State Water Resources Control Board

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Winston H. Hickox
Secretary for Environmental Protection

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July 11, 2000

Distribution List

SCIENTIFIC ADVISORY GROUP

On August 10, 2000, the State Water Resources Control Board (SWRCB) will sponsor a meeting of scientists to review the draft Proposal for a Comprehensive Ambient Surface Water Quality Monitoring Program (Enclosed). The SWRCB is required by California Water Code Section 13192 (AB 982, Ducheny, 1999) to assess and report on the State monitoring programs and to prepare a proposal for a comprehensive surface water quality monitoring program. The SWRCB staff have met for several months with a Public Advisory Group to address policy aspects of water quality monitoring. It is now time for the technical and scientific portions of the document to be reviewed.

You have been nominated to review the draft monitoring proposal as part of a Scientific Advisory Group (SAG). We are inviting scientists with the following expertise: toxicology, ecology, bacteriology, organic and inorganic chemistry, experimental design, statistics, pesticide management, monitoring program implementation, and bioaccumulation.

The role of the SAG is to review the scientific and technical portions of the document to ensure that the State's monitoring program will collect meaningful information to find water quality problems and to assess the effectiveness of the State's water quality program. The draft proposal is not a intended to be a site-specific study plan; but rather is a framework that the SWRCB and Regional Water Quality Control Boards can use to implement a consistent and comprehensive monitoring program that allows regional variations in specific program design.

You may wish to familiarize yourself with the AB 982 activities by viewing the SWRCB web site (http://www.swrcb.ca.gov/ab982/index.html). In reviewing the draft proposal, I would like you to focus on the following questions:

1. Are the monitoring objectives stated clearly?

2. Are the proposed monitoring approaches sufficient to answer the questions posed (i.e., Is it safe to swim?, Is it safe to drink the water?, etc.) and achieve the more specific monitoring objectives?

3. Are the proposed water quality indicator categories adequate?

4. Is the Quality Assurance proposal adequate?

5. Are the range of cost estimates reasonably accurate?

If you would like to participate in this review process, please let us know in writing or via electronic mail by July 31, 2000. The mailing address is:

Gita Kapahi
Division of Water Quality
State Water Resources Control Board
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You may also send an email to Gita Kapahi at kapag@dwq.swrcb.ca.gov.

If you have any questions regarding the SAG meeting or the AB 982 activities, please call me at (916) 657-1108. Your assistance is greatly appreciated.

Sincerely,

Craig J. Wilson, Chief
Bays and Estuaries Unit
Division of Water Quality

Enclosure

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State of California
STATE WATER RESOURCES CONTROL BOARD

PROPOSAL FOR A COMPREHENSIVE AMBIENT SURFACE WATER QUALITY MONITORING PROGRAM

DRAFT – Subject to Revision
July 8, 2000

EXECUTIVE SUMMARY

The State Water Resources Control Board (SWRCB) is required by California Water Code Section 13192 to assess and report on the State monitoring programs and to prepare a proposal for a comprehensive surface water quality monitoring program. This report contains the monitoring program proposal. The major activities proposed are:

1. The SWRCB will establish a new program (the Surface Water Ambient Monitoring Program or SWAMP) to implement comprehensive environmental monitoring focused on providing the information the SWRCB and Regional Water Quality Control Boards (RWQCBs) need to effectively manage the State's water resources.

2. The monitoring efforts implemented through SWAMP will be: adaptable to changing circumstances, built on cooperative efforts, established to meet clear monitoring objectives, incorporate already available information, be implemented using scientifically sound monitoring design with meaningful indicators of the environment, comparable methods, regular reporting, and data management.

3. Current monitoring and assessment capability at the SWRCB is limited and tends to be focused on specific program needs. This has led to a fragmentation of monitoring efforts resulting in gaps in needed information and a lack of integrated analyses. For FY 2000-01 the Governor's budget includes the SWRCB's Water Quality Initiative BCP to support and expand the implementation of ambient monitoring. The BCP is consistent with the approach proposed in this program. As monitoring efforts are further developed and refined through the process outlined in the proposal, additional funding requests may be made.

4. To ensure that SWAMP is coordinated and integrated, the monitoring efforts shall be overseen centrally by the SWRCB. The RWQCBs shall establish monitoring priorities for the water bodies within their jurisdictions.

5. The SWRCB will also develop a Water Quality Control Policy that will provide listing/delisting criteria, an approach for setting priorities, minimum data needed to list waterbodies, and other factors that will allow consistent implementation of the CWA Section 303(d) requirements.

TABLE OF CONTENTS

LIST OF TABLES

SECTION I. INTRODUCTION

The State Water Resources Control Board (SWRCB) is required, in part, by Water Code Section 13192 to prepare a report to the Legislature on the SWRCB's proposal for a comprehensive surface water quality monitoring program. This report includes a combination of monitoring objectives, sampling design, indicators, and other factors to fully implement the Surface Water Ambient Monitoring Program (SWAMP).

This report contains a proposal for the program, including steps and costs associated with developing the program, cost of implementing the program and appropriate funding mechanisms. The SWRCB has included general information required to be submitted to the U.S. Environmental Protection Agency (EPA) pursuant to Clean Water Act (CWA) Section 305(b), information required to be submitted under Water Code Section 13181(c)(1), and any information required to be submitted to the Legislature by the Supplemental Report of the Budget Act of 1999.

In considering and designing the proposal, the SWRCB has included all of the following:

1. Physical, chemical, biological, and other parameters about which the program shall collect and evaluate data and other information and the reasonable means to ensure that the data is accurate in determining ambient water quality.

2. The use of models and other forms of information not directly measuring water quality.

3. Reasonable quality assurance and quality control protocols sufficient to allow sound management while allowing and encouraging, where appropriate, data collection by entities, including citizens and other stakeholders, such as dischargers.

4. A strategy to expeditiously develop information about waters which the State presently possesses little or no information.

5. A strategy for assuring that data collected as part of monitoring programs and any associated quality assurance elements associated with the data collection will be made readily available to the public.

6. A strategy for assessing and characterizing discharges from nonpoint sources of pollution and natural background sources.

7. A strategy to prioritize and allocate resources in order to effectively meet water quality monitoring goals.

SECTION II. BACKGROUND

The Porter-Cologne Water Quality Control Act and the federal Clean Water Act (CWA) direct the water quality programs to implement efforts intended to protect and restore the integrity of waters of the State. Ambient monitoring is independent of the water quality programs and serves as a measure of (1) the overall quality of water resources and (2) the overall effectiveness of RWQCB's prevention, regulatory, and remedial actions. This section provides a definition of ambient monitoring, presents an overview of the major monitoring efforts in California, and describes the legislation that requires the proposal for a comprehensive surface water quality monitoring program.

Ambient Monitoring

Protecting and restoring environmental resources requires an understanding of where you are and deciding where you want to be in the future. Monitoring is a key component in determining if we are making adequate progress toward our environmental goals. It is impossible to directly assess progress without a tool to do so. Monitoring is the tool that helps measure the success of environmental programs and the overall quality of our water resources.

Ambient monitoring refers to any activity in which information about the status of the physical, chemical, and biological characteristics of the environment is collected to answer specific questions about the status and trends in those characteristics. For the purposes of SWAMP, ambient monitoring refers to these activities as they relate to the characteristics of water quality. SWAMP does not include monitoring to identify sources of pollutants or to assess the effectiveness of individual best management practices (BMPs).

Summary of Monitoring Planning Efforts

Many efforts are underway to plan and encourage ambient water quality monitoring programs. In 1998, the SWRCB and the RWQCBs staff convened a team to evaluate the State's water quality monitoring and assessment approaches, efforts, and needs. These discussions led to the Coastal Monitoring Strategy (California Environmental Protection Agency, 1998) and the FY 2000-01 budget proposal.

In 1997, the SWRCB and RWQCBs began implementation of the Watershed Management Initiative (WMI) (SWRCB and RWQCBs, 1998). The WMI is attempting to achieve the water quality goals in all of California's watersheds by supporting the development of local solutions to local problems with the full participation of all affected parties. Some commitments have already been made by RWQCBs to work collaboratively with local stakeholders to meet specific watershed goals.

The WMI is focused on integrating the water quality activities of the SWRCB, RWQCBs, and the EPA. These include regulatory, monitoring, assessment, planning, standard setting, and nonpoint source activities. The related efforts at other State, local, and federal agencies will also be addressed, as will the need to coordinate with local stakeholders and non-agency initiatives and interests.

Another effort is the California Aquatic Bioassessment Workgroup (CABW) that is focused on coordinating scientific and policy-making efforts toward implementing aquatic bioassessment in California (CABW, 1999).

For the San Francisco Bay and Delta, agencies are developing the Comprehensive Monitoring, Assessment, and Research Program (CMARP) for the San Francisco Bay-Delta system. CMARP is directed at providing new facts and scientific interpretations necessary for CALFED program implementation (CALFED, 1999).

Current Ambient Monitoring Programs and Approaches

A number of ambient water quality monitoring programs are underway that are already collecting information that may influence SWAMP by contributing needed information to the SWRCB and RWQCBs to assess water quality (Table 1).

Most of these monitoring programs are focused on local monitoring, but some programs are directed towards broader questions related to estimating polluted area in some State waters. The majority of monitoring programs are designed to assess potential exposure to chemical and bacterial pollutants. Many assess the impacts of pollutants on biological resources.

Some of the programs have made significant strides in assessing biological impacts using measures of effects. An inventory of enclosed bay, estuary, and coastal monitoring programs was completed in 1998 (http://www.sfei.org/camp).

AB 411 requires the Department of Health Services (DHS), in consultation with local health officers and the public, to establish minimum standards for the sanitation of public beaches. These regulations require: (1) testing of waters adjacent to all public beaches for total coliform, fecal coliform, and enterococci bacteria; (2) standards to be set for total coliform, fecal coliform, the ratio of total coliform to fecal coliform, and enterococci; (3) establishment of sampling protocols; (4) weekly bacterial testing between April 1 and October 31 for any beach visited annually by more than 50,000 people which also has a storm drain outlet that flows in the summer; (5) posting of beaches whenever that beach fails to meet bacteriological standards; and (6) establishment of a telephone hotline by the health officer to inform the public of all beaches currently closed, posted, or otherwise restricted. These requirements are mandatory only during a fiscal year in which the Legislature has appropriated sufficient funds.

Legislative Report on Ambient Monitoring

In February 2000, the SWRCB submitted a report to the Legislature on a plan for implementing comprehensive ambient monitoring (SWRCB, 2000). The report provided the starting point for implementing comprehensive surface and groundwater ambient monitoring programs. It presented background information on ambient monitoring and where it fits into the water quality regulatory programs. Also presented were steps for implementing an ambient monitoring program including the starting point for the policy questions that should direct the monitoring programs, approaches available for collecting the needed information, and the concepts to manage data, quality assurance, and reporting.

AB 982 (Ducheny)

AB 982 (Statutes of 1999) also focused the SWRCB efforts on developing a comprehensive surface water quality monitoring program. Among other things, the bill requires the SWRCB to convene an advisory group or groups to assist in the evaluation of program structure and effectiveness as it relates to the implementation of the requirements of Section 303(d) of the federal Clean Water Act (CWA), applicable federal regulations, and monitoring and assessment programs.

AB 982, in addition, requires the SWRCB, on or before November 30, 2000, to assess and report to the Legislature on the SWRCB's and the Regional Water Quality Control Boards' (RWQCB) current surface water quality monitoring programs for the purpose of designing a proposal for a comprehensive surface water quality monitoring program for the State.

The AB 982 Public Advisory Group (PAG) was established in February 2000. The PAG has met several times to discuss and evaluate the SWRCB's proposals for ambient monitoring. This report reflects most of the PAG's recommendations and advice to the SWRCB on the comprehensive surface water ambient monitoring program proposal.

Statutory References for Ambient Monitoring

Even though ambient monitoring is an important tool used to assess the quality of the State's water resources, ambient monitoring is discussed only briefly in the Water Code. For example, Water Code Section 13177 discusses the need for the California Mussel Watch Program and expresses the importance of the Program in the SWRCB's comprehensive monitoring strategy and how the Program should guide the SWRCB and RWQCBs in protecting water quality.

Section 13181 requires an index of monitoring programs and a comprehensive program to monitor the quality of the State's coastal waters, their resources, and various pollutants with a determination of whether standards are being met, methods of improvement, and recommendations. Section 13392.5 requires the RWQCBs to develop an ongoing monitoring and surveillance program to identify toxic hot spots.

The CWA requires the use and collection of ambient water quality information. Section 305(b) of the CWA requires that states and other jurisdictions receiving CWA grant funding submit a water quality report to USEPA every two years. The 305(b) report (SWRCB, 1999b) contains summary information about water quality conditions in rivers, lakes, estuaries, bays, harbors, wetlands, and coastal waters. States must also identify and prepare a list [Section 303(d) list] of waters that do not meet water quality standards after applying existing required controls (e.g., minimum sewage treatment technology). States are required to prioritize waters/watersheds and target high priority waters/watersheds for Total Maximum Daily Load (TMDL) development.

TABLE 1: TYPES OF SURFACE WATER AMBIENT MONITORING PROGRAMS

Program (Agency)	Site-Specific Monitoring	Regional Monitoring	Effects	Exposure	Reference
State Mussel Watch Program (SWRCB)	●			●	1
Toxic Substances Monitoring Program (SWRCB)	●			●	2
Bay Protection and Toxic Cleanup Program (SWRCB)	●	●	●	●	3
Southern California Bight Projects (SCCWRP)		●	●	●	4
San Francisco Regional Monitoring Program (SFEI)		●	●	●	5
Interagency Ecological Program (IEP)	●		●	●	6
USEPA Environmental Monitoring and Assessment Program (EMAP) (USEPA)		●	●	●	7
Rapid bioassessments (DFG and RWQCBs)	●		●	●	8
Toxicity studies (SWRCB and others)	●		●		9
Coastal Fish Contamination Program (SWRCB)	●			●	10
Citizen monitoring programs (various groups)	●			●	11
Timber Harvest Plans, Non-Industrial Timber Management Plans	●			●	12
Surveys of swimming area water quality (Counties)	●			●	13

1 e.g., Rasmussen, 1996
2 e.g., Rasmussen, 1997
3 e.g., SWRCB, 1998; SWRCB, 1999a; Hunt et al., 1998a; Hunt et al., 1998b; Anderson et al., 1998; Fairey et al., 1996
4 e.g., SCCWRP, 1998a; SCCWRP, 1998b; Schiff and Gossett, 1998; Bergen et al., 1998; Allen et al., 1998; Bay et al., 1998
5 e.g., San Francisco Estuary Institute (SFEI), 1999
6 e.g., IEP, 1999
7 e.g., Western EMAP study, in progress; Anderson et al., 1997
8 e.g., Davis et al., 1996; Harrington, personal communication, November 1999
9 deVlaming et al., 1999
10 Contract with DFG (#9-035-250); contract with OEHHA (#9-038-250)
11 http://www.epa.gov/owow/monitor/dir2.html#california
12 Levine, personal communication, June 2000; California Department of Forestry
13 Data from Counties provided to SWRCB

SECTION III. PROGRAM GOALS

SWAMP is proposed as a new program at the SWRCB and RWQCBs. To ensure that the Program is coordinated and integrated, the monitoring efforts shall be overseen centrally by the SWRCB. The RWQCBs shall establish monitoring priorities for the water bodies within their jurisdictions.

The Surface Water Ambient Monitoring Program (SWAMP) is intended to meet four goals as follows:

1. Identify specific problems preventing the SWRCB, RWQCBs, and the public from realizing beneficial uses in targeted watersheds.

2. Create an ambient monitoring program that addresses all hydrologic units of the State using consistent and objective monitoring, sampling and analysis methods; consistent data quality assurance protocols; and centralized data management.

3. Document ambient water quality conditions in potentially clean and polluted areas.

4. Provide the data to evaluate the effectiveness of water quality regulatory programs in protecting beneficial uses of waters of the State.

Section IV provides a brief overview of SWAMP. Section V provides the general monitoring design for meeting Goal 1. Section VI provides the monitoring design to meet Goals 2 and 3. The last goal will be addressed in the development of the Clean Water Act Section 303(d) list and the CWA Section 305(b) report as well as in the analysis of the performance of the State's water quality program (National Pollutant Discharge Elimination System (NPDES), Chapter 15, and Storm Water Programs).

Each of the SWRCB and RWQCB's existing monitoring programs (e.g., the State Mussel Watch Program, Toxic Substances Monitoring Program, toxicity studies, and fish/shellfish contamination studies) shall be incorporated into SWAMP to ensure a coordinated approach without duplication.

SECTION IV. OVERVIEW OF THE SURFACE WATER AMBIENT MONITORING PROGRAM

SWAMP will implement a comprehensive environmental monitoring program focused on providing the information needed by the SWRCB and RWQCBs to effectively manage the State's water resources. The monitoring efforts implemented by SWAMP will be built around the following factors:

Adaptability

California has a huge diversity of natural resources with a variety of surface water resources. The State's water resources include streams, rivers, lakes, estuaries, coastal lagoons, enclosed bays, wetlands, and coastal waters. The State's monitoring approach will allow adaptation to each of these systems because the scale, dimension, and environmental resources vary so greatly.

Cooperative efforts

Monitoring can be expensive due to the scale of the monitoring efforts and the costs of analysis. The most cost-effective efforts are those that bring together all stakeholders to jointly design and implement the ambient monitoring program. The WMI and SWRCB Strategic Plan emphasize full participation of affected parties. This type of cooperative planning initially helps identify redundant efforts and areas in need of monitoring activity and ultimately reduces costs. Cooperative efforts also help the SWRCB and RWQCBs identify where they can rely on existing information to serve monitoring information needs.

Clear Objectives

Because environmental monitoring can be costly, it is important to clearly define the information most useful to resource agencies and stakeholders to better protect water quality and safeguard resources. Clear monitoring objectives are essential if the ambient monitoring program is to produce meaningful and useful information.

Use of Available Information

Once monitoring objectives are identified, useful information may already be available. All sources of information should be used if it serves the Boards' intended purpose(s) and is of sufficiently high quality. Sources of available information include: compliance monitoring data, regional monitoring efforts already underway, or other monitoring by Federal, State, local agencies, volunteer groups, and University efforts. These types of data should be reviewed before any new monitoring is undertaken. If another organization is performing monitoring that serves the purposes of the RWQCBs then scarce resources can be directed towards other priorities.

Scientifically sound monitoring design

All monitoring programs shall be based on solid, defensible scientific design. Solid scientific information provides a sound basis for changes in water quality programs, policies, and standards set to protect the environment. This will assist in comparing results among programs. To the extent possible, the RWQCBs shall use Statewide templates and protocols in developing and implementing this and other monitoring programs in the Regions. Using the Statewide templates and protocols will allow greater use of other high quality monitoring data collected by citizen monitoring groups, academic institutions, private parties, and government agencies.

Meaningful indicators

The ambient monitoring program shall use the best available condition and response indicators of water quality. These indicators will be scientifically valid and practical, and they will address the needs of the water quality programs. The selected indicators will provide evidence of the quality of biological resources and human uses.

Comparable methods of sampling and analysis

In order for monitoring information to be comparable between monitoring locations and programs, there must be a measure of consistency in the approaches and analytical methods used, as well as stated minimum detection limits, measurement quality requirements, and other strict quality assurance requirements. The data produced will be of definable or equivalent quality so both within and between water body comparisons can be made. All methods will be described, validated, performed competently, and to the extent possible, compared to a reference and be performance-based.

Results evaluation

Monitoring data must be evaluated in order to make meaningful assessments of the status of water quality. Such evaluations are integral in evaluating the effectiveness of water quality programs and assessing whether they need modification. Results evaluation is important for CWA Sections 305(b) reports, CWA Section 303(d) lists of impaired waters, permitting, enforcement, State and local watershed management programs, voluntary pollution prevention and reduction programs, and preservation and restoration programs.

Continual refinement

Monitoring efforts that are driven by clear objectives generate useful information that resource managers need to evaluate the success of their water quality protection efforts. Such information is vital in indicating where resources should be directed to address specific problems, and which policies and programs should be fine tuned. Such refinement of programs and policies makes the monitoring process dynamic and meaningful.

Data Management

Data management is a high priority for the State's monitoring programs. Too often, limited funds are spent collecting information that ultimately will be of little use due to lack of standardized data management. The Program will, to the extent possible, include the use of existing data to the extent it can be verified and placed or linked into centralized locations. Any data that are collected as part of the Program shall be made available to all stakeholders centrally along with accompanying metadata.

Regular reporting

Although monitoring news may not always be good, assessments of water quality and the changes over time provide needed information for decision makers and the public. Monitoring information is essential in setting priorities. Also, monitoring identifies issues and areas that are not a problem. Such information is useful for long-term planning, enabling us to evaluate changing conditions and in gauging future stresses on environmental resources.

Monitoring reports provide the feedback to the SWRCB and RWQCBs on the success of regulatory programs and strategies as well as the success of prevention and cooperative efforts of stakeholders. Additionally, monitoring results are useful for the public to increase public awareness and education on the impacts of their activities on the aquatic environment.

To inform the public, monitoring data and reports will be made available through the SWRCB web site (http://www.swrcb.ca.gov).

SECTION V. STUDY DESIGN: IDENTIFYING SPECIFIC PROBLEMS IN TARGETED WATERSHEDS

The overall goal of this section of SWAMP is to develop site-specific information on sites that are known or suspected to have water quality problems. It is intended that this portion of SWAMP will be implemented at specific locations in each region. This portion of SWAMP is focused on collecting information on locations in water bodies the State suspects should be listed or delisted under CWA Section 303(d).

Monitoring Objectives

In developing the SWAMP monitoring objectives, the SWRCB used a modified version of the model for developing clear monitoring objectives proposed by Bernstein et al. (1993). The model makes explicit the assumptions and/or expectations that are often embedded in less detailed statements of objectives (as presented in SWRCB, 2000). This section is organized by each major question posed in the SWRCB report to the Legislature on comprehensive monitoring (SWRCB, 2000).

Is it safe to swim?

Beneficial Use: Water Contact Recreation

1. At storm drains, publicly owned treatment works, or sites influenced by nonpoint sources of pathogenic contaminants, estimate the concentration of bacteria or pathogens above screening values, health standards or adopted water quality objectives.

Is it safe to drink the water?

Beneficial Use: Municipal and Domestic Water Supply

2. At specific locations in lakes, rivers and streams that are sources of drinking water and suspected to be contaminated, estimate the concentration of microbial and chemical contaminants above screening values, drinking water standards, or adopted water quality objectives used to protect drinking water quality.

3. At specific locations in lakes, rivers and streams that are sources of drinking water and suspected to be contaminated, verify previous estimates of the concentration of microbial and chemical contaminants above screening values,

drinking water standards, or adopted water quality objectives used to protect drinking water quality.

Is it safe to eat fish and other aquatic resources?

Beneficial Uses: Commercial and Sport Fishing, Shellfish Harvesting

4. At specific sites influenced by sources of bacterial contaminants, estimate the concentration of bacterial contaminants above health standards or adopted water quality objectives to protect shellfish harvesting areas.

5. At specific sites influenced by sources of chemical contaminants, estimate the concentration of chemical contaminants in edible aquatic life tissues above advisory levels and critical thresholds of potential human health risk.

6. At frequently fished sites, estimate the concentration of chemical contaminants in commonly consumed fish and shellfish target species above advisory levels and critical thresholds of potential human health risk.[1]

7. At frequently fished sites, verify previous estimates of the concentration of chemical contaminants in commonly consumed fish and shellfish target species above advisory levels and critical thresholds of potential human health risk.[2]

8. Throughout waterbodies (streams, rivers, lakes, nearshore waters, enclosed bays and estuaries), estimate the concentration of chemical contaminants in fish and aquatic resources from year-to-year using several critical threshold values of potential human impact (advisory or action levels).

Are aquatic populations, communities, and habitats protected?

Beneficial Uses: Cold Freshwater Habitat; Estuarine Habitat; Inland Saline Water Habitats; Marine Habitat; Preservation of Biological Habitats; Rare, Threatened or Endangered Species; Warm Freshwater Habitat; Wildlife Habitat

9. At storm drains, publicly owned treatment works, or sites influenced by nonpoint sources of pollutants, identify specific locations of degraded water in rivers, lakes, nearshore waters, enclosed bays or estuaries using several critical threshold values of toxicity, water column or epibenthic community analysis, habitat condition, and chemical concentration.

[1] Adapted from EPA, 1995.
[2] Adapted from EPA, 1995.

10. At storm drains, publicly owned treatment works, or sites influenced by nonpoint sources of pollutants, identify specific locations of degraded fine-grained sediment in rivers, lakes, nearshore waters, enclosed bays or estuaries using several critical threshold values of toxicity, benthic community analysis, habitat condition, and chemical concentration.

11. Identify the areal extent of degraded fine-grained sediment locations in rivers, lakes, nearshore waters, enclosed bays and estuaries using several critical threshold values of toxicity, benthic community analysis, habitat condition, and chemical concentration.

Beneficial Use: Spawning, Reproduction and/or Early Development

12. At storm drains, publicly owned treatment works, or sites influenced by nonpoint sources of pollutants, identify specific locations of degraded water or fine-grained sediment in rivers, lakes, nearshore waters, enclosed bays and estuaries using several critical threshold values of early life-stage toxicity and chemical concentration.

13. At storm drains, publicly owned treatment works, or sites influenced by nonpoint sources of pollutants, verify previous measurements identifying specific locations of degraded water or fine-grained sediment in rivers, lakes, nearshore waters, enclosed bays and estuaries using several critical threshold values of early life-stage toxicity and chemical concentration.

Is water flow sufficient to protect fisheries?

Beneficial Use: Migration of Aquatic Organisms; Rare, Threatened or Endangered Species; Wildlife Habitat

14. At specific sites influenced by pollution, estimate the presence of conditions necessary for the migration of aquatic organisms, such as anadromous fish, using measures of habitat condition including water flow, watercourse geomorphology, sedimentation, temperature, and biological communities.

15. At specific sites influenced by pollution, verify previous estimates of the presence of conditions necessary for the migration of aquatic organisms, such as anadromous fish, using measures of habitat condition including water flow, watercourse geomorphology, sedimentation, temperature, and biological communities.

Sampling Design

The precise sampling design can only be established once funding levels are firmly established and several decisions are made on monitoring objectives, sample site selection, and indicators. While this effort will be coordinated by SWRCB, the region-specific decisions must be made by the RWQCBs. The steps to establish the specific sampling design are:

1. Identify site-specific problem(s) or potential problem(s) to be monitored.

2. Select monitoring objective(s) based on site-specific problem(s).

3. Review available information. The RWQCB shall consider all available information including data reported as part of compliance monitoring programs, State monitoring efforts, other agency monitoring, citizen monitoring efforts, and research efforts.

4. Evaluate the quality and applicability of available information then make determination on the need for new monitoring.

5. Select sites using investigator pre-selection (i.e., point estimates) or a probability-based approach. The approach depends on the RWQCB's needs. If a stratified random sampling approach is used, ensure adequate numbers of samples are selected to represent the stratum with adequate precision (please refer to Section VI for the discussion of the number of samples needed).

   In watersheds, the form and function of hydrogeomorphic characteristics make targeted sampling strategies very appropriate. A study design based on monitoring at sub-watershed drainage points (e.g., a replicated paired watershed design) and on mainstem watercourses above sub-watershed confluences can clearly identify water quality problems. By monitoring numerous watersheds in this way, the variability between watersheds is considered and the results from this study design can be transferred to other watersheds in the Region (D. Paradies, Morro Bay Foundation, personal communication, July 2000).

6. Select appropriate water quality indicators. RWQCBs shall select indicators based on the potential for impacts on specific beneficial uses of the water body. For example, if a suspected problem is related to potential aquatic life impacts near or at stormdrains, the RWQCBs should focus on this specific concern.

Specific study design will be incorporated into contracts or task orders to implement the monitoring program.

Program Management

The following decision matrix shall be used by the SWRCB and RWQCB staff to implement this aspect of SWAMP.

Task	Responsible Organization		
	SWRCB	RWQCBs	Contractors
Develop contract(s) for monitoring services.	●		●
Identify waterbodies or sites of concern		●	
Identify site-specific locations with potential beneficial use impacts.		●	
Decide if concern is related to objectives focused on location or trends of impacts.		●	
Select monitoring objective(s) based on potential beneficial use impact(s).		●	
Identify already-completed monitoring and research efforts focused on potential problem and monitoring objective.		●	●

Task	Responsible Organization		
	SWRCB	RWQCBs	Contractors
Make decision on adequacy of available information.		●	●
Prepare site-specific study design based on monitoring objectives, the assessment of available information, sampling design, and indicators.	●	●	●
Implement study design. (Collect and analyze samples.)			●
Track study progress. Adapt study as needed.	●	●	●
Report data through SWRCB web site.	●		●
Prepare written report of data.	●	●	●

SWAMP will be implemented by and supported by a number of State and local agencies. SWAMP will be coordinated with the Department of Health Services, the Office of Environmental Health Hazard Assessment, the Department of Water Resources, the Department of Fish and Game, and the Department of Pesticide Regulation. In order for SWAMP to be comprehensive and to not overlap existing efforts it is necessary to involve Federal, other State, and local agencies in the implementation of SWAMP. The SWRCB, RWQCB and other agencies involvement in SWAMP will be coordinated through a staff-level task force.

SECTION VI. STUDY DESIGN: DOCUMENTING AMBIENT WATER QUALITY CONDITIONS IN POTENTIALLY CLEAN AND POLLUTED AREAS

The overall goal of this section of SWAMP is to develop a Statewide picture of the status and trends of the quality of California's water resources. It is intended that this portion of SWAMP will be implemented in each hydrologic unit of the State at least one time every five years. This portion of SWAMP is focused on collecting information on water bodies for which the State presently has little information and to determine the effects of diffuse sources of pollution.

Need for Regional Monitoring

Monitoring is needed that defines the larger scale condition of beneficial uses. This regional monitoring can determine if known local impacts can be observed over large distances and allows the assessment of Regionwide or Statewide water resource conditions. The SWRCB and RWQCBs have a need to clearly determine the effectiveness of the State's water quality program.

The California Legislature is also very interested in establishing a closer link between budgeted water quality program activities and the impact those activities have on protecting and improving water quality. In 1999, the Legislature's Supplemental Report Language to the Budget Act directed the SWRCB to "…develop performance measures for its core regulatory programs….that relate directly to water quality outcomes…." While the SWRCB and RWQCBs have established performance measures to manage many activities, the ability to directly relate the performance of its programs to water quality outcomes has been hampered by limited data management capabilities and fragmented and incomplete water quality monitoring data.

Since 1995, the SWRCB has used several performance objectives and measures for its programs. The measures are generally output related and designed to measure program efficiency and timeliness (e.g., percent of total inspections completed versus the number of sites with Waste Discharge Requirements (WDRs), number of Cleanup and Abatement Orders (CAO's); median time required to issue new NPDES permits and WDRs, etc.).

Regional monitoring will provide the SWRCB and RWQCBs with a better picture of the water quality outcomes of its programs. The information needed to assess performance (and support CWA Section 305(b)) reporting focuses of the area or percentages of the area of State water resources that are impacted and not impacted.

Monitoring Objectives

In developing the SWAMP monitoring objectives, the SWRCB used a modified version of the model for developing clear monitoring objectives proposed by

Bernstein et al. (1993). The model makes explicit the assumptions and/or expectations that are often embedded in less detailed statements of objectives (as presented in SWRCB, 2000). This section is organized by each major question posed in the SWRCB Report to the Legislature on comprehensive monitoring (SWRCB, 2000).

Is it safe to swim?

Beneficial Use: Water Contact Recreation

1. Throughout waterbodies that are used for swimming, estimate the concentration of pathogenic contaminants above screening values, health standards or adopted water quality objectives after the influence of storms has passed.

2. Estimate the percent of beach area that pose potential health risks of exposure to pathogens in streams, rivers, lakes, nearshore waters, enclosed bays and estuaries using several critical threshold values of potential human impact (pathogen indicators).

3. Throughout waterbodies that are used for swimming, estimate the concentration of bacterial contaminants from month-to-month above screening values, health standards or adopted water quality objectives.

Is it safe to drink the water?

Beneficial Use: Municipal and Domestic Water Supply

4. Throughout waterbodies, estimate the area of lakes, rivers and streams that are sources of drinking water where the concentration of microbial or chemical contaminants are above screening values, drinking water standards or adopted water quality objectives used to protect drinking water quality.

5. Throughout waterbodies that are used as a source of drinking water, estimate the concentration of microbial or chemical contaminants from month-to-month above screening values, drinking water standards, or adopted water quality objectives used to protect drinking water quality.

Is it safe to eat fish and other aquatic resources?

Beneficial Uses: Commercial and Sport Fishing, Shellfish Harvesting

6. Estimate the area of streams, rivers, lakes, nearshore waters, enclosed bays and estuaries where the concentration of chemical contaminants in edible fish or shellfish tissue exceeds several critical threshold values of potential human impact (screening values or action levels).

7. Assess the geographic extent of chemical contaminants in selected size classes of commonly consumed target species that exceed several critical threshold values of potential human impact (screening values or action levels).[1]

8. Throughout waterbodies (streams, rivers, lakes, nearshore waters, enclosed bays and estuaries), estimate the concentration of chemical contaminants in fish and aquatic resources from year-to-year using several critical threshold values of potential human impact (advisory or action levels).

9. Throughout waterbodies that are used for shellfish harvesting, estimate the concentration of bacterial contaminants from month-to-month above health standards or adopted water quality objectives.

10. Throughout waterbodies that are used for shellfish harvesting, estimate the concentration of bacterial contaminants above health standards or adopted water quality objectives after the influence of storms has passed.

Are aquatic populations, communities, and habitats protected?

Beneficial Uses: Cold Freshwater Habitat; Estuarine Habitat; Inland Saline Water Habitats; Marine Habitat; Preservation of Biological Habitats; Rare, Threatened or Endangered Species; Warm Freshwater Habitat; Wildlife Habitat

11. Estimate the percent of water area in lakes, nearshore waters, enclosed bays and estuaries using several critical threshold values of toxicity, water or epibenthic community analysis, habitat condition, and chemical concentration.

12. Estimate the percent of degraded fine-grained sediment area in rivers, lakes, nearshore waters, enclosed bays and estuaries using several critical threshold values of toxicity, benthic community analysis, habitat condition, and chemical concentration.

13. Identify the areal extent of degraded fine-grained sediment locations in rivers, lakes, nearshore waters, enclosed bays and estuaries using several critical threshold values of toxicity, benthic community analysis, habitat condition, and chemical concentration.

14. Estimate the percent of degraded fine-grained sediment area from year-to-year in rivers, lakes, nearshore waters, enclosed bays and estuaries using several critical threshold values of toxicity, benthic community analysis, habitat condition, and chemical concentration.

[1] Adapted from EPA, 1995.

15. Estimate the percent of degraded water area from year-to-year in rivers, lakes, nearshore waters, enclosed bays and estuaries using several critical threshold values of toxicity, water column or epibenthic community analysis, habitat condition, and chemical concentration.

Beneficial Use: Spawning, Reproduction and/or Early Development

16. Estimate the degraded area of water or sediment toxicity associated with toxic pollutants in rivers, lakes, nearshore waters, enclosed bays and estuaries using critical threshold values of early life-stage toxicity and chemical concentration.

17. Estimate the degraded area of water or sediment toxicity associated with toxic pollutants from year-to-year using critical threshold values of early life-stage toxicity and chemical concentration.

Is water flow sufficient to protect fisheries?

Beneficial Use: Migration of Aquatic Organisms; Rare, Threatened or Endangered Species; Wildlife Habitat

18. Throughout waterbodies, estimate the area with the conditions necessary for the migration of aquatic organisms, such as anadromous fish, using measures of habitat condition including water flow, watercourse geomorphology, sedimentation, temperature, and biological communities.

19. Throughout waterbodies, estimate the area with the conditions from month-to-month necessary for the migration of aquatic organisms, such as anadromous fish, using measures of habitat condition including water flow, watercourse geomorphology, sedimentation, temperature, and biological communities.

Sampling Design

The precise sampling design can only be established once funding levels are firmly established and several decisions are made on monitoring objectives, sample site selection, and indicators. While this effort will be coordinated by the SWRCB, the region-specific decisions must be made by the RWQCBs. The steps to establish the specific sampling design are:

1. Identify hydrologic units to be monitored.

2. Identify specific water bodies to sample or select the water body population to sample.

3. Select monitoring objective(s) based on applicable beneficial uses of the waterbodies selected. Applicable beneficial uses are uses that are listed in the RWQCB's basin plan or potential beneficial uses for the water body and are included in the scope of SWAMP.

4. Review available information. The RWQCB shall compile all available information including data reports as part of compliance monitoring programs, State monitoring efforts, other agency monitoring, citizen monitoring efforts, or research efforts.

5. Evaluate quality and applicability of available information then make a determination on the need for new monitoring.

6. Select sites using probability-based approach. The approach may be either random or stratified random approach (strata can correspond to a subpopulation of interest) with a mechanism for systematically separating samples (e.g., Stevens, 1997; SCCWRP, 1998). For example, RWQCBs may wish to stratify based on urbanization or discharge location. If a stratified random sampling approach is used, ensure adequate numbers of samples are selected to represent the stratum with adequate precision. Thirty sites should be allocated to each stratum to provide a 90 percent confidence interval of no larger than roughly ±10 percent of the area in the subpopulation (this assumes a binomial probability distribution and p=0.2). Fewer or more sites may be allocated if smaller or larger confidence intervals are needed.

7. If a probability-based approach is not used, the RWQCB in coordination with the SWRCB shall (1) provide an explanation of the representativeness of the samples, (2) demonstrate how the approach can be compared to information collected using probability-based approaches, and (3) provide a description of the sampling strategy.

8. Select necessary water quality indicators. RWQCBs shall select indicators based on the beneficial uses of the water body. For example, if a water body is not a source of drinking water it is not necessary to implement monitoring focused on drinking water. RWQCBs may select alternative indicators if they meet the selection criteria (presented in Section VII).

Specific study design will be incorporated into contracts or task orders to implement the monitoring program.

Program Management

The following decision matrix shall be used by the SWRCB and RWQCB staff to implement this portion of SWAMP.

Task	Responsible Organization		
	SWRCB	RWQCBs	Contractors
Develop contract(s) for monitoring services.	●		●
Identify waterbodies to be monitored.		●	
Select regional monitoring objective(s) based on beneficial uses of waterbody.		●	
Make decision on adequacy of available information.		●	●
Prepare specific study design based on monitoring objectives, the assessment of available information, sampling design, and indicators.	●	●	●
Implement study design. (Collect and analyze samples.)		●	●
Track study progress. Adapt study as needed.	●	●	●
Report data through SWRCB web site.	●		●
Prepare written report of data.	●	●	●

SWAMP will be implemented by and supported by a number of State and local agencies. In order for SWAMP to be comprehensive and to not overlap existing efforts it is necessary to involve Federal, other State, and local agencies in the implementation of SWAMP. SWAMP will be coordinated with the Department of Health Services, the Office of Environmental Health Hazard Assessment, the Department of Water Resources, the Department of Fish and Game, and the Department of Pesticide Regulation. Agency involvement in the implementation of SWAMP will include: (1) Performing the monitoring, (2) Coordinating the studies, and (3) Improving data sharing capabilities. The SWRCB, RWQCB and other agencies involvement in SWAMP will be coordinated through a staff-level task force.

SECTION VII. WATER QUALITY INDICATORS

One of the most important steps in the development of an ambient monitoring program is the selection and use of indicators of water quality (ITFM, 1995). Indicators are the tools used to assess and measure water quality. This section describes the characteristics of indicators, provides supporting rationale for their use, and lists some of the indicators that will be used in SWAMP. The indicators in this section are intended for common use with the monitoring efforts described in Sections V and VI.

What is an indicator?

An indicator is a "... measurable feature or features that provide managerially and scientifically useful evidence of environmental and ecosystem quality or reliable evidence of trends in quality." Indicators must be measurable with available technology, scientifically valid for assessing or documenting ecosystem quality, and useful for providing information for management decision making. Environmental indicators include tools for assessment of chemical, physical, and biological conditions and processes.

Selection of Appropriate Indicators

One of the hardest tasks for development of an ambient monitoring program is the selection of meaningful indicators of water quality. General criteria are needed to help shape the monitoring efforts so the results are useful in the decision making process. The use of criteria streamlines the indicator selection process, potentially reduces costs, prevents the use of indicators that will not allow program effectiveness to be assessed, and provides consistency.

Scientific validity is the foundation for determining whether data can be compared with reference conditions or other sites. An indicator must not only be scientifically valid, but its application must be practical (that is, not too costly or too technically complex) when placed within the constraints of a monitoring program. Of primary importance is that the indicator must be able to address the questions posed by the ambient monitoring program.

Scientific Validity

Table 2 lists several considerations for assessing the scientific validity of indicators. Measurements of environmental indicators should produce data that allow comparisons on temporal and spatial levels. This is particularly important for comparisons with the reference conditions. Indicators should be sensitive and provide resolution sufficient to detect important environmental change and to indicate the presence of a problem. The indicator methodology should be reproducible and provide the same level of sensitivity regardless of geographic location.

Practical Considerations

The success of a monitoring program is dependent on the ability to collect consistent data. The practical considerations include monitoring costs, availability of experienced personnel, and the practical application of the technology.

A cost-effective procedure should supply a large amount of information in comparison to cost and effort. It is significant to acknowledge that not every quantitative characteristic needs to be measured unless it is required to answer specific questions. Cost effectiveness may be dependent on the availability of experienced personnel and the ability to find or detect the indicating parameters at all locations.

Water Quality Programmatic Considerations

Stated objectives of a monitoring program are an important factor in selecting indicators. Sampling and analysis programs should be structured around questions to be addressed. The term "programmatic considerations" simply means that the program should be evaluated to confirm that the original objectives will be met once the data have come together. If the design and the data being produced by a monitoring program do not meet the original objective(s) within the context of scientific validity and resource availability, then the selected indicators should be reevaluated.

Another important consideration is the ease with which the information obtained can be communicated to the public. Although it is essential to present information for the SWRCB and RWQCBs, scientists, or other specialized audiences, information for the general public needs to be responsive to public interests.

TABLE 2: ENVIRONMENTAL INDICATOR SELECTION CRITERIA (ITFM, 1995).

Criteria	Definition(s)
Scientific validity (technical consideration)	
Measurable/quantitative	Feature of water quality measurable over time; has defined numerical scale and can be quantified simply.
Sensitivity	Responds to broad range of conditions or perturbations within an appropriate time frame and geographic scale; sensitive to potential impacts being evaluated.
Resolution/discriminatory power	Ability to discriminate meaningful differences in environmental condition with a high degree of resolution.
Integrates effects/exposure	Integrates effects or exposure over time and space.
Validity/accuracy	Parameter is true measure of some environmental conditions within constraints of existing science. Related or linked unambiguously to an endpoint in an assessment process.
Reproducible	Reproducible within defined and acceptable limits for data collection over time and space.
Representative	Changes in parameter/species indicate trends in other parameters they are selected to represent.
Scope/applicability	Responds to changes on a geographic and temporal scale appropriate to the goal or issue.
Reference value	Has reference condition or benchmark against which to measure progress.
Data comparability	Can be compared to existing data sets/past conditions.
Anticipatory	Provides an early warning of changes.
Practical considerations	
Cost/cost effective	Information is available or can be obtained with reasonable cost/effort. High information return per cost.
Level of difficulty	Ability to obtain expertise to monitor. Ability to find, identify, and interpret chemical parameters, biological species, or habitat parameters. Easily detected. Generally accepted method available. Sampling produces minimal environmental impact.
Water quality programmatic considerations	
Relevance	Relevant to desired goal, issue, or SWRCB/RWQCB mission; for example, fish fillets for consumption advisories; species of recreational or commercial value.
Program coverage	Program uses suite of indicators that encompass major components of the ecosystem over the range of environmental conditions that can be expected.
Understandable	Indicator is or can be transformed into a format that target audience can understand; for example, nontechnical for public.

List of Indicators

Monitoring programs sponsored by the SWRCB and the RWQCBs have used a variety of environmental indicators. Indicators that have been used in ambient monitoring efforts and meet the requirements of the general criteria are presented in Table 3.

These indicators should be viewed as a starting point for the types of indicators that should be used in the State's ambient monitoring efforts.

TABLE 3: LIST OF INDICATORS FOR SITE-SPECIFIC PROBLEM AND REGIONAL MONITORING

Beneficial Use	Monitoring Objectives		Category	Indicator
	Section VI (Regional)[1]	Section V (Site-Specific Problems)[2]		
Water Contact	1, 2, and 3	1	Contaminant exposure	Total coliform bacteria Fecal coliform bacteria Enterococcus bacteria Enteric viruses
Drinking Water	4 and 5	2 and 3	Contaminant exposure	Inorganic water Chemistry Nutrients Organic water chemistry Total coliform bacteria Cryptosporidum Giardia
Fish and Shellfish Contamin-ation	6, 7, 8, 9 and 10	4, 5, 6, 7, and 8	Contaminant exposure	Fish tissue chemistry Shellfish tissue Chemistry Coliform bacteria in Shellfish

[1] Numbers in this column refer back to the monitoring objectives posed on pages 18-20.
[2] Numbers in this column refer back to the monitoring objectives posed on pages 11-13.

Beneficial Use	Monitoring Objectives		Category	Indicator
	Section VI (Regional)[1]	Section V (Site-Specific Problems)[2]		
Aquatic Life	11, 12, 13, 14, 15, 16, and 17	9, 10, 11, 12, and 13	Biological response	Benthic infauna (Animals that live in sediment.) Fish assemblage Fish pathology Interstitial water toxicity Macroinvertebrate Assemblage Periphyton Sediment toxicity Water toxicity
			Pollutant exposure	Acid volatile sulfides Debris Interstitial water metal Chemistry Reporter Gene System (RGS 450) Organic and inorganic sediment chemistry Shellfish or fish tissue chemistry Nutrients Inorganic and organic Water chemistry
			Habitat	Dissolved oxygen Sediment grain size Sediment organic carbon Water flow Water temperature Channel morphology Wetland vegetation Riparian vegetation
Sufficient Flow	18 and 19	14 and 15	Habitat	Water flow Suspended solids Channel morphology Water temperature
			Biological response	Fish assemblage Macroinvertebrate Assemblage Periphyton Wetland habitat Riparian habitat

Adapted from: SWRCB, 1993; SPARC, 1997; SCCWRP, 1998; Stephenson et al., 1994; CalEPA, 1998; CABW, 1998; CDFG, 1998; Noble et al., 1999.

SECTION VIII. QUALITY ASSURANCE

Quality assurance shall be a central feature of SWAMP. To be of the most use to the SWRCB and RWQCB programs, it is essential that data of the highest quality be developed. This section describes the general quality assurance approach, the need for quality assurance project plan, and lists measurement quality requirements.

Quality Assurance (QA) includes activities to ensure that data collected are of adequate quality given the monitoring objectives. QA consists of two separate but interrelated activities. Quality Control (QC) activities include standardized sampling collection and processing protocols and requirements for technician training. Quality assessment activities are usually implemented to quantify the quality control procedures.

Quality Control

QC refers to the technical activities employed to ensure that the data collected are adequate given the monitoring objectives and the specific hypotheses to be tested. The purpose of quality control is to control errors that tend to occur in the field, laboratory, or office. This is accomplished by establishing procedures to ensure that sampling, processing, and analysis techniques are applied consistently and correctly. This makes certain that the number of lost, damaged, and uncollected samples are recorded and that the integrity of the data record is maintained and documented from sample collection to entry into the data record. In this way, data collected can be comparable with similar data collected elsewhere; and the study results can be reproduced.

QC activities will include both internal and external checks. Internal checks will be a combination of internal test samples, repeated measurements, and standard reference materials. External checks will include evaluation of reproducibility and comparability of tests using interlaboratory comparisons.

Quality Assessment

Quality assessment activities are implemented to quantify the effectiveness of the quality control procedures. These activities ensure that measurement error is estimated and accounted for and that bias associated with the monitoring program can be identified. Quality assessment consists of both internal and external checks, including repetitive measurements, internal test samples, interchange of technicians and equipment, use of independent methods to verify findings, exchange of samples among labs, use of standard reference materials, and audits.

An effective QA system must begin at the onset of the monitoring program planning process and must continue to be an integral component throughout from program implementation to information dissemination. In this way, the level of uncertainty associated with obtaining the required information can be balanced

against the cost of obtaining the data. The activities of converting resulting data into useful information and the feedback loops designed to help refine monitoring objectives and approaches must also be taken into account in designing the QA program.

Quality Assurance Project Plan

A Quality Assurance Project Plan (QAPP) will be developed for SWAMP as a first step in implementing the Program. The QAPP will contain descriptions of laboratory and field operations; sampling collection and processing methods; chemical, toxicological, and biological analysis procedures; laboratory data management; measurement quality requirements (including descriptions of representativeness, completeness, comparability, accuracy, and precision); and quality assurance reporting requirements.

Representativeness

This data quality attribute addresses two fundamental concerns: (1) all samples taken and analyzed are representative of the waterbody or site of interest and (2) the data obtained are an accurate reflection of the sample collected and analyzed. The data quality attribute of "representativeness" applies not only to the overall sampling design, but also to individual measurements and samples obtained as part of the SWAMP.

The concern of sample representativeness for biological, chemical, and field methods is extremely complex that involves sampling/reference-site selection, sampling device(s), sampling methods, field subsampling/processing, and sample preservation/transport/storage, microbial procedures, chemical analytical methods, method detection limits, toxicological procedures, holding times, biological community sorting/identification, and data entry, management, and analysis.

These requirements will be described in the QAPP.

Completeness

Completeness is defined as "a measure of the amount of data collected from a measurement process compared to the amount that was expected to be obtained under the conditions of measurement" (Stanley and Verner, 1985). The completeness goal is 90 percent for the various indicators that will be measured. Failure to achieve this goal usually results from lost or destroyed samples. The QAPP will establish protocols for tracking samples during shipment and laboratory processing to minimize data loss following successful sample collection.

Comparability

Comparability is defined as "the confidence with which one data set can be compared to another" (Stanley and Verner, 1985). Comparability of reporting units and calculations, data base management processes, and interpretation will be

stated in the QAPP. Both field and laboratory methods will be described in full detail in field and analytical manuals and made available to the field personnel and analytical laboratories. In addition, the comparability of laboratory measurements will be monitored through interlaboratory comparison exercises. The results of comparability analysis will be report with other quality assurance metadata. Failure to achieve this comparability goal will result in corrective actions that may include, changes in field and laboratory methods or quality assurance requirements.

Accuracy and Precision

Accuracy or certainty is the difference between a measured value and the true or expected value. Measurement accuracy is determined by comparing a sample to a known value for a standard reference material. Some important measures of animal response or impact may not have true standard references (e.g., toxicity tests).

To the extent that methods are available, the monitoring will employ quantitative measures that are compared to standard reference materials, reference collections, or other references.

Precision is the degree of agreement among repeated measurements of the same characteristic. To the extent possible the monitoring efforts shall use high precision, quantitative measurements with written procedures and with quantified measures of precision (replicated measurements within a test, stated measurement quality requirements), professional personnel (or professional oversight), controlled laboratory conditions and controlled measurements in the field.

Collectively, accuracy and precision can provide an estimate of the total error or uncertainty associated with an individual measured value. Measurement quality requirements for the various indicators are expressed separately as accuracy and precision requirements in Table 4. Accuracy and precision requirements may not be definable for all parameters due to the nature of the measurement type. For example, accuracy measurements are not possible for toxicity testing because "true" or expected values do not exist for these measurement parameters (Table 4). In order to evaluate the measurement quality requirements for accuracy and precision, various QC samples will be collected and analyzed for most data collection activities.

TABLE 4: SWAMP MEASUREMENT QUALITY REQUIREMENTS

Indicator	Accuracy Requirement[1]	Precision Requirement[2]	Completeness Goal[3]
Pathogens			
Total Coliform	NA[4]	2 SD[5]	90%
Fecal Coliform	NA	2 SD	90%
Enterococcus	NA	2 SD	90%
Giardia	NA	16%	90%
Cryptosporidium	NA	19%	90%
Enteric viruses	NA	NA	90%
Toxicity			
Water	NA	2 SD[6]	90%
Sediment	NA	2 SD	90%
Interstitial water	NA	2 SD	90%
Benthos			
Sample collection	NA	NA	90%
Sorting	10%	NA	90%
Counting	10%	NA	90%
Identification	10%	NA	90%
Sediment grain size	NA	20%	90%
Total organic carbon	15%	20%	90%
Mineralogy	NA	10%	90%
Fish assemblages			
Sample collection	NA	NA	90%
Counting	10%	NA	90%
Identification	5%	NA	90%
Length (fish)	10%	10%	90%
Biomass	NA	10%	90%
Gross pathology	NA	NA	90%
Tissue chemistry			
Organics	30%	30%	90%
Metals	20%	30%	90%

[1] Accuracy requirements are expressed as either maximum allowable percent deviation (%) or absolute difference (± value) for the "true" value.
[2] Precision requirements are expressed as maximum allowable relative percent difference or relative percent standard deviation between two or more replicate measurements.
[3] Completeness goals are the percentage of expected results to be obtained successfully.
[4] Not Applicable.
[5] Repeated analysis of bacterial indicators within two standard deviations (SD) of the average value for the laboratory.
[6] For toxicity tests, reference toxicant endpoint is within two standard deviations of the average value for the laboratory.

Indicator	Accuracy Requirement[1]	Precision Requirement[2]	Completeness Goal[3]
Sediment chemistry			
Organics	30%	30%	90%
Metals	20%	30%	90%
Water Chemistry			
Organics	30%	30%	90%
Metals	20%	30%	90%
Dissolved oxygen	±0.5 mg/L	10%	90%
Salinity	±1.0 ppt	10%	90%
"pH"	±0.2 units	NA	90%
Temperature	±0.5°C	NA	90%
Nutrients	10%	5%	90%
Total suspended solids	NA	10%	90%

Adapted from Noble et al., 1999; Leecaster, personal communication; SCCWRP, 1999; Stephenson et al., 1994; Valente and Strobel, 1993; Lowe et al., 1999; and EPA, 1999a.

SECTION IX. DATA MANAGEMENT, DATA EVALUATION, AND REPORTING

Data management, data evaluation, and reporting are high priorities for SWAMP. Too often, limited funds are spent collecting information that ultimately will be of little use due to lack of standardized data management, evaluation, and reporting. SWAMP will, to the extent possible, include the use of existing data to the extent it can be verified and placed or linked into centralized locations. Any data that are collected as part of the Program shall be made available to all stakeholders centrally along with accompanying metadata.

This section of the proposal is focused on the management of information produced by SWAMP and the use of additional information to support the monitoring efforts, a proposal to develop data evaluation tools, and the types of reports that will be produced.

Data Management

Background

With the advent of the World Wide Web, it is now possible to share information easily among interested scientists, regulators, dischargers, and the public. It is not necessary to centralize data; but rather, it is now possible to establish links to databases available on the Internet. For example, the California Environmental Resources Evaluation System (CERES) is an information system developed by the California Resources Agency to facilitate access to a variety of electronic data describing California's rich and diverse environments (its Internet address is: http://www.ceres.ca.gov).

Another source of information is the Statewide Coastal Monitoring Inventory (http://www.sfei.org/camp). The purpose of the web site is to provide information about California's Coastal Water Quality Monitoring Programs. Information available includes:

- Listings of the major water quality monitoring programs along the California coast and its bays.
- Details about each program including the types of water quality measurements made, frequency of measurement, and quality assurance information.
- Provisions for searches of the inventory for specific information.
- Contact information including World Wide Web links to programs that have web sites and/or actual databases, where available.

The Central Coast RWQCB has established the Central Coast Ambient Monitoring Program (http://www.ccamp.org) that has a mission to collect, assess, and disseminate scientifically-based water quality information to aid decision makers and the public in maintaining, restoring, and enhancing water quality and

associated beneficial uses. One of the stated objectives is to ensure that data and information is made accessible to users in the most effective ways.

Laboratory

Each laboratory involved in SWAMP will coordinate data management so that the Program will consistently:

- Document sampling activities and methods
- Document sample tracking and shipments
- Process and organize field, laboratory, and QC data
- Perform range checks on selected numerical data
- Facilitate data entry, data dissemination, and archiving of data

Each of these factors will be presented in the QAPP in order to (1) correct or remove erroneous individual values, and (2) correct or remove inconsistencies that may damage the integrity of the database.

System for Water Information Management

Once all laboratory checks are completed, all information collected by SWAMP will be coordinated with and included in the System for Water Information Management (SWIM). The SWRCB and RWQCBs have a compelling need to improve our data management capabilities. The SWRCB has submitted for approval a Feasibility Study Report for Phase II of SWIM to enhance its data management system. This new system will have two components: a program information/reporting system and a Geographic Information System (GIS). The program information and reporting component will include data on core regulatory programs, all known potential and actual discharge sites, water quality, ambient monitoring programs, electronic self monitoring reports for enhanced enforcement and compliance, and an interface to water rights data. The GIS component will provide data analysis for the SWRCB's watershed management efforts. Approximately $3.6 million is needed to initiate this task. The total cost for SWIM Phase II is approximately $13.2 million over Fiscal Years 2001-02 to 2004-05.

The SWAMP data management activities will provide easy access to the collected data and related information. The variety of reports and analyses generated by a monitoring program will be made available on the SWRCB web site. The new data generated will be stored in SWIM and available on the SWRCB web site; other information will be accessed through links to other data management systems.

Data Evaluation

Monitoring data must be evaluated in order to make meaningful assessments of the status of the environment. Such evaluations are integral in evaluating the status of the environment at the time of the study, as well as in evaluating environmental change over time. Conclusions based on a full analysis of

monitoring data enable resource managers to assess the condition of the environment, answer whether the monitoring objectives were achieved, and ultimately evaluate the success of existing water quality programs and policies.

For the SWAMP monitoring data to meaningfully influence the SWRCB and RWQCB decision making, it is necessary that the data collected be evaluated. The evaluation is especially important in determining whether sites or waterbodies should be listed on the CWA Section 303(d) list. This section of the proposal presents the SWRCB's approach for developing a consistent set of data evaluation criteria. These criteria shall be focused on primarily listing and delisting sites or waterbodies but will be useful for evaluating all the monitoring information collected.

Background

In 1997, an ad hoc workgroup of staff from the RWQCBs, SWRCB, and the U.S. Environmental Protection Agency developed informal guidelines that focused on CWA Section 303(d) listing/delisting factors, scheduling and priority setting, public notice procedures, and the Section 303(d) list submittal package. EPA found that these informal guidelines were consistent with federal law, regulations and guidance related to CWA Section 303(d).

Based in large part on the informal guidelines, the California CWA Section 303(d) list has 509 water bodies listed (SWRCB, 1999b).

Comments from a variety of sources have been critical of the guidelines and listing process. There have been suggestions to revise the guidelines substantially. Major revisions that have been suggested include: interpretation of narrative water quality objectives, representativeness of samples of up and down stream conditions, data quality requirements, minimum data needed to support listing decisions, and priority setting.

Approach

To begin to resolve some of these issues, the SWRCB will adopt a policy outlining the listing and delisting criteria for establishing the CWA Section 303(d) list, the criteria for assigning priority on Section 303(d)-listed waterbodies, public notice procedures, and other pertinent factors. This policy will allow for the consistent development of the Regional and Statewide Section 303(d) lists.

The SWRCB will develop one document as formal guidance on the development of the CWA Section 303(d) list and ranking. This document will be a Water Quality Control Policy (California Water Code Section 13140, 13142) that contains a specific listing and delisting criteria, criteria to assist the SWRCB and the RWQCBs in establishing priorities for developing total maximum daily loads (TMDLs), and other measures necessary to facilitate the completion of TMDLs. The Policy will be accompanied by a functional equivalent document (FED) to facilitate California Environmental Quality Act (CEQA) and Office of

Administrative Law (OAL) compliance and to provide technical justification to withstand peer review (as required by the Health and Safety Code).

For adoption of the Policy, the SWRCB will use the procedures for adopting and revising Water Quality Control Plans.

Reporting

A variety of reports shall be developed to support SWAMP. To the extent possible, most of the reports shall be made available to the public in paper and electronic form. The types of reports that will be produced include:

1. Periodic management reports. These reports will focus on the status of the implementation of the monitoring efforts including progress on sampling, chemical and biological analysis, and data/interpretative report preparation.

2. Field sampling reports. These reports will document: date and time of sampling, personnel, location of station, station description, type of grab used, field observations, station depth, number of grabs necessary and amount sampled, visual characteristics, water temperature, and other necessary parameters.

3. Data reports. These reports will include all data generated for each task, a written description of any deviations from the stated testing procedures, and a written description detailing QA criteria and the degree to which each is met or compromised. The data reports will be completed in both electronic and paper copies.

4. Quality Assurance Reports. These reports will summarize the measurement error estimates for the various data types using the QA sample data. The precision, accuracy (as appropriate), completeness, and representativeness of the data will be addressed in this document. QA reports will also accompany each major sampling event and will address QA concerns relevant to data collected during the sampling event.

5. Interpretative Reports. These reports will provide an analysis and interpretation of the data collected. The reports will have written descriptions of the study design, methods used, graphical, statistical, and textual descriptions of the data, interpretation of the data including comparisons to any evaluation criteria provided by the SWRCB or RWQCBs.

SECTION X. COSTS

As a part of the comprehensive surface water proposal, the SWRCB is required to estimate the costs of implementing the program. This section presents the estimated cost of implementing the various types of monitoring that the RWQCBs may perform. This section provides descriptions of the approach used to estimate costs, the assumptions made, and the costs to implement the monitoring efforts.

Approach

Total costs for ambient monitoring depends on a variety of factors including: parameters measured, tests performed, sampling strategy, data management, interpretation of data, and program management. The cost estimates for SWAMP are presented by contract resources needed per type of study.

The estimated costs for each type of study is presented in Table 5.

Assumptions

1. The costs presented in Table 5 are estimated from previous contracts or informal discussions and may not represent costs that would be negotiated with potential contractors.

2. Each RWQCB shall have a designated monitoring staff person.

3. Contracts are implemented through a master contract (i.e., a prime contractor/subcontractor arrangement).

4. Implementation of monitoring objectives from Section VI shall require at least 30 samples per stratum.

5. Implementation of monitoring objectives in Section V shall require at least 10 samples per site or location.

Baseline Budget (FY 1999-00)

The baseline budget for surface water quality monitoring activities is approximately $2.3 million. These resources are split as follows: 8.9 personnel years (PYs) and $1.4 million in contracts.

Proposed Budget (FY 2000-01)

The SWRCB and the Department of Pesticide Regulation have proposed a Budget Change Proposal titled the Water Quality Initiative that requests a budget augmentation of $9,742,000 and 37.9 PYs. Of this amount, 10 PYs and $3.6 million have been allocated for ambient surface water quality monitoring for the SWRCB and RWQCBs.

Future Needs and Funding Source(s)

To be completed.

TABLE 5: ESTIMATED COSTS FOR SAMPLING, ANALYSIS, AND REPORTING AMBIENT MONITORING DATA.

Sample Type	Estimated Costs Per Sample		Water Contact	Drinking Water	Shellfish coliform	Tissue Fish-Shellfish	FW Ambient	Marine Ambient	Flow (Initial)	Flow (2nd yr +)
	Low	High[1]	30 samples	30 samples	30 samples	30 samples	30 samples	30 samples	10 stations	10 stations
Total/fecal coliform bacteria	$40	$60	$1,800	$1800						
Enterococcus bacteria	$25	$45	$1,350							
Cryptosporidum Giardia	$300	$450		$13,500						
Coliform in shellfish	$45	$65			$1,950					
Water column chemistry[2]	$700	$2,200		$66,000			$66,000			
Tissue chemistry		$2,000				$60,000				
Sediment chemistry		$2,200					$66,000	$66,000		
Freshwater benthos		$900					$27,000			
Other benthos		$1,700						$51,000		
Fish bioassessment		$600								
Fish pathology										
Freshwater habitat		$600					$18,000			
Other habitat		$500						$15,000		
Toxicity tests-freshwater		$300					$9,000			

Sample Type	Estimated Costs Per Sample		Water Contact	Drinking Water	Shellfish coliform	Tissue Fish-Shellfish	FW Ambient	Marine Ambient	Flow (Initial)	Flow (2nd yr +)
	Low	High[1]	30 samples	30 samples	30 samples	30 samples	30 samples	30 samples	10 stations	10 stations
Toxicity tests-other water		$450								
Sediment toxicity		$1,000						$30,000		
Pore water toxicity		$560						$16,800		
Flow gauges installation		$30,000							$300,000	$0
Flow gauges operation		$15,000							$150,000	$150,000
Sampling	$150	$1,500	$4,500	$45,000	$45,000	$45,000	$45,000	$45,000	$0	$0
Reporting	$15,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000
Estimated Study Cost			$65,650	$166,300	$86,950	$145,000	$271,000	$263,800	$490,000	$190,000

1. Most cost estimates were developed using “high” estimated cost per sample.
2. Costs for water column chemistry are lower for conventional parameters and greater for toxic pollutants.

Cost estimates are based on: Bay Protection and Toxic Cleanup Program, State Mussel Watch Program, Toxic Substances Monitoring Program, and M. Yahya, Orange County Sanitation District, personal communication, May 2000.

SECTION XI. STRATEGY TO PRIORITIZE AND ALLOCATE RESOURCES

As a part of the comprehensive surface water proposal, the SWRCB is required to develop a strategy to set priorities and allocate resources among the SWRCB and RWQCBs to effectively implement the program. This section presents the strategy of allocating resources for the various types of monitoring that the RWQCBs may perform. This section provides descriptions of the Watershed Management Initiative (WMI) and the approach to be used to allocate resources and set priorities.

Watershed Management Initiative

A key component in the 1997 Strategic Plan for the SWRCB and the nine RWQCBs is a watershed management approach. The Watershed Management Initiative (WMI) is intended to support the goals in the Strategic Plan to:

1. Preserve, enhance and restore water resources while balancing economic and environmental impacts,

2. Promote cooperative relationships and to improve support for the regulated community and the public,

3. Encourage balanced and efficient use of water through water transfers, recycling and conservation,

4. Continuously improve internal efficiency and effectiveness, and

5. Establish a more stable, and flexible mix of funding sources.

The WMI seeks to facilitate solutions from all interested parties in a watershed, and coordinate measures to improve watershed health, and ultimately the beneficial uses of water. Each RWQCB has identified watersheds in their region, prioritized water quality issues, and developed their own watershed management strategies. The vision is to incorporate all the strategies with the SWRCB's coordination role into a single integrated plan. Each RWQCB's strategy is then a "chapter" in the Statewide plan.

For initial implementation of the WMI, each RWQCB identified the watersheds in their Region, prioritized water quality issues, and developed watershed management strategies. These strategies and the SWRCB's overall coordinating approach to WMI are contained in the Integrated Plan for Implementation of the WMI which is updated annually. In subsequent years, the RWQCBs have continued to build upon their early efforts to utilize this approach.

Approach

The RWQCBs shall include monitoring and assessment activities in the both the Watershed Activities and Regionwide Activities Sections of existing WMI Chapters.

Information to be included in WMI Chapter, Region-wide Section

Documenting Ambient Water Conditions In Potentially Clean And Polluted Areas

One of the overall goals of SWAMP is to develop a Statewide picture of the status and trends of the quality of California's water resources. It is intended that this portion of SWAMP will be implemented in each hydrologic unit of the State at least one time every five years. In this section of the WMI Chapter each RWQCB shall:

1. Highlight existing monitoring efforts by other entities,

2. Describe RWQCB ongoing monitoring efforts, and

3. List priorities for monitoring within the next five years along with estimated staff and contract costs. This listing shall be listed by hydrologic unit and shall focus on the high priority monitoring needed by the RWQCB.

Information to be included in WMI Chapter, Watershed Activities Section

Identifying Specific Water Problems In Targeted Watersheds

Another overall goal of SWAMP is to develop site-specific information on sites that are known or suspected to have water quality problems. It is intended that this portion of SWAMP will be implemented at specific locations in each region. This portion of SWAMP is focused on collecting information on locations in water bodies the State suspects should be listed or delisted under CWA Section 303(d). In this section of the WMI Chapter each RWQCB shall include:

1. The specific objectives selected.

2. Linkage to Regulatory Programs (303(d), TMDL, NPS etc.).

3. Highlight of the Region-specific strategy for monitoring and assessment, if any.

4. A brief description of the significant ongoing monitoring that is taking place in the Region (Mussel Watch, Coastal Fish Monitoring Program, Toxic Substances Monitoring Program, special studies, etc.).

5. A description of any existing or planned links to citizen monitoring efforts, if any.

6. Priority tasks and costs for next two fiscal years.

7. Data management activities.

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LIST OF ABBREVIATIONS

AB	Assembly Bill
BCP	Budget change proposal
BPTCP	Bay Protection and Toxic Cleanup Program
Cal/EPA	California Environmental Protection Agency
CALFED	California Federal Bay Delta Program
CAO	Cleanup and abatement order
CERES	California Environmental Resources Evaluation System
CMARP	Comprehensive Monitoring, Assessment and Research Program
CWA	Clean Water Act
DFG	Department of Fish and Game
DHS	Department of Health Services
DPR	Department of Pesticide Regulation
DWR	Department of Water Resources
EMAP	Environmental Monitoring and Assessment Program
FED	Functional Equivalent Document
FY	Fiscal year
GIS	Geographic information system
IEP	Interagency Ecological Program
ITFM	Intergovernmental Task Force on Monitoring
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
OEHHA	Office of Environmental Health Hazard Assessment
PAG	Public Advisory Group
PY	Personnel year
QA/QC	Quality Assurance/Quality Control
RWQCB	Regional Water Quality Control Board
SAG	Scientific Advisory Group
SCCWRP	Southern California Coastal Water Research Project
SFEI	San Francisco Estuary Institute
SWAMP	Surface Water Ambient Monitoring Program
SWIM	System for Water Information Management
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load
USEPA	U.S. Environmental Protection Agency
WDR	Waste discharge requirements
WMA	Watershed Management Area
WMI	Watershed Management Initiative

GLOSSARY

Ambient Monitoring	Any activity in which information about the status of the physical, chemical, and biological characteristics of the environment is collected to answer specific questions about the status and trends in the characteristics.
Beneficial Use	Regulatory definitions of the resources, services, and qualities of specific water bodies that are the ultimate goals of protecting and achieving high water quality. These include, but are not limited to, domestic, municipal, agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves.
Bioassessment	A tool for evaluating the biological integrity of a water body and its watershed, using surveys of the organisms living in the water body.
Chapter 15	The Chapter 15 Program is part of the Core Regulatory Program for waste treatment, storage, or disposal sites. Statute specifically requires the State Water Resources Control Board to develop regulations to "ensure adequate protection of water quality and statewide uniformity in the siting, operation, and closure of waste discharge sites." These regulations are found in California Code of Regulations [CCR] Title 27 [solid waste, including mining waste] and CCR Title 23, Division 3, Chapter 15 [hazardous waste].
Compliance Monitoring	Monitoring to determine if a specific discharger is meeting the requirements established in Waste Discharge Requirements WDRs, NPDES permits, or water quality certifications.
Contamination	An impairment of the quality of the waters of the state by waste to a degree which creates a hazard to the public health through poisoning or through the spread of disease. It includes any equivalent effect resulting from the disposal of waste, whether or not waters of the State are affected.
Habitat	The environment occupied by individuals of a particular species, population, or community.

Indicator	The tools used to assess and measure water quality. Indicators must be measurable with available technology, scientifically valid, and useful for providing information for management decision making. Environmental indicators include tools for assessment of chemical, physical, and biological conditions and processes.
Site-specific Monitoring	Monitoring that is focused on areas known or suspected to be polluted and areas that may serve as sources of pollution.
Monitoring	Periodic or continuous collection of environmental information to assess the current status or changes in the environment over time. It can be short or long term in duration and is typically driven by statutory, policy or other regulatory requirements.
Pollution	An alteration of the quality of the waters of the State by waste to a degree which unreasonably affects either the waters for beneficial uses or the facilities which serve these beneficial uses.
Regional Monitoring	Monitoring that defines the larger scale condition of aquatic life, determines if known local impacts can be observed at large distances, and assesses the natural variability inherent in the environment. Sampling locations are chosen randomly without regard for the presence or absence of known or suspected areas of pollution or other impairments.
Research	Scientific investigation that involves short-term studies focused on cause-and-effect relationships, understanding causative mechanisms, open-ended questions, methods development, and special studies focused on questions generated by monitoring.
Watershed	Lands that drain to a common place. As physical systems, watersheds consist of hillslopes, valleys, and drainage networks.