3-1998

Water Quality Program. Programmatic EIS/R Technical Appendix

CalFed Bay-Delta Program

CALFED
BAY-DELTA
PROGRAM

Water Quality Program

Programmatic EIS/R
Technical Appendix
March 1998

CALFED Draft Water Quality Program Plan
Errata Sheet

February 27, 1998

Please note the following changes to the CALFED *Water Quality Program Plan* (Draft: January 5, 1998).

Page iv - Note to Reader
The following two sentences should be inserted at the beginning of the third paragraph:

The WQPP has been developed at the programmatic level of detail. Work remains to identify the specific projects, activities, management actions, and other implementation measures needed to achieve the desired improvements in water quality. During the next phase of the CALFED program, the water quality activities will be further developed, refined, and evaluated before any specific improvement methods are adopted.

Page 2 - Introduction
The following sentences replace the first two full sentences in the right hand column:

To achieve this goal, CALFED is developing and intends to implement a Water Quality Program. The purpose of this report is to describe the proposed Water Quality Program (in its current form) and detail the results of the Water Quality Program activities conducted during Phase II of the Program and highlight those activities planned in Phase III.

Page 6 - Stakeholder Involvement Process

The term "Environmental Water Caucus" replaces the term "Clean Water Caucus" in the first paragraph.

Page 38, Table 5 - CALFED Water Quality Targets for Parameters of Concern

Table 5 has been modified to include human health criteria and has been peer reviewed by the federal Environmental Protection Agency. Table 5 includes the proposed California Toxics Rule values for human health. In several cases, these values are much lower than the aquatic life criteria included in the matrix. The table follows:

Parameter	Sacramento River	San Joaquin River	Delta
Cadmium	Human Health:[z] EPA is not promulgating human health criteria for this contaminant.[aaa]	Human Health:[z] EPA is not promulgating human health criteria for this contaminant.[aaa]	Human Health:[z] EPA is not promulgating human health criteria for this contaminant.[aaa]
Copper	Human Health:[z] **1300 µg/l** (water and organisms) **No value** (organisms only)	Human Health:[z] **1300 µg/l** (water and organisms) **No value** (organisms only)	Human Health:[z] **1300 µg/l** (water and organisms) **No value** (organisms only)
Mercury (inorganic)	Human Health:[z] **0.050 µg/l** (water and organisms)[bbb] **0.051 µg/l** (organisms only)[bbb]	Human Health:[z] **0.050 µg/l** (water and organisms)[bbb] **0.051 µg/l** (organisms only)[bbb]	Human Health:[z] **0.050 µg/l** (water and organisms)[bbb] **0.051 µg/l** (organisms only)[bbb]
Selenium	Human Health:[z] EPA is not promulgating human health criteria for this contaminant.[aaa]	Human Health:[z] EPA is not promulgating human health criteria for this contaminant.[aaa]	Human Health:[z] EPA is not promulgating human health criteria for this contaminant.[aaa]
Chlordane	Human Health:[z] **0.00057 µg/l** (water and organisms)[bbb,ccc] **0.00059 µg/l** (organisms only)[bbb,ccc]	Human Health:[z] **0.00057 µg/l** (water and organisms)[bbb,ccc] **0.00059 µg/l** (organisms only)[bbb,ccc]	Human Health:[z] **0.00057 µg/l** (water and organisms)[bbb,ccc] **0.00059 µg/l** (organisms only)[bbb,ccc]
Parameter	**Sacramento River**	**San Joaquin River**	**Delta**
DDT	Human Health:[z] **0.00059 µg/l** (water and organisms)[bbb,ccc] **0.00059 µg/l** (organisms only)[bbb,ccc]	Human Health:[z] **0.00059 µg/l** (water and organisms)[bbb,ccc] **0.00059 µg/l** (organisms only)[bbb,ccc]	Human Health:[z] **0.00059 µg/l** (water and organisms)[bbb,ccc] **0.00059 µg/l** (organisms only)[bbb,ccc]
PCB's	Human Health:[z] **0.00017 µg/l** (water and organisms)[ddd] **0.00017 µg/l** (organisms only)[ddd]	Human Health:[z] **0.00017 µg/l** (water and organisms)[ddd] **0.00017 µg/l** (organisms only)[ddd]	Human Health:[z] **0.00017 µg/l** (water and organisms)[ddd] **0.00017 µg/l** (organisms only)[ddd]
Toxaphene	Human Health:[z] **0.00073 µg/l** (water and organisms)[bbb,ccc] **0.00075 µg/l** (organisms only)[bbb,ccc]	Human Health:[z] **0.00073 µg/l** (water and organisms)[bbb,ccc] **0.00075 µg/l** (organisms only)[bbb,ccc]	Human Health:[z] **0.00073 µg/l** (water and organisms)[bbb,ccc] **0.00075 µg/l** (organisms only)[bbb,ccc]

[z] United States Environmental Protection Agency. Federal Register, Part II. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Proposed Rule, 40 CFR Part 131, (August 1997). [California Toxics Rule].

[aaa] Permit authorities should address these contaminants in NPDES permit actions using the State's existing narrative criteria for toxics.

[bbb] These criteria have been revised to reflect the Agency ql* or RfD, as contained in the Integrated Risk Information System (IRIS) as of October 1, 1996. The fish tissue bioconcentration factor (BCF) from the 1980 documents was retained in each case.

[ccc] These criteria are based on carcinogenicity of 10 (-6) risk.

[ddd] This criterion applies to total PCBs or congener or isomer analyses.

Page 54 - Human Health

The following language replaces the paragraph under "Human Health":

"The CALFED Water Quality Program has developed several water quality actions to address human health concerns associated with pathogens and disinfection by-product precursors in drinking water and contaminants in fish and shellfish tissues consumed by people. Human health concerns are addressed through comprehensive monitoring and research which can result in providing input into the development of health advisories by regulatory agencies, drinking water source actions, increased public awareness educational programs, water treatment actions, wastewater and industrial discharge actions, agricultural drainage and runoff actions, and urban and industrial runoff actions.

Human health actions are intended to reduce impacts associated with the consumption of fish and shellfish containing elevated levels of DDT, chlordane, toxaphene, mercury, and PCBs and their derivatives. Water treatment actions are intended to reduce the formation of disinfection by-products and pathogens in drinking water through treatment to reduce the concentrations of total organic carbon, pathogens, turbidity, and bromides. Wastewater and industrial discharge actions are intended to reduce pathogens, evaluate the loadings of total organic carbon and pathogens from wastewater treatment plant discharges, and assess the need for source control measures to reduce drinking water effects. Agricultural drainage and runoff actions are intended to reduce total organic carbon by controlling total organic carbon discharges from Delta islands and to reduce pathogens by controlling inputs from rangelands, dairies, and confined animal facilities. Urban and industrial runoff actions are intended to reduce sediment and subsequent turbidity through source control, to evaluate the loadings of total organic carbon, salinity, and pathogens in urban runoff, and to assess the need for source control measures to reduce drinking water parameters of concern.

CALFED BAY-DELTA PROGRAM
WATER QUALITY PROGRAM PLAN

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WATER QUALITY PROGRAM PLAN

NOTE TO READER

This version of the Water Quality Program Plan (WQPP) has been developed as an appendix to the Water Quality Technical Report of the draft Programmatic EIS/EIR, scheduled for release to the public in early 1998. It is intended to provide the reader with information on the Water Quality Program not contained in the draft Programmatic EIS/EIR. Detailed information on current and historic water quality problems, water quality data, monitoring programs, the basis for water quality actions, and impacts to water quality is contained in the draft Programmatic EIS/EIR - Water Quality Technical Report.

The WQPP has been developed based on the input of numerous technical experts involved in the Water Quality Program. Every attempt has been made to incorporate, where appropriate, stakeholder comments received to date (i.e, September 22, 1996 through November 22, 1997).

In its current form, the WQPP is designed to be used by the Water Quality Program to assist in the development and implementation of water quality actions to address beneficial use impairments. CALFED staff welcomes stakeholder input on the WQPP.

CALFED BAY-DELTA PROGRAM
WATER QUALITY PROGRAM PLAN

ACKNOWLEDGMENTS

CALFED staff appreciate the participation and contribution of all the stakeholders involved with the Water Quality Program. We extend a special thanks to the Water Quality Technical Group and the Parameter Assesssment Team. Both groups represent a broad cross-section of interests advising the Water Quality Program. Appendix A contains a listing of the 218 Water Quality Technical Group members and 18 Parameter Assessment Team members. The PAT members are: William R. Alsop, Terry Barry, Jean-Pierre Cativiela, William H. Crooks, Brian Finlayson, Chris Foe, Tom Grovhoug, Fawzi Karajeh, G. Fred Lee, Mary Meays, Markus Meier, Stephen Murrill, Robin Reynolds, Theodore G. Roefs, K.T. Shum, Lynda A. Smith, Inge Werner, and Perri Standish-Lee. We also extend thanks to the people involved with the peer review of the Draft Water Quality Program Plan.

CALFED BAY-DELTA PROGRAM
WATER QUALITY PROGRAM PLAN

GLOSSARY

Following are working definitions of terms found throughout the WQPP. This section is intended to facilitate the reader's understanding of the CALFED Water Quality Program and is designed for the Water Quality Program Plan only. It is not intended as a general scientific glossary of terms.

Adaptive Management - A process of testing alternative ways of meeting objectives, and adapting future management actions according to what is learned.

Bay Region - The Bay Region includes Suisun Bay and Marsh, San Pablo Bay, and the Bay watershed. In addition, a zone of approximately 25 miles offshore from Point Conception to the Oregon border has been included to cover potential ocean harvest management of anadromous fish along the California coast. Certainly anadromous fish roam beyond this artificial boundary, but the purpose of this boundary is to identify the area where most anadromous fish from the Bay-Delta system occur and cover where harvest management actions would be employed.

Beneficial Use - Refers to water uses that are included in the Water Quality Program. Specifically, these water uses are urban, agricultural, industrial, environmental, and recreational beneficial uses.

Comprehensive Monitoring, Assessment, and Research Program (CMARP) - A program currently under development by the CALFED Bay-Delta Program to identify the monitoring, assessment and research needed for CALFED-related projects, actions, and activities. CMARP is a critical component of the CALFED adaptive management strategy.

Delta Region - The Delta Region is defined as the statutory Delta (in Section 12220 of the California Water Code) and is comprised roughly of lowlands (lands approximately at or below the 5-foot contour) and uplands (lands above the 5-foot contour that are served water by lowland Delta channels). The Delta Region has been carved out of the Sacramento and San Joaquin River watersheds because of the Program's focus on this region.

Indicators of Success - The endpoints used to determine when beneficial uses are no longer impaired. These endpoints may be based on achievement of a variety of measurable factors including: numerical and narrative objectives for water, sediment, and tissue and lack of toxicity as indicated by toxicity testing. Indicators of success answer the question "Have water quality goals been achieved?".

Parameter Assessment Team (PAT) - A technical working sub-group of the Water Quality Technical Group representing a variety of interests. See Appendix A and the Acknowledgments for a listing of PAT members.

Parameters of Concern - Substances or characteristics identified by the Water Quality Program as causing water quality problems to beneficial water uses based on the input of technical experts and stakeholders. Substances may be added to or deleted from the Water Quality Program's list of parameters of concern based on new knowledge. Once a parameter of concern is identified, water quality targets are established for the parameter and actions are developed to address the water quality problems associated with the parameter.

Performance Measures - A means to gauge the progress of an action. Progress may be judged based on a variety of factors such as reduced concentrations of a parameter. Performance measures answer the question "Is water quality improving?".

Sacramento River Region - The Sacramento River Region is essentially bounded by the ridge tops of the Sacramento River watershed or hydrologic region. The Goose Lake watershed, in the northeast corner of California, has been left out of the study area because it rarely contributes to the flow of the Pit and Sacramento rivers---apparently Goose Lake last spilled very briefly sometime in the 1950's and only a few times in between 1869 and the present---and no actions are proposed in the watershed. Though the Trinity River is connected by a pipeline to the Sacramento River system, the Trinity River does not flow naturally into the Sacramento River watershed, and no CALFED program actions are being proposed for the Trinity River or its watershed.

San Joaquin River Region - The San Joaquin River Region includes both the San Joaquin and Tulare Lake hydrologic basins. Although the Tulare Lake basin only intermittently---during wet years or a series of wet years---spills over into the San Joaquin basin, there are potentially significant water quality management issues linked to the San Joaquin River watershed (and ultimately, the Bay-Delta system).

State Water Project and Central Valley Project Service Areas Outside the Central Valley - The service areas outside the Central Valley include small portions of Santa Cruz, San Benito, and Santa Clara counties outside the Bay watershed, served by the CVP (San Felipe Diversion). The SWP service areas include most of the urbanized areas of Southern California as well as Santa Barbara and San Luis Obispo counties. There are CVP and SWP service areas within the Central Valley but the Central Valley watersheds cover those areas. In addition, Imperial Irrigation District is included in this region because the significant water use efficiency and transfer potential in the District could help reduce the water supply and demand mismatch in Southern California urban areas.

Toxicity of Unknown Origin - Refers to toxicity to native or laboratory test organisms due to unknown sources.

Water Quality Action - A programmatic action developed by the CALFED Water Quality Program to address impairments to agriculture, environment, drinking water, industrial, and recreational beneficial uses.

Water Quality Target - A numeric or narrative water, sediment, or tissue value associated with a parameter of concern. Water quality targets are based upon existing water quality, sediment, and tissue objectives recognized by the scientific community and regulatory authorities. In general, targets have been established to represent a threshold below which beneficial uses of water are not impaired. The target represents the goal toward which the Water Quality Program will strive; realizing targets may not in all cases be possible. A water quality target has no regulatory meaning within the context of CALFED.

Water Quality Technical Group (WQTG) - A group of 218 technical experts and stakeholders representing the environment, agriculture, drinking water, industry, and recreation who participate in the development of the Water Quality Program. See Appendix A for a listing of WQTG members.

CALFED BAY-DELTA PROGRAM
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ABBREVIATIONS

BMPs - best management practices

CMARP - Comprehensive Monitoring, Assessment and Research Plan

CVP - Central Valley Project

CWA - Clean Water Act

DDT - dichloro diphenyl trichloroethane

DFG - Department of Fish and Game

EC - electrical conductivity

PAT - Parameter Assessment Team

PCBs - polychlorinated biphenyls

Program - CALFED Bay-Delta Program

SAR - sodium adsorption ratio

SWP - State Water Project

TDS - total dissolved solids

TIE - toxicity identification evaluation

TMDL - total maximum daily load

TOC - total organic carbon

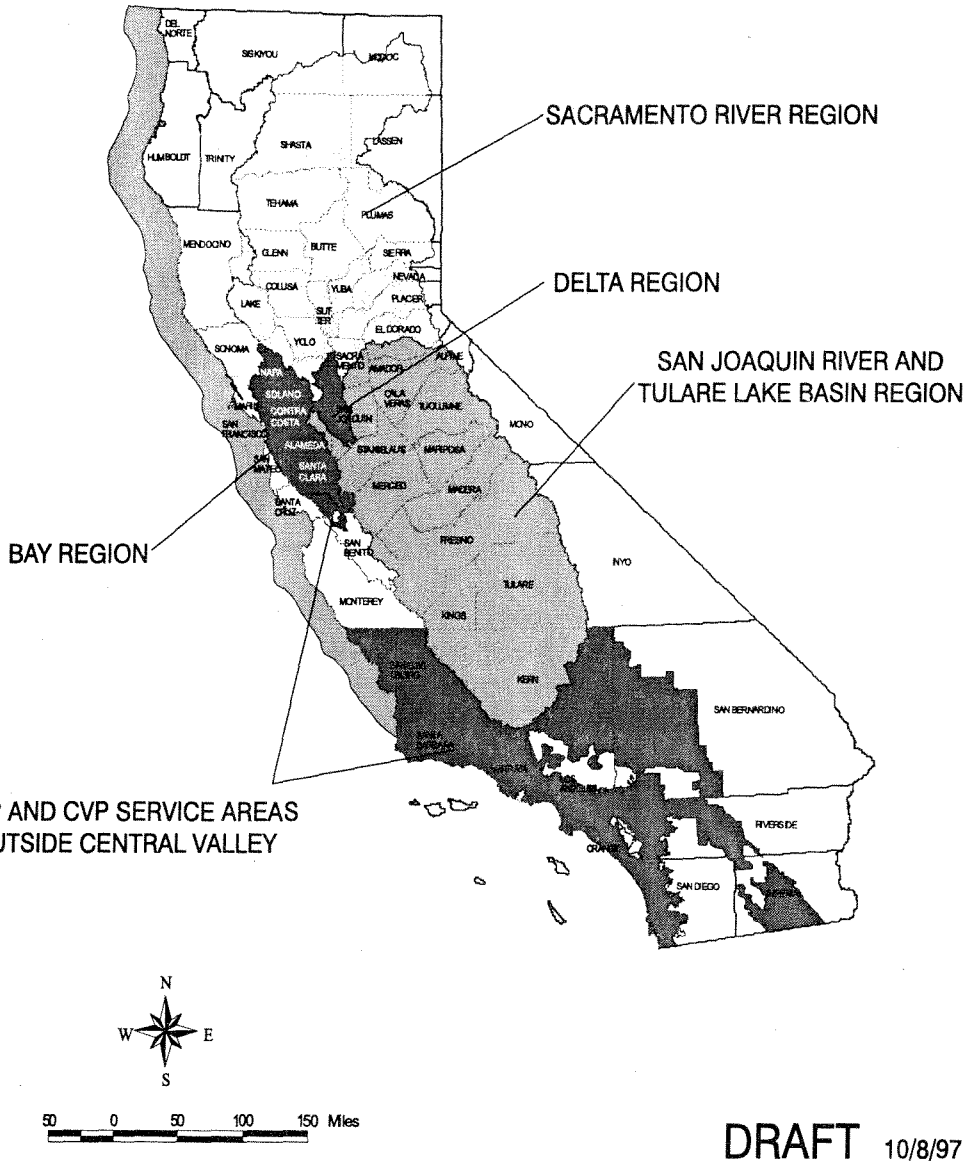
USEPA - US Environmental Protection Agency

WQPP - Water Quality Program Plan

WQTG - Water Quality Technical Group

CALFED BAY-DELTA PROGRAM
WATER QUALITY PROGRAM PLAN

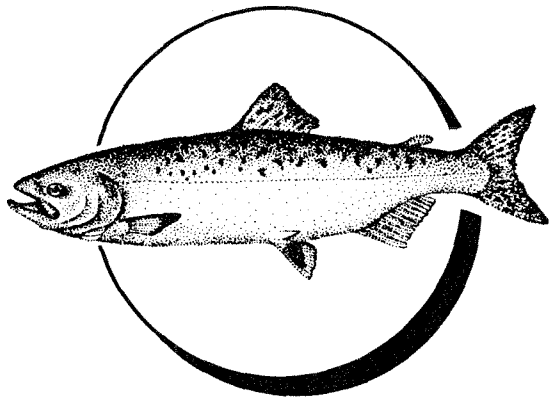
GEOGRAPHIC SCOPE



DRAFT 10/8/97

NOTE: A description of the five regions is included in the Glossary

WATER QUALITY PROGRAM BACKGROUND



CALFED
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PROGRAM

WATER QUALITY PROGRAM BACKGROUND

INTRODUCTION

The mission of the CALFED Bay-Delta Program (Program) is to develop a long-term comprehensive plan that will restore ecosystem health and improve water management for beneficial uses of the Bay-Delta system. The Program has identified six solution principles as fundamental guides for evaluating alternative solutions:

Reduce Conflicts in the System
Solutions will reduce major conflicts among beneficial uses of water.

Be Equitable
Solutions will focus on solving problems in all problem areas. Improvements for some problems will not be made without corresponding improvements for other problems.

Be Affordable
Solutions will be implementable and maintainable within the foreseeable resources of the Program and stakeholders.

Be Durable
Solutions will have political and economic staying power and will sustain the resources they were designed to protect and enhance.

Be Implementable
Solutions will have broad public acceptance and legal feasibility, and will be timely and relatively simple to implement compared with other alternatives.

Have No Significant Redirected Impacts
Solutions will not solve problems in the Bay-Delta system by redirecting significant negative impacts, when viewed in their entirety, within the Bay-Delta or to other regions of California.

The Program addresses problems in four resource areas: ecosystem quality, water quality, levee system integrity, and water use efficiency. Each resource area forms a component of the Bay-Delta solution and is being developed and evaluated at a programmatic level. Therefore, problems and corrective actions are described in a general manner sufficient to make broad decisions on program direction. The complex and comprehensive nature of a Bay-Delta solution requires that it be composed of many different programs, projects, and actions, that will be implemented over time.

The Program is being completed in three phases (Figure 1). Phase I of the Program began in June 1995 and was completed in August 1996. During this phase, three conceptual alternatives were developed to solve Bay-Delta problems. These conceptual alternatives all include program components to comprehensively address ecosystem restoration, water quality improvements, enhanced Delta levee system integrity, and increased water use efficiency.

1995 – 1996	1996 – 1998	1998 – 2030?
Phase I	**Phase II**	**Phase III**
3 Conceptual Alternatives	Alternatives Refinement Programmatic EIS/EIR Selection of Preferred Alternative	Project-specific Environmental Documentation Implementation of Preferred Alternative Adaptive Management Assurances

Figure 1. The three phases of the CALFED Bay-Delta Program.

Phase II of the Program is currently underway and will be completed in Fall 1998. It includes a broad-based environmental review, the development of a Programmatic EIS/EIR, refinement of the three alternative solution options, and the selection of a preferred alternative.

Phase III of the Program will begin in late 1998 or early 1999 and will continue for 20 to 30 years. During this phase, a more focused analysis, environmental documentation, and implementation of specific programs and actions will occur.

The CALFED Bay-Delta Program's goal for water quality is to provide good water quality for environmental, agricultural, drinking water, industrial, and recreational beneficial uses. To achieve this goal, CALFED has developed and is implementing a Water Quality Program. The purpose of this report is to detail the results of Water Quality Program activities conducted during Phase II of the Program and to highlight those activities planned in Phase III. Water Quality Program plans for Phase III will be described in a later document called the *Water Quality Implementation Plan*. See Appendix B for a preliminary draft outline of the *Water Quality Implementation Plan*. However, the strategy upon which the Implementation Plan will be based is included within the Programmatic EIS/EIR.

During Phase I of the Water Quality Program, parameters of concern to beneficial uses were identified and a preliminary set of actions to address those parameters were developed. During Phase II, which is currently underway, the list of parameters of concern and programmatic water quality actions are being refined, performance measures and indicators of success for each action are being defined, and monitoring and research needs are being defined. Before Phase III, scheduled to begin in late 1998 or early 1999, the *Water Quality Implementation Plan* will be developed to prioritize and implement water quality actions. The three phases of the Water Quality Program and associated documents are shown in Figure 2.

1995 – 1996	1996 – 1998	1998 – ?
Phase I	**Phase II**	**Phase III**
Parameters of Concern Preliminary Set of Actions	Refinement of Parameters and Actions Performance Measures and Indicators of Success Strategies for Phased Implementation	Prioritization and Implementation of Actions Adaptive Management
DOCUMENTS		
Agriculture Subteam Report Urban Subteam Report CALFED Water Quality Supplemental Information Document	Programmatic EIS/EIR Water Quality Technical Report (Affected Environment and Impact Analysis) Water Quality Program Plan	Water Quality Implementation Plan

STAKEHOLDER INVOLVEMENT THROUGHOUT

Figure 2. The three phases of the Water Quality Program and associated program documents.

CALFED staff recognize that the necessity to formulate the Water Quality Program at a level of detail appropriate to a programmatic environmental document leaves many questions unanswered. Water quality problems are not spelled out in detail and the actions to address the problems are described only generally. At the programmatic level of detail, the identified actions constitute a commitment to improving water quality. In many cases, this commitment cannot be fulfilled until additional study, evaluation, feasibility determination, and pilot scale implementations are accomplished. These activities must be relegated to Phase III of the process beginning in 1998.

At this time, however, linkage is needed between the programmatic actions of Phase II and project specific activities in Phase III. A *Water Quality Implementation Plan* provides the needed bridge, and an outline of that *Plan* is included as Appendix B to this document. The *Water Quality Implementation Plan* firms up the programmatic commitment to water quality actions by describing the steps to be taken and how stakeholders, agencies, and the public are to participate.

GEOGRAPHIC SCOPE

Consistent with the CALFED Programmatic EIS/EIR, the geographic scope of the Water Quality Program encompasses five regions:

- Sacramento River Region
- San Joaquin River Region
- Delta Region
- Bay Region
- State Water Project and Central Valley Project Services Areas Outside of the Central Valley

Descriptions of these regions are contained in the Glossary at the front of this document. A map showing the location of these regions within the state immediately follows the Glossary.

STAKEHOLDER INVOLVEMENT PROCESS

In accordance with CALFED efforts to work in partnership with diverse interests, CALFED staff have sought input on the Water Quality Program from a variety of technical experts representing federal, state, and local agencies, environmental groups, industry, agriculture, recreation, urban, water supply and watershed interests. During Phase I, the Water Quality Program was composed of three subteams: the urban subteam, the agricultural subteam, and the ecosystem subteam (Figure 3). The teams met separately for several months to identify parameters of concern to their respective beneficial uses and to formulate actions to address their parameters.

The teams were composed of technical experts from various public agencies and private entities. The ecosystem subteam was composed of federal and state agency representatives from the California Department of Fish and Game, US Fish and Wildlife Service, US Environmental Protection Agency, State Water Resources Control Board, Central Valley Regional Water Quality Control Board, and San Francisco Regional Water Quality Control Board. The urban subteam was composed of both agency staff and urban water agency representatives. The agricultural subteam was composed of agency staff, farmers, and agricultural water suppliers. A variety of technical experts representing federal, state, and local agencies, environmental groups, industry, agriculture, recreation, urban water supply and watershed interests have provided valuable input into the development of the program.

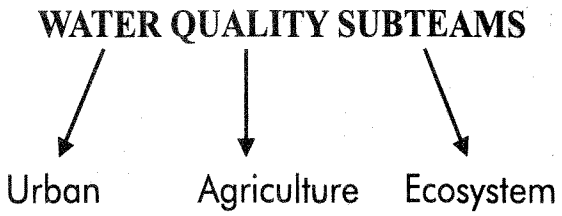


Figure 3. CALFED Water Quality Subteams involved in Phase I.

Based upon available data and technical knowledge, each subteam identified "parameters of concern" to its respective beneficial water use based on a set of criteria. The subteams also identified actions to address their parameters of concern.

At the end of Phase I, the three teams met to discuss their findings. The findings of each subteam can be found in the CALFED Water Quality Supplemental Information document.

During Phase II, additional stakeholders have been invited to join the Water Quality Program to ensure participation by a broad array of interests. Together with individuals from the subteams, these stakeholders have formed a technical advisory body to the Water Quality Program, known as the Water Quality Technical Group (Figure 4).

The WQTG is currently composed of 218 individuals, representing 104 private entities and public agencies (Appendix A). The WQTG meets regularly to discuss the Water Quality Program, review CALFED water quality documents, and make recommendations to CALFED on water quality related issues. Recommendations from the WQTG are incorporated into the Water Quality Program, as appropriate.

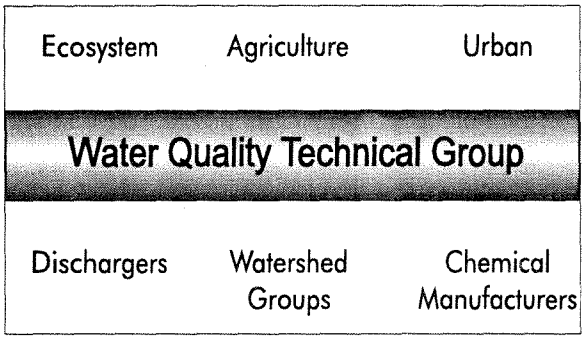


Figure 4. Stakeholder Groups Participating in the WQTG.

In addition to the WQTG, a second advisory body, known as the Parameter Assessment Team, makes recommendations to the Water Quality Program. The Parameter Assessment Team (PAT) is composed of 18 individuals representing 17 private entities and public agencies (Appendix A). PAT members are Water Quality Technical Group members who have volunteered to participate on the PAT.

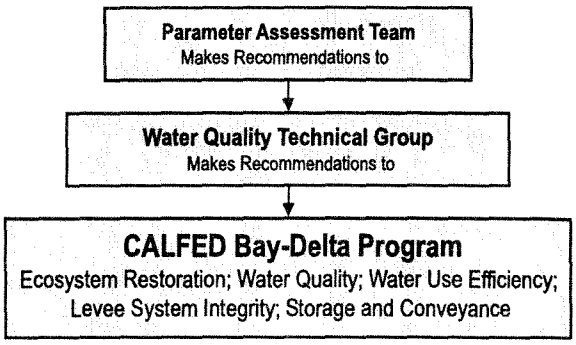


Figure 5. Relationship between the CALFED Water Quality Program and its Advisory Bodies.

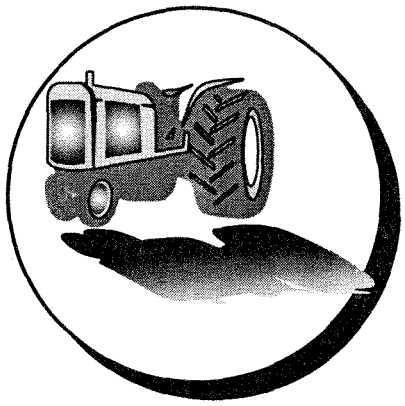
The PAT has four primary functions:

- Propose or receive recommendations to add or delete parameters of concern
- Present or receive scientific evidence regarding proposed parameters of concern
- Debate whether to add or delete parameters of concern, and make recommendations to the WQTG (the WQTG, in turn, will consider PAT recommendations and make recommendations to CALFED as appropriate)
- Determine targets for any additional parameters of concern and recommend them to the WQTG (the WQTG, in turn, will consider PAT recommendations and make recommendations to CALFED, as appropriate).

In addition to meetings of the WQTG and PAT, CALFED staff have held workshops to inform the general public about activities of the Water Quality Program. CALFED staff have met with a variety of groups including the Clean Water Caucus, California Water Environment Association, and the California Urban Water Agencies. The CALFED Bay-Delta Advisory Committee has been kept abreast of the Water Quality Program's progress through informational segments at their regularly scheduled meetings.

Stakeholder involvement in the CALFED Water Quality Program is planned to continue throughout the life of the CALFED Bay-Delta Program.

WATER QUALITY PROGRAM ACTIONS



CALFED
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WATER QUALITY PROGRAM ACTIONS

INTRODUCTION

The Water Quality Program has developed programmatic actions to address beneficial use impairments within its geographic scope. Implementing these actions will further the program's goal of providing good water quality for environmental, agricultural, drinking water, industrial, and recreational beneficial uses of water. The Water Quality Impact Analysis of the Programmatic EIS/EIR contains a comprehensive analysis of the impacts of CALFED actions on water quality and other components of the CALFED Bay-Delta Program.

Determining impairment to a beneficial use is always a difficult and complicated matter. For some beneficial uses, such as drinking water use and agricultural water use, concentrations of parameters of concern in ambient water that may impact their use are well quantified. For other beneficial uses such as ecosystem use, concentrations of parameters of concern in ambient water that may impact the diverse assemblages of species in the Delta Region are less well understood. As a result, the Program has relied on the technical expertise of a variety of stakeholders representing beneficial uses. These stakeholders have worked with CALFED staff to identify parameters of concern to beneficial uses, the locations of beneficial use impairments, the types of water quality actions needed to address these impairments, and the ways to assess the effectiveness of actions.

BACKGROUND

Stakeholders and CALFED staff have developed a list of parameters of concern to beneficial uses (Table 1). The list is composed of 27 constituents and characteristics. Three more substances (nitrogen, nitrite and bioavailable phosphorus) have been recommended by the Parameter Assessment Team for addition to the list. The list of parameters of concern may be updated as new information becomes available, consistent with the adaptive management policy of the CALFED Bay-Delta Program.

Water quality problems associated with these parameters have been identified by the State in accordance with the Clean Water Act. Existing information from the Clean Water Act 303(d) list of impaired water bodies for California was used by the program to identify the locations of beneficial use impairments associated with parameters of concern. The "303(d) list" identifies water bodies with impaired beneficial uses, the parameters of concern within each water body, and the likely sources of the parameters of concern. Table 2 (at the end of this section) lists the 152 impaired water bodies within the Water Quality Program's geographic focus identified by the State in 1996. The state is currently in the process of updating the 303(d) list and this information will be used by CALFED as it becomes available.

TABLE 1. WATER QUALITY PARAMETERS OF CONCERN TO BENEFICIAL USES

METALS & TOXIC ELEMENTS	ORGANICS/PESTICIDES	DISINFECTION BY-PRODUCT PRECURSORS	OTHER
Cadmium	Carbofuran	Bromide	Ammonia
Copper	Chlordane**	TOC	Dissolved Oxygen
Mercury	Chlorpyrifos		Salinity (TDS, EC)
Selenium	DDT**		Temperature
Zinc	Diazinon		Turbidity
	PCBs**		Toxicity of Unknown Origin*
	Toxaphene**		Pathogens
			Nutrients (Nitrate)
			pH (Alkalinity)
			Chloride
			Boron
			Sodium adsorption ratio

*Toxicity of Unknown Origin refers to observed aquatic toxicity, the source of which is unknown.
**These compounds are no longer used in California. Toxicity from these compounds is remnant from past use.

Although the data used to develop the "303(d) list" of impaired water bodies are subject to criticism (many people note that the data need to be updated) it is the most comprehensive information on beneficial use impairment available at this time. The program recognizes the need for a comprehensive analysis of beneficial use impairments to Delta waters and will use such additional information as it becomes available, consistent with the adaptive management policy of the CALFED Bay-Delta program. The implementation strategy for the Water Quality Program envisions ongoing assessments involving experts, regulatory agencies, and the public to assure the best possible understanding is applied to CALFED investment decisions. It is anticipated that a great deal of information on the status of water quality and beneficial use impairments throughout the geographic scope will be compiled by the Comprehensive Monitoring, Assessment, and Research Plan (CMARP).

There are 25 water quality actions. These actions are grouped into nine categories: mine drainage (2), urban and industrial runoff (5), wastewater and industrial discharges (5), agricultural drainage and runoff (7), water treatment (2), water management (2), human health (1) and toxicity of unknown origin (1). These actions are located throughout the Program's geographic focus (Table 3).

Water quality actions to address beneficial use impairments may include a combination of research, pilot studies, and targeted activities. This approach allows actions to be taken on known water quality problems and sources of those problems, while allowing further research of potential problems and solutions. For example, for some parameters of concern, such as mercury, little is understood about its

TABLE 3. SUMMARY OF WATER QUALITY PROGRAM ACTIONS BY REGION

TOPIC	REGION				
	DELTA	BAY	SACRAMENTO RIVER	SAN JOAQUIN RIVER	SWP & CVP SERVICE AREAS OUTSIDE THE CENTRAL VALLEY
Mine Drainage	✔		✔	✔	
Urban and Industrial Runoff	✔		✔	✔	
Wastewater and Industrial Discharge	✔	✔		✔	
Agricultural Drainage and Runoff	✔		✔	✔	
Water Treatment	✔				✔
Water Management	✔				
Human Health	✔				
Toxicity of Unknown Origin	✔	✔	✔	✔	

sources, the bioavailability of the various mercury species, factors contributing to its bioavailability, and the load reductions needed to reduce fish tissue concentrations to levels acceptable for human consumption.

Therefore, further study of mercury is recommended before full-scale projects are implemented. For other parameters, such as selenium, sources are better documented, and source control or treatment actions may be taken with a reasonable expectation of positive environmental results.

Actions will be adapted over time to ensure the most effective use of resources. The effectiveness of actions will be assessed based on the achievement of action-specific objectives. Two types of action-specific objectives have been established for each action: performance measures and indicators of success.

Performance measures are used to gauge the progress of an action. Progress may be judged based on a variety of factors such as reduced concentrations of a parameter. In other words, performance measures answer the question "Is water quality improving?"

For source control actions, performance measures are quantifiable reductions in loadings of parameters of concern, whenever possible. For actions that recommend further study of a parameter, performance measures may be a focused outcome. For example, an action for mercury may be further research to better understand the sources and mechanisms of mercury accumulation in the Delta Region while the performance measure may be the development of pilot scale projects to determine the feasibility of cleaning up mercury contaminated sediment. In order for the effectiveness of actions to be assessed, performance measures are based on demonstrable evidence indicating that water quality improvement is occurring, whenever possible. For example, performance measures such as increased fish populations, decreased abnormalities, and decreased toxicity are preferable to subjective measures such as improved public awareness.

Indicators of success are the endpoints used to determine when beneficial uses are no longer impaired (i.e., they indicate when actions have been successful). These endpoints may be based on achievement of a variety of measurable factors including: numerical and narrative objectives for water, sediment and tissue and lack of toxicity as indicated by toxicity testing. In other words, indicators of success answer the question "Have water quality goals been achieved?"

The beneficial use impairment and the parameter of concern being evaluated determine which type of endpoints are most appropriate. For example, numerical water quality objectives for drinking water sources have been documented by state and federal agencies. These numbers can be used to determine the success of actions to address drinking water beneficial use impairments. On the other hand, numerical water quality objectives for ecosystem uses are not as well documented as they relate to ecosystem impairments. Therefore, achievement of numerical water quality objectives alone may not be enough to ensure good water quality for ecosystem beneficial uses. Other indicators such as tissue concentrations and lack of toxicity to native and laboratory species may be used, where appropriate, to determine whether ecosystem beneficial uses are being adequately protected. Table 4, at the end of this section, shows a variety of indicators of success that could potentially be used as tools to assess the effectiveness of water quality actions.

The Water Quality Program has identified narrative or numerical water quality targets for each parameter of concern (Table 5 at the end of this section). These targets represent desirable in-stream concentrations of parameters of concern that will be used as indicators of success to determine the effectiveness of water quality actions. However, the degree to which these targets are realized will depend upon overall CALFED solutions. Targets may not be fully realized because of competing CALFED solution requirements or because attainment of a target is technically infeasible.

In general, water quality targets are based on Water Quality Control Plans (Basin Plans) of the Bay Area and Central Valley Regional

Water Quality Control Boards, U.S. Environmental Protection Agency ambient water quality objectives, standard agricultural water quality objectives, and target source drinking water quality ranges as defined by technical experts. Other indicators of success may be used in conjunction with these targets on a project-specific basis to determine the effectiveness of actions toward protecting beneficial uses.

PRE-FEASIBILITY ANALYSIS

Individual programmatic actions may vary in cost, technical feasibility, and in other respects which may affect the final choices for implementation. Therefore, actions will be subjected to pre-feasibility analysis to determine which programmatic actions are most appropriate to be implemented. This analysis has begun and will continue into Phase III of the CALFED Program. Full feasibility analysis in conjunction with project-specific environmental documentation will be performed in Phase III. The process by which actions will be implemented will be identified in the *Water Quality Implementation Plan* scheduled for release during Phase III. A draft outline for the *Water Quality Implementation Plan* is located in Appendix B.

DESCRIPTION OF WATER QUALITY ACTIONS

Following is a description of actions for each major category:

- Mine Drainage
- Urban and Industrial Runoff
- Wastewater and Industrial Discharge
- Agricultural Drainage and Runoff
- Water Treatment
- Water Management
- Human Health
- Toxicity of Unknown Origin

Each action is cross-referenced with the other actions to facilitate the reader's understanding of the relationship between water quality actions. Methods, performance measures, and indicators of success for each action are *not* listed in order of priority or preference.

MINE DRAINAGE

ACTION 1: Reduce the impairment to environmental beneficial uses within the Delta and Sacramento River regions associated with cadmium, copper, and zinc loadings by source control or treatment of mine drainage at inactive and abandoned mine sites. Actions are targeted at the Upper Sacramento River (Shasta Dam to Red Bluff) and its tributaries that are major contributors of copper, cadmium and zinc loadings.
[Urban and Industrial Runoff - Action 1]

METHODS

Source control methods include capping tailings piles, removing tailings piles, diverting water courses from metal sources, sealing mines, removing contaminated sediments, and similar measures to prevent metals from leaching or draining into water bodies.

Treatment methods involve collecting and treating mine drainage to remove metals and neutralize acidity.

PERFORMANCE MEASURES

- Reduced annual copper, cadmium and zinc loadings (during an average water year) to the Upper Sacramento River (Shasta Dam to Red Bluff).

- Reduced duration, frequency, and spatial extent of exceedances of target ranges.

- Reduced toxicity to native and laboratory test organisms due to mine drainage.

INDICATORS OF SUCCESS

- Achievement of water quality targets for cadmium, copper and zinc in the Sacramento River above Hamilton City and below Shasta Dam (See Water Quality Technical Report).

- No likely significant toxicity to native and laboratory test organisms due to mine drainage.

- Tissue level concentrations in aquatic organisms that are not harmful to the organisms.

ACTION 2: Reduce the impairment of environmental and recreation beneficial uses within the Delta, Sacramento and San Joaquin River regions associated with mercury loadings by source control and/or treatment of mine drainage at inactive and abandoned mine sites.
[Human Health - Action 1]

RESEARCH/MONITORING

- Conduct fish mercury body burden and fish consumption studies to evaluate whether
additional mercury health advisories are needed.

- Complete a targeted action plan to remediate mercury loadings to the Delta Region and its tributaries.

- Develop a system-wide research program to identify bioavailable forms of mercury, sources of the bioavailable forms, factors contributing to bioavailability (e.g., increased shallow marsh habitat may increase methylation and drive it into the aquatic food web), and an action plan to reduce loadings of these forms to the Delta Region and its tributaries.

- Through comprehensive monitoring and research, obtain an improved understanding of sources and mechanisms of mercury bioaccumulation and methylation in the Delta Region.

• Through comprehensive monitoring and research, obtain an improved understanding of the cost/benefit associated with remediation of mercury contaminated sediment.

• Through comprehensive monitoring and research, obtain an improved understanding of sources and processes leading to enhancement of mercury bioavailability.

METHODS

Source control methods include capping tailings piles, removing tailings piles, diverting water courses from mercury sources, sealing mines, removing contaminated sediments, and similar measures to prevent mercury from leaching or draining into water bodies.

Treatment methods involve collecting and treating mine drainage to remove mercury.

Pilot scale projects can be developed to determine feasibility of cleaning up mercury contaminated sediment. Actions can be targeted at the Cache Creek and its tributary watersheds.

Mercury contaminated mine drainage can be treated. Actions can be targeted at the Cache Creek Watershed and Mt. Diablo mine areas.

PERFORMANCE MEASURES

• Reduced concentrations of mercury and its derivatives within edible aquatic organisms.

• Reduced bioavailable mercury loadings to the Delta and Sacramento River regions.

INDICATORS OF SUCCESS

• Achievement of water quality targets for mercury (See Table 5 for more information).

• Reduction in fish and shellfish tissue levels so that fish health advisories in the Delta Region can be removed.

URBAN AND INDUSTRIAL RUNOFF

ACTION 1: Reduce the impairment of environmental beneficial uses in the Delta, Sacramento and San Joaquin River regions associated with copper, zinc, and cadmium from urban and industrial runoff.
[Mine Drainage - Action 1]

RESEARCH/MONITORING

• Through comprehensive monitoring and research, obtain an improved understanding of the composition, fate and transport of urban runoff.

• Through comprehensive monitoring and research, obtain an improved understanding of the sources and mechanisms for bioaccumulation of cadmium, copper, and zinc in the Delta Region.

METHODS

Enforce existing source control regulations.

Provide incentives for additional source control of urban and industrial runoff, particularly those areas that have runoff associated with vehicle usage.

Work with watershed stakeholder groups on source control education.

PERFORMANCE MEASURES

- Reduced duration, frequency and spatial extent of exceedances of target ranges.

- Reduced copper loadings at selected stormwater monitoring stations.

- Reduced toxicity to laboratory and native test organisms due to metals in urban and industrial runoff.

INDICATORS OF SUCCESS

- For copper, cadmium and zinc, achievement of water quality targets (See Table 5 for more information).

- No likely significant toxicity to native and laboratory test organisms due to metals in urban and industrial runoff.

ACTION 2: ***Reduce (or eliminate) the impairment of environmental beneficial uses in the Delta, Sacramento and San Joaquin River regions associated with the urban, industrial and residential pesticides chlorpyrifos and diazinon through source control of urban and industrial runoff.***
[Agricultural Drainage and Runoff - Action 3]

RESEARCH/MONITORING

- Through comprehensive monitoring and research, obtain an improved understanding of the composition, fate, and transport of urban runoff.

- Through comprehensive monitoring and research, obtain an improved understanding of the toxicity and sources and mechanisms of chlorpyrifos and diazinon transport into the receiving waters from urban areas.

METHODS

Provide regulatory and financial incentives for implementation of additional urban and industrial runoff source control measures.

Provide source control incentives, such as additional education for homeowners on pesticide usage and incentives for pesticide

users to increase implementation of best management practices.

Work with watershed stakeholder groups on source control education.

Work with registrants, urban stakeholder groups, and Department of Pesticide

Regulation to develop practical, economically feasible BMPs.

PERFORMANCE MEASURES

- Reduced toxicity at selected stormwater monitoring locations measured by improved survivability from a three-species test.

- Reduced concentration, duration, and frequency of exceedances of water quality targets.

INDICATORS OF SUCCESS

- No likely significant toxicity from chlorpyrifos and diazinon in the Delta, Sacramento and San Joaquin River regions.

- Achievement of water quality targets for chlorpyrifos and diazinon (See Table 5 for more information) (Note: There is disagreement among the WQTG regarding the applicability of these numbers).

ACTION 3: Reduce the impairment of environmental and recreational beneficial uses within the Delta Region (specifically near Stockton) due to oxygen-depleting substances (nutrient loadings) through source control of urban and industrial runoff.

[Wastewater and Industrial Discharge - Action 2]

RESEARCH/MONITORING

- Through comprehensive monitoring and research, obtain an improved understanding of the composition, fate, and transport or urban runoff.

- Through comprehensive monitoring and research, obtain an improved understanding of the sources and mechanisms for nutrient transport in the Delta Region. One way this may be achieved is through the development of a mass load model for the South Delta.

METHODS

Enforce existing source control regulations, including implementation of best management practices.

Provide incentives for additional source control including best management practices, public education, and better planning of new developments (e.g., design of storm drainage systems or on-site or regional stormwater sedimentation facilities and public education.

PERFORMANCE MEASURES

- No measurable impacts to aquatic life from low dissolved oxygen levels in the Lower San Joaquin River.

- Reduced loadings of nutrients to the Delta and associated excessive plant growth.

INDICATORS OF SUCCESS

- Achievement of water quality targets for nutrients (See Table 5 for more information).

- No impairment of recreation beneficial uses by excessive plant growth caused by nutrient loadings from urban and industrial runoff in the Delta Region.

ACTION 4: ***Reduce the impairment of environmental and drinking water beneficial uses of the Delta and Sacramento River regions associated with sediment and subsequent turbidity through source control of urban and industrial runoff.***

[Agricultural Drainage and Runoff - Action 4; Water Treatment - Actions 1 and 2]

RESEARCH/MONITORING

- Through comprehensive monitoring and research, obtain an improved understanding of the composition, fate, and transport of urban runoff.

- Evaluate the feasibility of detention basins in new developments for control of sediment and its associated pollutants.

METHODS

Improve enforcement of existing source control regulations for construction sites.

Educate construction personnel on impacts of construction site discharges.

PERFORMANCE MEASURE

- Decreased turbidity levels in urban runoff discharges to the Delta and Sacramento River regions and at water supply intakes in the Delta Region.

INDICATORS OF SUCCESS

- Achievement of water quality targets for turbidity (See Table 5 for more information).

- No likely significant toxicity to aquatic organisms associated with smothering benthic organisms and eggs in spawning gravels.

ACTION 5: ***Evaluate the loadings of TOC, salinity, and pathogens in urban runoff and assess the need for source control measures to reduce these parameters of concern to drinking water beneficial uses.***
[Wastewater and Industrial Discharge - Actions 1 and 5; Agricultural Drainage and Runoff - Actions 2, 5 and 7; Water Management - Actions 1 and 2]

RESEARCH/MONITORING

- Improved understanding of the sources of TOC, salinity, and pathogens in the Delta Region and its watersheds.

METHODS

Include monitoring for TOC, salinity, and pathogens in stormwater and dry season runoff as part of CMARP.

Evaluate the relative loading of TOC, salinity, and pathogens in urban runoff, wastewater discharges, and agricultural drainage discharges.

Development of appropriate actions to reduce TOC, salinity, and pathogen loads entering the Delta Region and its tributaries.

PERFORMANCE MEASURES

- Reduced TOC loads, salinity concentrations, and pathogen loads entering the Delta Region and its tributaries.

- Reduced peaks in salinity concentrations at water supply intakes.

INDICATOR OF SUCCESS

- Achievement of water supply target levels for TOC, salinity and pathogens (See Table 5 for more information).

WASTEWATER AND INDUSTRIAL DISCHARGE

ACTION 1: Reduce the impairment of drinking water, recreational and environmental beneficial uses within the Delta Region due to pathogens from boat discharges within the Delta Region and its tributaries [priority will be given to addressing boat discharges in the Delta Region].
[Water Treatment - Actions 1 and 2; Agricultural Drainage and Runoff - Action 7; Urban and Industrial Runoff - Action 5]]

RESEARCH/MONITORING

- Through comprehensive monitoring and research, obtain an understanding of the concentrations, loadings, and effects of discharges from boats.

METHODS

Improve enforcement of boat domestic waste discharge regulations.

Educate boaters about boat wastes and pathogens.

Install more extensive, better, and more economical pumpout stations in the Delta Region.

Install more public toilet facilities in the Delta Region.

PERFORMANCE MEASURES

- Increased usage of pumpout facilities by boaters as indicated by quantifiable records. Usage should match expected boater domestic waste quantities.

- Increased public awareness of boat wastes and pathogens as indicated by public opinion and surveys.

- Increased number of pumpout and toilet facilities in the Delta Region.

- Reduced bacteriological counts in marinas and other recreational areas.

- Lower pathogen levels near water supply intakes.

INDICATORS OF SUCCESS

- Achievement of water quality targets for pathogens (See Table 5 for more information).

ACTION 2: Reduce the impairment of environmental and recreational beneficial uses due to oxygen depleting substances within the Delta Region (specifically the Lower San Joaquin River) through cost effective source control and treatment of industrial and municipal wastewater discharges.
[Urban and Industrial Runoff - Action 3]

METHODS

Provide financial and regulatory incentives to industries to pre-treat discharges containing oxygen depleting substances.

Provide financial and regulatory incentives to municipalities for improved wastewater effluent treatment.

Provide financial and regulatory incentives to municipalities for the identification and implementation of wastewater reclamation and reuse.

Treat a portion of upstream municipal wastewater effluent in constructed wetlands (i.e., lands of low or no ecological value).

Implement best management practices for industrial, commercial, and residential sources.

PERFORMANCE MEASURES

- Reduced nutrient loadings from Delta municipal wastewater treatment facilities.

- Reduced eutrophication as indicated by EPA algal bioassay.

INDICATORS OF SUCCESS

- No impairment of recreational beneficial uses by excessive plant growth caused by nutrient loadings from wastewater and industrial discharge.

- Achievement of water quality targets for dissolved oxygen and nutrients in the Lower San Joaquin River (See Table 5 for more information).

ACTION 3: Reduce the impairment of environmental beneficial uses in the Delta Region associated with selenium loadings through source control and treatment of industrial discharges. Action should be targeted at industries that discharge selenium to the Suisun Bay and Carquinez Strait area.
[Agricultural Drainage and Runoff - Action 1]

RESEARCH/MONITORING

- Perform research to determine harmful levels of selenium to aquatic organisms in the Delta Region.

- Through comprehensive monitoring and research, evaluate biological effects of selenium in the Delta Region.

METHOD

Treat oil refinery discharges in the Delta Region for selenium removal (Note: current selenium treatment methodologies are experimental).

PERFORMANCE MEASURES

- Reduced selenium loadings to the Delta Region from industrial discharges.

- Reduced tissue concentrations of selenium to levels that are not harmful to aquatic organisms in the Delta Region.

INDICATORS OF SUCCESS

- No likely significant chronic toxicity to aquatic organisms caused by

bioaccumulation and biomagnification of selenium.

- Achievement of water quality targets for selenium in the Delta Region (See Table 5 for more information).

ACTION 4: Reduce the impairment of environmental beneficial uses in the Delta Region and its tributaries associated with ammonia from wastewater treatment plant discharges through improved treatment. This action is focused on wastewater treatment plant discharges to water bodies with minimum "dilution" flows.
[Agricultural Drainage and Runoff - Action 6]

METHOD

Provide incentives for improved wastewater treatment facilities and processes.

PERFORMANCE MEASURE

- Reduced toxicity due to ammonia in Delta Region channels and lower reaches of its tributary streams.

INDICATORS OF SUCCESS

- No likely significant toxicity to test organisms in three-species toxicity bioassays.
- Indicate through toxicity identification evaluation testing that ammonia is not a significant cause of toxicity in Delta Region.
- Achievement of water quality targets for ammonia in the Delta Region and its tributaries (See Table 5 for more information).

ACTION 5: Evaluate the loadings of TOC, salinity, and pathogens from wastewater and industrial treatment plant discharges, and assess the need for source control measures to reduce these parameters of concern to drinking water beneficial uses.
[Agricultural Drainage and Runoff - Actions 2,5, and 7; Water Management - Actions 1 and 2; Urban and Industrial Runoff - Action 5]

RESEARCH/MONITORING

- Improved understanding of the sources of TOC, salinity, and pathogens in the Delta Region and its tributaries.

METHODS

Monitor TOC, salinity, and pathogens in wastewater and industrial treatment plant discharges.

Evaluate the relative loading of these constituents in urban runoff, wastewater discharges, and agricultural discharges.

Development of appropriate actions to reduce TOC, salinity, and pathogen loads entering the Delta Region and its tributaries

PERFORMANCE MEASURES

- Reduced TOC loads, salinity concentrations, and pathogen loads entering the Delta Region and its tributaries.

• Reduced peaks in salinity concentrations at water supply intakes.

INDICATOR OF SUCCESS

• Achievement of water supply target levels for TOC, salinity and pathogens (See Table 5 for more information).

AGRICULTURAL DRAINAGE AND RUNOFF

ACTION 1: ***Reduce the impairment of environmental beneficial uses to the Lower San Joaquin River and Delta regions associated with selenium loadings by controlling sources of selenium in agricultural subsurface drainage.***
[Wastewater and Industrial Discharge - Action 3]

RESEARCH/MONITORING

• Evaluate the feasibility of treatment options.

• Evaluate land management programs that include planting crops that use water from the high water table.

• Evaluate the feasibility of implementing economic incentives such as tiered water pricing and tradable discharge permits.

• Determine harmful levels of selenium to aquatic organisms in the Delta Region and lower San Joaquin River.

• Evaluate the biological effects of selenium in the Delta Region.

• Evaluate integrated on-farm management systems.

METHODS

Reduce drainage flows through increased water use efficiency.

Treat drainage for selenium removal where feasible.

Change land uses that are major sources of selenium through voluntary landowner participation and by compensated arrangements to reduce drainage volumes.

PERFORMANCE MEASURES

• Reduced selenium loadings to the San Joaquin River Region, particularly Mud Slough.

• Reduced tissue concentrations of selenium to levels that are not harmful to aquatic organisms in the Bay-Delta.

INDICATOR OF SUCCESS

• Achievement of water quality targets for selenium in the San Joaquin River and Delta regions (See Table 5 for more information).

ACTION 2: Reduce salinity impairment of drinking water and agricultural beneficial uses to Delta Region associated with salinity through source control and treatment of agricultural surface and sub-surface drainage in the San Joaquin River Region.

[Water Management - Actions 1 and 2; Wastewater and Industrial Discharge - Action 5; Urban and Industrial Runoff - Action 5]

RESEARCH/MONITORING

- Continue research into other treatment techniques.

METHODS

Improved source irrigation water quality in subsurface drainage areas through treatment processes.

Dispose of agricultural drainage in an environmentally safe manner.

Treatment of agricultural drainage by reverse osmosis, low pressure membranes, constructed wetlands or other means.

Time agricultural drainage discharges to coincide with periods when dilution flow is sufficient to achieve water quality target ranges for salinity (Note: Dilution should only be utilized in emergency situations for spill response or uncontrollable discharges. Storing or using water with the explicit intent of diluting a pollutant is inconsistent with federal and state laws, and conflict with the water use efficiency program objectives. Use of dilution flows will likely reduce local salinity concentrations in an emergency but not overall loads to the Delta Region).

Change land and water uses through voluntary landowner participation and by compensated arrangements to reduce salinity loadings.

Establish comprehensive on-farm management systems that include cropping patterns, water recycle and reuse, and on-farm treatment of small drainage volumes.

PERFORMANCE MEASURES

- Reduced salinity loads to the Delta Region and salt concentrations entering the San Joaquin River from adjacent lands.

- Reduced peaks in salinity concentrations at water supply intakes.

- Reduced salinity in the San Joaquin River near Vernalis, where the river flows into the Delta Region.

INDICATOR OF SUCCESS

- Achievement of water quality targets to protect urban and agricultural beneficial uses (See Table 5 for more information).

ACTION 3: Reduce the impairment of environmental beneficial uses in the Delta Region associated with the pesticides carbofuran, chlorpyrifos, and diazinon through incentives.

[Urban and Industrial Runoff - Action 2]

RESEARCH/MONITORING

- Establish the ecological significance of carbofuran, chlorpyrifos and diazinon exceedances in the Delta Region and its tributaries.

• Through comprehensive monitoring and research, obtain an improved understanding of the toxicity and sources and mechanisms of carbofuran, chlorpyrifos and diazinon transport into the Delta Region.

METHODS

Provide regulatory and financial incentives for implementation of agricultural drainage source control measures that include incentives for pesticide users to improve applicator education and increase implementation of best management practices.

Provide financial incentives and assistance for pilot-scale testing of best management practices to control pesticide discharges in agricultural surface runoff.

Work with property owner and managers on source control education.

PERFORMANCE MEASURE

• Reduced (or eliminated) toxicity in the Delta Region and its tributaries due to carbofuran, chlorpyrifos, and diazinon.

INDICATORS OF SUCCESS

• No likely significant toxicity to aquatic test organisms in three-species toxicity bioassays.

• Indicate through toxicity identification evaluation (TIEs) testing that chlorpyrifos, carbofuran and diazinon are not a significant cause of toxicity in the Delta Region.

• Achievement of water quality targets for carbofuran, chlorpyrifos and diazinon (See Table 5 for more information).

ACTION 4: Reduce the impairment of environmental and drinking water beneficial uses in the Delta Region and its tributaries associated with sediment loading through incentives.
[Urban and Industrial Runoff - Action 4]

METHOD

Provide incentives and assistance for implementation of agricultural land use practices and improved irrigation strategies to reduce soil erosion, and for installation of buffer strips.

PERFORMANCE MEASURE

• Reduced sediment loading to the Delta Region and its tributaries from agricultural areas with high erosion rates.

INDICATOR OF SUCCESS

• Achievement of water quality targets at drinking water intakes in the Delta Region and tributaries (See Table 5 for more information).

ACTION 5: Reduce the impairment of drinking water beneficial uses associated with TOC by controlling TOC discharges from Delta islands.

[Water Treatment - Actions 1 and 2; Urban and Industrial Runoff - Action 5; Wastewater and Industrial Discharge - Action 5]

METHODS

Provide financial assistance and incentives for pilot-scale testing and implementation of water management practices and cropping

patterns to reduce contributions of TOC from Delta islands.

Through voluntary landowner participation, change or modify land use on Delta islands with peat soils.

Treatment of drainage water prior to discharge.

PERFORMANCE MEASURE

- Reduced TOC loads to the Delta Region.

INDICATOR OF SUCCESS

- Achievement of water quality targets at drinking water supply intakes (See Table 5 for more information).

ACTION 6: Reduce the impairment of environmental and recreational beneficial uses in the Delta Region and its tributaries associated with nutrients and ammonia through source control of agricultural surface drainage.

[Wastewater and Industrial Discharge - Action 4]

RESEARCH/MONITORING

- Through comprehensive monitoring and research, obtain an improved understanding of the sources, mass loadings, and effects of nutrients, ammonia and dairy wastes discharged within the Delta Region and to the San Joaquin River.
- Through comprehensive monitoring and research, assess the degree of impairment, areal extent, and type of plants responsible, i.e., water hyacinths, attached algae, excessive emergent aquatic plant growth, planktonic algal scums, etc.

METHOD

Provide incentives for implementation of best management practices at dairies, other animal operations, and fertilized lands in the watersheds that discharge into the Delta Region, including the North Bay, and the lower reaches of the Sacramento and San Joaquin rivers, and westside stream tributaries to the Delta Region.

PERFORMANCE MEASURES

- Reduced toxicity due to ammonia in Delta Region channels and lower reaches of its tributary streams.

- Reduced nutrient loadings to the Delta Region and San Joaquin River Region.

INDICATORS OF SUCCESS

- No recreational beneficial use impairment caused by excessive plant growth.

- No likely significant toxicity to aquatic test organisms in three-species toxicity bioasssays, and indications through the toxicity identification evaluation testing that ammonia is not a significant cause of toxicity in Delta Region channels.

- Achievement of water quality targets for ammonia in the Delta Region and its tributaries (See Table 5 for more information).

ACTION 7: Reduce the impairment of drinking water beneficial uses within the Delta Region associated with pathogens by controlling inputs from rangelands, dairies, and confined animal facilities.
[Wastewater and Industrial Discharge - Action 1; Water Treatment - Actions 1 and 2; Urban and Industrial Runoff - Action 5]

RESEARCH/MONITORING

- Monitor pathogens discharged from rangelands, dairies, and confined animal facilities.

- Develop a comprehensive monitoring and research plan to obtain an understanding of the sources, mass loadings, and effects of dairy wastes discharged within the Delta Region (especially in San Joaquin, Sacramento, Stanislaus, and Merced counties).

METHODS

Provide financial incentives and educational assistance for pilot-scale testing and implementation of best management practices that control pathogen discharges

from rangelands, dairies, and confined animal facilities.

Work with dischargers and agencies to ensure the achievement of waste discharge requirements.

PERFORMANCE MEASURE

- Reduced pathogen loads entering the Delta Region and its tributaries from confined animal facilities and rangelands.

INDICATOR OF SUCCESS

- Achievement of water quality targets for pathogens (See Table 5 for more information).

WATER TREATMENT

ACTION 1: Reduce impairment of drinking water beneficial uses (including reduction in formation of disinfection by-products) in the Delta Region through treatment to reduce concentrations of TOC, pathogens, turbidity, and bromides.
[Wastewater and Industrial Discharge - Actions 1 and 5; Agricultural Drainage and Runoff - Actions 5 and 7; Urban and Industrial Runoff - Actions 4 and 5]

RESEARCH/MONITORING

- Monitor treatment performance.

METHODS

Provide incentives for the addition of enhanced coagulation, ozone, granular activated carbon filtration and/or membrane

filtration facilities to the water systems treating water from the Delta Region.

PERFORMANCE MEASURE

- Decreased detection of TOC, pathogens, turbidity and bromides in analytical tests at drinking water intakes.

INDICATORS OF SUCCESS

- Quantitative evidence of treatment success by measures such as bacteria counts, pathogen counts, and measurements of TOC, disinfection byproducts, and turbidity.

- Meet drinking water standards.

ACTION 2: Reduce impairment of drinking water beneficial uses in the Delta Region associated with TOC, pathogens, turbidity and bromides by improving levels of these substances at domestic water supply intakes.

[Wastewater and Industrial Discharge - Actions 1 and 5; Agricultural Drainage and Runoff - Actions 5 and 7; Urban and Industrial Runoff - Actions 4 and 5]

METHODS

Relocate water supply intakes to areas that are less influenced by discharges and seawater intrusion.

Reduce Delta island discharges that are high in TOC, pathogens, and turbidity.

PERFORMANCE MEASURE

- Decreased detection of TOC, pathogens, turbidity and bromides in analytical tests at drinking water intakes.

INDICATOR OF SUCCESS

- Achievement of targets for TOC, bromide, turbidity, and pathogen targets (See Table 5 for more information).

WATER MANAGEMENT

ACTION 1: Reduce the impairment of environmental, agricultural and drinking water beneficial uses associated with salinity using water management techniques.

[Agricultural Drainage and Runoff - Action 2; Urban and Industrial Runoff - Action 5; Wastewater and Industrial Discharge - Action 5]

METHODS

Acquire dilution water from willing sellers

(Note: Dilution should only be utilized in emergency situations for spill response or uncontrollable discharges. Storing or using water with the explicit intent of diluting a pollutant is inconsistent with federal and state laws, and conflict with the water use efficiency program objectives. Use of dilution flows will likely reduce local salinity concentrations in an emergency but not overall loads to the Delta Region).

Provide incentives for more efficient water management of dams, including reservoir re-operation.

Provide incentives to conserve water to make dilution water available. (Note: Dilution should only be utilized in emergency situations for spill response or uncontrollable discharges. Storing or using water with the explicit intent of diluting a pollutant is inconsistent with federal and state laws, and conflict with the water use efficiency program objectives. Use of dilution flows will likely reduce local salinity concentrations in an emergency but not overall loads to the Delta Region).

Increase use of recycled wastewater.

Reclamation programs could focus on facilities that currently discharge treated wastewater to salt sinks or other degraded bodies of water that are not reusable.

Develop additional groundwater supplies (including conjunctive use opportunities).

PERFORMANCE MEASURES

- Reduced salinity concentration in Delta Region tributaries.

- Reduced concentrations of total dissolved solids, chloride, and bromide in the San Joaquin River near Vernalis, where the River flows into the Delta Region.

INDICATOR OF SUCCESS

- Achievement of water quality targets for salinity (See Table 5 for more information).

ACTION 2: Reduce impairment of agricultural beneficial uses in the South Delta associated with salinity through improved outflow patterns and water circulation in the Delta Region.

[Agricultural Drainage and Runoff - Action 2; Urban and Industrial Runoff - Action 5; Wastewater and Industrial Discharge - Action 5]

METHODS

Construct one or more tide gates, weirs, dams or sills at the head of Old River and possibly other southern Delta locations to manage drainage flows, tidal currents and stages in the San Joaquin and Middle River and interconnecting channels (Note: This method should be evaluated to determine if it would increase salinity concentrations at the Contra Costa Water District's intakes).

Relocate Delta island drainage to more efficiently route salinity away from source water.

Provide dilution water for salinity control. (This measure would be considered as one possible means of mitigating salinity impacts of other CALFED actions, if such mitigation were necessary.) (Note: Dilution should only be utilized in emergency situations for spill response or uncontrollable discharges. Storing or using water with the explicit intent of diluting a pollutant is inconsistent with federal and state laws, and conflict with the water use efficiency program objectives. Use of dilution flows will likely reduce local salinity concentrations in an emergency but not overall loads to the Delta Region).

PERFORMANCE MEASURES

- Reduced salinity loads entering southern Delta Region channels.

• Reduced total dissolved solids in the southern reaches of the Old and Middle rivers.

INDICATOR OF SUCCESS

• Achievement of water quality targets for salinity (See Table 5 for more information).

HUMAN HEALTH

ACTION 1: Reduce impairment of recreational beneficial uses within the Delta Region due to human health concerns associated with consumption of fish and shellfish containing elevated levels of DDT, chlordane, toxaphene, mercury, and PCBs and their derivatives.
[Mine Drainage - Action 2]

RESEARCH/MONITORING

• Through comprehensive monitoring and research, obtain an improved understanding of bioconcentration factors within the Delta by conducting tissue studies and consumption surveys.

METHODS

Enforce existing source control regulations for agricultural drainage and runoff, wastewater and industrial discharge, and urban and industrial runoff including implementations of best management practices.

Provide incentives for additional source control of urban and industrial runoff, agricultural drainage and runoff, and wastewater and industrial discharge.

Work in cooperation with the California Department of Public Health, Office of Environmental Health Hazard Assessment, and Department of Fish and Game.

PERFORMANCE MEASURES

• Reduced incidence of public health advisories for consumption of fish and shellfish.

• Reduced human health risk associated with consumption of fish and shellfish, as indicated by human health risk assessments.

INDICATOR OF SUCCESS

• Indication from health risk assessment, that human health is not threatened by consumption of fish and shellfish.

TOXICITY OF UNKNOWN ORIGIN

ACTION 1: Identify parameters of concern in the water and sediment within the Delta, Bay, Sacramento River and San Joaquin River regions and implement actions to reduce their toxicity to aquatic organisms.

RESEARCH/MONITORING

• Determine the extent of toxicity in water and sediments

• Identify toxicants.

• Determine sources of toxicants.

- Develop techniques and protocols for toxicity bioassays for native species.

- Evaluate source control measures.

METHODS

Conduct toxicity testing and toxicity identification evaluations and/or other appropriate methods.

Coordinate efforts with other monitoring programs.

PERFORMANCE MEASURES

- Successful identification of causal agents of toxicity in the Delta, Bay, Sacramento River and San Joaquin River regions.

- Significant reduction (or elimination) of the amount of toxicity present in rivers and sediments due to successful implementation of control measures for toxicants identified in the CMARP.

INDICATORS OF SUCCESS

- No likely significant toxicity to aquatic test organisms in sediment or aquatic toxicity bioassays.

- Indications through toxicity identification evaluations (TIEs) that toxicity is attributable to known sources in the Delta Region.

TABLE 2. CLEAN WATER ACT SECTION 303(d) LISTED IMPAIRED WATER BODIES

BAY REGION

WATER BODY	REGIONAL BOARD	PARAMETERS OF CONCERN	PROBABLE SOURCES
Napa River	2	Pathogens	Urban Runoff, Agriculture
		Nutrients	Agriculture
		Turbidity	Agriculture, Urban Runoff
Petaluma River	2	Pathogens	Agriculture, Urban Runoff
		Nutrients	Agriculture, Urban Runoff
		Turbidity	Agriculture, Urban Runoff
Richardson Bay	2	Pathogens	Urban Runoff, Marinas
San Francisco Bay, Central	2	Metals	Municipal and Industrial Point Sources, Mining, Urban Runoff
San Francisco Bay, Lower	2	Metals	Municipal Point Sources, Urban Runoff
San Francisco Bay, South	2	Metals	Municipal Point Sources, Urban Runoff, Mining
San Pablo Bay	2	Metals	Municipal and Industrial Point Sources, Mining, Urban Runoff
Sonoma Creek	2	Nutrients	Agriculture, Urban Runoff, Construction
		Pathogens	Agriculture, Urban Runoff, Construction
		Turbidity	Agriculture, Urban Runoff, Construction
Suisun Bay	2	Metals	Municipal and Industrial Point Sources, Mining, Urban Runoff
Suisun Bay Marsh Wetlands	2	Metals	Agriculture, Urban, Flow Regulation
		Nutrients	Agriculture, Urban, Flow Regulation
		Salinity	Agriculture, Urban, Flow Regulation
		Dissolved Oxygen	Agriculture, Urban, Flow Regulation

Note:

These water bodies represent CWA Section 303(d) impaired water bodies that are impaired due to the presence of one or more CALFED water quality parameters of concern. Source: 1996 California 303(d) and TMDL Priority List.

The Clean Water Act Section 303(d) list is currently being updated by the state. This table may be updated as new information becomes available.

TABLE 2. CLEAN WATER ACT SECTION 303(d) LISTED IMPAIRED WATER BODIES

DELTA REGION

WATER BODY	REGIONAL BOARD	PARAMETERS OF CONCERN	PROBABLE SOURCES
Carquinez Strait	2	Metals	Municipal and Industrial Point Sources, Mining, Urban
Delta Waterways	5	Mercury	Mining
		Diazinon, Chlorpyrifos	Agriculture, Urban
		Group A Pesticides (Chlordane, Toxaphene)	Agriculture
		Unknown Toxicity	Unknown
		DDT	Agriculture
		Dissolved Oxygen	Municipal, Urban
		Salt	Agriculture
Lone Tree Creek	5	Ammonia, Salt, Dissolved Oxygen	Dairies
Marsh Creek	5	Mercury	Mining

Note:
These water bodies represent CWA Section 303(d) impaired water bodies that are impaired due to the presence of one or more CALFED water quality parameters of concern. Source: 1996 California 303(d) and TMDL Priority List.

The Clean Water Act Section 303(d) list is currently being updated by the state. This table may be updated as new information becomes available.

TABLE 2. CLEAN WATER ACT SECTION 303(d) LISTED IMPAIRED WATER BODIES

SACRAMENTO RIVER REGION

WATER BODY	REGIONAL BOARD	PARAMETERS OF CONCERN	PROBABLE SOURCES
American River, Lower	5	Mercury	Mining
		Group A Pesticides	Urban
		Unknown Toxicity	Unknown
Beach Lake	5	Copper, Mercury, Zinc	Urban
		Pesticides	Industrial, Urban
Berryessa Lake	5	Mercury	Mining
Cache Creek	5	Mercury	Mining
		Unknown Toxicity	Unknown
Clear Lake	5	Mercury	Mining
		Nutrients	Unknown
Colusa Drain	5	Pesticides (Carbofuran)	Agriculture
		Unknown Toxicity	Unknown
Feather River, Lower	5	Mercury	Mining
		Diazinon, Chlorpyrifos	Agriculture, Urban
		Group A Pesticides	Agriculture
		Unknown Toxicity	Unknown
Harley Gulch	5	Mercury	Mining
Horse Creek	5	Copper, Cadmium, Zinc	Mining
Humbug Creek	5	Copper, Mercury, Zinc	Mining
		Sedimentation	Mining
James Creek	5	Mercury	Mining
Keswick Reservoir	5	Copper, Cadmium, Zinc	Mining

Note:
These water bodies represent CWA Section 303(d) impaired water bodies that are iinpaired due to the presence of one or more CALFED water quality parameters of concern. Source: 1996 California 303(d) and TMDL Priority List.

The Clean Water Act Section 303(d) list is currently being updated by the state. This table may be updated as new infonnation becomes available.

TABLE 2. CLEAN WATER ACT SECTION 303(d) LISTED IMPAIRED WATER BODIES

SACRAMENTO RIVER REGION

WATER BODY	REGIONAL BOARD	PARAMETERS OF CONCERN	PROBABLE SOURCES
Little Backbone Creek	5	Copper, Cadmium, Zinc	Mining
		pH	Mining
Little Cow Creek	5	Copper, Zinc, Cadmium	Mining
Natomas East Main Drain	5	PCBs	Industrial, Urban
		Diazinon, Chlorpyrifos	Agriculture, Urban
Pit River	5	Low Dissolved Oxygen	Hydromodification, Agriculture
Sacramento River	5	Cadmium, Copper, Zinc	Mining
(Shasta Dam to Red Bluff)		Unknown Toxicity	Unknown
		Temperature	Dam
Sacramento River	5	Mercury	Mining
(Red Bluff to Delta)		Diazinon, Chlorpyrifos	Agriculture
		Carbofuran	Agriculture
		Unknown Toxicity	Unknown
Sacramento Slough	5	Mercury	Unknown
		Diazinon, Chlorpyrifos	Agriculture, Urban
Shasta Lake	5	Copper, Cadmium, Zinc	Mining
Spring Creek	5	Copper, Cadmium, Zinc	Mining
	5	pH	Mining
Sulfur Creek	5	Mercury	Mining
Town Creek	5	Copper, Cadmium, Zinc	Mining
West Squaw Creek	5	Copper, Cadmium, Zinc	Mining
Whiskeytown Reservoir	5	Pathogens	On-site Disposal
Willow Creek	5	Copper, Zinc	Mining
		pH	Mining

Note:
These water bodies represent CWA Section 303(d) impaired water bodies that are impaired due to the presence of one or more CALFED water quality parameters of concern. Source: 1996 California 303(d) and TMDL Priority List.

The Clean Water Act Section 303(d) list is currently being updated by the state. This table may be updated as new information becomes available.

TABLE 2. CLEAN WATER ACT SECTION 303(d) LISTED IMPAIRED WATER BODIES

SAN JOAQUIN RIVER REGION

WATER BODY	REGIONAL BOARD	PARAMETERS OF CONCERN	PROBABLE SOURCES
Grasslands Marshes	5	Selenium	Agriculture
		TDS	Agriculture
Kings River, Lower	5	Copper	Unknown
	5	TDS	Agriculture
	5	Toxaphene	Agriculture
Merced River, Lower	5	Group A Pesticides	Agriculture
		DDT	Agriculture
Mokelumne River, Lower	5	Copper, Zinc	Mining
		Dissolved Oxygen	Dam
Mud Slough	5	Selenium	Agriculture
		TDS	Agriculture
		Boron	Agriculture
		Pesticides	Agriculture
		Unknown Toxicity	Agriculture
Orestimba Creek	5	Pesticides	Agriculture
		Unknown Toxicity	Unknown
Panoche Creek	5	Mercury	Mining
		TDS	Agriculture
		Selenium	Agriculture
Salt Slough	5	Selenium	Agriculture
		TDS	Agriculture
		Mercury	Mining
		Pesticides	Agriculture
		Boron	Agriculture

Note:
These water bodies represent CWA Section 303(d) impaired water bodies that are impaired due to the presence of one or more CALFED water quality parameters of concern. Source: 1996 California 303(d) and TMDL Priority List.

The Clean Water Act Section 303(d) list is currently being updated by the state. This table may be updated as new information becomes available.

TABLE 2. CLEAN WATER ACT SECTION 303(d) LISTED IMPAIRED WATER BODIES

SAN JOAQUIN RIVER REGION

WATER BODY	REGIONAL BOARD	PARAMETERS OF CONCERN	PROBABLE SOURCES
San Carlos Creek	5	Mercury	Mining
San Joaquin River	5	Selenium	Agriculture
		Diazinon, Chlorpyrifos	Agriculture
		Unknown Toxicity	Unknown
		Group A Pesticides	Agriculture
		Salt, Boron	Agriculture
Stanislaus River, Lower	5	Group A Pesticides	Agriculture
		DDT	Agriculture
		Unknown Toxicity	Unknown
Temple Creek	5	Ammonia, Salt	Dairies
Tuolumne River, Lower	5	Group A Pesticide (Chlordane, Toxaphene)	Agriculture
		DDT	Agriculture
		Unknown Toxicity	Unknown
Turlock Irrigation District (Number 5)	5	Ammonia	Wastewater Discharge, Agriculture
		Pesticides	Agriculture
		Unknown Toxicity	Unknown

Note:
These water bodies represent CWA Section 303(d) impaired water bodies that are impaired due to the presence of one or more CALFED water quality parameters of concern. Source: 1996 California 303(d) and TMDL Priority List.

The Clean Water Act Section 303(d) list is currently being updated by the state. This table may be updated as new information becomes available.

Table 4. Potential Tools and Indicators of Success for Assessing Effectiveness of CALFED Water Quality Actions

Tool	Applicable Parameters of Concern	Strengths	Weaknesses	Current Uses
Water Quality Objectives [Environmental, agricultural, drinking water, recreational, industrial beneficial uses]	All, except SAR and unknown toxicity.	Monitoring tests exist for most parameters of concern. Convenient, toxicity-based, nationally accepted values. Can be correlated directly to recreational, drinking water, industrial, and agricultural beneficial use objectives and standards. Standard nationally accepted procedure available to calculate values for constituents without objectives.	Can only be correlated indirectly to environmental beneficial use objectives and standards. Objectives not developed for all parameters of concern (e.g., diazinon).	NPDES permits/ waste discharge requirements. Nonpoint source assessments. TMDLs/waste load allocations. Remedial investigations and risk assessments. Clean-up activities/assessments.
Freshwater Toxicity Test (three species test) [Environmental beneficial uses]	Boron, cadmium, copper, zinc, carbofuran, chlordane, chlorpyrifos, diazinon, PCBs, bromide, and toxicity of unknown origin.	Used in conjunction with chemical tests to reveal the impacts of chemicals on organisms. Acute and chronic tests available. Tests using resident species are sometimes possible (e.g., rainbow trout for mountain stream bioassays). Lethal and reproductive effects detected.	Standard tests may not be representative of species affected or field conditions. Typical tests are limited to fathead minnows, zooplankton, and algal assays. Does not detect sub-lethal effects.	NPDES permits/ waste discharge requirements. Nonpoint source assessments. TMDLs/waste load allocations. Remedial investigations and risk assessments. Special studies and region-wide water quality assessments.
Toxicity Identification Evaluation (TIE) [Environmental beneficial uses]	Boron, cadmium, copper, zinc, carbofuran, chlordane, chlorpyrifos, diazinon, PCBs, bromide, and toxicity of unknown origin.	Narrows causes of toxicity to specific substances by using laboratory treatments to test separate fractions of water. Can be used for water column and sediment. Tests using resident species are sometimes possible (e.g., rainbow trout for mountain stream bioassays). When toxicity is detected, TIE's are used to identify the specific chemicals or class of chemicals responsible for the toxicity. Detects lethal and reproductive effects for acute and chronic exposure.	Standard tests may not be representative of species affected or field conditions. Saltwater sediment TIE more developed than freshwater sediment TIE.	NPDES permits/ waste discharge requirements. Nonpoint source assessments. Regional Board assessments of sources of toxicity. Special studies and region-wide water quality assessments.

Table 4. Potential Tools and Indicators of Success for Assessing Effectiveness of CALFED Water Quality Actions

Tool	Applicable Parameters of Concern	Strengths	Weaknesses	Current Uses
Sediment Quality Concentrations/ Objectives [Environmental beneficial uses]	All, except temperature, dissolved oxygen, SAR, TOC, toxicity of unknown origin, and pathogens. Sediment absorptive, binding, flocculating chemicals, and turbidity.	Sediment concentrations act as long-term integrator for chemical loading to the immediate area and from upstream influences. Preserves historical indications of contamination. May detect contaminants not detected by water column tests. Some guidelines developed for the Great Lakes region, British Columbia, and Florida (DWR has compiled a report on these guidelines).	**No Freshwater Sediment Objectives for the Delta or Central Valley.** Few other criteria or accepted guidelines for evaluating concentrations. Important to analyze sediment characteristics in addition to parameters of concern. Highly variable spatial distributions. Difficult to estimate exposure to benthic and aquatic organisms. Deposition and resuspension difficult to quantify.	Dredge reuse and disposal assessments. Special studies/baseline characterization. Remedial investigations. Ecological risk assessments. Long-term Management Strategy in Bay-Delta.
Freshwater Sediment Toxicity Test [Environmental beneficial uses]	All, except temperature, dissolved oxygen, SAR, TOC, toxicity of unknown origin, and pathogens. Sediment absorptive, binding, and flocculating chemicals.	Standard sediment toxicity tests are available (e.g., amphipod, midge, or mayfly tests). Measures reproductive rates and lethal dose levels. May detect toxicity to benthic organisms not detected by water column TIE or water toxicity three species test. Indicates lethal dose for chronic and acute exposure. Detects exposure to bioaccumulative substances in sediments. When long term transplants are used in situ.	Standard tests may not be representative of species affected or field conditions. Highly variable spatial distributions. Important to analyze sediment characteristics in addition to parameters of concern. Deposition and resuspension difficult to quantify. Does not efficiently measure chemicals toxic because of bioaccumulation and magnification in food web (e.g., selenium and mercury).	Dredging disposal assessments. Special studies. Remedial investigations. Ecological risk assessments.

Table 4. Potential Tools and Indicators of Success for Assessing Effectiveness of CALFED Water Quality Actions

Tool	Applicable Parameters of Concern	Strengths	Weaknesses	Current Uses
Tissue Concentration (Bioaccumulation and Biomagnification) [Environmental beneficial uses]	All metals and organics, diazinon, chlorpyrifos and carbofuran have rapid uptake and depuration.	Provides information on tissue concentrations due to long and short term sub-lethal exposure to resident species. May detect exposure not detected by toxicity tests.	Applicable to limited chemicals of concern. Difficult to differentiate short term vs. long term exposure. Difficult to specify source/s of exposure. Ecological significant not well-established.	Remedial investigations. Ecological risk assessments. Special studies/baseline characterizations. Human health warnings regarding fish consumption.
Biological Assessment [Environmental beneficial uses]	All, except SAR, bromides, TOC, and pathogens.	Reveals ecological response to complex stressors to the fish or macroinvertebrate community. Uses native species as indicators of beneficial use impairment. Indicates biodiversity/homogeneity of an area.	Criteria are now being developed and are only applicable to limited types of environments. No baseline data is available for comparison or to aid in interpreting results. Difficult to identify sources and types of stressors. Must be correlated to other information such as natural and human caused stressors to be meaningful.	Special studies in support of point and nonpoint source investigations. Ecological risk assessments and baseline characterizations.

Table 5. CALFED Water Quality Targets for Parameters of Concern

Parameter	Sacramento River	San Joaquin River	Delta
Boron		Water: Mouth of Merced to Vernalis: **2.0 mg/l** (15 March - 15 September)[d] **0.8 mg/l** (monthly mean, 15 March - 15 September)[d] **1.0 mg/l** (monthly mean, 16 September - 14 March)[d] **1.3 mg/l** (monthly mean, critical year)[d]	Water: Agricultural Intakes: **< 0.7 mg/l**
Cadmium	Water: River and Tributaries from above State Hwy 32 bridge at Hamilton City: **0.22 µg/l** [a,c,d] Below Hamilton City: **2.2 µg/l** (4 day average) [a,e] **4.3 µg/l** (1 hour average) [a,e] Sediment: [z] **5.0 ppm** (dry weight)	Water: **2.2 µg/l** (4 day average) [a,e] **4.3 µg/l** (1 hour average) [a,e] Sediment: [z] **5.0 ppm** (dry weight)	Water: East of Antioch Bridge: **2.2 µg/l** (4 day average) [a,e] **4.3 mg/l** (1 hour average) [a,e] West of Antioch Bridge: **1.1 µg/l** (4 day average) [x] **3.9 µg/l** (1 hour average) [x] Sediment: [z] **1.2 ppm** (dry weight)
Copper	Water: River and Tributaries from above State Hwy 32 bridge at Hamilton City: **5.6 µg/l** [a,c,d] Below Hamilton City: **10 µg/l** (no hardness connection) [a,d,f] Sediment: [z] **70.0 ppm** (dry weight)	Water: **9.0 µg/l** (4 day average) [a,e] **13 µg/l** (1 hour average) [a,e] Sediment: [z] **70.0 ppm** (dry weight)	Water: East of Antioch Bridge: **10 µg/l** (no hardness connection) [a,d,f] West of Antioch Bridge: **6.5 µg/l** (4 day average) [x] **9.2 µg/l** (1 hour average) [x] Sediment: [z] **34.0 ppm** (dry weight)

Note:
Water quality targets have no regulatory meaning within the context of CALFED.

Table 5. CALFED Water Quality Targets for Parameters of Concern

Parameter	Sacramento River	San Joaquin River	Delta
Mercury (inorganic)	Water: **0.012 µg/l** (4 day average) [b,e] **2.1 µg/l** (1 hour maximum) [a,e] Sediment: [z] **0.15 ppm** (dry weight) Tissue: [i,y] **0.5 µg/gm** (whole fish, wet weight)	Water: **0.012 µg/l** (4 day average) [b,e] **2.1 µg/l** (1 hour maximum) [a,e] Sediment: [z] **0.15 ppm** (dry weight) Tissue: [i,y] **0.5 µg/gm** (whole fish, wet weight)	Water: East of Antioch Bridge: **0.012 µg/l** (4 day average) [b,e] **2.1 µg/l** (1 hour maximum) [a,e] West of Antioch Bridge: **0.025 µg/l** (4 day average) [x] **2.4 µg/l** (1 hour average) [x] Sediment: [z] **0.15 ppm** (dry weight) Tissue: [i,y] **0.5 µg/gm** (whole fish, wet weight)
Selenium	Water: **20 µg/l** (1 hour maximum) [b,e] **5.0 µg/l** (4 day average) [b,e] Tissue: [aa] **4-12 ppm** (fish, whole body, dry weight) **3-7 ppm** (fish food items, food chain, dry weight)	Water: [j] South of Merced River: **20 µg/l** (1 hour maximum) [b,e] **5.0 µg/l** (4 day average) [b,e] North of Merced River: **12 µg/l** (maximum) [b,e] **5.0 µg/l** (4 day average) [b,e] Tissue: [aa] **4-12 ppm** (fish, whole body, dry weight) **3-7 ppm** (fish food items, food chain, dry weight)	Water: East of Antioch Bridge: **20 µg/l** (1 hour maximum) [b,e] **5.0 µg/l** (4 day average) [b,e] West of Antioch Bridge: **20 µg/l** (1 hour average) [b,e] **5.0 µg/l** (4 day average) [b,e] Tissue: [aa] **4-12 ppm** (fish, whole body, dry weight) **3-7 ppm** (fish food items, food chain, dry weight)

Note:
Water quality targets have no regulatory meaning within the context of CALFED.

Table 5. CALFED Water Quality Targets for Parameters of Concern

Parameter	Sacramento River	San Joaquin River	Delta
Zinc	Water: River and Tributaries from above State Hwy 32 bridge at Hamilton City: **16 µg/l** [a,c,d] Below Hamilton City: **100 µg/l** (no hardness connection) [a,d,g] Sediment: [z] **120.0 ppm** (dry weight)	Water: **120 µg/l** (4 day average) [a,e] **120 µg/l** (1 hour average) [a,e] Sediment: [z] **120.0 ppm** (dry weight)	Water: East of Antioch Bridge: **100 µg/l** [a,d] (no hardness connection) West of Antioch Bridge: **106µg/l** (4 day average) [x] **117 µg/l** (1 hour average) [x] Sediment: [z] **150.0 ppm** (dry weight)
Carbofuran	Water: [k] **0.4 µg/l** (daily max. and total pesticide) [h]	Water: **0.4 µg/l** (daily max. and total pesticide) [h]	Water: **0.4 µg/l** (daily max. and total pesticide) [h]
Chlordane	Water: **2.4 µg/l** (instantaneous max.) [e] **0.0043 µg/l** (4 day average, total pesticide) [e] Sediment: [z] **7.1 ppm** (dry weight)	Water: **2.4 µg/l** (instantaneous max.) [e] **0.0043 µg/l** (4 day average, total pesticide) [e] Sediment: [z] **7.1 ppm** (dry weight)	Water: **2.4 µg/l** (instantaneous max.) [e] **0.0043 µg/l** (4 day average, total pesticide) [e] Sediment: [z] **7.1 ppm** (dry weight)
Chlorpyrifos	Water: [m] **0.02 µg/l** (4 day average, total pesticide) [l,g]	Water: [m] **0.02 µg/l** (4 day average, total pesticide) [l,g]	Water: [m] **0.02 µg/l** (4 day average, total pesticide) [l,g]
Diazinon	Water: [n] **0.08 µg/l** (1 hour average, total pesticide) [l] **0.04 µg/l** (4 day average, total pesticide) [l]	Water: [n] **0.08 µg/l** (1 hour average, total pesticide) [l] **0.04 µg/l** (4 day average, total pesticide) [l]	Water: [n] **0.08 µg/l** (1 hour average, total pesticide) [l] **0.04 µg/l** (4 day average, total pesticide) [l]

Note:
Water quality targets have no regulatory meaning within the context of CALFED.

Table 5. CALFED Water Quality Targets for Parameters of Concern

Parameter	Sacramento River	San Joaquin River	Delta
DDT	Water: **1.1 µg/l** (instantaneous max., total pesticide) [e] **0.001 µg/l** (4 day average, total pesticide) [e] Tissue: [y] **1 µg/l** (whole fish, wet weight)	Water: **1.1 µg/l** (instantaneous max., total pesticide) [e] **0.001 µg/l** (4 day average, total pesticide) [e] Tissue: [o,y] **1 µg/l** (whole fish, wet weight)	Water: East of Antioch Bridge: **1.1 µg/l** (instantaneous max., total pesticide) [e] **0.001 µg/l** (4 day average, total pesticide) [e] West of Antioch Bridge: **1.1 µg/l** (instantaneous maximum) **0.001 µg/l** (24 hour average) Tissue: [y] **1 µg/l** (whole fish, wet weight)
PCB's	Water: **0.014 µg/l** (4 day average) [e] (each of 7 congeners) Sediment: [z] **50 ppm** (dry weight, total) Tissue: [y] **0.5 µg/l** (whole fish, wet weight, total)	Water: **0.014 µg/l** (4 day average) [e] (each of 7 congeners) Sediment: [z] **50 ppm** (dry weight, total) Tissue: [y] **0.5 µg/l** (whole fish, wet weight, total)	Water: East of Antioch Bridge: **0.014 µg/l** (4 day average) [e] (each of 7 congeners) West of Antioch Bridge: **0.014 µg/l** (24 hour average) Sediment: [z] **50 ppm** (dry weight, total) Tissue: [y] **0.5 µg/l** (whole fish, wet weight, total)

Note:
Water quality targets have no regulatory meaning within the context of CALFED.

Table 5. CALFED Water Quality Targets for Parameters of Concern

Parameter	Sacramento River	San Joaquin River	Delta
Toxaphene	Water: **0.73 µg/l** (1 hour average) [e] **0.0002 µg/l** (4 day average) [e] Tissue: [y] **0.1 µg/l** (whole fish, wet weight) (sum of 9 organochlorine insecticides)	Water: **0.73 µg/l** (1 hour average) [e] **0.0002 µg/l** (4 day average) [e] Tissue: [y] **0.1 µg/l** (whole fish, wet weight) (sum of 9 organochlorine insecticides)	Water: East of Antioch Bridge: **0.73 µg/l** (1 hour average) [e] **0.0002 µg/l** (4 day average) [e] West of Antioch Bridge: **0.0002 µg/l** (4 day average) [e] Tissue: [y] **0.1 µg/l** (whole fish, wet weight) (sum of 9 organochlorine insecticides)
pH	Water: **≥ 6.5 ≤ 8.5** [vv]	Water: **≥ 6.5 ≤ 8.5** [vv]	Water: **≥ 6.5 ≤ 8.5** [vv] Agricultural Intakes: [ww] **< 1.5 me/l**
Ammonia	Water: **0.08 - 2.5 µg/l** (4 day average) [e,p] **0.58 - 35 µg/l** (1 hour average) [e,p]	Water: **0.08 - 2.5 µg/l** (4 day average) [e,p] **0.58 - 35 µg/l** (1 hour average) [e,p]	Water: East of Antioch Bridge: **0.08 - 2.5 µg/l** (4 day average) [e,p] **0.58 - 35 µg/l** (1 hour average) [e,p] West of Antioch Bridge: **0.025 µg/l** (annual median) **0.16 µg/l** (maximum)
Bromide*			Water: Drinking Water Intakes: **<50 µg/l** [gg, hh,ll] ; **50 - 150 µg/l** [uu]
TOC*			Water: Drinking Water Intakes: **<3 mg/l** [gg-pp]; **2 - 4 mg/l** [tt]

* On December 3, 1997, a meeting between the drinking water industry, USEPA, and CALFED was held to identify source water quality targets for bromide and TOC. As a result of the discussion, urban water agencies are going to further analyze different levels of treatment for different levels of a constituent and report their findings to CALFED.

Note:
Water quality targets have no regulatory meaning within the context of CALFED.

Table 5. CALFED Water Quality Targets for Parameters of Concern

Parameter	Sacramento River	San Joaquin River	Delta
Chloride			Water: Agricultural Intakes: For surface irrigation: [bb] **SAR: < 3** [cc] For sprinkle irrigation: [dd] **< 3 me/l** Drinking Water Intakes: **250 mg/l** [ii, rr]; **150 mg/l**[ss]
Nutrients (Nitrate)			Water: Agricultural Intakes: **< 5.0 mg/l** Drinking Water Intakes: **10 mg/l** [jj]; no increase in nitrate levels[mm]
Salinity (EC_w)			Water: East of Antioch Bridge: West of Antioch Bridge: Agricultural Intakes: **< 0.7 dS/m or mmho/cm** [ee]
Salinity (EC)	Water: Knights Landing above Colusa Drain:[xx, yy] ≥ **230 mmho/cm** (50 percentile) or ≥**235 mmho/cm** (90 percentile) I Street Bridge:[xx, yy] ≥**240 mmho/cm** (50 percentile) or ≥**340 mmho/cm** (90 percentile)	Water: Friant Dam to Gravelly Ford:[xx] ≥ **150 mmho/cm** (90 percentile)	

Note:
Water quality targets have no regulatory meaning within the context of CALFED.

Table 5. CALFED Water Quality Targets for Parameters of Concern

Parameter	Sacramento River	San Joaquin River	Delta
SAR:EC_w[ff] relationship			Water: Agricultural Intakes: SAR EC_w: **0 - 3 > 0.7** **3 - 6 > 1.2** **6 - 12 > 1.9** **12 - 20 > 2.9** **20 - 40 > 5.0**
Salinity (TDS)	Water:	Water:	Water: East of Antioch Bridge: West of Antioch Bridge: Agricultural Intakes: **< 450 mg/l** Drinking Water Intakes: <220mg/L (10-yr avg); <440mg/L (monthly avg)[oo]
Dissolved Oxygen	Water: Keswick Dam to Hamilton City, June 1 to August 31: **9.0 mg/l**[d,q] Below I Street Bridge: **7.0 mg/l**[d]	Water: Between Turner Cut and Stockton, September 1 through November 30: **6.0 mg/l**[d]	Water:[s] All Delta waters west of Antioch Bridge: **7000 µg/l** (minimum) [d,x] All Delta waters: **5.0 mg/l**[d,r]
Pathogens			Water: Drinking Water Intakes: **no MCL standard**[kk]; <1 oocyst/100L for *Giardia* and *Cryptosporidium*[nn]

Note:
Water quality targets have no regulatory meaning within the context of CALFED.

Table 5. CALFED Water Quality Targets for Parameters of Concern

Parameter	Sacramento River	San Joaquin River	Delta
Temperature	Water: Keswick Dam to Hamilton City: **< 56° F** [d,u] Hamilton City to I Street Bridge: **< 68° F** [d,u] I Street Bridge to Freeport: **< 68°F** [d,v] I Street Bridge to Freeport, January 1 through March 31:**< 66°F** [d,w]	Water: At Vernalis: **< 68°F** [d,v]	Water: West of Antioch Bridge: **< 5°C** increase above for receiving water designated as cold or warm freshwater habitat. [x] Alteration of temperature shall not adversely affect beneficial uses. [x] Agricultural Intakes:
Turbidity			Water: West of Antioch Bridge: **No adverse effect or > 10 % change** Drinking Water Intakes: **0.5 or 1.0 NTU** [jj]**; 50 NTU** [qq] Agricultural Intakes:
Toxicity of Unknown Origin [t]			Water: West of Antioch Bridge: Acute- A median of not less than **90%** survival and a 90 percentile of not less than **70%** survival Chronic - **no chronic toxicity** in ambient waters

[a] dissolved form
[b] total recoverable form
[c] The effects of these concentrations were measured by exposing test organisms to dissolved aqueous solutions of 40 mg/l hardness that had been filtered through a 0.45 micron membrane filter. Where deviations from 40 mg/l of water hardness occur, the objectives, in mg/l shall be determined using the following formulas:
$Cu = e^{(0.905)(\ln \text{hardness})} - 1.612 \times 10^{-3}$
$Zn = e^{(0.830)(\ln \text{hardness})} - 0.289 \times 10^{-3}$
$Cd = e^{(1.160)(\ln \text{hardness})} - 5.777 \times 10^{-3}$
[d] Central Valley Regional Water Quality Control Plan
[e] General EPA 304(a) guideline

Note:
Water quality targets have no regulatory meaning within the context of CALFED.

Table 5. CALFED Water Quality Targets for Parameters of Concern

[f] Within the next year the State Water Resources Control Board or EPA will promulgate/adopt objectives which are hardness dependent. The adoption language is likely to contain a clause saying that the most stringent objective applies. Sometimes the 10 µg/l objective will be more stringent and at other times the new rule will be more stringent.

[g] Similar to the objectives for copper, we expect the State Water Resources Control Board or EPA to promulgate new objectives within the next year which will be more stringent than current objectives.

[h] The Central Valley Regional Water Quality Control Board expects to adopt an objective for carbofuran within the next year. The objective will probably be very similar to the performance goal.

[i] Water quality limited segments for mercury in fish tissue occur in the Sacramento River and Delta.

[j] Water quality limited segments for selenium in the water column from Salt Slough to Vernalis on the San Joaquin River.

[k] Lower Sacramento River is a water quality limited segment for carbofuran.

[l] California Department of Fish and Game acute (1 hour) and chronic (4 day) hazard assessment criteria.

[m] Sacramento River, San Joaquin River, and Delta water quality limited segments for chlorpyrifos.

[n] Sacramento River, San Joaquin River, and Delta water quality limited segments for diazinon.

[o] San Joaquin River water quality limited segment for DDT in tissue.

[p] Values are a function of pH, temperature, and designation of water body as cold or warm water fish beneficial use.

[q] When natural conditions lower dissolved oxygen below this level, the concentrations shall be maintained at or above 95% of saturation.

[r] Except those water bodies which are constructed for special purposes and from which fish have been excluded or where the fishery is not important and a beneficial use.

[s] Southern Delta around Stockton is a water quality limited segment for dissolved oxygen.

[t] Bioassay results or other special studies demonstrate toxicity. Sacramento River, San Joaquin River, and Delta are water quality limited segments for "toxicity of unknown origin."

[u] The temperature shall not be elevated above 56°F in the reach from Keswick Dam to Hamilton City nor above 68°F in the reach from Hamilton City to I Street Bridge during periods when temperature increases will be detrimental to the fishery.

[v] The daily average water temperature shall not be elevated by controllable factors above 68°F from the I Street Bridge to Freeport on the Sacramento River, and at Vernalis on the San Joaquin River between April 1 through June 30 and September 1 through November 30 in all water year types.

[w] The daily average water temperature shall not be elevated by controllable factors above 66°F from the I Street Bridge to Freeport on the Sacramento River between January 1 through March 31.

[x] San Francisco Regional Water Quality Control Board objectives at 100 mg/l hardness. Formulas for calculating objectives for varying hardness levels are as follows:

$Cd = e^{(0.7852H - 3.490)}$ (4 day average)

$= e^{(1.128H - 3.828)}$ (1 hour average)

$Cu = e^{(0.8545H - 1.465)}$ (4 day average)

$e^{(0.9422H - 1.464)}$ (1 hour average)

$Zn = e^{(0.8473H + 0.7614)}$ (4 day average)

$= e^{(0.8473H + 0.8604)}$ (1 hour average)

[y] National Academy of Sciences (NAS)-National Academy of Engineering 1973

[z] Effect range-low (ERLs) concentrations

[aa] San Luis Drain Reuse, Technical Advisory Committee Selenium ecological risk guidelines

[bb] For surface irrigation, most tree crops and woody plants are sensitive to sodium and chloride, use the values shown. Most annual crops are not sensitive, use the salinity tolerance in Ayers and Westcot or equivalent.

Note:
Water quality targets have no regulatory meaning within the context of CALFED.

Table 5. CALFED Water Quality Targets for Parameters of Concern

[cc] SAR means sodium adsorption ratio. SAR is sometimes reported by the symbol RNa.

[dd] For overhead sprinkle irrigation, and low humidity (< 30%), sodium and chloride greater than 70 or 100 mg/l, respectively, have resulted in excessive leaf adsorption and crop damage to sensitive crops, see Ayers and Westcot.

[ee] EC_w means electrical conductivity of irrigation water, reported in mmho/cm or dS/m.

[ff] At a given SAR, the infiltration rate increases as salinity EC_w increases. To evaluate a potential permeability problem examine SAR and EC_w together.

[gg] Value arrived at in discussion with California Urban Water Agencies (CUWA), based on report prepared by nationall recognized water treatment experts.

[hh] Bromide value is predicated on the assumption that the MCL for bromate will be 5 µg/l in treated water.

[ii] U.S. EPA Secondary MCL for treated water. 1995.

[jj] U.S. EPA Current MCL for treated water. 1995.

[kk] U.S. EPA requires removal of 99.9 % of *Giardia* and 99.99% of viruses during water treatment. Higher levels of removal are required in poor water quality source waters.

[ll] Target level based on the CUWA Expert Panel Report recommendations (Bay-Delta Water Quality Criteria, December 1996). Expert panel assumed future drinking water regulatory scenario for disinfection by-product (DBP) control and inactivation of *Giardia* and *Cryptosporidium* based on the proposed Stage 2 D/DBP Rule and Proposed Enhanced Surface Water Treatment Rule (ESWTR).
The bromide target level is constrained by the formation of bromate when using ozone to inactivate *Cryptosporidium*.

[mm]Nutrients are a critical reservoir management issue. Nutrient levels are a determining factor governing the growth of taste- and odor-producing algae in water storage reservoirs. SWP supplies are nitrogen-limited; however, phosphorous is present in great excess. This is a problem with respect to the growth of blue-green algae, which can fix their own nitrogen. Water quality impacts of nutrients are driven by reservoir management issues as opposed to human health effects; as a result, use of the MCL for nitrate (as N) of 10 mg/L is not appropriate.

[nn] Desirable target levels are based on likely future regulatory scenarios under the ESWTR that will base required levels of pathogen removal/inactivation treatment on pathogen density in source water. Future regulations may require removal requirements for *Cryptosporidium*. Increasing treatment for removal of pathogens makes it more difficult to control the formation of DBPs. To balance disinfection requirements for controlling pathogens with the production of DBPs selection of a Bay-Delta alternative should not result in degraded water quality necessitating increased removal requirements for pathogens.

[oo] Target levels for TDS would allow compliance with the TDS objectives contained in Article 19 of the SWP Water Service Contract. The average TDS levels in SWP supplies over the last ten years have consistently exceeded the 220 mg/L (10-year average) SWP objective. The 10-year averaging period for the 220mg/L objective is too long to be sufficiently protective of source water quality. MWD staff are currently exploring the development of appropriate alternative TDS objectives for shorter time frames (i.e., 1 year and 6 month averages) and will forward that information to CALFED when available. The SWP TDS objective of 440 mg/L (monthly average) is a problem for water resource management programs, especially in the months of April and September, and there is a real need to reduce peaks in TDS in SWP supplies. Consistently low TDS levels are needed to minimize the following salinity-related impacts: Increased demand for Delta water supplies when such water is used to blend with other higher salinity water sources; adverse impacts on water recycling and groundwater replenishment programs, which depend on Delta water supplies to meet local resource program salinity objectives. Failure to develop local resource programs may result in increased demand on Delta exports; economic impacts on industrial, residential, and agricultural water users.

[pp] Target level based on the CUWA Expert Panel report recommendations (Bay-Delta Drinking Water Quality Criteria, December 1996). Expert panel assumed future drinking water regulatory scenario for DBP control and inactivation of *Giardia* and *Cryptosporidium* based on the proposed Stage 2 D/DBP Rule and proposed ESWTR. The proposed D/DBP Rule requires increased levels of TOC removal as TOC concentrations in source waters increase. The recommended TOC target level is constrained by the formation of total trihalomethanes when using enhanced coagulation for TOC removal and free chlorine to inactivate *Giardia*.

[qq] Reduced variability in turbidity is needed to improve treatment plant performance. When source water turbidity increases, water is more difficult and costly to treat. Also, increased turbidity reduces protection from pathogens because turbidity interferes with disinfection.

[rr] Water Quality Control Plan for the San Francisco Bay/Sacramento - San Joaquin Delta Estuary. May 1995. 95-IWR. SWRCB and Cal-EPA. According to the

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Table 5. CALFED Water Quality Targets for Parameters of Concern

Water Quality Control Plan, this value applies from October - September during all water year types for Contra Costa Canal at Pumping Plant No. 1, West Canal at Mouth of Clifton Court Forebay, Delta-Mendota Canal at Tracy Pumping Plant, Barker Slough at North Bay Aqueduct Intake and Cache Slough at City of Vallejo Intake.

[ss] Water Quality Control Plan for the San Francisco Bay/Sacramento - San Joaquin Delta Estuary, May 1995. 95-IWR. According to the Water Quality Control Plan, this value applies to a certain number of days per year, depending on water year type, to the Contra Costa Canal at Pumping Plant No. 1 and the San Joaquin River at Antioch Water Works Intake.

[tt] Recommendation of September 30, 1997, from Karen Schwinn, Water Division, USEPA.

[uu] Recommendation of July 24, 1997, from Bruce Macler, Water Division, USEPA.

[vv] Changes in normal ambient pH levels shall not exceed 0.5 in fresh water with designated COLD or WARM beneficial uses.

[ww] Alkalinity as $CaCO_3$.

[xx] At 25° C. Central Valley Regional Water Quality Control Plan.

[yy] Based upon previous 10 years of record. Central Valley Regional Water Quality Control Plan.

Note:
Water quality targets have no regulatory meaning within the context of CALFED.

STRATEGIES FOR PHASED IMPLEMENTATION

CALFED
BAY-DELTA
PROGRAM

STRATEGIES FOR PHASED IMPLEMENTATION

INTRODUCTION

The objective of CALFED's Water Quality Program is to provide good water quality for all beneficial uses - urban, agricultural, industrial, environmental and recreational. This objective will be carried out by phased implementation of the water quality actions that have been identified to address parameters of concern. Each water quality action has been subdivided into specific objectives that will be part of a long-term adaptive management process to improve water quality. Following initial implementation, the effectiveness of each action will be evaluated and the implementation program for the action will be modified, as necessary, to better achieve the objectives of the CALFED Water Quality Program.

In Phase II, all components of the CALFED Bay-Delta Program are being developed and evaluated at a programmatic level. The complex and comprehensive nature of the Bay-Delta issues requires a response that is composed of many different programs, projects, and actions - all of which will be implemented in an integrated approach. This section on phased implementation provides a programmatic overview of the intended approach to implementing the WQPP. Over the estimated 20- to 30-year period during which the majority of the actions will be implemented, the adaptive management process will be employed to refine and refocus actions, when necessary, to better achieve improvements in water quality.

The actions included in the WQPP are the result of a comprehensive process for receiving stakeholder input, advice, review and expertise. As described earlier, this large group of technical experts, representatives from stakeholder groups, and staff of the CALFED agencies have played and will continue to play a major role in defining and evaluating program components to better achieve increases in beneficial uses.

The development of the programmatic set of water quality improvements identified in the WQPP resulted from analyzing which water quality parameters are of concern to beneficial uses of the waters of the Bay-Delta.

RANKING OF WATER QUALITY ELEMENTS AND SETTING IMPLEMENTATION PRIORITIES

The WQPP is structured to provide improved water quality for all beneficial uses in the Bay-Delta system. The impacts of parameters of concern on beneficial uses are many. The proposed methods of achieving the water quality benefits may

impact different stakeholders differently, involve difficult technical or operational decisions, and require the significant expenditure of capital and operating funds. Moreover, many of the actions involve treatment techniques, enforcement measures, and incentives that have not been fully tested in complex estuaries like the Delta.
The WQPP has been developed at the programmatic level of detail - much work remains to identify the specific projects, activities, management actions, and other implementation measures needed to achieve the desired improvements in water quality. During the next phase of the CALFED program, the water quality activities will be further developed, refined, and evaluated before any specific improvement methods are adopted. The four cornerstones of the process that will be used to determine specific water quality strategies and actions include the following:

- Continued stakeholder involvement to ensure that the WQPP focuses on the highest priority water quality activities most affecting beneficial uses of the Bay-Delta
- Additional research concerning the relationship between parameters of concern and beneficial uses
- Further development of strategies, actions, and methods of implementation, so that the items affecting the benefit and cost of an action may be compared to other actions that would achieve similar results
- Monitoring of efforts - following Adaptive Management Principles being employed on all CALFED Program elements

These four cornerstones will be used to develop a phased implementation program that will achieve, in measurable steps, improved water quality for all beneficial uses.

Figure 6 shows the implementation process that will be applied to each of the proposed actions described in the WQPP. The right-hand side of the figure describes the progressive series of evaluations that will be performed on each action before implementation. The left-hand side of the figure diagrams the extensive effort to seek both expert and public input at every step of the process.

The implementation process has been designed to provide a logical and scientifically-supportable basis for the actions while providing stakeholders, public, experts, and regulatory agencies numerous input opportunities. A detailed implementation plan, further defining the steps outlined in the figure, will be prepared early in Phase III.
The WQPP is comprised of many component parts. Included are actions for each of the following:

- Mine Drainage
- Urban and Industrial Runoff
- Wastewater and Industrial Discharge
- Agricultural Drainage and Runoff
- Water Treatment
- Water Management
- Human Health
- Toxicity of Unknown Origin

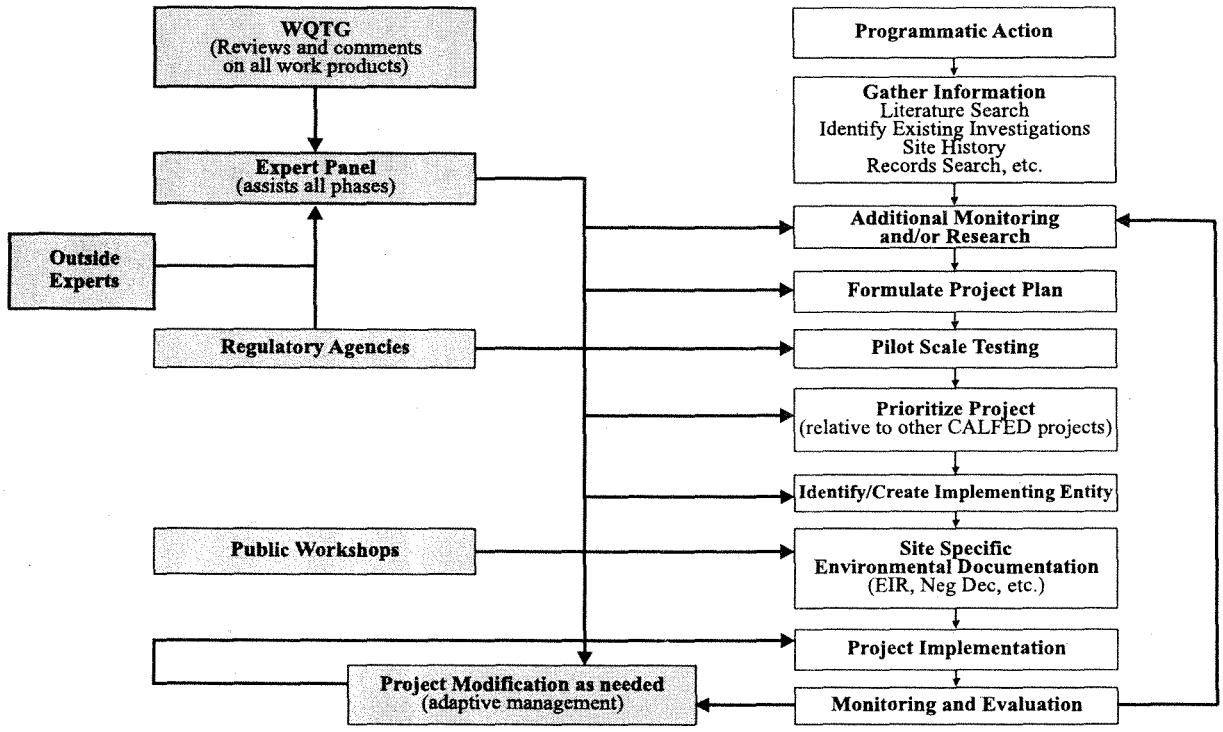

Figure 6. CALFED Water Quality Program Implementation Scheme.

Each action has differing implementation methods, performance targets (quantifiable reductions of parameters of concern), and indicators of success (attainment of water quality objectives). The actions will vary in cost, technical feasibility, and organizational responsibility for implementation and time schedule. Components of the actions will be subjected to pre-feasibility analysis and pilot scale evaluation to determine how best to implement programmatic actions.

MINE DRAINAGE

Two specific mine drainage actions are included in the WQPP. The first action is to reduce toxic effects of metals (principally, cadmium, copper, zinc) contained in waters of the Delta and Sacramento River regions. The principal method for reducing the metal inputs is by source control or treatment of mine drainage at inactive or abandoned mine sites. Actions are targeted at sites on the Upper Sacramento River and its tributaries that are major contributors of metal loadings. Successful implementation will bring the concentration of the parameters into compliance with basin plan objectives. The second action is to reduce the toxic effects of mercury loadings to the Delta, Sacramento and San Joaquin River regions. Mercury levels would be reduced by employing source control and treatment of mine drainage at inactive and abandoned mine sites.

Both actions propose controlling the discharge of the metals from mine sites and/or treating mine drainage waters to prevent metals from entering water bodies. The second action includes the development of applied research programs to better

determine sources, treatment methods and impacts on beneficial uses.

URBAN AND INDUSTRIAL RUNOFF

Urban and industrial runoff improvements will be accomplished under five specific actions. Similar to the mine drainage, the first action is to reduce toxic effects of metal (principally, cadmium, copper, zinc) substances contained in the Delta, Sacramento River, and San Joaquin River regions. The action will be accomplished by enforcement of existing source control regulations and by providing incentives for entities that achieve additional runoff controls.

The second action is to reduce toxicity from pesticides in the Delta, Sacramento River and San Joaquin River regions. Both regulatory and financial incentives will be employed to improve source control measures. The third action is to reduce the effects of nutrient loadings which lead to oxygen depletion in the Delta Region. This condition is especially apparent in the Stockton area. Proposed implementation methods include enforcement of source control regulations and provision of best management practices to further reduce runoff.

Reduction of the amount of sediments discharged to the Delta and Sacrament River regions is the subject of the fourth action. This action will be accomplished by better enforcement of the existing runoff controls at construction sites and education of construction personnel.

The fifth action is to evaluate loadings of TOC, salinity and pathogens to determine the need for source control. This action will be accomplished by monitoring stormwater and dry season runoff as part of CMARP, and evaluating the relative loading of these parameters in urban runoff, wastewater discharges and agricultural drainage discharges. Appropriate actions will be developed to reduce TOC, salinity and pathogen loads to the Delta and its tributaries.

WASTEWATER AND INDUSTRIAL DISCHARGE

Methods to reduce the effects of wastewater and industrial discharge on beneficial uses involve combinations of actions which include: source control, enforcement measures, incentives and technological advances. To protect the beneficial uses of the Bay-Delta system, specific actions are proposed.

Boat discharges will be controlled to reduce the impact of domestic wastes on drinking water, environmental, and recreational beneficial uses within the Delta Region.

Source control and improved treatment techniques will be applied to waste discharges to the Delta Region that contain oxygen depleting substances (focus will be placed on discharges to the lower San Joaquin River).

The toxic impacts of selenium discharges will be reduced by applying source control and treatment techniques to targeted industrial

discharges impacting Suisun Bay and Carquinez Strait areas.

Improved treatment techniques will be instituted to reduce the effects of ammonia entering the Delta.

AGRICULTURAL DRAINAGE AND RUNOFF

Agricultural drainage and runoff can affect the Bay-Delta system due to agricultural operations on upstream lands and farming practices within the Delta. Agricultural drainage actions are focused on reducing the toxic effects of those actions. Specific actions include the following:

- Reducing selenium loadings to the San Joaquin River Region and Delta Region
- Lowering salinity levels in the Delta Region due to agricultural practices in the San Joaquin River Region
- Reducing pesticide-caused toxicity in the Delta Region
- Lowering agriculture-caused elevated levels of sediment discharges
- Controlling the high TOC discharges from Delta islands
- Reducing toxicity by lowering nutrients and ammonia levels in agricultural drainage water
- Minimizing pathogen loads entering the Delta Region by controlling discharges from confined animal facilities or rangelands

WATER TREATMENT

Improving the quality of drinking water provided to the 20 million people who rely on the Delta as a source of all, or part, of their drinking water supply requires two major actions:

- Application of state-of-the-art treatment techniques to Delta waters and
- Locating and operating domestic water supply intakes to reduce the effect of excursions in Delta water quality.

WATER MANAGEMENT

The water management strategy involves actions to reduce the effect of salinity on beneficial uses of the system. Two actions are proposed:

- Reducing the salinity concentration entering the Delta using water management techniques; and

- Reducing the effects of elevated salinity levels on beneficial uses of water in the South Delta.

HUMAN HEALTH

Human health concerns due to consumption of fish and shellfish containing elevated levels of DDT, chlordane, toxaphene, mercury, PCBs and their derivatives will be reduced through enforcement of existing source control regulations, incentives for additional source control and cooperative efforts between the Department of Public Health, Office of Environmental Health Hazard Assessment, and Department of Fish and Game.

TOXICITY OF UNKNOWN ORIGIN

This strategy continues efforts to identify and find solutions to Delta, Sacramento River and San Joaquin River regions toxicity events (affecting aquatic organisms) that cannot be attributed to other causes.

APPENDICES

CALFED
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APPENDIX A

CALFED WATER QUALITY TECHNICAL GROUP MEMBERS

Following is a list of all Water Quality Technical Group (WQTG) Members and Parameter Assessment Team (PAT) Members. Individuals participating in meetings of the WQTG and PAT have varied over time. The individuals noted here provide input into the Water Quality Program by attending meetings and responding to program materials they receive in the mail.

NAME	ORGANIZATION
Aiton, Bruce	Boyle Engineering
Alemi, Manucher M.	Department of Water Resources
Allen, Morris	City of Stockton
Alsop, William R. *	Chem Risk
Archibald, Elaine M.	Archibald & Wallberg Consultants
Ballman, Ed	Environmental Water Resources
Barry, Terry *	California Environmental Protection Agency
Beck, James M.	Kern County Water Agency
Bennett, Bill	UC Davis c/o Friday Harbor Labs
Berger, Robert	East Bay Municipal Utility District
Bertolero, Toni	City of Benicia
Beuttler, John	United Anglers of California
Beyer, John	US Department of Agriculture
Bingham, Nathaniel	Pacific Coast Fisherman Federation
Bischel, David	California Forestry Association
Bishop, Walter	Contra Costa Water District
Blodgett, Bruce	California Farm Bureau Federation
Bobker, Gary	The Bay Institute
Boles, Jerry L.	Department of Water Resources
Borgonovo, Roberta	League of Women Voters
Bowes, Gerald	State Water Resources Control Board
Braziel, Pat	Sacramento County
Breitenbach, Rick	CALFED Bay-Delta Program
Brenunger, David A.	Placer County Water Agency
Breuer, Rich	Department of Water Resources
Briggs, Dave	Contra Costa Water District
Brockbank, Marcia	San Francisco Estuary Project
Brodberg, Robert	Office of Environmental Health Hazard Assessment
Brown, Russ	Jones & Stokes Associates
Brown, Randall	Department of Water Resources

* Denotes Parameter Assessment Team Member

NAME	ORGANIZATION
Bruns, Jerry	Central Valley Regional Water Quality Control Board
Bryant, Jerry	Firebaugh Canal Water District
Buck, Byron	California Urban Water Agencies
Bucknell, Patty	Anlab
Bunker, Charlie	EcoLogic Engineers
Burnam, Jack	Carrollo Engineers
Buttz, John	Kennedy/Jenks Engineers
Byron, Earl R.	CH2M HILL
Candee, Hal	Natural Resources Defense Counsel
Candy, Peter J.	
Carpenter, Marc	Westlands Water District
Cativiela, Jean-Pierre *	California Rice Industry Association
Cawley, Ken	Regional Council of Rural Counties
Chan, Grace	Metropolitan Water District of Southern California
Chatfield, David	Clean Water Action
Chung, Francis	Department of Water Resources
Coburn, John	State Water Contractors
Cohen, Ronnie	Natural Resources Defense Council
Condon, Deborah C.	Department of Water Resources
Connor, Val	Central Valley Regional Water Quality Control Board
Crane, David	Department of Fish and Game
Creager, Clayton	
Crooks, William H. *	Representative for City of Sacramento
Croyle, Bill	Central Valley Regional Water Quality Control Board
Daniel, Dick	CALFED Bay-Delta Program
Davis, John	Woodward-Cyde Consultants
deVlaming, Victor	State Water Resources Control Board
Decker, Jennifer A.	California Department of Fish and Game
Denton, Richard A.	Contra Costa Water District
Dickey, John	CALFED Bay-Delta Program
Donhoff, Kevin	Metropolitan Water District of Southern California
Dubrovsky, Neil	US Geological Survey
Duncan, Jeanne	Jeanne Duncan
Dunne, Mary	California Department of Fish and Game
Elder, Jean	US Fish and Wildlife Service
Enson, Jennifer	Psomas and Associates
Eslamian, Dordaneh	
Falaschi, Dennis	Panoche Water District
Fields, John	US Bureau of Reclamation
Finalyson, Brian *	California Department of Fish and Game
Fish, Richard	Lawrence Berkeley Laboratories
Flowers, Dale	Dale Flowers & Associates
Foe, Chris *	Central Valley Regional Water Quality Control Board
Fong, Bellory G.	Department of Water Resources
Ford, Steven	Department of Water Resources
Forkel, David	Delta Wetlands
Fowler, Amy	Santa Clara Valley Water District

* Denotes Parameter Assessment Team Member

NAME	ORGANIZATION
Fox, Phyllis	Metropolitan Water District of Southern California
Fox, Jennifer R.	FMC Corporation
Freedman Johnson, Leslie	The Nature Conservancy
Fuller, Russell E.	Antelope Valley-East Kern Water Agency
Fullerton, Dave	CALFED Bay-Delta Program
Gaston, John	CH2M HILL
Gibbs, Suzanne	Big Chico Creek Task Force
Gray, Jim	Western Crop Protection Association
Grimes, Russ	US Bureau of Reclamation
Grober, Les	Central Valley Regional Water Quality Control Board
Grovhoug, Tom *	Sacramento River Watershed Program
Gutierrez, Roney	Sand and Salt Creek Watershed Project
Halverson Martin, Wendy	CALFED Bay-Delta Program
Hansel, Kate	CALFED Bay-Delta Program
Hatfield, Susan	US Environmental Protection Agency - Region 9
Heath, Judy	CALFED Bay-Delta Program
Hemmeter, Tracy	Santa Clara Valley Water District
Herkert, Bob	California Rice Industry Association
Herrera, Steve	Parsons Engineering Science
Hinson, Diane M.	Department of Municipal Utilities
Hirsch, Steven P.	Metropolitan Water District of Southern California
Hockenberry, Jim	Department of Water Resouces
Holmgren, Sarah	Montgomery Watson
Hultquist, Robert	Technical Operations Section
Humphreys, Rick	State Water Resources Control Board
Izmirian, Richard	
James, Carol	C.R. James and Associates
James, Mary S.	Sacramento County Regional Wastewater Treatment Plant
James, Roger	
Jaraczeski, Jeff	Northern California Water Association
Jennings, William	DeltaKeeper
Jensen, Cecilia T.	Sacramento Regional County Sanitation
Jerveson, Ron	San Francisco Bay Regional Water Quality Control Board
Johnson, Ron	Sacramento County Regional Wastewater Treatment Plant
Johnston, William R.	Modesto Irrigation District
Jones, Dave	Bureau of Engineering, Department of Public Works
Joyce, Larry	Department of Water Resources
Jung, Marvin	Marvin Jung and Associates
Karajeh, Fawzi *	Department of Water Resources
Karkoski, Joe	US Environmental Protection Agency
Keith, Robin	DeltaKeeper
Korichuk, Walter	Delta Protection Commission
Kratzer, Charlie	US Geological Survey
Kuhlman, Cat	US Environmental Protection Agency - Region 9
Lang, Jordan	Jones and Stokes Associates
Laychak, Eugenia	California Center for Public Dispute Resolution
Lee, G. Fred *	G. Fred Lee & Associates

* Denotes Parameter Assessment Team Member

NAME	ORGANIZATION
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Linck, Gail	State Water Resources Control Board
Lozeau, Mike	San Francisco Bay Keeper
Macler, Bruce A.	US Environmental Protection Agency
Mangarella, Peter	Woodward-Clyde
Mannion, Kathy	Western Growers Association
Maurer, Tom	US Fish and Wildlife Service
McCallum, Larry	Contra Costa Water District
McCormick, Steve	The Nature Conservancy
McGahan, Joseph C.	Summers Engineering Inc.
McLean, Steve	Castaic Lake Water District
Meays, Mary *	Sierra Club
Meier, Markus *	Zeneca Ag Products
Meral, Gerald	Planning & Conservation League
Milea, Alexis	California Department of Health Services
Mongan, Thomas	Thomas Mongan
Morrison, Doug	US Fish and Wildlife Service
Mumley, Thomas	San Francisco Regional Water Quality Control Board
Murrill, Stephen *	S.D. Murrill & Co.
Nelson, Barry	Save San Francisco Bay Association
Notthoff, Ann	Natural Resources Defense Council
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* Denotes Parameter Assessment Team Member

APPENDIX B

CALFED WATER QUALITY IMPLEMENTATION PLAN DRAFT OUTLINE

EXECUTIVE SUMMARY ..... 5-7 PAGES
GLOSSARY OF TERMS ..... 3 PAGES
ACRONYMS ..... 2 PAGES
ACKNOWLEDGMENTS ..... 1 PAGE

INTRODUCTION (3 PAGES)
- PURPOSE OF THE PLAN ..... <1 PAGE
- GEOGRAPHIC SCOPE ..... <1 PAGE
- IMPLEMENTATION STRATEGY ..... 1 PAGE
- ORGANIZATION OF THE PLAN ..... 1 PAGE

ADAPTIVE MANAGEMENT (7 PAGES)
- INTRODUCTION ..... <1 PAGE
- VISION ..... <1 PAGE
- UNCERTAINTY ..... <1 PAGE
- POTENTIAL ADAPTIVE MANAGEMENT TOOLS ..... 4 PAGES
- MONITORING
  - INDICATORS OF PERFORMANCE
  - FOCUSED RESEARCH
  - COMPREHENSIVE MONITORING, ASSESSMENT, AND RESEARCH PLAN (CMARP)

STRATEGIES FOR PHASED IMPLEMENTATION (11-13 PAGES)
- INTRODUCTION ..... 1 PAGE
- IMPLEMENTATION STRATEGIES ..... 2 PAGES
- MECHANISMS TO PRIORITIZE PROJECTS ..... 2 PAGES
- PROJECT SPECIFIC INFORMATION ..... 6-8 PAGES
  - IMPLEMENTING ENTITIES/ SUPPORTING ENTITIES
  - TIME LINE FOR PROJECT IMPLEMENTATION
  - GEOGRAPHIC LOCATION

TOTAL PAGE LENGTH ..... 32-36 PAGES