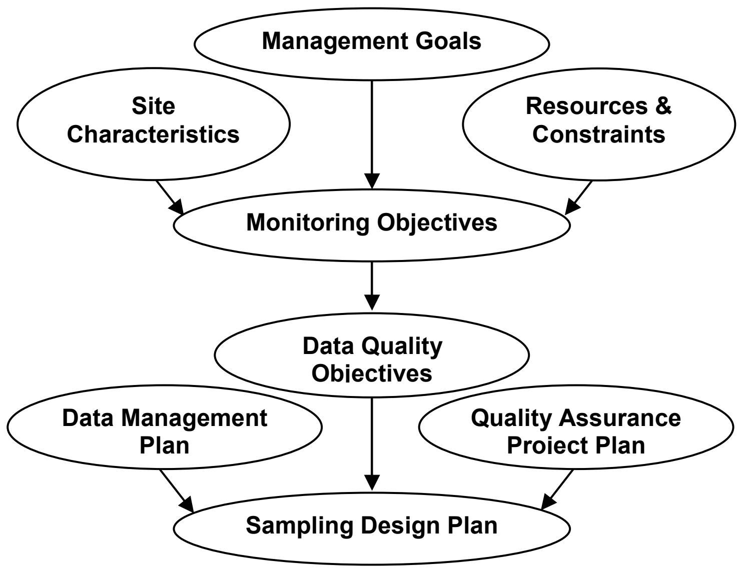
- Designing a monitoring study
- Identifying water quality indicators
- Performing necessary quality assurance
- Managing, evaluating, and reporting data

4.2. Monitoring Program Implementation

The implementation of the monitoring program requires that decisions made in the design step be translated into an operations field-monitoring program. Decisions must be made regarding

- Equipment installation and testing
- Finalization of field operating procedures

- Sample handling and processing
- Preliminary review of testing or initial monitoring results
- Sampling design plan and implementation review



Elements to Consider for Monitoring Objectives

- Monitoring approach selected
- Sampling locations identified
- Pollutants defined
- Stream flow
- Media (e.g., water column, sediment)
- Duration of sampling program
- Adequacy and sufficiency of data requirements
- Level of QA/QC required
- Roles and responsibilities of project staff defined

Elements to Consider for Sampling Design

- Data quality objectives
- Monitoring approach
- Data collection protocols
- Field operation procedures
- Laboratory analyses, detection limits, holding times, preservation, and chain of custody
- Data management system
- Data analysis techniques
- QA/QC

Figure 4-2. Components of Program Design

Public awareness and involvement are also important aspects of the monitoring program. Prior to commencement, community surveys and meetings concerning community expectations of aesthetic and recreational aspects of the design should be considered. A well-informed public would see the need for pollution control and would likely support the monitoring effort. The public will also want to see the results of the efforts in a timely manner. Carefully prepared press releases or articles are very effective in communicating ideas or results to the public. Additional information should be available to those who show a particular interest, and key project personnel should make time to be available for questions.

4.3. Monitoring Program Evaluation

The monitoring program culminates in the evaluation step. A good understanding of data limitations is essential for integrating the results into the technical analyses and selecting an appropriate data analysis methodology. Any conclusions or inferences should include a statement on the associated degree of confidence. Important considerations in assessing the degree of confidence associated with any conclusions are (1) how well do the data represent short- and long-term variability in the hydrologic regime, and (2) are the data sufficient to answer management questions to the desired degree of confidence.

Depending on the nature of the additional data collection and the results of the data analyses, the project plan may be revised or the project analysis may be initiated using the data provided by the supplemental monitoring program. For instance, the results of the additional data collection may indicate that the previous project plan is no longer appropriate. Ideally, the additional data would support an alternate project plan. Conversely, the additional data can confirm that the existing project plan is appropriate and provide the necessary temporal and spatial resolution to complete the plan.

Example of Supplementary Monitoring

The Shenandoah River drains more than 3,000 mi^2 of predominantly forested land in northwestern Virginia and northeastern West Virginia. Several segments of the river were identified on Virginia's and West Virginia's 303(d) lists as impaired due to polychlorinated biphenyl (PCB) contamination and subsequent fish consumption advisories. Because the impaired river crosses the Virginia-West Virginia border and applicable water quality criteria vary dramatically between the states, USEPA Region 3, Virginia Department of Environmental Quality, and West Virginia Department of Environmental Protection worked together to develop TMDLs using a consistent methodology that evaluated all relevant water quality standards.

Existing PCB data for the Shenandoah River were spatially limited in that they primarily reflected conditions at or near a historical contamination site; the were limited in the sense that most data failed to detect PCBs in either sediment or surface water at levels necessary to compare to standards because of the analysis technique used. Therefore, to better understand the variability in PCB concentrations in the Shenandoah River, and to either discount or identify other potential sources, a focused sampling effort was undertaken. This effort included collection of water column, sediment, and tissue samples at locations upstream, downstream, and within the impaired river segments to better ascertain the spatial distribution of PCBs in the aquatic environment. Eleven sites were selected based on spatial variability and the locations of existing sites. Given the need for a lower detection level and consistency with the state water quality standards, a USEPA-approved method with an acceptable detection limit was used for analyzing individual PCB congeners. Ultimately, the monitoring data were used to define boundary conditions for a site-specific simplified mass balance model that considered potential sources, critical in-stream processes and interactions, and the suite of potential water quality targets or endpoints.

Selected National Data Collection and Monitoring References

- *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition*. EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC. http://www.epa.gov/owow/monitoring/rbp/
- *National Handbook of Water Quality Monitoring. Part 600, National Water Quality Handbook*. U.S. Department of Agriculture, Natural Resources Conservation Service, Washington, DC.
- *Monitoring Guidance for Determining Effectiveness of Nonpoint Source Controls, Final*. EPA 841-B-96-004. U.S. Environmental Protection Agency, Office of Water, Washington, DC.
- *Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures—Agriculture*. EPA 841-B-97-010. U.S. Environmental Protection Agency, Office of Water, Washington, DC. http://www.epa.gov/owow/nps/agfinal.html
- *Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures—Forestry*. EPA 841-B-97-009. U.S. Environmental Protection Agency, Office of Water, Washington, DC. http://www.epa.gov/owow/nps/forestry/index.html
- *Volunteer Stream Monitoring: A Methods Manual*. EPA 841-B-97-003. U.S. Environmental Protection Agency, Office of Water, Washington, DC. http://www.epa.gov/owow/monitoring/volunteer/stream/
- *Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures — Urban*. EPA 841-B-00-007. U.S. Environmental Protection Agency, Office of Water, Washington, DC. http://www.epa.gov/owow/nps/urban2.html
- *National Water Quality Monitoring Council web site contains information on national approach to data quality and comparability* http://water.usgs.gov/wicp/acwi/monitoring/index.html

Selected California Data Collection and Monitoring References

- Surface Water Ambient Monitoring Program web site contains latest updates on Water Boards' monitoring guidance and requirements http://www.waterboards.ca.gov/swamp/index.html
- *Proposal for a Comprehensive Ambient Surface Water Quality Monitoring Program.* http://www.waterboards.ca.gov/legislative/2000.html

5. PROJECT ANALYSES

Up to this point, this document has focused on the planning and design of impaired waters projects. The next phase consists of project analyses that will determine the pollution or pollutant management requirements and provide the rationale and justification for the implementation of an optimal set of regulatory and nonregulatory actions needed to improve or maintain water quality to support beneficial uses. This chapter will outline the decision process and general steps for conducting project analyses. The use of conceptual models is introduced as a technique for understanding and communicating relationships between pollutants and impairments and for providing a framework for designing and executing project analyses. Project analyses successfully used in California for common impairment types are summarized. It is beyond the scope of this document to provide an exhaustive description of all the methods available. Instead, examples and references to more detailed information have been provided for each of the steps. Categorical technical modules that provide step-by-step guidance are under development as a companion to this document; modules for bacteria and urban pesticides are currently under way. <Insert Web page containing draft modules, when available.> The general steps outlined in this chapter include

> ***Conceptual Model***
>
> A *conceptual model* of an environmental system is developed using readily available information. The conceptual model is used to visualize all potential or suspected sources of impairment, types and concentrations of pollutants in the impaired water, potential sources and pathways, and interactions between pollutants and related stressors. The use of conceptual models can aid in the identification of the most likely pollutant(s) or stressors and support selection of appropriate analysis techniques.

Data Analyses: The compilation and analysis of data and information are essential to understanding the general water quality conditions and trends and potential pollutant sources. Data analyses, which are targeted or focused depending on the pollution and waterbody characteristics, can guide the approach for addressing the impaired water or completing the appropriate regulatory action (e.g., TMDL development).

Technical Analyses: In this step the conceptual model or understanding of the impaired waters is developed and specific technical analyses are selected and executed to evaluate impaired waters. This step typically provides the technical underpinnings of all future decisions and drives the regulatory and nonregulatory actions. The technical analyses can include applying models or other analytical tools to support an understanding of how pollutant loading affects instream conditions. The technical analysis of watershed loading and waterbody response (linkage analysis) results in the calculation of the allowable loading to meet water quality standards (e.g., the loading capacity for TMDLs) and supports the evaluation of multiple management and pollutant reduction scenarios to achieve water quality standards.

TMDL Allocation: Allocation analysis follows a stepwise process to identify the assimilative capacity of the receiving water and how the allowable loading capacity can be allocated among the various sources. The allocation analysis should result in the determination of the loading capacity (or TMDL), load allocation, waste load allocation, and margin of safety, and it should clearly identify background conditions considered. The analysis should also consider the seasonal variation of both the loading characteristics and hydrologic variability of the stream flow and its assimilative capacity.

The allocation phase might also consider permit requirements, watershed-based permitting, or pollutant trading opportunities.

Project Report: The project report documents the analyses performed, information sources, and results and conclusions. The project report for TMDLs provides documentation of the required elements of the TMDL. For actions requiring a Basin Plan amendment (e.g., TMDL), the report should also address the requirements for an administrative record documenting the process and technical backup for the analyses performed.

5.1. Selection of Project Analyses

A wide variety of waters are listed as impaired on California's 2002 Section 303(d) list. More than 160 different pollutants were identified as contributing to impairment of waterbodies across the state. However, 25 pollutants were found in more than 60 percent of the listed waters. Table 5-1 shows the most frequently identified pollutants and their associated cumulative percentage of the total listed waters. Note that some of the listed pollutants are associated with related impairments (e.g., high coliform, beach closures, and pathogens) and could be grouped into larger general categories.

Table 5-1. Top 25 Listed Pollutants (CA 2002 303(d) list)

Pollutant	Frequency	Percent	Cumulative Percent
Sedimentation/Siltation	129	7%	7%
Diazinon	85	5%	11%
High Coliform Count	77	4%	15%
Mercury	66	4%	19%
Pathogens	66	4%	22%
Fecal Coliform	60	3%	26%
DDT	54	3%	29%
Nutrients	54	3%	31%
PCBs	51	3%	34%
Bacteria Indicators	45	2%	36%
Beach Closures	42	2%	39%
Temperature	37	2%	41%
Ammonia	36	2%	43%
Copper	36	2%	45%
Algae	30	2%	46%
Lead	30	2%	48%
Organic Enrichment/ Low Dissolved Oxygen	29	2%	49%
Trash	28	1%	51%
Phosphorus	27	1%	52%
Total Dissolved Solids	27	1%	54%
Metals	26	1%	55%
Unknown Toxicity	26	1%	56%
Pesticides	24	1%	58%
Selenium	24	1%	59%
Sediment Toxicity	23	1%	60%

Understanding the types of impairments that occur in California can help identify the types of analyses that may be employed in investigating impairments, developing conceptual models, diagnosing causes of impairment, and identifying management solutions. An examination of the waterbody types (e.g., river, lake, reservoir, estuary, coastal) in combination with types of impairments has been used to identify 10 major categories of frequently observed combinations (Figure 5-1).

When evaluating the characteristics of a specific waterbody and associated impairment(s), a conceptual model that demonstrates an understanding of the system

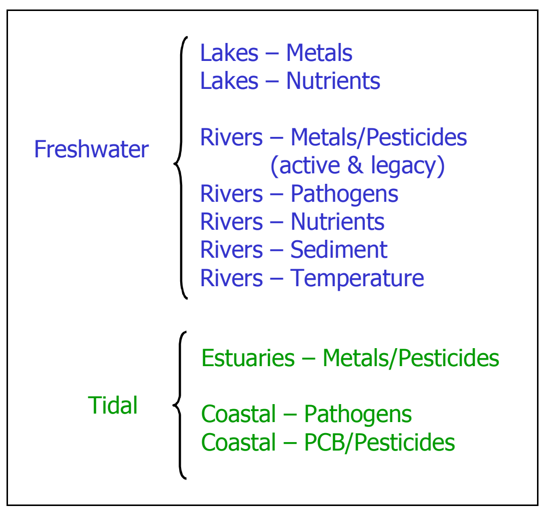


Figure 5-1. Ten Major Waterbody/Pollutant Combinations in California

should be developed. The use of conceptual models is derived from ecological risk assessment approaches, which bear many similarities in objectives and procedures to impaired waters analyses (USEPA, 1998). Conceptual models can be as simple as a statement (e.g., stormwater runoff is causing exceedances of the acute zinc WQO). For complex systems a conceptual model may identify chemical and biological relationships that describe multiple influences and interactions associated with the impairment, such as the conceptual model of the San Francisco Bay copper impairment shown in Figure 5-2.

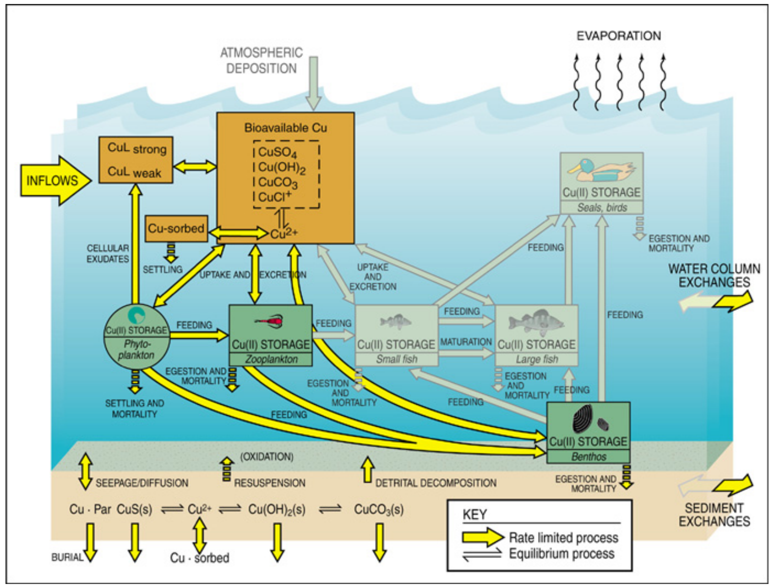


Figure 5-2. Conceptual Model Schematic for San Francisco Bay Copper Study

A conceptual model is based on an understanding of the impairment and the associated dynamics between the use to be supported, the pollutants identified, the processes of source loading, and instream processes. The conceptual model builds on an understanding of **what** the impairment is, **when** the impairment occurs, and **how** the associated loading occurs or stressor affects the use (Figure 5-3).

- **When** and under what environmental conditions does the impairment occur? (e.g., during a runoff event, during a dry, hot weather period). Understanding when the problem occurs leads to a determination of the critical environmental conditions defined by factors such as flow, temperature, or sunlight.
- **How** did the pollutant or related loading occur (e.g., legacy loading of toxics or pesticides, current loading of metals from stormwater)? Understanding how the loading of the pollutant occurred also defines the types of sources that may ultimately contribute to the impairment (e.g., stormwater runoff, point source discharges).

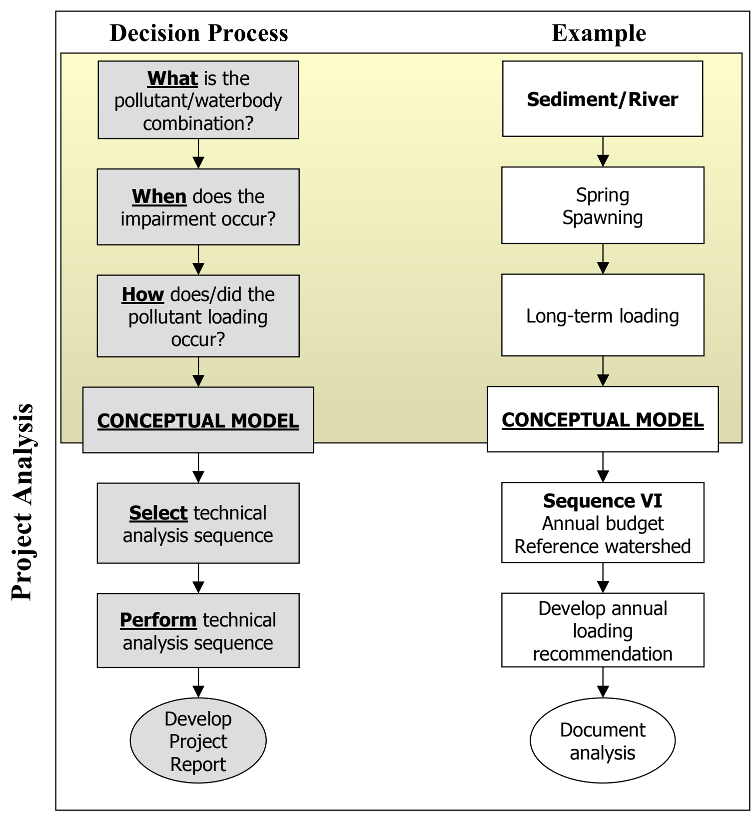


Figure 5-3. Project Analyses Decision Process

Typical sequences of technical analyses for 11 types (10 major combinations, and 1 combination having two types of pesticides—active and legacy) are shown in Table 5-2. The typical sequences are compilations of techniques successfully used in California and other states to perform impaired waters analyses. Practitioners may also derive their own technical analyses with the understanding that they must address key features of the impairment and the required elements of the UAA (Track B) or TMDL or pollution-related impairment (Track C). The following sections describe in more detail some of the analysis techniques used. Brief descriptions of the public domain models mentioned in Table 5-2 can be found on page 5-17. Categorical technical modules with detailed descriptions of technical approaches and case studies are also under development as a companion to this document. (Appendix E contains case studies highlighting various approaches for addressing impaired waters. Additional case studies will be added as relevant TMDLs are approved by the SWRCB.)

Table 5-2. Summary of Analysis Sequences for Selected Impaired Water Categories

What is the Impaired Water Category?	**I**	**II**	**III**
	River – Pathogens	**Lake – Nutrients**	**River – Nutrients**
When does the impairment occur?	Storm events or warm weather, dry season periods	Summer/dry season	Summer/dry season/year-round
How is the loading delivered?	Storm event runoff or dry weather discharge, direct deposition	Stormwater runoff, dry weather inflows, point sources	Dry weather inflows (point source discharges, nonpoint sources, groundwater)
Data analyses	o Exceedance analysis (geometric mean, not to exceed) o Flow frequency o Wet/dry day separation o Characterization of "hot spots"	o Lake trophic state evaluation o Nutrient/chlorophyll *a* o Summer statistics o Watershed loading estimates	o Stream dry and wet season statistics o Spatial analysis o Downstream of tributaries, phosphate sources o Undisturbed or reference areas for background o Benthic chlorophyll *a* or algal coverage
Technical Analyses: General Approach	Wet weather and dry weather pathogen analysis	Eutrophication analysis to identify nutrient loading thresholds to meet in-lake targets	Low- or high-flow analysis of nutrient loading thresholds to meet instream targets
Technical Analyses: Watershed Loading	Flow, concentration, and load estimation using HSPF	Load estimation using GWLF. More detailed option HSPF	Load estimation based on tributary and point source low-flow monitoring
Technical Analyses: Receiving Water Response	Instream response using HSPF (data collection consideration)	Lake response using BATHTUB. More detailed option using CEQUAL-W2 or EFDC.	Stream response using mass balance, QUAL2E low-flow model, or WASP
Calculation of Loading Capacity	Number of exceedance days based on model output or monitoring data and comparison with reference watershed	Loading of nitrogen and phosphorus needed to meet lake target as simulated by lake model	Loading or concentration for critical low-flow or average summer, or high-flow periods
Typical Implementation Practices	Targeted management of pathogen sources: stormwater, rural uses, septics	Targeted management of nutrient sources: stormwater, rural uses, open space uses, septics, point sources	Targeted dry or weather reductions from point sources, dry season nonpoint sources
Case Studies	Santa Monica, CA http://www.waterboards.ca.gov/rwqcb4/html/meetings/tmdl/tmdl_ws_santa_monica.html	Lake Elsinore and Canyon Lake, CA http://www.waterboards.ca.gov/rwqcb8/html/tmdls.html	Los Angeles River Nutrients TMDL, CA http://www.waterboards.ca.gov/rwqcb4/html/meetings/tmdl/tmdl_ws_los_angeles.html

Table 5-2. Summary of Analysis Sequences for Selected Impaired Water Categories (continued)

What Impaired Water Category?		IV	V	VI
		River – Pesticides/Urban (Active Pesticide Sources)	**River – Pesticides/Legacy (No Current Pesticide Sources)**	**River/Estuary – Toxics**
When does the impairment occur?		Mixed. Associated with application dates and days when transport occurs	Mixed. Associated with disturbance or resuspension of historical deposits	Mixed
How is the loading delivered?		Urban runoff, typically storm drains. Dry weather discharges including irrigation and dumping	Historic delivery. Resuspension due to storm events, aquatic life	Municipal and industrial wastewater, urban runoff, agricultural runoff, other sources
Data analyses		o Standards evaluation o Trends evaluation o Spatial analysis	o Standards evaluation o Trends evaluation o Spatial analysis o Fish/mussel data analysis	o Standards evaluation o Trends evaluation o Spatial analysis
Technical Analyses:	General Approach	Identification of reduction needed to meet water column toxicity-based targets	Identification of reduction needed to meet sediment, fish tissue, or water column water quality toxicity-based targets	Identification of reduction needed to meet sediment, fish tissues or water column toxicity-based targets
	Watershed Loading	Source characterization	Tributary monitoring	Source characterization
	Receiving Water Response	Allowable loading determination based on calculation from identified target at design flow or a range of flows	Allowable loading determination based on calculation from identified target at design flow or a range of flows	Allowable loading determination based on calculation from identified target at design flow or a range of flows
Calculation of Loading Capacity		Allowable load for design flow or annual period	Allowable load for design flow or annual period	Allowable load for design flow or annual period
Typical Implementation Practices		Reduction or elimination of active pesticide sources	Removal or stabilization of deposits, long-term attenuation	Reduction or elimination of active toxic sources
Case Studies		San Francisco Bay Area Urban Creeks Pesticide Toxicity/Diazinon TMDL, CA http://www.waterboards.ca.gov/rwqcb2/urbancrksdiazinontmdl.htm	Newport Bay, CA http://www.epa.gov/region09/water/tmdl/final.html	Newport Bay, CA http://www.epa.gov/region09/water/tmdl/final.html

Table 5-2. Summary of Analysis Sequences for Selected Impaired Water Categories (continued)

	VII	VIII	IX
What is the Impaired Water Category?	**River – Sediment**	**River – Temperature**	**River – Biological**
When does the impairment occur?	Nonseasonal: estuary infilling, pool filling Spring: spawning/incubation All seasons: rearing Winter: migration (turbidity-related)	Summer/dry-warm weather	Multiple/dry-wet season
How is the loading delivered?	Storms and throughout the wet season over a wide range of flows	Summer heat input	Depends on pollutants/stressors associated with the impaired conditions
Data analyses	o Total suspended solids (TSS) analysis o Spatial analysis o Historical trends o Physical/geomorphic instream conditions (channel physical parameters) o Hillslope conditions (road density, conditions, unstable areas) o Turbidity o Fish or other biological populations/distribution o Identification of reference watersheds o Identification of reference time periods (alternative to reference watershed if not available)	o Seasonal temperature analysis o Spatial temperature analysis o Exceedance analysis o Analysis of vegetation and stream corridor	o Biological criteria evaluation o Correlation analysis (biological to chemical/physical indicators) to determine dominant pollutants/stressors o Spatial analysis to identify potential sources/stressors o Identification of reference watersheds
Technical Analyses: General Approach	Long-term loading analysis based on sediment budget and reference approach. Sediment source analysis if full budget not possible Turbidity/TSS events Sedigraphs (combination of flow and turbidity/TSS data)	Temperature estimation based on flow, solar inputs, stream geometry, meteorologic conditions, vegetative shading, and other factors	Biological reference approach, load estimation for identified pollutants
Technical Analyses: Watershed Loading	Load estimation using sediment budget or sediment source analysis Estimation of inputs based on sediment yields and delivery from land use/erosion categories	Temperature estimation based on models of flow, travel time, solar/meteorologic conditions. Shade models do not address watersheds with dams or high levels of irrigation return flows, or cooling water discharges.	Load estimation of identified pollutant(s) contributing to biological impairment using GWLF or similar model
Technical Analyses: Receiving Water Response	Load target determined from comparison with desired reference watershed Rate of infilling Geomorphic/habitat targets derived from literature	SSTEMP or SNTEMP stream flow and temperature analysis, QUAL2E stream flow and temperature analysis	Comparison of estimated watershed/source loads with loads in reference watershed
Calculation of Loading Capacity	Average annual sediment load from dominant sources to meet reference conditions. Identification of achievable reductions by source category	Heat loading Shade dominated streams Effective shade allocations (% of stream shade	Annual loading benchmarked to reference watershed
Typical Implementation Practices	Targeted management of sediment sources for long-term restoration	Targeted management of vegetation and stream system, dam releases, irrigation withdrawals, or return flows	Targeted management of relevant pollutant sources
Case Studies	Garcia River, CA http://www.epa.gov/region09/water/tmdl/final.html	North Fork Eel River, CA http://www.epa.gov/region09/water/tmdl/final.html	Cooks Creek, VA http://www.deq.state.va.us/tmdl/tmdlrpts.html

Table 5-2. Summary of Analysis Sequences for Selected Impaired Water Categories (continued)

		X	XI
What is the Impaired Water Category?		**Estuary – Nutrients**	**Coastal – Pathogen**
When does the impairment occur?		Die-off of macrophytes, floating maps, algal blooms	Spring runoff or winter and summer dry weather
How is the loading delivered?		Annual/long-term nutrient loading from runoff, nutrients associated with sediment, groundwater	Runoff/wet weather sources or dry weather sources Direct deposition
Data analyses		o Load estimation o Long-term trends evaluation o Spatial analysis o Seasonal trends o Algal densities	o Standards evaluation o Seasonal evaluation o Wet and dry day analysis o Spatial analysis
Technical Analyses:	General Approach	Long-term loading, nutrient cycling, and response of estuaries	Wet weather loading and response of estuaries
	Watershed Loading	Load estimation using GWLF, HSPF, analyses of monitoring data, or similar model	Load estimation using HSPF or direct analysis of monitoring data
	Receiving Water Response	Estuary response using Tidal Prism, WASP, EFDC, or similar model	Response using WASP, EFDC, or similar model Alternatively determine correlation of coastal impairment with tributary loading
Calculation of Loading Capacity		Annual loading based on meeting estuary target condition	Wet and dry weather exceedance frequencies and associated loading
Typical Implementation Practices		Targeted management of nutrient and sediment sources: stormwater, rural uses, open space uses, septics, point sources, irrigation return flows, fertilizer management	Targeted management of pathogen sources: stormwater, rural uses, septics
Case Studies		(Several available nationally)	Santa Monica, CA http://www.waterboards.ca.gov/rwqcb4/html/meetings/tmdl/tmdl_ws_santa_monica.html

5.2. Data Analyses

The compilation and analysis of data and information is an essential step in understanding the general water quality conditions and trends, and potential pollutant sources. The data compilation and analysis will guide the approach used for addressing the impaired water or completing the appropriate regulatory action (e.g., TMDL development). Specifically, the compilation and subsequent review and analysis of data will support the following activities:

- Identification of data gaps and sampling needs
- Confirmation of impairment status
- Identification of potential sources (identify or confirm sources)
- Identification of critical conditions
- Evaluation of seasonal variation
- Selection of model/analysis options (discussed in the Technical Analyses section)
- Model setup and testing (discussed in the Technical Analyses section)

Typical Data Analyses Objectives

To compile and review data by

- Developing a data inventory
- Evaluating data quality
- Identifying data gaps

To analyze data for evaluation of

- Impairment status
- Spatial trends
- Temporal trends
- Other relationships and trends (e.g., flow vs. pollutant, pollutant vs. pollutant)

Data compilation and analyses are an ongoing process in the impaired waters analysis, with the focus, level of effort, and purpose varying from phase to phase. Table 5-3 presents the different levels and types of data review and analyses that might be conducted throughout the project. Most of the data analyses discussed in this section will build on activities performed during the Project Planning phase to evaluate the water's impairment and identify any relevant trends that would help to determine the staff and level of effort for completion of the project (e.g., WQS review, TMDL development).

Table 5-3. Levels of Data Review for the Impaired Waters Analysis

Data Compilation, Review, and Analysis Level	Project Phase	Description of Data Characterization	Examples of Data Review or Analysis Activity
I	Project Definition	Cursory review of data to understand the impairment and to evaluate data availability	▪ Identify the amount and type of data available for the impaired water (e.g., identify data available internally and in readily accessible national/state databases). ▪ Gain a better understanding of the data necessary to further evaluate the impaired water.
II	Project Planning	Targeted analyses of available data to characterize the impaired water for project planning purposes	▪ Conduct selected statistical analyses on water quality and flow data to confirm impairment, evaluate under what conditions impairment occurs, and identify spatial and temporal trends. ▪ Evaluate instream and watershed data (e.g., GIS, land use, permit information) to identify sources.
III	Project Analysis	Additional review and analyses of data for use in technical approach	▪ Review data types available to support model/approach selection. ▪ Analyze data to set up models (e.g., to identify appropriate model parameter values). ▪ Use data to directly complete technical analysis (e.g., use observed data to establish a spreadsheet mass balance calculation). ▪ Use data to support model calibration and validation. ▪ Determine method for filling data gaps.

Data Availability, Sources, and Quality

The first step in the data analysis is to compile and summarize all data that can be used to support the impaired waters analyses. In locating and compiling the data, it is also important to identify and consider the data sources and quality.

Data Availability and Inventory. The availability of data and the nature of the impairment will determine the types of data analyses and technical approaches that can be conducted. All relevant data should be compiled and a data inventory developed. The data inventory should provide a comprehensive summary of, and reference for, all relevant monitoring data. Table 5-4 provides examples of data and data sources that should be considered when preparing the data inventory.

The data inventory should list the data available, including monitoring period of record, location of data collection, number of samples or frequency of sampling, source of the data, and quality assurance/quality control (QA/QC) information associated with the data. If potentially relevant data is not recommended for use, the inventory should justify why the data is excluded (e.g., quality control, lack of documentation).

Information to be summarized in the data inventory:

- Type of data (e.g., monitored, geographic)
- Source of data (agency)
- Quality of data (QA/QC documentation, QAPP)
- Amount of data (number of samples)
- Spatial coverage (location of data collection)
- Temporal coverage (period of record)
- Data gaps
- Location of electronic and physical files

Table 5-4. Examples of Data Types and Sources to Consider for the Data Inventory[a]

Type of Data	Example Source
Monitored:	
Current/historical chemical, biological, and physical monitoring data	Check with RWQCB. USEPA's Storage and Retrieval (STORET) database (http://www.epa.gov/STORET/) USGS National Water Information System (NWIS) (http://waterdata.usgs.gov/nwis) USGS National Stream Water-Quality Monitoring Networks data (http://water.usgs.gov/pubs/dds/wqn96/) SWRCB Surface Water Ambient Monitoring Program (SWAMP) Data (check with regional contacts for database replica http://www.waterboards.ca.gov/swamp/contacts.html; validated SWAMP data available online through California Environmental Data Exchange Network (CEDEN) (http://baydelta.ca.gov/Php/ceden.php4?screen_width=1280&browser=IE)
Previous watershed or water quality analyses	Studies conducted by universities or by federal, state, or local agencies e.g. Natural Resource Project Inventory (http://www.ice.ucdavis.edu/nrpi/) California Environmental Resources Evaluation System (http://www.ceres.org/)
Flow and runoff information	USGS flow gage data (http://waterdata.usgs.gov/nwis)
Meteorological data	Climate data (e.g., precipitation, temperature, wind speed) available from the Western Regional Climate Center (http://www.wrcc.dri.edu/)
Point source monitoring data	Check with RWQCB. Discharge monitoring reports from permitted facilities (Facility and permit information available through USEPA's Permit Compliance System (PCS) [http://www.epa.gov/enviro/html/pcs/index.html])
Geographic (likely as geographic information system [GIS] data):	

Type of Data	Example Source
Maps of the watershed, point and nonpoint sources	Check with RWQCB, State Board (e.g. GIS viewer http://gisviewer.swrcb.ca.gov , GeoWBS), local agencies.
Waterbody size and shape information	California Spatial Information Library (CaSIL) (http://gis.ca.gov) USEPA's Reach File, Versions 1 and 3 (available in USEPA's Better Assessment Science Integrating Point and Nonpoint Sources [BASINS] modeling system [http://www.epa.gov/ost/basins/]) USGS National Hydrography Dataset (http://nhd.usgs.gov/data.html)
Tributary locations and characteristics	CaSIL (http://gis.ca.gov) USEPA's Reach File, Versions 1 and 3 (available in USEPA's BASINS [http://www.epa.gov/ost/basins/]) USGS National Hydrography Dataset (http://nhd.usgs.gov/data.html)
Current, historical, and potential future land uses	SPOT 10-meter through CaSIL (http://gis.ca.gov) California Department of Forestry and Fire Protection data (http://frap.cdf.ca.gov/data/frapgisdata/select.asp) USGS GIRAS land cover (available in USEPA's BASINS [http://www.epa.gov/ost/basins/]) USGS Multi-Resolution Land Characteristics (MRLC) land use/cover — http://www.epa.gov/mrlc/nlcd.htm) USGS's LULC data (http://edc.usgs.gov/geodata/) California Resources Agency's California Digital Atlas http://legacy.ca.gov/new_atlas.epl
Soil surveys and geologic information	U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) Soil Survey State Soil Geographic (STATSGO) coverage (available in USEPA's BASINS [http://www.epa.gov/ost/basins/])
Topographic information	USGS topographic maps CaSIL Digital Elevation Model (DEM) (http://gis.ca.gov) USGS DEM (http://edc.usgs.gov/geodata/) USEPA's BASINS DEM (http://www.epa.gov/ost/basins/)
Monitoring locations	Water quality monitoring locations available through USEPA's BASINS coverages (http://www.epa.gov/ost/basins/) SWRCB Surface Water Ambient Monitoring Program (SWAMP) station locations (check with regional contacts listed at http://www.waterboards.ca.gov/swamp/contacts.html; validated SWAMP data associated with station locations available online through California Environmental Data Exchange Network (CEDEN http://baydelta.ca.gov/Php/ceden.php4?screen_width=1280&browser=IE) SWRCB GisViewer (http://gisviewer.swrcb.ca.gov)
Point source locations	Check with the RWQCB. Facility locations available through USEPA's BASINS GIS coverages (http://www.epa.gov/ost/basins/) or through USEPA's PCS (http://www.epa.gov/enviro/html/pcs/index.html)
Regulatory:	
Applicable water quality standards	WQOs available in the applicable Basin Plan
Permits Waste Discharge Requirements (WDRs)	Permit information from USEPA's PCS (http://www.epa.gov/enviro/html/pcs/index.html) Check with RWQCB.
Qualitative:	
Hypothesis regarding the causes or sources of impairment from agency personnel or local contacts	Anecdotal information on the listing of the waterbody

Type of Data	Example Source
Anecdotal information on the waterbody conditions (e.g., citizen complaints)	Records of citizen complaints including water quality, agency assessments of water quality or habitat

[a]Many of the identified sources are nationally available data sets. The analyst should always check with the RWQCB and local agencies for availability of locally prepared data prior to using national data sets.

Data Quality. When compiling data and reviewing their applicability and usefulness for the impaired waters analyses, it is important to consider the quality of the data. In many cases, the data are compiled from a variety of sources, including external sources (e.g., federal, state, and local agencies; university studies). It is often difficult to identify the QA/QC procedures that were used in the collection of the external data. Therefore, it is beneficial to evaluate the data's quality and usability with some set of criteria or assessment factors. These criteria could be highly variable depending on the intended use of the data or the resulting product (i.e., general assessment vs. enforcement action). This section will outline several factors to consider in evaluating the data quality, but will not establish specific guidelines or criteria to use in deciding whether or not to use a specific data set in impaired waters analyses.

USEPA's *Assessment Factors for Evaluating the Quality of Information from External Sources* (USEPA, 2002) discusses several assessment factors and considerations used in evaluating the quality and relevance of information obtained from external sources in support of agency actions. The five categories of assessment factors identified are

- Soundness
- Applicability and utility
- Clarity and completeness
- Uncertainty and variability
- Evaluation and review

These assessment factors are broadly applicable to most types of information and are flexible. These assessment factors should be considered when evaluating the data quality for an impaired waters analysis.

Assessment Factors for Evaluating Data Quality

Soundness: The extent to which the procedures, measures, methods, or models employed to generate the information are reasonable for and consistent with the intended application and are scientifically/technically appropriate.
Applicability and utility: The extent to which the information is applicable and appropriate for the intended use (in the analysis).
Clarity and completeness: The degree of clarity and completeness with which the data, assumptions, methods, quality controls, and analyses employed to generate the information are documented.
Uncertainty and variability: The extent to which the variability and uncertainty in the information or in the procedures, measures, methods, or models are evaluated and characterized.
Evaluation and review: The extent of independent application, replication, evaluation, validation, and peer review of the information or of the procedures, measures, methods, or models employed to generate the information.

Source: USEPA (2002)

Data Gaps. The data inventory should also be used to identify any relevant gaps, especially those that may hinder the selection and completion of an appropriate analysis approach. The data inventory can be used to identify obvious, broader data gaps, such as a lack of water quality or flow data for the watershed. However, the identification of data gaps can be an iterative process with more specific data needs being identified during the data analysis and also during subsequent phases of the impaired waters analysis (e.g., during model setup for TMDL development or implementation). For example, a long period of record of water quality monitoring data would typically indicate sufficient water quality data for analysis of the impaired water. However, when data analysis begins, it may become apparent that the data are not sufficient for evaluation of seasonal trends or other relationships and patterns. Each analysis of the impaired water may identify more data needs. In that case, it is necessary to determine whether the data needs are crucial to the completion of the analysis and whether additional monitoring or data collection is warranted now or future data collection should be recommended as part of implementation. (Monitoring is discussed in Chapter 4.)

Analytical and Characterization Activities

This section provides a summary of data analysis techniques that can be used to characterize impairments, support development of conceptual models, and design subsequent technical analyses.

Listing Confirmation and Impairment Analysis. The purpose of the listing confirmation and impairment analysis is to reevaluate the water quality conditions leading to the listing of the impaired water and to confirm that the impairment is still supported by any data collected after the listing occurred. The expression of the applicable WQO(s) is a fundamental factor in how the data should be evaluated for the impairment analysis. The data must be analyzed in a way that allows comparison to WQOs and considers the appropriate parameter, statistical expression, and time scale.

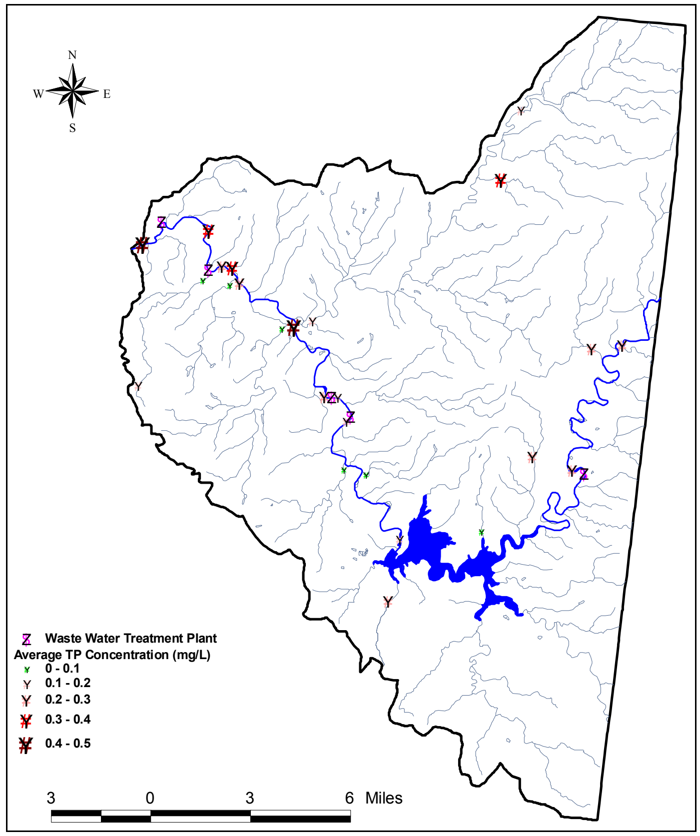


Figure 5-4. Sample Map Illustrating Spatial Variations in Water Quality Conditions

If the impairment analysis confirms that the waterbody is impaired, the impaired waters analyses will continue with the appropriate regulatory action (e.g., TMDL development, SSO). If the analysis of recent data or the reevaluation of historical data indicates that the waterbody is no longer impaired or was listed incorrectly, the impaired water should be delisted.

Spatial Trends. If instream water quality data are available at multiple sites throughout the watershed of the impaired water, an analysis of spatial variations or patterns in the data should be conducted. Evaluating spatial distribution of water quality conditions and the relative magnitude of WQO violations in the watershed can indicate the location of "hot spots" and sources potentially affecting impairment. Figure 5-4 presents an example of a graphic displaying the spatial variability of water quality conditions in a watershed.

Temporal Trends. Another important aspect to consider when evaluating impaired waters is the identification of temporal trends in water quality conditions. Evaluation of temporal patterns can assist in identifying potential sources in the watershed, seasonal variations, or declining/improving water quality trends.

Poor water quality during certain months or seasons can indicate the occurrence of a source that is active only during those times. For example, elevated concentrations of nutrients or bacteria during

> **Appropriate Analysis for Comparison to WQOs**
>
> Data analyses must allow for comparison to applicable WQOs. For example, fecal coliform objectives are often expressed as log means, using a minimum number of samples collected within a 30-day period. Therefore, the impairment analysis should calculate rolling log means of available samples within the specified time frame. Fecal coliform objectives typically also have an "instantaneous" standard allowing for a percent exceedance of samples (e.g., no more than 10 percent of samples in a 30-day period can exceed 400/100 milliliters). This objective allows for comparison of individual observations to a not-to-exceed value.

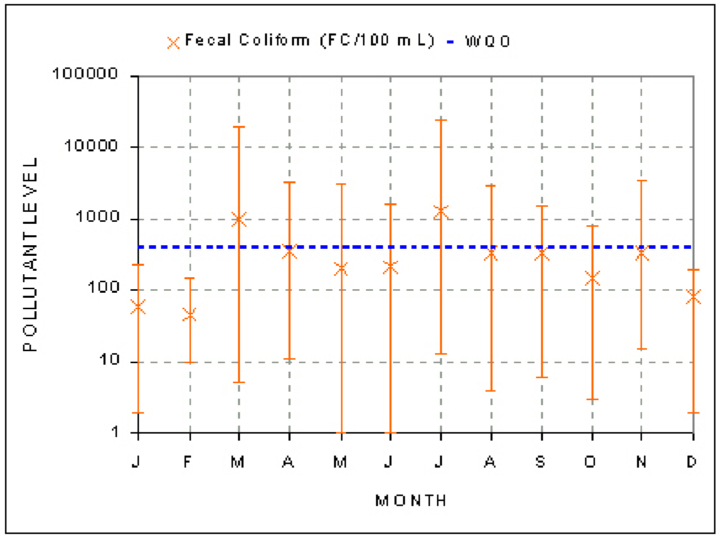


Figure 5-5. Sample Graphic of Monthly Variations in Instream Fecal Coliform Concentrations

summer months may indicate increased source activity during those months, such as livestock grazing. The poor water quality may also indicate a need for further analysis of other watershed conditions (e.g., weather, flow) that can exacerbate the impairment during summer months. For example, warmer temperatures during summer months may increase the growth of algae leading to greater decreases in dissolved oxygen. Identification of seasonal variations in water quality conditions, and therefore violations of WQOs, is an important consideration for the completion of the appropriate regulatory action. TMDL development must include seasonal variation in the analyses, and site-specific objectives may take into account the appropriateness of seasonal objectives. Figure 5-5 presents an example of a graphic used to summarize the monthly variations in water quality conditions.

Other Relationships and Trends. It is often beneficial to evaluate other relationships and trends in the available data in addition to spatial and temporal trends. Two important examples are

- Evaluating the relationship between flow and instream water quality
- Evaluating the relationship among related pollutants

An identifiable relationship between flow and instream water quality concentrations can indicate what types of sources dominate the instream impairment and can help identify critical conditions surrounding the impairment. For example, nonpoint sources that are precipitation-driven typically dominate instream water quality conditions during periods of high flow resulting from rainfall/runoff events, while point sources that provide relatively constant discharges to receiving waters dominate water quality during low flow when there is less water for dilution of effluent inputs.

It is also important to evaluate the correlation of instream concentrations (and loading) of pollutants of concern to other parameters that

- represent the same impairment

  For example, instream sediment or its effects can be represented by several parameters (e.g., TSS concentration, turbidty). Depending on what parameters are included in WQOs and what data are available, it might be beneficial to investigate any relationships among the different sediment parameters for use in future analyses for the impaired waters (e.g., TMDL development).

- are likely being contributed by similar sources or are acting as a source of the pollutant of concern.

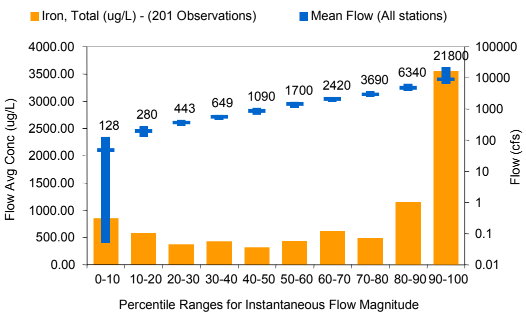
  For example, nutrients often attach to sediments, resulting in increased nutrient loading during times of high sediment erosion and runoff. Establishing a correlation between instream sediment and nutrient concentrations indicates that nutrient loading in the watershed is sediment-related. Understanding these relationships is important in the selection of approaches for the development and implementation of a TMDL or other regulatory action.

Critical Conditions. All of the analyses discussed in this section can support the identification of critical conditions, an important part of addressing impaired waters, especially in TMDL development. Critical conditions represent a description of when and under what conditions the impairment occurs. Specifically, the evaluation of temporal patterns in water quality data can provide substantial insight because the analysis identifies the times of greatest impairment and because many of the factors affecting critical conditions exhibit seasonal variations (e.g., flow and weather conditions, source activity). The results of the temporal analysis as well as the other data analyses can be evaluated to identify critical conditions for the impaired water, including flow conditions, season, weather conditions (e.g., temperature), or other applicable factors.

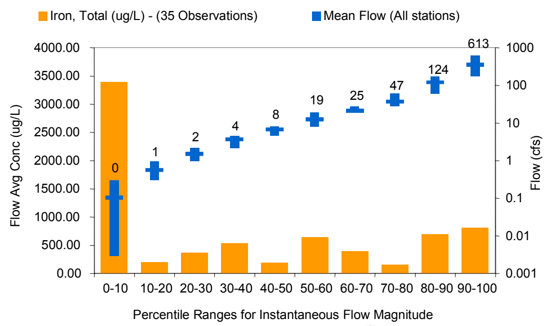
Examples of Data Analyses for Impaired Waters

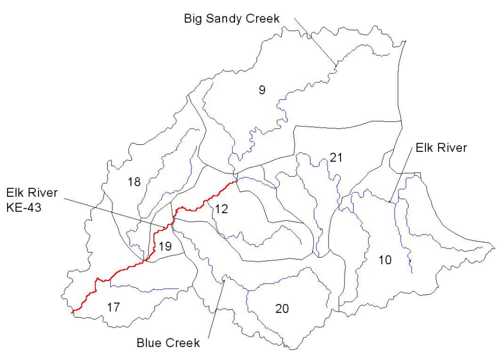
The Elk River watershed includes several stream segments impaired by metals, likely due to abandoned mines. Analysis of the available water quality and flow data was conducted to evaluate critical conditions, temporal variations in metals concentrations, and potential sources in the watershed. An evaluation of flow and metals concentrations at different points in the watershed indicated that metals impairments are occurring under very different conditions at different locations in the watershed, indicating the dominance of different sources. A station on the mainstem Elk River exhibited a correlation between metals concentrations and flow, with the highest metals concentrations occurring during higher flows. Meanwhile, analysis at an upstream tributary station indicated an inverse relationship between flow and metals concentration, with higher concentrations observed during low flows.

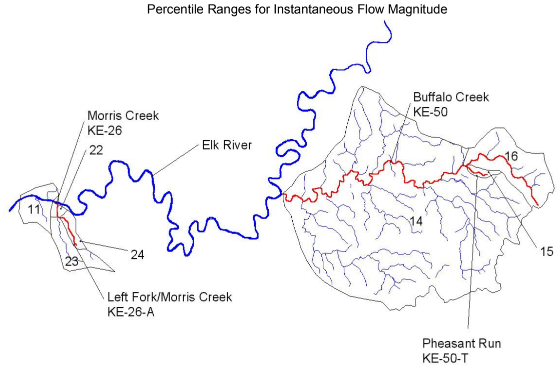
Mainstem Station—Flow and Iron



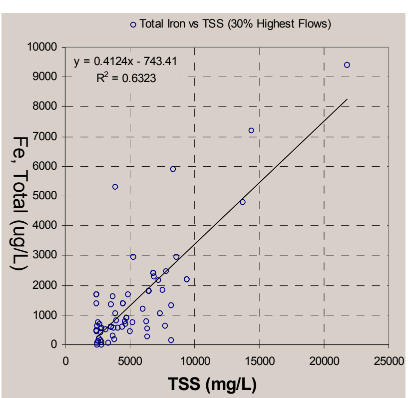
Tributary Station—Flow and Iron





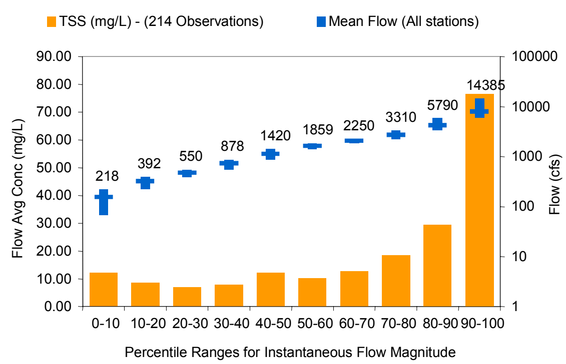


Mainstem Station—Flow vs. Sediment



Low flow is typically the critical condition for waters impacted by abandoned mine drainage. However, the water quality and flow relationship observed at the mainstem station indicated critical conditions during high flow—periods when abandoned mine drainage would be diluted and have a decreased effect on instream concentrations. Therefore, further analysis was conducted to evaluate potential sources affecting the mainstem. The relationships between sediment and metals and between sediment and flow were investigated, indicating a strong sediment-metals relationship and the occurrence of high instream sediment during the same flow conditions as those exhibiting high metals concentrations. The analysis suggested that the tributaries were impaired by abandoned mine drainage while the mainstem was also being affected by nonpoint source loading of metal-laden sediment.

Mainstem Station—Flow and Sediment



5.3. Technical Analyses

The technical analyses can include a variety of scientific, statistical, and modeling tasks designed to support the selection and testing of pollution management approaches. These analyses are ultimately used to understand the dose-response relationship, that is, to evaluate how changes in pollutant loading or stressors can result in meeting the water quality standards evaluated by objectives or target values. Table 5-2 presents sequences of data and technical analyses that are used successfully to evaluate typical waterbody/pollutant combinations from the California Section 303(d) list. Although there are no prescribed or required methods for impaired waters analysis in California, the practitioner must still identify methods that provide a technical rationale and supporting documentation for the recommended regulatory action. If new methods are proposed, a preliminary review of the methodology by the RWQCB, SWRCB, and USEPA is recommended. The selected analysis approach should use techniques with sufficient rigor to provide support for the selection of regulatory actions. This section discusses some of the typically used methods and defines key terminology used in describing the technical analyses employed.

One common misconception is that impaired waters analysis requires the use of a "computer model." A model is typically defined as a mathematical representation of a physical system. In the broadest interpretation, technical analyses are always a form of model—the analysis is our representation of the key features of the physical system. However, not all analyses need or require a computer modeling system or modeling package to perform the analysis. Selection of the appropriate technical analysis approach will determine when and if a computer modeling system is useful or necessary.

For some waterbody/impairment categories, approaches have evolved that can be used to determine the distribution and magnitude of loads that meet WQOs or provide simplified representation of the waterbody. The following are some of the techniques employed in impaired waters analyses:

Reference approach. This approach uses a reference watershed to identify numeric instream or loading targets for an impaired waterbody. The reference watershed is typically selected because it has been identified as an unimpaired waterbody with a watershed similar in land use, hydrology, and geology to the impaired waterbody's watershed.

Mass balance approach. This approach represents an aquatic system through an accounting of mass entering and exiting the system. Typically this analysis simplifies the representation of the waterbody and does not estimate or simulate detailed biological, chemical, or physical processes.

Flow duration/load duration approach. This method establishes allowable loads by plotting them as a function of flow. To establish a load duration curve, the applicable water quality concentration (e.g., water quality criterion) is multiplied by a range of flow values to calculate individual loads. The loads are then used to derive a curve of continuous flow-based loads. Conceptually, any point along the curve would identify the load necessary to meet water quality standards at the associated flow. This approach is used successfully in diagnosing and evaluating waters, but is typically not sufficient for determining allocation loads since the analysis does not explicitly describe where the loads are coming from or how they are delivered.

Some technical analyses will use modeling systems in various combinations to estimate loads, evaluate receiving water response, and consider various management scenarios. Selection of the appropriate model will depend on the key factors identified in Section 5.1 including waterbody/pollutant combination, when the impairment occurs, and how the loading is generated. An understanding of these factors can guide the user to selection of models that provide appropriate information. General categories of models include

Watershed models. Watershed models simulate watershed loading based on inputs such as precipitation, land use, geology, soils, and other watershed features.

Receiving water models. Receiving water models evaluate waterbody conditions based on external inputs (tributary loads, groundwater inputs, tides), waterbody features (volume, depth, internal recycling), and environmental conditions (temperature, precipitation).

Some receiving water modeling analyses are oriented toward dry weather conditions. These models are typically referred to as "steady-state" because they are used to evaluate a condition that may persist for a longer period of time. Many of the waters where impairment occurs under dry weather conditions can be evaluated by using this class of receiving water models. Other impairments may require the use of a "dynamic" or time-varying model to evaluate a range of wet or dry sequences. Brief profiles of and references for some of the public domain models used most frequently for impaired waters analysis are provided in the sidebar and the insert below. USEPA's 1997 *Compendium of Tools for Watershed Assessment and TMDL Development* and other published guidances and books provide extensive lists of other available modeling tools and information sources.

Regardless of whether simplified techniques, spreadsheet models, or one or more modeling systems are employed, the technical analysis typically includes three key steps.

1. ***Model setup/configuration*** involves defining units of analysis such as subwatersheds or portions of streams, categories of sources, and time period of analysis.
2. ***Model testing*** evaluates how reasonable the results of the analysis are. Even for the simplest analysis, available information and related studies can be used to evaluate the results. For more sophisticated applications a series of comparisons of model predictions and monitoring data might be needed.
3. ***Model application*** includes the evaluation of existing conditions and consideration of alternatives or management scenarios.

Modeling References

Bicknell, B.R., J.C. Imhoff, J.L. Kittle, A.S. Donigian, R.C. Johanson. 1987. *Hydrological Simulation Program – FORTRAN (HSPF): User's Manual for Release 10.0*. EPA 600/3-84-006. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA.

Bowie, G.L., et al. 1985. *Rates, Constants, and Kinetics Formulations in Surface Water Quality Modeling*. 2nd Edition. EPA/600/3-85/040. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA.

Nix, J.S. 1991. Applying urban runoff models. *Water Environment and Technology*. June 1991.

Thomann, R.V., and J.A. Mueller. 1987. *Principles of Surface Water Quality Modeling and Control*. Harper & Row, New York.

USEPA. 1988. *Storm Water Management Model Version 4, User's Manual*. EPA 600/3-88/001a. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA.

USEPA. 1995. *Technical Guidance Manual for Developing Total Maximum Daily Loads. Book II: Streams and Rivers. Part 1: Biological Oxygen Demand/Dissolved Oxygen and Nutrients/Eutrophication*. EPA 823-B-95-007. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 1997. *Compendium of Tools for Watershed Assessment and TMDL Development*. EPA841-B-97-006. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Typical Public Domain Models Used in Impaired Waters Analysis

Watershed Models

Generalized Watershed Loading Functions (GWLF). Mid-range watershed loading model developed to assess nonpoint source flow and sediment and nutrient loading from urban and rural watersheds.

Storm Water Management Model (SWMM). Detailed watershed model developed to evaluate urban stormwater flow and water quality through continuous or storm-event simulation for complex watersheds and land uses.

Hydrologic Simulation Program – FORTRAN (HSPF). Detailed, dynamic watershed and receiving water quality model developed for simulating water quantity and quality for a wide range of organic and inorganic pollutants from complex watersheds and land uses.

Loading Simulation Program – C++ (LSPC). GIS-based watershed assessment, analysis, and TMDL development system containing a watershed and receiving water quality model that uses HSPF algorithms.

Receiving Water Models

BATHTUB. Steady-state water quality model that simulates eutrophication-related water quality conditions in lakes and reservoirs.

Hydrologic Simulation Program – FORTRAN (HSPF). Detailed, dynamic watershed and receiving water quality model developed for simulating water quantity and quality for a wide range of organic and inorganic pollutants from complex watersheds and land uses.

Loading Simulation Program – C++ (LSPC). GIS-based watershed assessment, analysis, and TMDL development system containing a watershed and receiving water quality model that uses HSPF algorithms.

Enhanced Stream Water Quality Model (QUAL2E). Steady-state surface water quality model that simulates conventional water quality constituents in stream networks.

Water Quality Analysis and Simulation Program (WASP). Dynamic surface water quality model that simulates eutrophication kinetics, conventional water quality parameters, and toxics in one, two, or three dimensions.

Environmental Fluid Dynamics Code (EFDC). Hydrodynamic and water quality model that can be used to simulate surface aquatic systems in one, two, and three dimensions. EFDC simulates salinity, temperature, sediment, and conventional water quality parameters and includes a sediment diagenesis model.

SHADE. Modeling package that combines a GIS-based solar radiation prediction model with QUAL2E for instream steady-state temperature modeling.

For further information on models, general types of models, and their specific capabilities, refer to USEPA's *Compendium of Tools for Watershed Assessment and TMDL Development* (USEPA, 1997a).

5.4. Management/Allocation Approaches

One of the most complex decisions in the analysis of impaired waters is the development of a pollutant loading allocation plan. The plan requires the consideration of numerous factors, including cost, technical achievability, and equity. An allocation plan that achieves an acceptable balance between these factors has a greater chance of being accepted by the public and stakeholders.

The first step in the evaluation is to determine which segments and sources require load reductions to achieve WQOs. This evaluation identifies the scientifically feasible solutions. The determination of scientific feasibility should take into account the location of sources relative to the impairment and the critical conditions and potential seasonal load reduction needs.

Within the scientific constraints, those solutions that can achieve WQOs can be further evaluated. Loading scenarios may be adjusted in accordance with the administering agencies' policies and procedures and taking political, social, and economic factors into consideration. For instance, it may be decided that the reductions within a region are best spread out across all sources, or it may be decided to apply them to only a few targeted sources. The criteria for making these decisions (e.g., magnitude of impact, degree of management controls in place, feasibility, probability of success, cost) must also be established. The following represent a sampling of the factors that might need to be considered when making allocation decisions:

- Assessing alternatives
- Achieving a balance between WLAs and LAs
- How allocations can be translated into controls
    - Translate WLAs into NPDES permit requirements
    - Translate load allocations into implementation plans
- How issues of equity in allocations should be addressed
- How stakeholders should be involved

Relevant Legal Memos

Legal memos in Appendix B that might affect the allocation analysis include

- *Legal Authority for Offsets, Pollutant Trading, and Market Programs to Supplement Water Quality Regulation in California's Impaired Waters*
- *Guidance Regarding the Extent to Which Effluent Limitations Set Forth in NPDES Permits Can Be Relaxed in Conjunction With a TMDL*

Table 5-5 lists 19 different allocation schemes that can be considered when evaluating groups of sources that can be reduced. When performing analyses of source allocations, limitations for individual discharges and local impacts must still be protected.

Another consideration is the use of pollutant trading concepts to help optimize cost while fulfilling load reductions. (See box on Water Quality Trading on page 5-20.) Final loading scenarios can be represented as annual, seasonal, or daily loads for individual point sources and categories or subcategories of nonpoint sources. The selection of the appropriate time period and level of discretization of sources will depend on the impairment type and associated critical conditions. The level of specificity of the source loading allocation may vary from individual source, to categories of sources, within watersheds or subwatersheds. For point source discharges, the waste load allocations for TMDLs must generally include individual allocations. Further details of source management may be added during the implementation of the regulatory actions.

Table 5-5. Waste Load Allocation Methods

1.	Equal percent removal (equal percent treatment)
2.	Equal effluent concentrations
3.	Equal total mass discharge per day
4.	Equal mass discharge per capita per day
5.	Equal reduction of raw load (pounds per day)
6.	Equal ambient mean annual quality (mg/L)
7.	Equal cost per pound of pollutant removed
8.	Equal treatment cost per unit of production
9.	Equal mass discharged per unit of raw material used
10.	Equal mass discharged per unit of production

11a.	Percent removal proportional to raw load per day
11b.	Larger facilities to achieve higher removal rates
12.	Percent removal proportional to community effective income
13a.	Effluent charges (pounds per week)
13b.	Effluent charge above some load limit
14.	Seasonal limits based on cost-effectiveness analysis
15.	Minimum total treatment cost
16.	Best Available Technology (BAT) for industry, plus some level for municipal inputs
17.	Assimilative capacity divided to require an "equal effort among dischargers"
18a.	Municipal: Treatment level proportional to plant size
18b.	Industrial: equal percent between best practicable technology (BPT) and BAT
19.	Industrial discharges given different treatment levels for different stream flows and seasons

Source: Chadderton, R., A. Miller, and A. McDonnell, 1981. Analysis of wasteload allocation procedures. *Water Resources Bulletin* 17(5):760-66. (As cited in USEPA's *Technical Support Document for Water Quality-based Toxics Control*. 1991 (EPA/505/2-90-001).

5.5. Project Report

The Project Report should fully document the steps and outcomes of project analyses. For TMDL projects, the report should document all the required TMDL elements and any supporting information that will facilitate public understanding, and review and approval by the RWQCB, SWRCB, and USEPA. The amount and detail of information included in the project report will often be dictated by professional judgment and the specifics of the analyses. For relatively simple analyses, technical information can likely be documented in the main body of the report while, for more complex, detailed analyses, it may be beneficial to include technical information in one or more appendices with only a brief summary of the overall approach included in the main document. Appendix D provides a template for preparing a TMDL report consistent with California and USEPA Region 9 guidance.

The analyses performed should also be documented in the Administrative Record. This record provides a file of all the relevant material generated throughout the project. For project analyses, this file includes data, spreadsheets, model files, and notes. Documenting this information is essential during the course of the project. Materials generated and saved during the process will be needed should the conclusions of the analyses be legally contested. Do not expect to remember the details of how the analyses were done—document during the process! The sidebar describes some of the key information stored in the Administrative Record.

Administrative Record

An Administrative Record should be developed for TMDL projects to document the technical analysis, assumptions, and calculations. The Administrative Record makes it possible to defend the scientific analyses and associated assumptions, especially in cases where the supporting environmental data are limited. The Administrative Record will likely include

- TMDL document
- Public comments and responses
- List of references used in developing the TMDL (e.g., source of literature values used in modeling analysis)
- Spreadsheets of data analyses
- Spreadsheets used in TMDL calculation
- Modeling input and output files

No additional information may be added to the Administrative Record after final submittal to USEPA. Therefore, it is important to maintain a complete Administrative Record throughout TMDL development and prior to final USEPA decisions.

Summary of USEPA's Water Quality Trading Policy

(Source: USEPA's Fact Sheet on Water Quality Trading Policy, http://www.epa.gov/owow/watershed/trading/tradingpolicy.html)

Water quality trading is a market-based approach to improve and preserve water quality. Trading can provide greater efficiency in achieving water quality goals in watersheds by allowing one source to meet its regulatory obligations by using pollutant reductions created by another source that has lower pollution control costs. EPA's policy endorses trading as an economic incentive for voluntary pollutant reductions from point and nonpoint sources of pollution and as a way to achieve ancillary environmental benefits such as creation of habitat.

The Environmental Protection Agency (EPA) is issuing a Water Quality Trading Policy ("policy") to provide guidance to states and tribes on how trading can occur under the Clean Water Act and its implementing regulations. The policy discusses Clean Water Act (CWA) requirements that are relevant to water quality trading including: requirements to obtain permits, antibacksliding provisions, development of water quality standards including antidegradation policy, National Pollutant Discharge Elimination System permit regulations, total maximum daily loads (TMDLs) and water quality management plans.

EPA's policy supports trading of nutrients (e.g., total phosphorus, total nitrogen) and sediment load reductions. The policy recognizes the potential for environmental benefits from trading of pollutants other than nutrients and sediments but believes that these trades may warrant more scrutiny. The policy does not support any trading activity that would cause a toxic effect, exceed a human health criterion or cause an impairment of water quality. EPA does not support trading of persistent bioaccumulative toxic pollutants at this time.

The policy supports trading to improve or preserve water quality in a variety of circumstances. For example, in unimpaired waters trading may be used to preserve good water quality by offsetting new or increased discharges of pollutants; in waters impaired by pollutants trading may be used to achieve earlier pollutant reductions and progress towards water quality standards pending the development of a TMDL; and trading may be used to reduce the cost of achieving reductions established by a TMDL. EPA does not support trading that delays implementation of an approved TMDL.

The policy draws on lessons learned from pilot programs conducted under EPA's 1996 *Draft Framework for Watershed-Based Trading* by identifying common elements that EPA believes are necessary for trading programs to be credible and successful. These elements include clearly defined units of trade, use of standardized protocols to quantify pollutant loads and reductions, provisions to address the uncertainty of nonpoint source loads and reductions that are traded, accountability mechanisms for all trades, public participation and access to information, and monitoring and program evaluation.

Useful links:

USEPA's Water Quality Trading Web page, http://www.epa.gov/owow/watershed/trading.htm

USEPA's 2003 *Water Quality Trading Policy*, http://www.epa.gov/owow/watershed/trading/tradingpolicy.html

Case Studies, http://www.epa.gov/owow/watershed/hotlink.htm

USEPA Region 10's *Water Quality Trading Assessment Handbook*, http://yosemite.epa.gov/R10/OI.NSF/Effluent+Trading/ET

6. REGULATORY ACTIONS

RWQCBs have wide latitude, numerous options, and some legal constraints when determining how to address impaired waters. The process for addressing waters that do not meet applicable standards can be accomplished through several existing regulatory tools and mechanisms, one of which is the calculation and implementation of a TMDL. Chapters 1–5 of this document describe the foundation for identifying and understanding the issues to consider when addressing impaired waters in California. In Chapter 1, a summary of the important background information on the regulatory requirements is presented to ensure that the reader understands the context of this document, but the summary is not intended to provide details on how to select the appropriate regulatory action. Although the information in this chapter does not provide definitive answers, it does provide additional information and limited guidance on issues to consider when deciding how best to address impaired waters, including whether or not Basin Plan amendments are required.

6.1. Understanding Regulatory Action Options

Understanding the regulatory and nonregulatory options available to address impaired waters in California can be a challenging task. Because of the number of choices and the need to know when and where they are appropriate, it is important that analysts working on these projects understand the entire process and identify their options (including when a Basin Plan amendment will be required) at the beginning of each project. Most of the options available have been identified in other chapters and they can be summarized as follows:

- Delisting when standards are appropriate and are being met. This action requires documentation justifying the decision. No Basin Plan amendment is required.
- Standards are inappropriate. When changing the standard, the objective, or the use, a Basin Plan amendment is required, along with all relevant documentation.
- Impairment can be redressed by a single action (e.g., single NPDES permit, enforcement action). No Basin Plan amendment is required for TMDL implementation.
- Impairment cannot be redressed by a single action (e.g., develop an implementation plan). A Basin Plan amendment is required.

Any of these regulatory actions (or combinations of them) may be pursued given appropriate site-specific circumstances. Figure 6-1 presents the decision process for identifying the most appropriate regulatory action and the associated Basin Planning requirements, if applicable. An action should be identified early in the process so that the technical analysis; level of public, stakeholder, or board involvement and notice; and required documentation can be planned. In some cases, the original desired path will lead to a different path because of unforeseen circumstances. Such circumstances should be anticipated and alternate paths should be considered when planning the project.

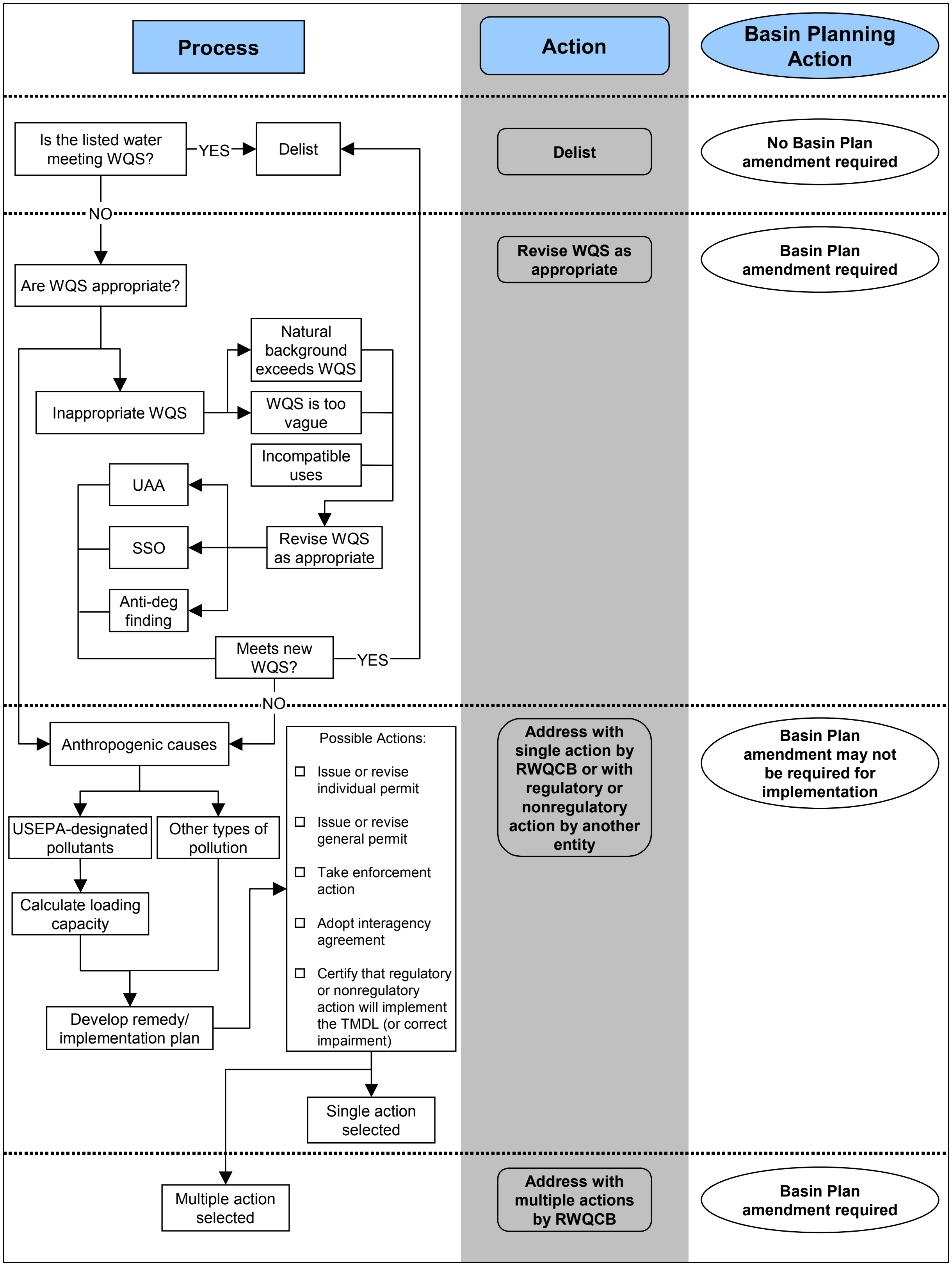


Figure 6-1. Regulatory Decision Tree

6.2. Selecting the Most Appropriate Regulatory Action

The decision process for selecting the appropriate path should take into account the questions presented in the box below. (Details on the requirements for each path are included in California's *Administrative Procedures Manual,* Chapter 8, Water Quality).

Is the water currently attaining standards?

If **YES**, the water should be delisted.
If **NO**, why?

- Do natural background levels exceed the WQOs?
- Are the WQOs too broad or vague?
- Do incompatible uses exist?
    - If **yes**, revise WQS as appropriate (e.g., UAA, SSO)
- Are discharges exceeding the WQS-based loading capacity?
    - If **yes**, calculate TMDL and develop an implementation plan

Can the cause of impairment be redressed by a single vote of the Regional Board?

If **YES, one** of the following actions **may** be appropriate to implement the TMDL:

- Issue or revise an individual permit
- Issue or revise general permit
- Take enforcement action
- Adopt interagency agreement

Can the cause of the impairment be redressed by a regulatory action of another local, state, or federal agency?

If **YES**,

- Certify that the regulatory action will implement the TMDL.

Can the cause of impairment be redressed by a nonregulatory action of another entity?

If **YES**,

- Certify that the regulatory action will implement the TMDL.

Will the cause of the impairment be redressed through multiple actions of the RWQCB alone or with other entities?

If **YES**,

- Adopt a Basin Plan amendment that guides staff in implementing the TMDL, using any of the above tools.

In most cases, the likely suite of regulatory actions available to address impaired waters can be identified from the onset. For example, if a combination of point and nonpoint sources is contributing pollutants under both wet and dry conditions, a single NPDES permit is not likely to address the impairment. Likewise, waters with several large dischargers, all contributing significant pollutant loads and all requiring revisions to their NPDES permits, cannot be redressed with a single vote. For cases such as these, the analyses will focus on the appropriateness of the standards and objectives and, assuming they are appropriate, the calculation of a TMDL. Selection of the regulatory actions will result in requirements associated with establishing TMDL and amendments of Basin Plans. Key requirements for each process are described below.

6.3. Process for Implementing the Most Appropriate Regulatory Action

Sections 6.1 and 6.2 outlined the suite of regulatory action options and provided guidance on how to determine the most appropriate option. This section provides guidance on how to implement the most appropriate option, whether it is to delist the waterbody, conduct a UAA or develop an SSO where the standard is inappropriate, or calculate a TMDL and draft an implementation plan. The reader should refer to Section 3.1 of this document for more detailed information on the types of data, information, and products associated with each of these options.

Delisting of Waterbody/Pollutant Combination(s)

The option to delist a waterbody is included as a regulatory action, despite no requirement for a Basin Plan amendment, because a plan amendment is not an appropriate method for removing a waterbody from the 303(d) list. The decision to delist should be based on an analysis of available data and comparison with WQS. The justification for delisting must be well documented because the decision is subject to public, SWRCB, and USEPA scrutiny. Although details on the delisting process will be outlined in the upcoming draft of the *Guidance on Assessing California Surface Waters* and will not be presented in this document, the types of information that should be included in delisting documentation include

- Cover memo that summarizes the findings of the data analysis
- Project report that includes watershed characterization, results of statistical data analysis, comparison with WQS, and conclusions
- Administrative Record

An example of a template for a delisting memo and staff report is included in Appendix D.

Use Attainability Analysis or Site-Specific Objective

If the determination is made that a waterbody is impaired and delisting is not appropriate, it may be appropriate to review the water quality standards to determine whether the designated uses and/or applicable objectives are appropriate (Appendix C).

Reviewing the appropriateness of standards is complex and involves processes that generally are beyond the scope of TMDL process (and this guidance document). Review of standards generally occurs in the triennial review process. The TMDL process is not designed to evaluate the appropriateness of standards, but to create a strategy to attain those standards that have already been

UAAs and SSOs

Ideally, beneficial uses are determined through a UAA. UAAs are "a structured scientific assessment of the factors affecting the attainment of a use which may include physical, chemical, biological, and economic factors…" (40 CFR 131.10(g)). There are four types of situations in which a UAA may be considered: (1) when a waterbody is considered impaired (i.e., 303(d) listed) but the use (and therefore, associated water quality standards) appear to be inappropriate or the use does not exist; (2) when adopting subcategories of a use that require less stringent criteria; (3) when the use does not appear to be attainable; and (4) when meeting the use would likely result in substantial and widespread economic and social impact" (40 CFR 131.10(g)).

SSOs or refinements in the water quality objective are often considered when a numeric objective is in question (e.g., copper or chloride standard) and not the use itself. Refinements to the objective may be appropriate if the water quality objective was based on questionable or inappropriate water quality information. For example, many priority pollutant metal objectives are based on water hardness. If an incorrect hardness was assumed for the site, the objective would be incorrect as well. In these instances, collection of appropriate water quality data may be used to refine the existing objective for the waterbody in question, and changes are made in terms of the data used to calculate the objective, not the objective itself.

established. Irrespective, it is always necessary to review the standards applicable to the listed waterbody to determine the appropriate target(s).

While in most cases the existing standards are appropriate and amenable to TMDL development, in some circumstances, investigation during the development of a TMDL reveals that the standards may be inappropriate or imprecise, thus rendering water quality attainment impossible through the TMDL process. This may be for any of a number of reasons. For example, some impairments have been shown to be from nonanthropogenic sources, in which case a standards action may be the most appropriate (or indeed, the only possible) corrective action. Additionally, some of the existing criteria assume a default set of parameters (e.g., the metals criteria) that may not be appropriate for the subject water body. For those constituents a site-specific objective may be an appropriate action apart from, or in addition to, source control measures. Likewise, it may be appropriate to consider seasonal or subcategories of uses, or refinements to objectives to allow consideration of the dynamic or variable conditions that exist and often affect the assimilative capacity of the water body.

The Clean Water Act contains detailed provisions regarding how to conduct a standards action. If a standards action is warranted, all applicable authorities, including but not limited to those set forth in part 131 of Title 40 of the Code of Federal Regulations and Article 3 of Division 7, Chapter 4 of the California Water Code, must be followed. It is not anticipated that a standards action will often be required as a result of the TMDL establishment process; however, it is appropriate that the TMDL process be designed to address the situation when it is required. It would be inappropriate, for instance, to adopt stringent source reduction measures for the ostensible purpose of protecting a beneficial use that natural background levels of pollutants would prevent achieving, and thus some sort of standards action is the only appropriate regulatory response.

In current practice, there are two types of conditions under which the need for a UAA may arise: (1) when a waterbody is considered impaired (i.e., 303(d) listed) but the use (and therefore, associated water quality objectives) may not be attainable, and (2) when considering whether an upgraded or different use from that designated is appropriate. A change of the use is appropriate in either of these conditions. If the designated use is known to be, or was, an existing use since November 1975, the use cannot be changed, and a UAA is not appropriate. In these cases, SSOs may be appropriate. Both the UAA and SSO options require a Basin Plan amendment and all required supporting documentation. The documentation for a UAA should include (from Chapter 8, *Administrative Procedures Manual*):

1. A staff report that includes
    - A description of existing conditions
    - Consideration of reasonable alternatives
    - A description of mitigation measures (see California Environmental Quality Act [CEQA] checklist)
    - Rationale for selecting the recommended approach
    - Consideration of economics
    - Consideration of antidegradation

    For a UAA, the report should also include
    - Demonstration that use cannot be attained because of
        - Naturally occurring pollutants
        - Naturally intermittent or low-flow conditions
        - Human-caused conditions or sources that cannot be remedied
        - Dams, diversion, or other hydrologic modification
        - Natural physical features or conditions
        - Widespread economic and social impacts

For an SSO, the report should also include
- Past, present, and probable future beneficial uses
- Environmental characteristics, including quality of water
- Water quality conditions that could be reasonably achieved through coordinated control of all factors affecting water quality
- Economic considerations
- The need for developing housing in the region
- The need to develop and reuse recycled water

Relevant Legal Memos

Legal memos in Appendix B that are relevant to establishing SSOs include

- *The Extent to Which TMDLs Are Subject to the Alaska Rule*
- *Guidance on Consideration of Economics in the Adoption of Water Quality Objectives*

2. An environmental checklist (http://ceres.ca.gov/topic/env_law/ceqa/guidelines)

3. A draft amendment containing the language to be inserted or deleted from the Basin Plan. This should be limited to regulatory language—all background information should be contained in the staff report.

4. A draft resolution to adopt the amendment. The *Administrative Procedures Manual* gives an example of a draft resolution.

The following additional actions should be planned:

- External scientific peer review
- Hearing notice/Notice of filing
- Response to comments
- Adoption hearing
- Transmission of the administrative record

Calculation of TMDL and Development of an Implementation Plan

In general, TMDLs are established when programs are instituted to correct the impairment and result in attainment of water quality standards. For example, TMDLs may be reflected in the assumptions underlying a Basin Plan amendment or another regulation or policy for water quality control that is designed to guide the RWQCB in correcting the impairment. In this case, the TMDL is established by adopting the regulations that guide how the region will implement it.

Relevant Legal Memos

The following legal memos in Appendix B are relevant to TMDL implementation plans:

- *Do TMDLs Have to Include Implementation Plans?*
- *Legal Authority for Offsets, Pollutant Trading, and Market Programs to Supplement Water Quality Regulation in California's Impaired Waters*
- *Guidance Regarding the Extent to Which Effluent Limitations Set Forth in NPDES Permits Can Be Relaxed in Conjunction With a TMDL*

California TMDLs have traditionally been established through an amendment to a Regional Board's basin plan, largely because of the requirements of the California Administrative Procedure Act. That Act prohibits the adoption of regulations (including plans, policies, and other rules of general application) unless they have been adopted in accordance with the Act's requirements. This is commonly referred to as the prohibition against "underground regulations." Implementing a TMDL usually requires a plan of some sort, since numerous dischargers are typically responsible for contributing to the impairment. Therefore, numerous regulatory actions will be required, and mutually dependent requirements will be imposed upon each discharger to achieve the assumptions of the TMDL. Accordingly, a plan is necessary to guide the Regional Board's implementation activities. In those situations, the elements of the TMDL (the loading capacity, the load and wasteload allocations, and the margin of safety) have been established through a basin plan amendment, along with the plan to implement the TMDL. Subsequently, permits or other quasi-adjudicative actions are taken, pursuant to the terms of the plan, to implement it.

However, in some circumstances a single discharger may be responsible for the impairment or a single order of the Regional Board may be adequate to address the impairment. In such instances, there is no legal requirement to first adopt a plan to correct the impairment before actually imposing requirements that do so. Since "the plan" to correct the impairment can be accomplished through a single permitting or other quasi-adjudicatory action, the "planning" step is redundant, and the TMDL can be both established and implemented through that single action. The Regional Board has the authority to issue a permit or an enforcement action without first adopting a regulation (basin plan amendment) instructing itself to undertake that single permitting or enforcement action. In these situations, the TMDL elements will be established and included within the permit or order.

This direct process does not absolve the Regional Board from incorporating the TMDL into California's water quality management plan. All TMDLs must be incorporated directly (or by reference if contained in separate documents) into California's water quality management plan, as described in 40 CFR 130.6(c)(1). (See 40 CFR 130.7(d)(2).) This requirement is not a function of CWA Section 303(d)(1) (regarding establishing TMDLs), but of Section 303(d)(2), which sets forth the approval process and requirements for TMDLs that have been established and approved by USEPA. The Regional Boards' water quality control plans (or basin plans) are components of the water quality management plan described in 40 CFR 130.6(c)(1). The basin plans are the primary venue to incorporate those TMDLs. However, since the permit or order is not dependent upon new authority conferred by the basin plan amendment, such incorporation may merely be an informational item, or a change without regulatory effect. (See Cal. Code Regs. Tit. 1 § 100.) Since TMDL establishment and implementation are not dependent upon such changes, they may be incorporated when another basin plan amendment is presented to the Regional Board, or during the triennial reviews, rather than as an additional regulatory hoop before establishing each TMDL.

The documentation for a Basin Plan amendment (Figure 6-2) for incorporating a TMDL should include the following (from Chapter 8, *Administrative Procedures Manual*; also see the checklist outlining the steps of the basin planning process in Appendix A):

1) A staff report that includes
   - A description of existing conditions
   - Consideration of reasonable alternatives
   - A description of mitigation measures (see CEQA checklist)
   - Rationale for selecting the recommended approach
   - Consideration of economics
   - Consideration of antidegradation

2) An environmental checklist (http://ceres.ca.gov/topic/env_law/ceqa/guidelines)

3) A draft amendment containing the language to be inserted or deleted from the Basin Plan. This should be limited to regulatory language—all background information should be contained in the staff report.

4) A draft resolution to adopt the amendment. The *Administrative Procedures Manual* gives an example of a draft resolution.

The following are other actions that should be planned:

- External scientific peer review
- Hearing notice/Notice of filing
- Response to comments
- Adoption hearing
- Transmission of the administrative record

For TMDLs adopted via a Basin Plan amendment or other regulation or policy for water quality control that is designed to guide the RWQCB in correcting the impairment, the Division of Water Quality should not transmit the TMDL for approval until the Office of Administrative Law has concluded any applicable review of the regulations implementing the TMDL.

For TMDLs adopted through a permitting action, enforcement action, or other single regulatory action that is designed, by itself, to correct the impairment, the TMDL should be transmitted to USEPA for approval by the RWQCB's Executive Officer. The Division of Water Quality has prepared a standard transmittal form for use by the RWQCBs. The RWQCB should not transmit the TMDL for approval until either the time to file a petition for review with the SWRCB has elapsed, or the SWRCB has dismissed any petitions challenging, or has otherwise approved, the certification or order. A copy of each transmittal by an RWQCB is to be sent to the Division of Water Quality.

Relevant Legal Memos

The following legal memo in Appendix B is relevant to USEPA review of TMDLs and water quality standards:

- *The Extent to Which TMDLs Are Subject to the Alaska Rule*

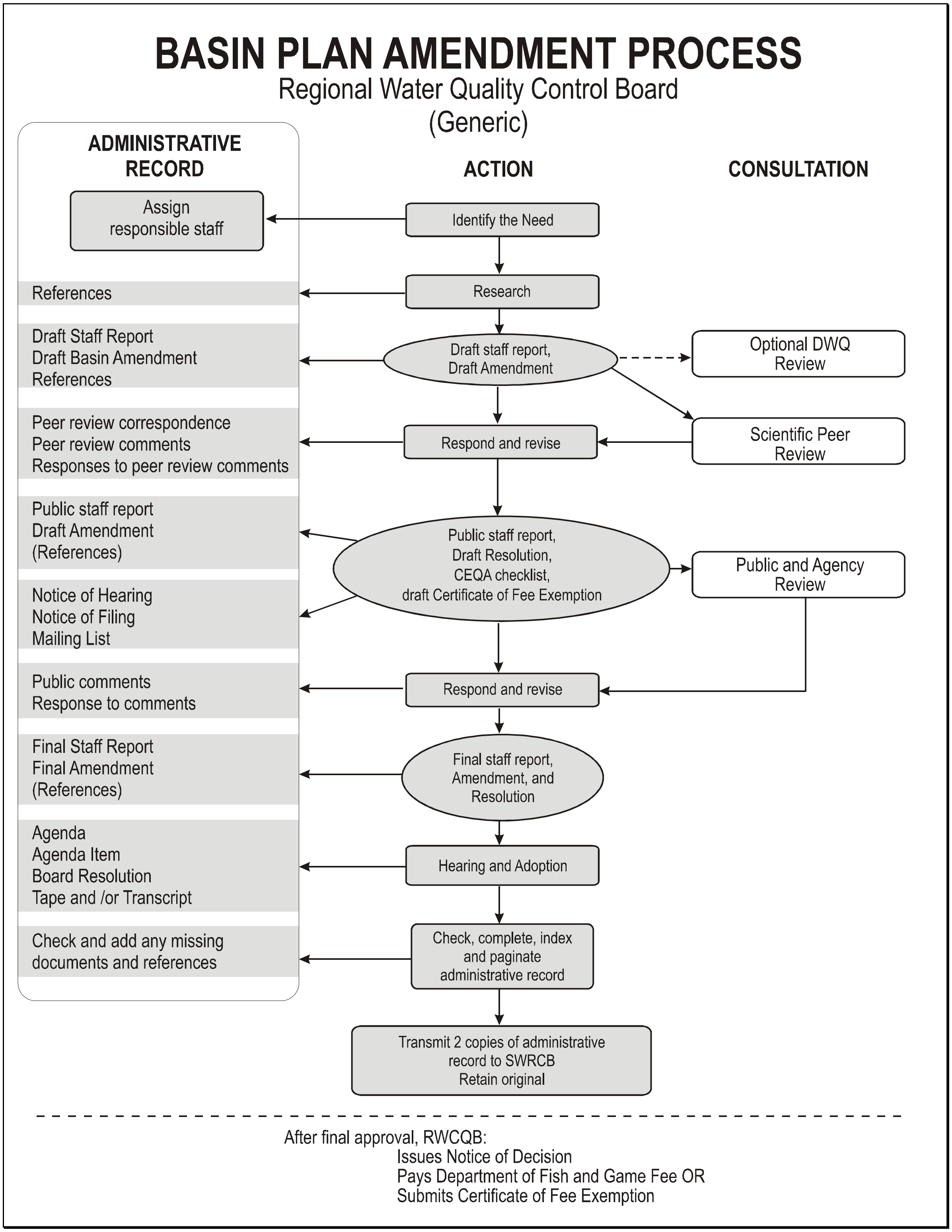


Figure 6-2. Basin Plan Amendment Process

Regardless of the implementing program, the RWQCB has the responsibility to determine the loading capacity (LC) (the TMDL) for the waterbody and the load reductions necessary (considering seasonal variations and a margin of safety) to attain standards. The RWQCB must then exercise its independent discretion to determine whether or not an implementation program is consistent with the LC. In some circumstances the implementation program may have been adopted by another regulatory or non-regulatory entity. On these occasions the RWQCB may not always need to adopt its own implementation program, but may instead rely upon the program adopted by the other entity. When doing so, the RWCQB should establish the TMDL via a resolution, which certifies that RWQCB has determined that the other entity's program will comply with the TMDL and attain standards. In doing this, the RWQCB must demonstrate in the resolution that the implementing program is consistent with the assumptions and requirements of the TMDL, that sufficient mechanisms exist to provide reasonable assurances that the program will address the impairment in a reasonable period of time, and that sufficient mechanisms exist to ensure that the program will be enforced, or that the RWQCB has sufficient confidence that the program will be implemented, such that further regulatory action by the RWQCB is unnecessary and would be redundant.

The determination of whether the implementation mechanisms are reasonable should be made on a TMDL-by-TMDL basis and should take into account the level of confidence associated with the project specifics. For example, a TMDL implementation plan that outlines relatively few required management practices by few affected (and known) parties might result in greater confidence in the implementation and success of the plan with less RWQCB oversight. Conversely, an implementation plan that outlines a complex, uncertain strategy for attaining standards might result in lower confidence in success and would dictate the need for greater RWQCB oversight and inclusion of sufficient fallback provisions to ensure that the impairment will be addressed in a reasonable period of time if the program is unsuccessful. Such fallback provisions should include instructions that RWQCB staff will commence a regulatory response if the impairment has not then been addressed within a specified time period. These TMDLs should also be referenced in the Basin Plan within a reasonable time after its establishment.

Employing these abbreviated procedures when warranted is a matter of efficiency and resource allocation. California is obligated to establish and implement 800 or more TMDLs over the next ten years for over 1,800 pollutant/water body combinations. Given existing resource constraints (both financial and personnel), to the extent California can consolidate regulatory actions or eliminate unnecessary regulatory processes when fulfilling our obligations under Section 303(d), the State and Regional Boards can expedite their responsibility to address and correct impaired waters in California, and expend resources on more TMDLs instead of redundant processes.

7. DEVELOPMENT OF AN IMPLEMENTATION PLAN

The information presented in Chapters 1 through 6 focuses on the technical and regulatory options analysts should consider when identifying how to effectively restore and support beneficial uses. Chapter 1 also introduced the concept of implementation planning, which emphasizes the need to consider possible management practices early in the project planning. By thinking about possible implementation options from the early phases of the project, the analyst will have facilitated the development of a detailed implementation plan that provides a road map of the control strategies, responsible agencies, and funding sources.

Adaptive Implementation

"Adaptive implementation is, in fact, the application of the scientific method to decision-making. It is a process of taking actions of limited scope commensurate with available data and information to continuously improve our understanding of the problem and its solutions, while at the same time making progress toward attaining the water quality standards." (NRC, 2001)

Because an implementation plan will often identify actions that have unknown or uncertain efficiencies, it is important that it be flexible to the need for change over time. The concept of adaptive implementation is important because it encourages the continuous adjustment and re-evaluation of methods and regulatory actions to ultimately achieve the goal of water quality standards attainment through environmental restoration. In California, adaptive implementation is the natural result of the project phases and implementation process as shown in the schematic diagram in Figure 7-1. Adaptive implementation considers the learning process inherent in the management process by allowing for short- and long-term actions, testing of new methods, and incremental evaluation of progress. If monitoring and surveillance during the implementation process indicate that the interim milestones are not being achieved, three options are possible: (1) the implementation can continue, (2) the implementation practices can be adjusted or new practices initiated, or (3) the regulatory actions can be revised by revisiting phases 1 through 7.

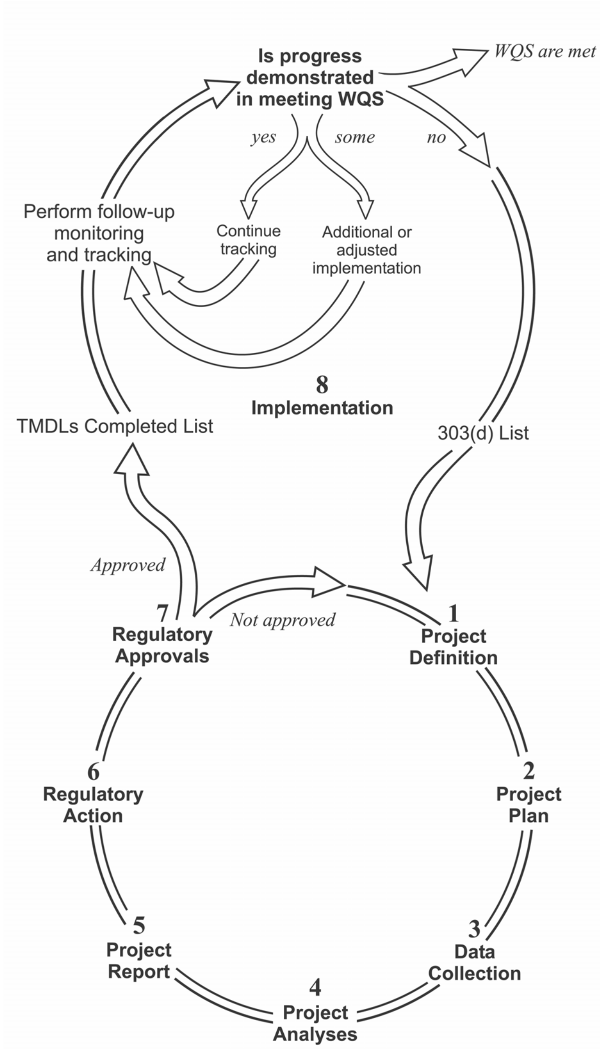


Figure 7-1. Adaptive Implementation Process

7.1. Regulatory Background

Relevant Legal Memos

The following legal memos in Appendix B are relevant to TMDL implementation plans:

- *Do TMDLs Have to Include Implementation Plans?*
- *Legal Authority for Offsets, Pollutant Trading, and Market Programs to Supplement Water Quality Regulation in California's Impaired Waters*
- *Guidance Regarding the Extent to Which Effluent Limitations Set Forth in NPDES Permits Can Be Relaxed in Conjunction With a TMDL*

Regardless of the technical track each project follows, the early planning of implementation options is essential. The early implementation planning will support the development of the implementation plan through the identification of existing regulatory controls and citations of the relevant sections of the California Water Code, which establishes the RWQCB's authority to enforce the regulatory actions.

State authorities are set out under the Porter-Cologne Water Quality Control Act, which is Division 7: Water Quality (Sections 13000–14958) of the California Water Code (http://www.waterboards.ca.gov/water_laws/docs/portercologne2003.pdf). Water Code Section 13242 provides for establishing an implementation program for achieving WQOs in water quality control plans (Basin Plans). The program of implementation must describe the nature of actions that are necessary to meet the objectives, including recommendations for action by both private and public entities. The program must also include a time schedule and describe proposed surveillance activities to assess compliance with objectives. Water Code Section 13263 provides authority to regulate discharges of waste through waste discharge requirements (WDRs). WDRs may be used to implement relevant water quality control plans. The term "discharge of waste" in Porter-Cologne covers nonpoint as well as point sources of pollution. "Discharges of waste" are not limited to waste disposal, but also include releases of pollutants as part of other activities. Hydrological or hydrogeological modifications, for example, that cause the release of wastes into state waters may be regulated under WDRs. Although an RWQCB may not "specify the design, location or type of construction" of the means of compliance, it can specify a particular management practice to define a level of compliance so long as the RWQCB allows the discharger to achieve compliance in any lawful manner.

The SWRCB has adopted a Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program (NPS Implementation and Enforcement Policy) (May 2004) as required by Water Code Section 13369. This policy provides a description of the framework for implementing and enforcing the State's nonpoint source pollution control program. Under the policy, nonpoint source dischargers are required to develop pollution control programs that include four key elements. These include: (1) dischargers must show they are knowledgeable about the water quality requirements they are required to meet and that the management practices (MPs) they propose to implement are designed to meet those water quality requirements; (2) the MPs to be implemented must be identified and the process for verifying their implementation described; (3) implementation time schedules with interim milestones must be established: this includes a time schedule for MP implementation and a time schedule for meeting water quality objectives; and (4) feedback mechanisms must be designed to track and evaluate progress. Implementation programs may be developed by individual dischargers or by groups of dischargers as participants in third-party coalition arrangements or a third-party local, state or federal program. Third-parties are defined as any entity that is not under the permitting or enforcement jurisdiction of the SWRCB or a RWQCB.

If a TMDL or other regulatory action is being adopted without sufficient information to develop a complete implementation plan, the implementation plan can be developed consistent with an adaptive approach that outlines the various stages of implementation that are expected and the process for fully realizing the regulatory actions. The implementation plan may adopt initial stages, such as a study program, or may contain a commitment by the RWQCB to reconsider the implementation plan by a specified time. In such cases, the Office of Administrative Law has held that the RWQCB must **require** itself (by use of the term *shall* in the adopting Resolution) to produce a full implementation plan, not just **intend** to do so (by use of the term *will*) (*Administrative Procedures Manual*, Chapter 8, Water Quality).

7.2. Components of Implementation Plans

Implementation plans may include both regulatory and nonregulatory actions. For regulatory actions, implementation plans should clearly describe what is required and who the responsible parties are. The plan can include recognition of actions that are already occurring; actions that may occur in the short term and long term; techniques that still must be designed, tested, and evaluated prior to "full" implementation; corrective or preventive actions; and monitoring/testing actions to resolve key uncertainties or verify assumptions. The plan also recognizes the direct or indirect responsibilities of the various responsible or cooperating agencies including federal, state, and local agencies, special districts, nongovernmental organizations, landowners, and dischargers. Although determination of the exact means of compliance is the role of the responsible agency, the plan must still provide a discussion of the anticipated and/or possible means of compliance. For regulatory actions requiring Basin Plan amendments, the scientific basis of the implementation plan is subject to peer review as well. In many cases multiple responsible jurisdictions and responsible agencies will be tasked with carrying out the implementation efforts.

An implementation plan in California should include the following items:

- Description of the actions necessary to achieve water quality standards. For TMDLs, they are actions to achieve waste load and load allocations and numeric targets
- Action to resolve key uncertainties and verify key assumptions
- A schedule and key milestones for the actions to be taken
- Monitoring and surveillance to be undertaken to determine compliance with the water quality standards. For TMDLs, this includes tracking and evaluating actions and attainment of waste load and load allocations and numeric targets

Implementation planning should begin in the earliest stages of project planning and incorporate stakeholder involvement and recognition of the various sources likely to be affected by the management actions. In cases involving nonpoint source management, the general components of the implementation plan should be consistent with Nonpoint Source Program Implementation Policy (SWRCB, 2004).

Project analyses are performed with the goal of evaluating and selecting solutions that can be implemented. Selection of management alternatives and TMDL allocations also incorporates knowledge of how implementation can be achieved and what cost-effective options are available. Although stakeholders often have latitude in selecting how a loading goal will be achieved, identifying feasible and successful actions is essential to building effective plans. Steps in designing an implementation plan include

- **Identify current activities.** Often actions have already been initiated to begin to address water quality impairments. Practitioners should check the Basin Plan for existing or ongoing regulatory actions. Implementation plans should be designed to be consistent with existing policies and procedures. Future actions may need to build on these efforts to avoid duplication. For example, existing NPDES permit requirements for directly affected discharges and similar ones should be reviewed; the status of implementation of nonpoint source management measures and practices for applicable categories or specific sources should also be reviewed.

- **Identify common interests and overlapping objectives.** Implementation of regulatory actions may benefit and support other related restoration projects or help to prevent future degradation of related water quality parameters. Potential related activities may be associated with projects that address endangered species, flood protection, water supply, watershed management, and land use planning.
- **Engage stakeholders.** Early in the process stakeholders can be involved in the consideration of solutions and alternatives. Stakeholders can guide the selection of management activities, provide valuable perspective on past activities, and build support for volunteer initiatives. Engaging stakeholders early helps to identify collaboration opportunities and optimize the trade-offs between certainty of actions and flexibility. Related guidance is provided in the stakeholder issue paper in Appendix F.
- **Identify opportunities for management practices.** The most viable opportunities need to be identified based on considerations of source type, impairment type, and size of load reduction required. Opportunity evaluation can consider the suitability of local conditions for management measures (e.g., soil type appropriate for infiltration trenches), the availability of technology (e.g., advanced wastewater treatment sufficient to meet a nutrient target), or the accessibility or availability of land (e.g., sites for stormwater facilities or riparian corridors).
- **Consider alternatives and cost.** The implementation plan can include consideration of multiple alternatives to achieve the water quality standards. Alternatives can be described and evaluated based on their effectiveness in meeting water quality standards and associated loading targets, and the cost associated with implementation. Implementing agencies have latitude to develop more specific plans that select an alternative, incorporate features from multiple alternatives, or define additional management techniques. Implementation planning may also incorporate pollutant trading or other innovative funding mechanisms.

Typical Source Categories

NPDES Wastewater. Wastewater discharges under NPDES discharge permits, subject to regulation under the state's Porter-Cologne Water Quality Control Act (Division 7 of the Water Code) and the federal CWA.

NPDES Stormwater. The CWA requires various industrial facilities, construction sites, and urban areas with more than 10,000 people to control the amount of pollutants entering their storm drain systems. (http://www.swrcb.ca.gov/stormwtr/index.html)

Nonpoint Sources. Nonpoint sources contribute diffuse loadings in major categories defined by the coastal zone management program, including urban, agriculture, forestry, marina, hydromodification, and wetlands. (California's nonpoint source Web site at http://www.swrcb.ca.gov/nps/index.html, and the USEPA's Web site at http://www.epa.gov/OWOW/NPS/MMGI/)
Typical nonpoint sources in California are:

- Agriculture-Orchards
- Agriculture-Row crops
- Agriculture-Grazing
- Agriculture-Confined animals
- Forestry-Timber harvest
- Forestry-Recreational use
- Urban
- Urban-Rural residential
- Marinas
- Hydromodification
- Wetlands
- SLIC/DOD/Superfund

Bay Protection and Toxic Clean-up Program (BPTCP). The BPTCP is a comprehensive effort by the SWRCB and RWQCBs to programmatically link environmental monitoring and remediation planning. (http://www.swrcb.ca.gov/bptcp/)

Land Application of Waste. The biosolids program addresses land application of solid waste to agricultural, silvicultural, horticultural, and land reclamation activities. (http://www.swrcb.ca.gov/programs/biosolids/index.html)

Mines. California Department of Conservation provides oversight for mining and mine reclamanation activities. The Office of Mine Reclamation (OMR) was created in 1991 to administer the Surface Mining and Reclamation Act of 1975 (SMARA). Established to meet the act's requirements, OMR provides assistance to cities, counties, state agencies, and mine operators for reclamation planning and promotes cost-effective reclamation. (http://www.consrv.ca.gov/OMR/)

However, the specific plans must be designed to meet regulatory actions as incorporated in the Basin Plan amendment.

7.3. Technical Considerations in Implementation Planning

Designing an effective implementation plan requires consideration of the impairment type, sources and load delivery mechanisms, and the linkage of the management needs to the sources. Major source types considered in impaired water analyses and implementation plans are wastewater discharges (i.e., municipal, industrial), stormwater discharges, nonpoint sources, toxic hot spots, land application of waste, and various other discrete sources. These major source categories are described in the sidebar on p. 7-4.

Nonpoint source guidance is being developed, in conjunction with development of the California Impaired Waters Guidance, to support the technical aspects of nonpoint source implementation, as well as the development of TMDL implementation plans and watershed plans. The goal of the Nonpoint Source Guidance is to provide a central resource for technical information regarding nonpoint source management practices in the state of California. The information will assist state agencies, regional boards, local agencies, and nonpoint source practitioners in the identification and implementation of practices to protect high-quality waters and restore impaired waters. The Nonpoint Source Guidance is organized by the six nonpoint source categories (agriculture, forestry, urban areas, marinas and recreational boating, hydromodification, and wetlands/riparian areas/vegetated treatment systems) that are identified in the Plan for California's Nonpoint Source Pollution Control Program (January 2000).

In all cases, management techniques are selected based on how appropriate they are to the individual source type. Some factors to consider in the selection of management practices are

Additional Information on Management Techniques

Documents:

Metcalf and Eddy. 1991. *Wastewater Engineering: Treatment, Disposal, Reuse*. 3rd ed. McGraw-Hill, Inc., New York.

USEPA. 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA-840-B-93-001c. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 1997b. *Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures — Agriculture*. EPA 841-B-97-010. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 1997c. *Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures — Forestry*. EPA 841-B-97-009. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 2001. *Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures -- Urban*. EPA 841-B-00-007. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

California Stormwater Quality Association (CASQA). 2003. *California Stormwater Best Management Practices Handbooks:*
Municipal
New Development and Redevelopment
Construction
Industrial and Commercial
(http://www.cabmphandbooks.com/)

Databases:

The SWRCB's Web-enabled Nonpoint Source Database completed November 2003) providing a reference guide to available management practices, the effectiveness of techniques to remove pollutants, and the range of expected installation and maintenance costs. (http://www.swrcb.ca.gov/nps/index.html)

USEPA and American Society of Civil Engineers (ASCE) database of performance data on best management practices (BMPs) for more than190 BMP studies conducted over the past 15 years. (http://www.bmpdatabase.org/ [through http://www.epa.gov/ost/stormwater/])

- Availability of appropriate techniques, management measures, and individual practices for the impairment and source categories.
- Type of analyses needed to evaluate the ability of proposed management techniques to meet the objectives (WQOs, allowable loadings, or other measures) identified by the regulatory actions.
- The locations of the impairment(s) and the need to target management by location and source type.
- Acceptance by responsible parties.
- Overlapping benefits for multiple pollutants or stressors.
- Incremental initiation of management activities based on supporting experiments or investigation of management techniques in an adaptive process.

For information on available techniques, estimates of effectiveness, and considerations in the design and siting of management practices, refer to the references and Internet sites listed in the sidebar on p. 7-5.

Information on the nonpoint source program is available on the Waterboards web site at http://www.waterboards.ca.gov/nps information available at the site includes:

- **California Nonpoint Source Encyclopedia.** A condensed quick reference guide that provides an entry point to information, including an overview of nonpoint source management; discussion of each of the six source categories and associated management measures, practices, and applicability to California regions; description of techniques used to analyze management practice effectiveness, source loading, and management costs; and key contact information, references, and resources.
- **Nonpoint Source Database.** An online system that provides a quick reference guide to available management practice technologies, the effectiveness of techniques to remove pollutants, and the range of expected installation and maintenance costs.

In addition the adopteded The Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program is available on the SWRCB's Web site at http://www.waterboards.ca.gov/nps/docs/oalfinalcopy052604.doc .

7.4. Estimating Management Effectiveness

Based on the results of project analyses and an understanding of the source loading characteristics, various estimates of management effectiveness can be performed. These analyses can be used to link the proposed management actions with the desired load reductions, and determine whether the proposed management actions will be sufficient to meet WQOs (e.g., through TMDL allocations). Table 7-1 provides a sample worksheet for a TMDL study in which a load reduction of 150 pounds is required. This is a generalized illustration and is not intended to represent any particular location or pollutant. This illustration shows three sources contributing loads to the impaired waterbody. For two of the sources, a portion of the load is expected to be managed. A percent effectiveness is selected for each managed area based on the type of source, management technique employed, and the type of pollutant managed. In this example, one source area (A3) is assumed to have no additional management. Typically this would occur if the source loading was associated with natural conditions (e.g., wildlife, undisturbed forest) or was already fully managed and no further reductions were expected.

Table 7-1. Sample Worksheet for Estimating Management Needs to Meet Loading Target

Project #/Name				
Date				
Total Estimated Load (lb) to be managed				1,000
Practice	Load Treated	Percent Effectiveness	Load Reduction (lb)	
Source Category A1 - Total Load = 200 lb				
Managed area 1	100	50%	(50)	
Managed area 2	50	65%	(33)	
No additional management	50	0%	0	
				(83)
Source Category A2 - Total Load = 300 lb				
Managed area 3	100	50%	(50)	
Managed area 4	50	35%	(18)	
No additional management	150	0%	0	
				(68)
Source Category A3 - Total Load = 500 lb				
No additional management	500	0%	0	
				0
Implementation Estimate				850
Targeted Load	150-lb load reduction required			850

7.5. Consideration of Cost in Implementation Plans

Economics is always a consideration in the evaluation and formulation of management alternatives. Stakeholders may offer insights and concerns regarding the cost of management options. Ongoing dialogue with stakeholders is beneficial and can result in incorporating cost factors in the selection and evaluation of management alternatives. Consideration of economics can also help to identify opportunities for collaboration or leveraging in conjunction with existing projects.

The RWQCBs, in general, adopt TMDLs or other management actions as Basin Plan amendments. Under state law, there are three specific triggers for RWQCB consideration of economics or costs in basin planning:

- The RWQCBs must estimate costs and identify potential financing sources in the Basin Plan before

Relevant Legal Memos

The following legal memos in Appendix B are relevant to consideration of costs in the impaired waters process:

- *Economic Considerations in TMDL Development and Basin Planning*
- *Guidance on Consideration of Economics in the Adoption of Water Quality Objectives*

implementing any agricultural water quality control program.

- The RWQCBs must consider economics in establishing WQOs that ensure the reasonable protection of beneficial uses.
- The RWQCBs must comply with the California Environmental Quality Control Act (CEQA, http://ceres.ca.gov/topic/env_law/ceqa/) when they amend their Basin Plans. CEQA requires that the RWQCBs analyze the reasonably foreseeable methods of compliance with proposed performance standards and treatment requirements. This analysis must include economic factors.

Economic factors come into play under federal law when the RWQCBs designate uses. Specifically, the RWQCBs can decide not to designate, to dedesignate, or to establish a subcategory of a potential use where achieving the use would cause substantial and widespread economic and social impact.

As part of implementation planning, the RWQCBs may include analysis of the cost of the potential management techniques identified in one or more alternatives. The cost can be approximated based on available information on potential management techniques to be applied, examination of the locations or sites where management could be initiated, typical literature or local experiences with specific practices, and estimates provided by interested stakeholders. The SWRCB's Web-enabled Nonpoint Source Database (to be completed November 2003) will also provide a reference guide to cost associated with available management practices, including the range of expected installation and maintenance costs (http://www.waterboards.ca.gov/nps/index.html).

Sample Cost Estimate for Implementation Planning for the Alamo River Sedimentation/Siltation TMDL

For the Alamo River sedimentation/siltation TMDL, the estimated total cost of implementing MPs ranges from $5.00 to $52.50 per acre per year, which is generally estimated to be less than 2 percent of production costs. The development of Farm Water Quality Management Plans is estimated to be less than $200.00 per field. Monitoring costs are estimated to range from $100.00 to $500.00 depending on the monitoring program. The preparation of the IID monitoring plan is estimated to be $25,000. Implementation of the IID monitoring plan is estimated to be $70,000 per year, and the cost of characterizing dredging impacts is estimated to be $20,000.

Potential sources of financing are private financing by individual sources; bond indebtedness or loans from government institutions; surcharge on water deliveries to lands contributing to the sediment pollution problem; taxes and fees levied by the Irrigation District that provides drainage management; state and/or federal grants and low-interest loans, including State Proposition 13 (Costa-Machado Act of 2000) grant funds and Federal Clean Water Act Section 319(h) grant funds; and single-purpose appropriations from federal and/or state legislative bodies.

Source: Colorado River Basin Regional Water Quality Control Board, 2002. Basin Plan Amendment for the Alamo River Sedimentation/Siltation TMDL. Page 16 of 20.

The SWRCB's Economics Unit provides support for the analysis of economic implications of management. In an implementation plan, funding sources should be identified to the extent possible, as options, grants, utilities, or other mechanisms. An example of implementation planning text for a TMDL is shown in the sidebar.

7.6. Monitoring and Surveillance Plans

Essential to the implementation plan are the methods that will be used to monitor and track progress. Monitoring and tracking are needed for the following purposes:

- Evaluate progress toward meeting water quality standards
- Check attainment of numeric targets and TMDL allocations
- Verify or refine assumptions, resolve uncertainties, and improve scientific understanding

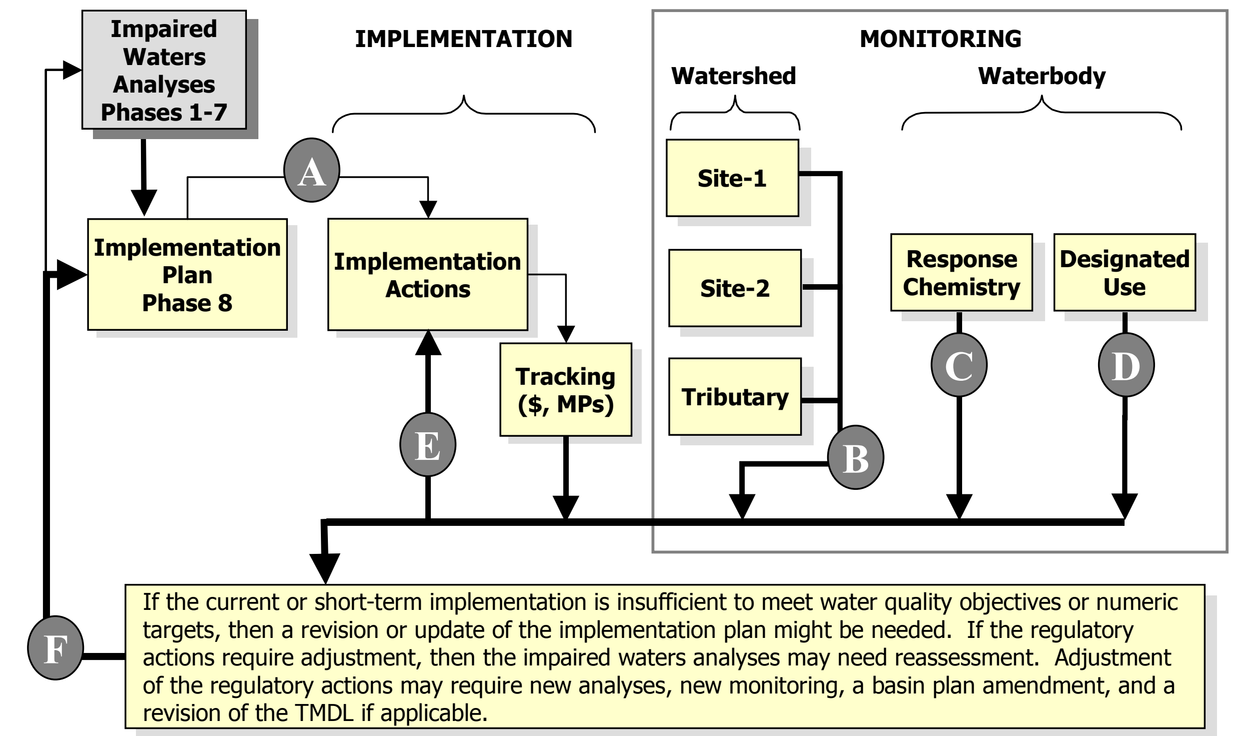
- Track and evaluate short- and long-term implementation actions
- Identify resource or implementation shortfalls
- Check compliance with specific requirements
- Identify potential needs for revision or update of regulatory actions

Designing a monitoring and surveillance program requires addressing technical, economic, and logistical challenges. The monitoring of progress may require examination of multiple measures of water quality, including chemical, physical, and biological measurements. Hydrologic variability (daily, seasonal, and annual) can make water quality response to management difficult to discern. Monitoring may need to be targeted to specific critical time periods associated with the protection of the beneficial use (e.g., aquatic life). The size of the watershed and location of impairment will need to be considered in determining where and how often sampling can occur. For many watersheds, especially larger ones, the lag time between the initiation of an action and a downstream receiving water response may necessitate long-term monitoring and tracking. Sediment studies often show that even with the aggressive adoption of management practices, it may take more than 25 years before water quality standards are fully achieved. In other cases, management practices may take a long time to become fully effective. For example, for temperature impairments related to insufficient shading, restoration time frames are on the order of 20 years or more since forested riparian zones need time to establish.

The use of multiple monitoring and tracking techniques can also help to evaluate progress on a continuous basis, from the procurement of funding resources, to the initiation of management techniques, until beneficial use support is achieved. The following are some of the monitoring and tracking techniques that can be used:

- Funding (dollars committed or expended)
- Actions (e.g., MPs installed, load reduction per MP)
- Local response (e.g., edge of field/MP effectiveness)
- Measurements of pollutant concentrations or loads in tributaries
- Receiving water chemistry (e.g., comparison to WQOs or targets)
- Aquatic life indicator (presence or diversity of fish population)

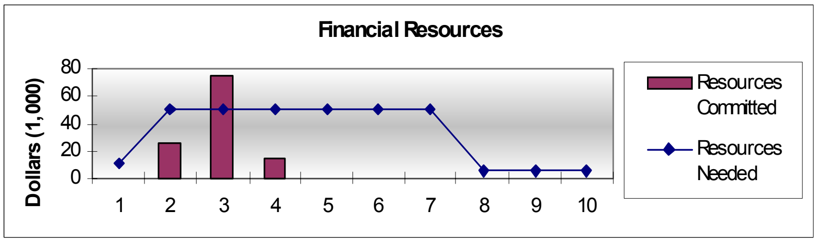
Multiple levels of tracking can help to diagnose problems and guide actions in an adaptive management approach. Considerations in the selection of the appropriate monitoring and tracking techniques include the impairment type, size, location, sources, and management techniques; funding availability for management; time constraints or requirements; and monitoring resources. Monitoring and evaluation can be built into the implementation plan to evaluate management techniques before initiating long-term actions. This continuous process of evaluation and improvement supports the adaptive implementation process. If management actions are deemed insufficient or more information is available indicating the need for reassessment, then the adaptive process allows for initiating a new impaired waters analysis (i.e., phases 1–7). Figure 7-2 illustrates the adaptive management approach and describes the relationships between various levels of tracking, the multiple opportunities for evaluation of progress, and the potential for adjustment.



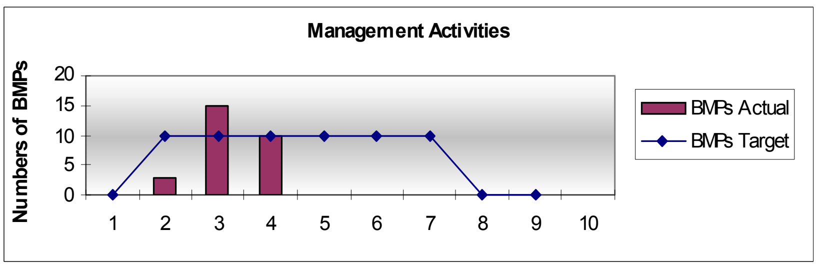
A. Regulatory actions are identified and implemented through appropriate local, state, and federal authorities. Management activities can include nonpoint source management measures, permits, stormwater management, compliance, and abatement activities. Financial or stakeholder resources are required to put management plans in place. Typically, procurement of these resources must be in place before the management activities can proceed.
B. Response can be most easily measured closest to the management action. Selected monitoring locations can be used to directly evaluate the **localized** benefit of various management practices.
C. Chemical/biological response to management can be measured in the impaired waterbody to evaluate improvement or trends relative to WQOs. As the distance from management activities and size of the watershed increase, the direct immediate benefit of management is harder to discern, and depending on the pollutant, there may be a considerable delay between management actions and measurable receiving water response. For example, phosphorus load reductions in the watershed may not immediately result in improved lake quality based on measures of summer chlorophyll *a*.
D. Direct measurement of the beneficial use impairment can identify positive trends and desirable responses. For example, if the lake is impaired for aquatic life due to eutrophication, direct measure of fish population and recreational use may identify an improvement in use support.
E. Monitoring at multiple scales (B, C, D) can also lead to a reevaluation of the rate of implementation (are practices being installed?), the type of practices used (some practices might be demonstrated as highly effective), or the need for maintenance of existing management practices (e.g., periodic clean-out of stormwater ponds). In an adaptive approach, initial short-term actions may not fully result in meeting standards. Limited or pilot-scale monitoring can be used to test techniques and support revision or expansion of implementation techniques as appropriate. This reevaluation may indicate that a readjustment of the implementation plan is necessary within the context of the identified regulatory actions.
F. If current actions are insufficient, the implementation plan could be revised or updated based on information gathered during monitoring and tracking (A-E). If adjustment of the implementation plan is insufficient, a reassessment of the regulatory actions and potentially the associated project analyses is indicated. This update could result in new data collection, project analyses, revised regulatory actions, additional basin plan amendments, or re-submittal of the TMDL, if applicable.

Figure 7-2. Monitoring and Adaptive Management Approach

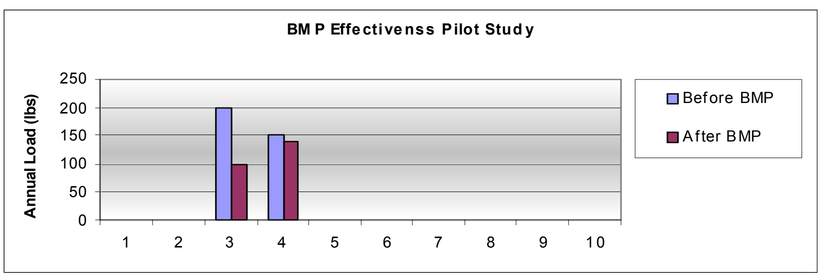
Multiple levels of tracking and monitoring can be employed over time to determine trends and evaluate the trend or trajectory indicating movement toward the water quality management goals. Figure 7-3 provides an illustration of how multiple types and levels of tracking can be used to support an adaptive management approach to implementation. This figure shows five monitoring and surveillance measures for a nutrient TMDL for a lake with aquatic life and recreational beneficial use impairments, with a timeline as years from the project start (on the x-axis). Review of implementation progress at the end of year 4 of the example is described for each of the graphical displays (A through E).



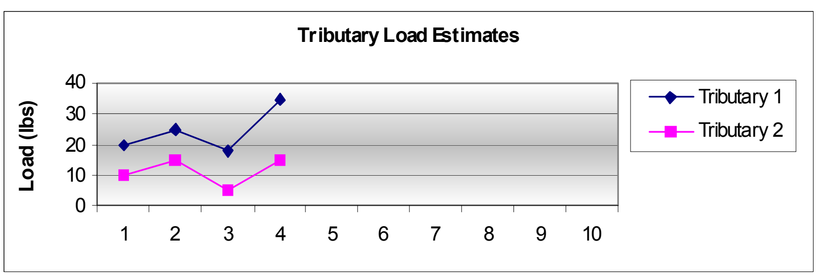
A. Financial resources are not consistent and need to be increased in year 5.



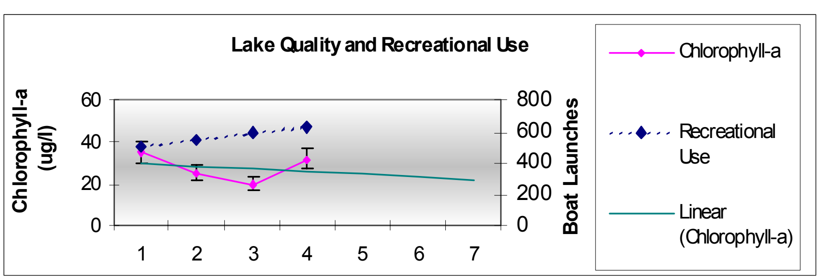
B. Limitations in funding in years 1 and 3 affected management implementation in year 1. Year 3 exceeded goals. Year 4 met goals but financial limitations could impact year 5.



C. Localized monitoring of a BMP pilot study on one tributary shows strong evidence of effectiveness in year 3, but only minimal effectiveness in year 4.



D. Lower loads in year 3 for two tributaries where BMP implementation occurred are probably due to lower rainfall, while high loads in year 4 are likely due to several large storms.



E. Lake mean summer chlorophyll *a* monitoring appears to show a generally decreasing trend, although variability could be due to wet and dry years. Recreation use based on boat launch frequency continues to increase.

Figure 7-3. Example of Multiple Tracking Techniques

Based on review of Figure 7-3 for this example, the manager might conclude that the focus should continue on the procurement of funding and the installation of MPs to meet or exceed identified goals. Continued monitoring of the tributary loading and lake conditions is needed to evaluate trends and determine whether progress is being made. As is often the case in environmental systems, a longer time period is needed to determine whether water quality conditions are improving. However, the multiple levels of tracking provide an indicator of potential success and a need for strong financial support of the implementation.

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9. GLOSSARY

Beneficial Uses. Uses of water that may be protected against degradation, including domestic, municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources and preserves. (California Water Code Section 13050(f))

Bioassessment. Biological assessment is the use of biological community information along with the measure of the physical and habitat quality to determine the integrity of a waterbody.

California Toxics Rule (CTR). Numerical water quality criteria established by USEPA for priority toxic pollutants for California's inland surface waters, enclosed bays, and estuaries.

Conceptual Model. A "conceptual model" of an environmental system is developed using readily available information. The conceptual model is used to visualize all potential or suspected sources of impairment, types and concentrations of pollutants in the impaired water, potential sources and pathways, and interactions between pollutants and related stressors. The use of conceptual models can aid in the identification of the most likely pollutant(s) or stressor(s) and support selection of appropriate analysis techniques.

Delist. To remove a water body from the state's 303(d) list through a formal action and approval by USEPA. The process typically involves submitting the state list to USEPA.

Loading Capacity (LC). The greatest amount of loading that a water can receive without violating water quality standards. The LC equals the total maximum daily load.

Load Allocation (LA). The portion of a receiving water's loading capacity that is attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources.

Best Management Practices (BMPs). (Cf. Management Practices, below.) This term has different meanings depending upon whether the discussion relates to Point or Nonpoint Source controls.

1. (**Relating to Point Source Controls**) BMPs include schedules of activities, prohibitions of practices, maintenance procedures, **and other management practices** to prevent or reduce the pollution of 'waters of the United States.' BMPs also include treatment requirements operating procedures (See 40 CFR 122.2.). The term in this context is broad and refers to the entire suite of management practices that may be employed.
2. (**Relating to Nonpoint Source Controls**) Methods, measures or practices **selected by an agency** to meet its nonpoint source control needs. BMPs include but are not limited to structural and nonstructural controls and operation and maintenance procedures. BMPs can be applied before, during and after pollution producing activities to reduce or eliminate the introduction of pollutants into receiving waters. (See 40 CFR 130.2(m).) Relatively few BMPs have been "selected" by the SWRCB, and so for Nonpoint Source controls, the broader term "management measures" should be used in most instances. In California, only one nonpoint source BMP has been certified. It relates to timber operations on federal and non-federal lands.

Management Practices (MPs). This term is roughly equivalent to the federal term BMPs as defined by the federal regulations for point sources (40 CFR 122.2). .

Margin of Safety (MOS). A required component of the total maximum daily load that accounts for the uncertainty about the relationship between effluent limitations and water quality and the quality of the receiving waterbody (Clean Water Act Section 303(d)(1)(C)).

Nonpoint Source (NPS). Pollution sources that are diffuse and do not have a single point of origin or are not introduced into a receiving stream from a specific outlet. Nonpoint source pollutants are generally carried off the land by uncontrolled stormwater runoff. The commonly used categories of nonpoint sources are agricultural return flow, forestry, urban runoff, mining, construction, land disposal, and saltwater intrusion. The term also includes certain sources that may have a single point of origin but are excluded from the definition of "point source" by the Clean Water Act (such as agricultural return flow).

Point Source. Any discernible, confined, and discrete conveyance, including any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigation agriculture or agricultural stormwater runoff. (40 CFR 122.2)

Pollutants. The term *pollutant* is defined in Section 502(6) of the Clean Water Act as "dredged spoil, solid waste, incinerator residue, 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. The term *pollution* is defined in Section 502(19) of the Clean Water Act as the "man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water." The term pollution thus includes impairments caused by discharges of pollutants. *Pollution* is also defined in Section 13050(l) of the California Water Code as an alteration 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.

Reference Condition. The characteristics of waterbody segments least impaired by human activities. Reference conditions can be used to describe attainable biological or habitat conditions for waterbody segments with common watershed/catchment characteristics within defined geographical regions.

Site-Specific Objectives (SSO). Objectives that reflect site-specific conditions and are appropriate when it is determined that promulgated water quality standards or objectives are not protective of beneficial uses or when site-specific conditions warrant more or less stringent effluent limits than those based on promulgated water quality standards or objectives, without compromising the beneficial uses of the receiving water.

Total Maximum Daily Load (TMDL). The sum of the individual waste load allocations for point sources, load allocations for nonpoint sources and natural background, and a margin of safety. TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standards.

Use Attainability Analysis (UAA). A structured scientific assessment of the factors affecting the attainment of the use, which may include physical, biological, and economic factors as described in Section 303.10(g) of the Clean Water Act (40 CFR 131.3).

Waste Discharge Requirements (WDRs). WDRs are issued under State law pursuant to California Water Code Section 13263 and apply to dischargers that discharge waste to land or to water. WDRs implement water quality control plans and take into consideration beneficial uses, water quality objectives, other waste discharges, the need to prevent nuisance, and the provisions of California Water Code Section 13241. The disposal method may be by agricultural or non-agricultural irrigation, ponds, landfills, mono-fills, or leachfields. When WDRs are issued for point source discharges to waters of the United States, the WDRs are issued under CWC section 13370 et seq., and constitute an NPDES permit.

Waste Load Allocation (WLA). The portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs are a type of water quality-based effluent limitation. (40 CFR 130.2(h))

Water Quality Limited Segment. Any segment of a waterbody that does not meet applicable water quality standards or is not expected to meet applicable water quality standards, even after application of certain technology-based effluent limitations.

Water Quality Standard (WQS). Provisions of state and federal law that consist of a designated use or uses for the waters of the United States, water quality criteria for such waters based upon such uses, and an anti-degradation policy. Water quality standards are to protect public health or welfare, enhance the quality of the water, and serve the purpose of the Clean Water Act (40 CFR 131.3). Under California law, designated uses are referred to as beneficial uses. In addition to federally promulgated criteria such as the California Toxics Rule, water quality criteria include California adopted narrative or numerical water quality objectives.

10. ACRONYMS

ASCE	American Society of Civil Engineers
BASINS	Better Assessment Science Integrating Nonpoint and Point Sources
BAT	Best available technology
BPT	Best practicable technology
BPTCP	Bay Protection and Toxic Clean-up Program
CASQA	California Stormwater Quality Association
CEQA	California Environmental Quality Control Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
CWC	California Water Code
DEM	Digital elevation model
DoD	Department of Defense
EFDC	Environmental Fluid Dynamics Code
GIS	Geographic information system
GWLF	Generalized Watershed Loading Functions
HSPF	Hydrologic Simulation Program – FORTRAN
IID	Imperial Irrigation District
LA	Load allocation
LC	Loading capacity
LOE	Level of effort
LSPC	Loading Simulation Program – C++
MOS	Margin of safety
MP	Management practice
MRLC	Multi-resolution Land Characteristics
NGO	Non-governmental Organization
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NWIS	USGS's National Water Information System
OMR	Office of Mine Reclamation
PCB	Polychlorinated biphenyl
PCS	Permit Compliance System
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
QUAL2E	Enhanced Stream Water Quality Model
RWQCB	Regional Water Quality Control Board
SLIC	Spills, Leaks, Investigations and Clean-up program
SMARA	Surface Mining and Reclamation Act of 1975
SSO	Site-specific objective
STATSGO	State Soil Geographic database
STORET	USEPA's STOrage and RETrieval system
SWAMP	Surface Water Ambient Monitoring Program
SWMM	Storm Water Management Model
SWRCB	State Water Resources Control Board
TDS	Total dissolved solids
TMDL	Total maximum daily load
TSS	Total suspended solids
UAA	Use attainability analysis
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WASP	Water Quality Analysis and Simulation Program

WDR	Waste discharge requirement	WQS	Water quality standard
WQO	Water quality objective	WLA	Waste load allocation