

A. PROJECT MANAGEMENT

1. Title Page and Approvals

QUALITY ASSURANCE PROJECT PLAN FOR MONITORING FOR THE SACRAMENTO RIVER WATERSHED PROGRAM

QA Office Chief	----- Vance Fong, Chief, Quality Assurance Program, EPA Region IX	Date
Project Officer	----- Debra Denton, EPA Region IX	Date
Project Manager	----- Jerry Troyan, Sacramento Regional County Sanitation District	Date
QA Manager	----- Claus Suverkropp, Larry Walker Associates	Date
QA Officer	----- Scott Ogle, Pacific EcoRisk Laboratory, Martinez, CA	Date
QA Officer	----- Jay Davis, San Francisco Estuary Institute	Date
QA Officer	----- Jim Harrington, CDFG, Rancho Cordova	Date
QA Officer	----- Mark Stephenson, CDFG, Marine Pollution Studies Lab, Moss Landing	Date

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APPENDICES

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APPENDIX B: CALCULATIONS FOR DATA QUALITY ASSESSMENTS

APPENDIX C: SUPPORTING DOCUMENTS FOR CHEMICAL WATER QUALITY MONITORING

- Field Sampling Procedures (CDFG 1993)
- Methylmercury Field Sampling Procedures (CDFG 2000)
- Methyl Mercury in Water by Distillation, Aqueous Ethylation, Purge and Trap, and CVAFS by USEPA Method 1630 (DRAFT) (USEPA 2001)
- Evapo-Concentration Procedure (CDFG 1993)
- Total Hardness (Pacific EcoRisk 1995)
- Total Alkalinity (Pacific EcoRisk 1995)
- Total Dissolved Solids by EPA Method 160.1
- Total Suspended Solids by EPA Method 160.2
- Total and Dissolved Organic Carbon by UV-Promoted Persulfate Oxidation (Sierra Foothill Laboratory SOP, 5-19-2000)
- SOP: Organophosphorus Compounds by Gas chromatography: Capillary Column Technique by Gas Chromatography by EPA Method 8141A (APPL 1997)
This proprietary SOP is on file with the U.S. EPA Quality Assurance Division and is not available for public review.
- SOP: Triazine Compounds by Gas Chromatography by EPA Method 619 (APPL 1999) *This proprietary SOP is on file with the U.S. EPA Quality Assurance Division and is not available for public review.*
- SOP: Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection (APPL 1997) *This proprietary SOP is on file with the U.S. EPA Quality Assurance Division and is not available for public review.*
- Forms: Labels, Log Sheets, Data Reports

APPENDIX D: SUPPORTING DOCUMENTS FOR AQUATIC TOXICITY MONITORING

- Quality Assurance/Quality Control Manual, May 2000 (Pacific EcoRisk 2000).
- *Ceriodaphnia dubia* 7-Day Survival and Reproduction Bioassay Standard Operating Procedures (Pacific EcoRisk 1997)
- Flow Charts of TIE Procedures (Deanovic *et al* 1998; Norberg-King et al 1991)
- The Use of Ion Exchange Resins to Determine the Biototoxicity and Concentration of Dissolved Trace Metals in Natural Waters (Connor 1991)
- Forms: Labels, Log Sheets, Data Reports

APPENDIX E: SUPPORTING DOCUMENTS FOR PATHOGEN MONITORING

- EPA Method 1623 (USEPA 1999)

APPENDIX F: SUPPORTING DOCUMENTS FOR BENTHIC INVERTEBRATE MONITORING

- California Stream Bioassessment Procedures (CDFG 1996)
- Methods For Collecting Benthic Invertebrate Samples As Part Of The National Water-Quality Assessment Program (USGS 1993a)

APPENDIX G: SUPPORTING DOCUMENTS FOR FISH TISSUE MONITORING

- CDFG Fish Sampling and Sample Handling Protocols
- Analytical Protocols: PCBs and Chlorinated Pesticides in Fish Tissue
(California Department of Fish and Game Water Pollution Control Laboratory, Rancho Cordova)
- Analytical Protocols: Mercury in Fish Tissue
- Forms: Labels, Log Sheets, Data Reports

APPENDIX H: EXAMPLE LABEL AND CHAIN OF CUSTODY FORM

3. Distribution List

Primary Distribution List for SRWP Quality Assurance Project Plan

Name	Agency or Company
Debra Denton	EPA, Region IX
Vance Fong	EPA, Region IX
Mark Kutnink	EPA, Region IX
Andrew Frankel	Sacramento Regional County Sanitation District (Coordinated Monitoring Program)
Rick Johnson	Sacramento Regional County Sanitation District (Coordinated Monitoring Program)
Scott Ogle	Pacific EcoRisk, Martinez, CA
Stephen Clark	Pacific EcoRisk, Martinez, CA
Jason Gold	Applied Marine Sciences Livermore, CA
Brenda Lasorsa	Battelle Marine Science Laboratories, Squim, WA
David Crane	California Department of Fish and Game (Water Pollution Control Lab)
Jim Harrington	California Department of Fish and Game (Water Pollution Control Laboratory)
Marcia Ames	City of Redding (Industrial Waste Division)
Mark Stephenson	California Department of Fish and Game (Moss Landing Marine Lab)
Rick Danielsen	BioVir Laboratories Inc., Benicia, CA
Glen Brown	APPL Labs, Fresno, CA
Sandy Nurse	Sierra Foothill Laboratory, Jackson, CA
Jerry Boles	Department Of Water Resources, Northern District
Rich Gresham	Placer County Resource Conservation District
Fraser Sime	Department Of Water Resources, Northern District
Karen Larsen	Central Valley Regional Water Quality Control Board, Sacramento, CA
Val Connor	State Water Resources Control Board, Sacramento, CA

4. Project Organization and Responsibility

The Sacramento River Watershed Program (SRWP) is an association of stakeholders in the Sacramento River watershed. These stakeholders include representatives of local municipalities and districts, state and federal agencies, agriculture, industry, landowners, environmental organizations, universities, technical consultants, and watershed conservancies. The SRWP was formed in 1996 through a series of stakeholder meetings.

Formation of the SRWP was facilitated by the Sacramento River Toxic Pollutant Control Program (SRTPCP), a locally initiated effort led by Sacramento County and the Sacramento Regional County Sanitation District. The SRTPCP is a watershed-based approach to the management of toxic pollutants in surface waters of the Sacramento Valley.

Funding for the SRTPCP is provided primarily by the federal government and is administered by EPA Region IX. A portion of the SRTPCP funding was specifically designated to assist in the formation of the broader watershed program. This project is the SRWP monitoring program.

The SRWP monitoring program is managed by Larry Walker Associates (LWA). The monitoring program manager is Tom Grovhoug of LWA. The project quality assurance manager is Claus Suverkropp, Senior Scientist with LWA.

Sample collection and analysis will be performed by the following agencies and subcontractors:

- Pacific EcoRisk
- Applied Marine Sciences
- California Department of Fish and Game (Moss Landing Marine Lab, and Water Pollution Control Lab)
- Battelle Marine Science Laboratories
- APPL Laboratories
- BioVir Laboratory
- Sierra Foothill Laboratory
- Sacramento Regional County Sanitation District

For the parameters measured by the monitoring program of the Sacramento River Watershed Program, the agencies selected to perform sampling and laboratory analyses provide the precision, accuracy, detection and reporting limits, and meet the quality control criteria necessary to satisfy the data quality objectives described in this document.

Sampling and analytical responsibilities and primary contacts are listed in Appendix A.

The organizational structure of the SRWP monitoring program is illustrated in Figure A-1.

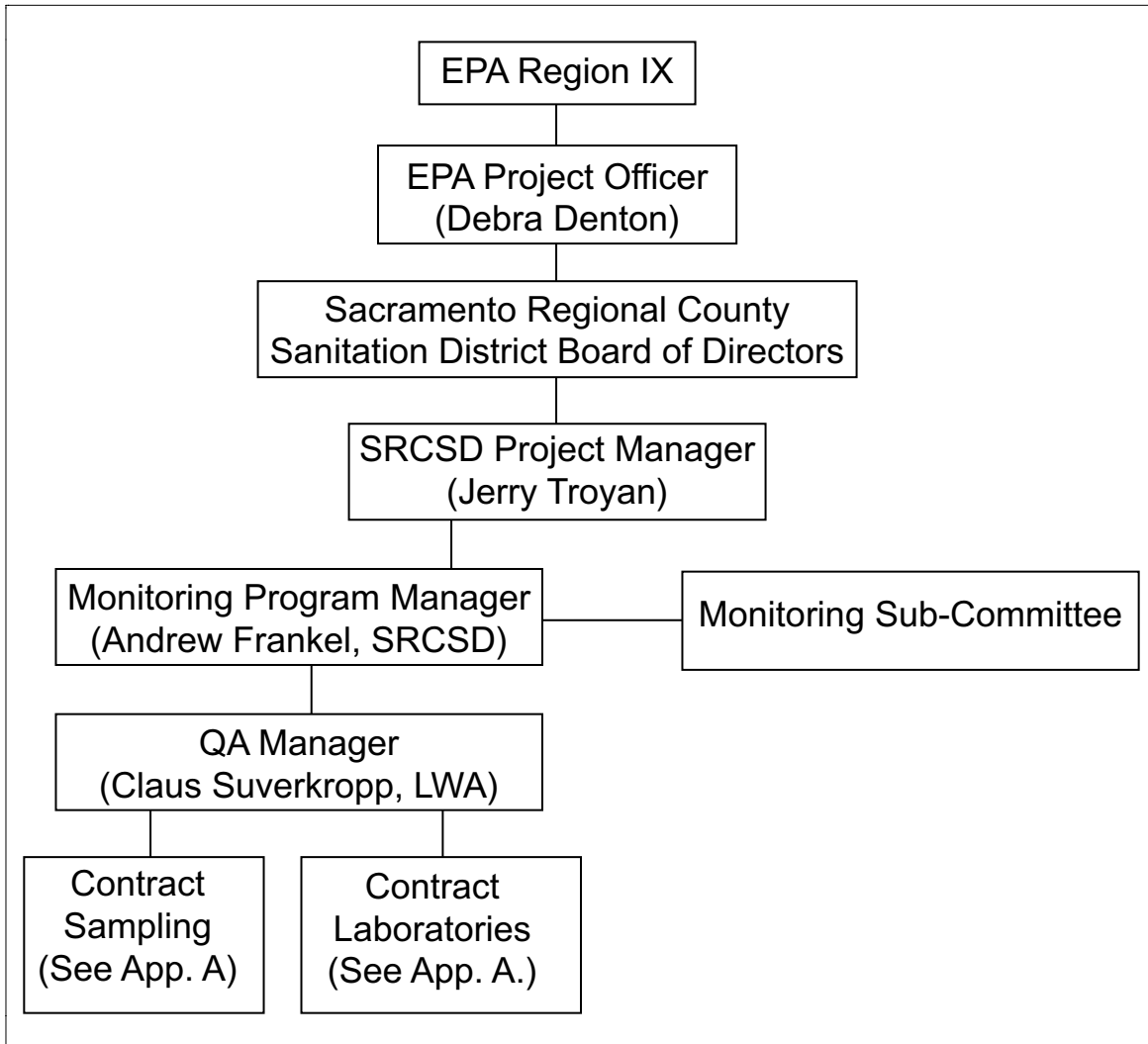


Figure A-1. SRWP Monitoring Program Management Structure.

5. Problem Definition

The goal statement for the SRWP developed by the participating stakeholders is as follows:

SRWP Goal Statement

To ensure that current and potential uses of the watershed's resources are sustained, restored, and where possible, enhanced while promoting the long-term social and economic vitality of the region.

One of the primary tasks of the SRTPCP and the SRWP is the design and implementation of a monitoring program for the watershed. In early stakeholder meetings, a Monitoring Subcommittee was formed to lead the development of the monitoring program.

6. Project Description

Project Objectives and Approach

The Monitoring Subcommittee has established the following long-term goal for the SRWP monitoring program:

SRWP Monitoring Program Long-Term Goal

In coordination with other subcommittees and the larger stakeholder group, develop a cost-efficient and well-coordinated long term monitoring program within the watershed to identify the causes, effects and extent of constituents of concern that affect the beneficial uses of water and to measure progress as control strategies are implemented.

The SRWP monitoring program is envisioned by the subcommittee to be a long-term (e.g. 20 year) effort that will provide information to promote the understanding of conditions in the watershed and to assess the relative health of the watershed. The monitoring program will be a dynamic activity that will change over time as information is accumulated and new information needs are identified.

The Monitoring Subcommittee has set the following initial goal for the monitoring program:

SRWP Monitoring Program Short-Term Goal

To assess conditions in the main stem of the Sacramento River through the collection of baseline information, with an emphasis on examining the degree to which beneficial uses are attained.

The monitoring program will augment and coordinate with a number of other monitoring efforts that are ongoing in the watershed, including the USGS National Water Quality

Assessment Program, the Sacramento Coordinated Water Quality Monitoring Program, and monitoring efforts by the Department of Water Resources, Department of Pesticide Regulation, US Bureau of Reclamation, City of Sacramento, and City of Redding. The SRWP monitoring program includes chemical, physical, biological and toxicological monitoring elements.

Measurements

The following environmental monitoring elements are included in the SRWP monitoring program:

- Mercury, PCBs, and chlorinated pesticides in fish tissue
- Mercury, methylmercury, and pesticides in water
- Toxicity in water
- Pathogen indicator organisms in water
- Organic carbon and ultraviolet absorbance in water
- Nitrogen and phosphorus compounds in water
- General constituents in water (solids, alkalinity, hardness) in water
- Physical habitat assessment and benthic invertebrates

Specific individual parameters measured by the SRWP monitoring effort are listed in Table A-1. The purpose for monitoring these parameters is discussed below.

Fish Tissue Monitoring. Mercury and certain organic contaminants (including DDT and PCBs) readily accumulate in the food web, resulting in concentrations in fish tissue which may be of concern to humans and wildlife. Monitoring levels of these pollutants in fish provides an effective way to assess the degree of contamination of the Sacramento River system. Because fish accumulate contaminants throughout their life span and their habitat, measurements of contaminant concentrations in fish tissue provide an indication of average conditions over space and time. Fish tissue data can be useful in the determination of long term trends of bioaccumulative contaminants (such as mercury, DDT and PCBs) in the watershed. This long-term data can be used to measure the effectiveness of activities to control these pollutants.

Mercury in water. As stated above, low levels of mercury and methylmercury in water are of potential concern to human health. Several programs are currently planned or under way in the Sacramento River watershed to monitor mercury levels at various locations, including the Sacramento Coordinated Water Quality Program, the USGS National Water Quality Assessment for the Sacramento River, and CALFED. SRWP mercury monitoring will supplement existing data, and planned and ongoing monitoring efforts, with information for twenty locations. Data obtained will be used to quantify ambient levels of mercury and methylmercury in the Sacramento River watershed and to assess whether these levels are causing or contributing to potential human health risks or otherwise adversely affecting beneficial uses. Locations for mercury monitoring were selected to augment and coordinate with existing and planned monitoring efforts in the watershed.

Pesticides in water. Low levels of pesticides in water can affect the growth, reproduction and/or survival of sensitive aquatic species. Pesticides of potential concern to aquatic life in the Sacramento River system include organophosphate (OP), carbamate, and triazine pesticides. These classes of pesticides are responsible for the presence of several Sacramento River watershed waterbodies on the 303(d) list of impaired waterbodies.

Several programs are currently under way in the Sacramento River watershed to monitor pesticides at various locations in the Sacramento River watershed, including programs administered by the California Department of Pesticide Regulation (DPR), the California Regional Water Quality Control Board, the Department of Water Resources, and the USGS National Water Quality Assessment for the Sacramento River. SRWP pesticide monitoring will supplement the existing data with information for eleven additional locations. Locations for pesticide monitoring were selected on the basis of documented use of these pesticides upstream from the locations monitored, on pesticide-caused toxicity detected at these streams/ivers, and on inclusion for pesticides on the 303(d) list of impaired water bodies. Data obtained will be used to quantify ambient levels of pesticides in the Sacramento River watershed and to assess whether these levels are adversely affecting uses.

Toxicity in water. Ambient samples of water can be tested in the laboratory for toxicity to provide an indication of the conditions that exist in the natural environment. Standard test species and test procedures are used to provide reliable and comparable results. Toxicity is considered to occur when test species are adversely affected by exposure to ambient water. Adverse effects may include impaired growth or reproduction, abnormalities, or mortality of test species. Effects may occur rapidly (acute toxicity) or may occur over a longer period (chronic toxicity). For the SRWP monitoring program, the results of toxicity testing with *Ceriodaphnia dubia* will be used to trigger further investigations to determine the cause of observed toxicity. These investigations include the consideration of a number of factors, including contributing watershed characteristics, chemistry, biology, and additional toxicity testing. Results from these weight-of-evidence investigations are useful in identifying potential water quality problems in the watershed. Toxicity testing in water will be performed at fourteen locations in the watershed. Sites for aquatic toxicity monitoring were selected to provide an overall survey of the distribution of toxicity in the watershed, to coordinate with existing monitoring programs, and to characterize causes of observed toxicity.

Pathogens in water. Pathogens are disease-producing organisms (protozoa, bacteria, viruses) which adversely affect the quality of drinking water and may pose health risks for water contact recreation. Two pathogens are of particular concern—*Cryptosporidium* and *Giardia*—due to their ineffective removal by conventional water treatment technologies. Although limited data sets exist for the Sacramento River near Redding and in the Sacramento River below Sacramento, data on the levels of these pathogens is generally lacking for most of the Sacramento River system. In addition to monitoring conducted by SRWP, monitoring has been conducted in the lower end of the watershed near Sacramento to assess levels of *Cryptosporidium*, *Giardia*, and coliform organisms (common indicators of fecal contamination) by the Department of Water Resources, Metropolitan Water District, and the City of Sacramento. SRWP will not monitor *Giardia* and *Cryptosporidium* in 2001-2002, but will evaluate the results of the SRWP and other monitoring efforts to determine the need for additional monitoring of the pathogens. SWRP pathogen monitoring will continue monitoring for pathogen indicator organisms (total and fecal coliforms, *E. coli*, and *Enterococcus*) at eight additional locations in the Sacramento River watershed. Data will be used to determine the magnitude and extent of levels of these organisms in the main stem of the Sacramento River and selected tributaries.

Organic carbon in water. The organic content of water (measured as organic carbon) is a parameter important to drinking water suppliers. High levels of organic compounds in source waters leads to the production of disinfection by-products as a result of conventional water treatment. These by-products pose human health problems at relatively low concentrations. For these reasons, baseline data on typical organic carbon

levels and seasonal variability of those levels in the Sacramento River system are important to the assessment of drinking water uses. SRWP monitoring for organic carbon at seven sites will augment or continue fairly extensive monitoring conducted by the USGS NAWQA program, the City of Sacramento, and the Department of Water Resources.

General constituents (suspended and dissolved solids, hardness, alkalinity, and nitrogen and phosphorus compounds) in water. These conventional water quality parameters are important to the evaluation of the attainment of a variety of uses, including drinking water supply, recreation, aesthetics, aquatic habitat, and agricultural supply. Data on these parameters is available from a number of other programs, including USGS NAWQA, the Sacramento Coordinating Monitoring Program and the Department of Water Resources. SRWP monitoring will augment these ongoing data collection efforts for some of these constituents at twelve sites.

Benthic invertebrates. Benthic invertebrates are the aquatic insects and other organisms that live along the bottom of water bodies. Procedures have been developed and recently refined to standardize the assessment of biological habitat and benthic communities for use as a monitoring tool (Plafkin et al. 1989, CDFG 1996, DWR 1997). Information collected at specific sites is typically compared against expected conditions (or reference stream conditions) to evaluate the relative health of the biological community at that location (bioassessment). This information is used in combination with chemistry and toxicity information to assess ecosystem conditions at various locations. Different procedures are used depending on the characteristics of the stream reach (i.e. wadable versus non-wadable). This monitoring tool can also be effectively used by citizen monitoring groups in smaller tributary watersheds. The Department of Water Resources and Department of Fish and Game are actively working with a number of tributary watershed groups to provide education and training regarding the assessment methods. SRWP bioassessment monitoring in 2001-2002 will be focused on developing the process for selecting reference sites and conditions, and identifying potential reference sites for sampling in 2002. The process developed is expected to be applicable throughout the watershed and the state.

Table A-1. Parameters Measured for the SRWP Monitoring Program

Chemical and Physical Water Quality Characteristics	
<i>Mercury</i> Mercury, filtered and unfiltered Methylmercury, filtered and unfiltered <i>Nitrogen and Phosphorus Compounds</i> Ammonia Nitrogen Nitrate and Nitrite Nitrogen Total Kjeldahl Nitrogen Dissolved Orthophosphate and Total Phosphorus <i>Pesticides</i> Organophosphate Pesticides Carbamate Pesticides Triazine Pesticides	<i>General Constituents</i> Alkalinity Hardness Total Suspended Solids Total Dissolved Solids Dissolved Organic Carbon Total Organic Carbon UVA ₂₅₄ <i>Field Parameters</i> Temperature pH Dissolved Oxygen Conductivity
Microbiological Water Quality Characteristics	
<i>Escherichia coli</i> <i>Enterococcus spp.</i>	Total coliform bacteria Fecal coliform bacteria
Aquatic Toxicity	
<i>Ceriodaphnia</i> reproduction	<i>Ceriodaphnia</i> mortality
Fish Tissue	Bioassessment
Mercury Chlorinated pesticides PCBs	<i>Physical Habitat</i> Selection of potential reference sites Measures of habitat quality <i>Benthic Invertebrates</i> Community abundance and diversity metrics

Assessment Tools

The QAPP and any amendments to QAPP elements will be reviewed and approved by project Quality Assurance Officers, and by the U.S. EPA Quality Assurance Manager prior to the initiation of monitoring.

Project Schedule

The proposed schedule for SRWP monitoring is summarized in Table A-2.

Table A-2. Project Implementation Schedule for 2001-2002 Monitoring

Finalize and Execute Contracts for 2001-2002 Monitoring	July 2001
Submit Revised QAPP to EPA for Review	7/23/2001
Receive Comments on Revised QAPP	8/6/2001
Respond to EPA Comments on Revised QAPP	8/10/2001
Conditional Approval for QAPP for 2000-2001 Monitoring	8/17/2001
Initiate 2000-2001 Monitoring	8/18/2001
Final Approval for QAPP	9/1/2001

Sampling Schedule

The sample collection frequency varies by location and the parameter to be tested, as summarized below:

- *Water quality monitoring*—for mercury, pesticides, pathogens, organic carbon, general constituents in water, and for aquatic toxicity sampling will be “event-based”, for a total of 6 sampling events. These. “event-based” sample events will be planned to coincide with a range of hydrological conditions and other events expected to significantly affect water quality (e.g. during seasonal pesticide applications, expected periods of agricultural or urban runoff, high and low flows), or conditions that match a previously observed pattern of toxicity or changes in concentrations of parameters. The exact nature and timing of these events will be determined by the Toxicity Focus Group of the SRWP and the sampling contractor (Pacific EcoRisk).
- *Fish tissue*—sampling will be conducted once annually for all sites to be monitored.
- *Bioassessment*—physical habitat assessment will be conducted once annually for all sites to be monitored.

The 6 sample events will typically be conducted over a period of two or three days. A breakdown of sampling sites, sampling frequency, and parameters to be analyzed are provided in Table A-3. The list of sampling sites in Table A-3 supersedes all lists of sampling sites included in previous versions of QAPPs or monitoring plans, approved or unapproved, relating to the monitoring described herein.

Table A-3. Summary of Sampling Sites, Frequency, and Parameters.

Monitoring Locations	Chemical Characteristics															Aquatic Toxicity		Fish Tissue		Bioassessment ^(b)	
	Hg and MeHg (unfiltered and unfiltered)	TSS	Hardness	Alkalinity	TOC	DOC	UVA 254	TDS	Nitrogen and Phosphorus compounds	OP pesticides	carbamate pesticides	triazines	E. coli	Enterococcus	Total, Fecal Coliforms	Ceriodaphnia	WC Tox Followup (a)	Mercury	PCBs & chlor. pest.	Benthic Invertebrates	Habitat Assessment
Pit R. above Shasta			atox	atox												6 E	E			RB	
Sac. R. below Keswick	5 E	5 E	atox	atox				RED		DWR	DWR					6 E	E	2	2		
Cottonwood Ck at mouth	DWR	DWR	atox	atox						DWR	DWR					6 E	E				
Cottonwood Creek (3 sites)	12 E	12 E																			
Battle Creek (3 sites)	12 E	12 E																			
Sac. R. at Bend Br	5 E	5 E	atox	atox	6 E	6 E	6 E	6 E	6 E	DWR	DWR		6 E	6 E	6 E	6 E	E				
Mill Creek @ Los Molinos	DWR	DWR	DWR							3 E											
Deer Creek	DWR	DWR	DWR							3 E											
Thomes Creek (3 sites)	12 E	12 E																			
Dry Creek (trib to Little Chico Ck)	4 E	4 E																			
Little Chico Creek	4 E	4 E																			
Big Chico Creek at Mouth	DWR	DWR	DWR							3 E											
Sac. R. near Hamilton City	5 E	5 E	atox	atox	6 E	6 E	6 E	6 E	6 E	6 E			6 E	6 E	6 E	6 E	E				
Sac. R. @ Colusa	5 E	5 E	atox	atox	6 E	6 E	6 E	6 E	6 E	6 E			6 E	6 E	6 E	6 E	E				
Sac. Slough	4 E	4 E	atox	atox	6 E	6 E	6 E	6 E	6 E	6 E	6 E		6 E	6 E	6 E	6 E	E				
Colusa Basin Dr	4 E	4 E	atox	atox	6 E	6 E	6 E	6 E	6 E	6 E	6 E		6 E	6 E	6 E	6 E	E	2	3		
Yuba R. at Marysville	5 E	5 E	atox	atox	6 E	6 E	6 E	6 E	6 E	6 E	6 E		6 E	6 E	6 E	6 E	E				
Feather R. between Yuba and Bear R.																		2	2		
Feather R. near Nicolaus	5 E	5 E	atox	atox	6 E	6 E	6 E	6 E	6 E	6 E		4 E	6 E	6 E	6 E	6 E	E	2	2		
Sac. R. at Veterans Br.	CMP	CMP	CMP	6	CMP	CMP	6	6	6	6 E		4 E	CMP	6	CMP						
Arcade Creek	4 E	4 E	atox	atox						6 E	6 E	6 E				6 E	E				
Natomas East Main Drain			DWR	DWR	DWR	DWR	DWR	DWR	6				6 E	6 E	6 E						
American R. at J St.																		2	2		
American R. at Discovery Pk	CMP	CMP	atox	atox	CMP	CMP	6	CMP	6	CMP			CMP	6	CMP	6 E	E	2	2		
Sac. R. at Freeport	CMP, GS	CMP	atox	atox	CMP	CMP	6	CMP	6	GS	GS	GS	CMP	6	CMP	6 E	E				
Sac. R. at RM44	CMP	CMP	CMP	6	CMP	CMP	6	CMP	6	CMP			CMP	6	CMP			4	4		
Cache Creek at Rumsey		CF	atox	atox		CF	CF	CF								6 E	E	2	2		
Prospect Slough																		2	2		
Number Sites Monitored by SRWP	14	14	14	16	7	7	11	8	12	11	4	3	8	12	8	14	(a)	9	9	(b)	(b)
Number of Regular Analyses	86	86	0	12	42	42	66	48	72	57	24	14	48	72	48	84	(a)	20	21	(b)	(b)
Additional QC Analyses	12	9	0	0	12	12	12	6	12	12	12	12	6	6	6	12	(a)	2	2	(b)	(b)

Table Notes: Values indicate number of environmental samples collected annually. Additional samples are collected for Quality Assurance. Values appended with "E" indicate that monitoring will be "event-based". "atox" indicates parameter will be measured as part of aquatic toxicity monitoring effort. Other text entries indicate data or samples collected by primary coordinating programs: CMP = Sacramento River Coordinated Monitoring Program; GS = USGS; CF = CALFED; RB =Central Valley Regional Board; DWR = Dept of Water Resources; TEH = Tehama County RCD

(a) A fixed budget of \$60,000 is allocated for Toxicity follow-up consisting of chemistry, TIE testing, and additional sampling that has no fixed frequency.

(b) Bioassessment monitoring includes physical habitat and biological assessments. Monitoring in 2001-2002 will consist primarily of identifying potential reference sites.

7. Quality Objectives and Criteria for Measurement Data

The objective of data collection for this program is to produce data that represent as closely as possible, *in situ* conditions of the Sacramento River watershed. This objective will be achieved by using accepted methods to collect and analyze water, sediment, and biota. Assessing the program's ability to meet this objective will be accomplished by evaluating the resulting laboratory measurements in terms of detection limits, precision, accuracy, comparability, representativeness, and completeness, as presented in Section B of this document.

8. Documentation and Records

Data To Be Included In Data Reports

For each sample event, the field crew or monitoring agency shall provide the Quality Assurance Manager with copies of relevant pages of the field logs and copies of the Chain of Custody forms for all samples submitted for analysis. At a minimum, the following sample-specific information will be provided for each sample collected:

- sample ID (unique for each sample and replicate)
- SRWP monitoring location
- sample depth
- sample type, e.g. grab or composite type (cross-sectional, flow-proportional, etc.)
- number of sub-samples in composite (if appropriate)
- QC sample type (if appropriate)
- date and time(s) of collection
- requested analyses (specific parameters or method references).

For each sample analyzed, the analyzing laboratory shall provide the Quality Assurance Manager with the following information:

- sample ID
- date of sample receipt
- dates of analysis
- analytical method(s)
- method detection limit (if appropriate)
- reporting limit (if appropriate)
- measured value of the analyte or parameter.

In addition, the analyzing laboratory shall provide results from all laboratory QC procedures (blanks, duplicates, spikes, reference materials, etc.) and the sample IDs associated with each analytical sample batch.

Reporting Format

In addition to the laboratory's standard reporting format, all results meeting data quality objectives and results having satisfactory explanations for deviations from objectives shall be reported in tabular format on electronic media.

B. DATA ACQUISITION

1. Sampling Design

The SRWP monitoring program includes monitoring at 33 locations in the Sacramento River watershed. Seven of these sites are located on the main stem of the Sacramento River, from the Sacramento River below Keswick Reservoir to the Sacramento River at River Mile 44. Five sites are located on major tributaries to the Sacramento River, two sites are located on major agricultural drains, and one site is located on an urban creek. The remaining 18 sites are located on smaller tributaries to the Sacramento River. These sites cover over 300 miles of the Sacramento River system and represent a drainage area of over 23,000 square miles. The SRWP monitoring sites are listed in Table B-1 and illustrated in Figure B-1.

All water quality monitoring samples will be collected as “event-based” grab samples. Six episodic events will be conducted at 15 of the above sites. Four episodic events will be conducted in three new tributary watersheds (Thomes, Cottonwood, and Battle creeks) and at two new sites being monitored for mercury (Dry Creek and Little Chico Creek in Butte County). Other monitoring will consist of one-time fish tissue monitoring events or or physical assessment for bioassessment monitoring. Table A-3 in the previous section provides a summary of sampling frequency and parameters monitored at each site.

Table B-1. SRWP Monitoring Sites

Site description	Site ID	Site Type
Pit River above Shasta	PRSHA	Tributary
Sacramento River below Keswick	SRBKR	Mainstem
MF Cottonwood Creek near Ono	CTMON	Tributary
NF Cottonwood Creek near Ono	CTNON	Tributary
SF Cottonwood Creek near Cottonwood	CTSCW	Tributary
Cottonwood Creek near Cottonwood	CTCTW	Tributary
NF Battle Creek	BANFA	Tributary
SF Battle Creek	BASFA	Tributary
Battle Creek near Cottonwood	BACTW	Tributary
Sacramento River above Bend Bridge	SRABB	Mainstem
Mill Creek at Mouth	MCMOU	Tributary
Thomes Creek above Paskenta	THAPK	Tributary
Thomes Creek at Paskenta	THPSK	Tributary
Thomes Creek at Rawson Rd Bridge	THRRB	Tributary
Deer Creek at Mouth	DCMOU	Tributary
Sacramento River near Hamilton City	SRHAM	Mainstem
Big Chico Creek at Mouth	CHMOU	Tributary
Dry Creek above Cherokee Canal	DRACC	Tributary
Little Chico Creek at Mouth	LCMOU	Tributary
Sacramento River at Colusa	SRCOL	Mainstem
Colusa Basin Drain above KL	COLDR	Agricultural Drain
Sacramento Slough	SACSL	Agricultural Drain
Yuba River at Marysville	YRMRY	Major Tributary
Feather River above Bear River	FRABR	Major Tributary
Feather River near Nicolaus	FRNIC	Major Tributary
Sacramento River at Veterans Bridge	SRVET	Mainstem
American River at J Street	ARJST	Major Tributary
American River at Discovery Park	ARDPK	Major Tributary
Arcade Creek at Norwood Ave.	ARCNW	Urban Creek
Sacramento River at Freeport	SRFPT	Mainstem
Sacramento River at River Mile 44	SRRMF	Mainstem
Cache Creek near Rumsey	CCHRM	Tributary
Prospect Slough	PROSL	Tributary

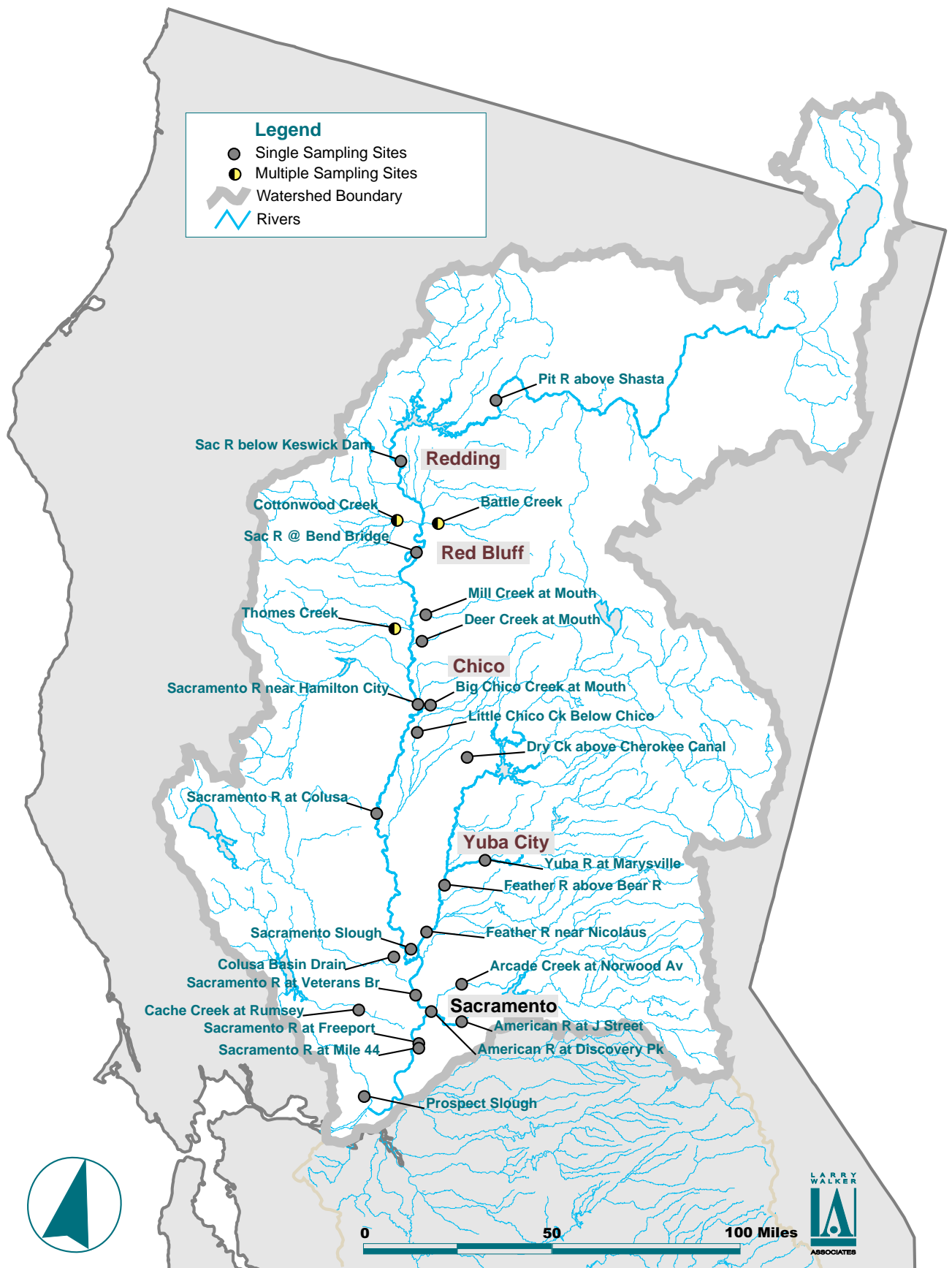


Figure B-1. SRWP Monitoring Program Sampling Sites

2. Sampling Methods Requirements

Samples will be collected from three environmental media: water, tissue, and biota. Three different sample collection methods will be used for the monitoring elements in water: (1) basic water quality sampling, (2) pathogen sampling, and (3) toxicity sampling. Sampling of tissue will include methods specific for fish, and sampling for biota will include methods for benthic macroinvertebrates. For each of these methods described or referenced, it is the combined responsibility of all members of the sampling crew to determine if the performance requirements of the specific sampling method have been met, and to collect an additional sample if required. Descriptions of specific sampling methods and requirements are provided below.

2.1 Basic Water Quality Characteristics

Basic water quality monitoring will include sampling for mercury and methylmercury, pesticides, total suspended solids, hardness, total dissolved solids, alkalinity, nitrogen and phosphorus compounds, total organic carbon, dissolved organic carbon, and ultraviolet absorbance. Field-measured parameters (temperature, dissolved oxygen, specific conductivity, and pH) will also be measured at each site and event where basic water quality characteristic samples are collected. Field parameters will be measured using a YSI Model 57 Oxygen Meter for dissolved oxygen, VWR Scientific Traceable Digital Thermometer (Cat. #61220416) for temperature, Orion Model 230A pH meter, and an Orion Model 130 conductivity meter, or comparable instrument(s).

All water quality samples will be collected using clean techniques that minimize sample contamination. Sampling methods will generally conform to EPA “clean” sampling methodology described in *Method 1669: Sampling Ambient Water for Trace Metals* (USEPA 1995a). Specific methods are also documented in Appendix C¹. Samples will generally be mid-depth grab samples and will be collected by boat or from shore using a peristaltic pump and acid-cleaned polyethylene or Teflon™ tubing. Grab samples will be collected into acid-cleaned glass carboys and aliquoted into glass, polyethylene, or Teflon™ sample containers appropriate for the analyses to be performed, *or* will be collected directly into the sample containers, if appropriate. Samples to be analyzed for dissolved (filtered) analytes will be filtered to 0.45 µm in the field using Gelman in-line filtration capsules.

After collection, samples will be stored at 4°C until arrival at the contract laboratory. Samples to be analyzed for mercury will be preserved using ultrapure hydrochloric or bromochloric acid at the contract laboratory, immediately on arrival. Samples to be analyzed for other constituents will be preserved in the field, as appropriate (Table B-2).

This sample collection method requires that the sample collection tubing, and the sample bottle and lid come into contact only with surfaces known to be clean, or with the water sample. Additionally, mercury samples must have no air bubbles or head space present in the bottle immediately following sample collection. If air is present in the sample container for mercury analyses, additional sample will be aliquoted into the same sample

¹ Water sampling for chemical parameters by Pacific EcoRisk will also generally adhere to their QA manual, which is included in Appendix D. Sections generally relevant to collecting samples for water chemistry include *Documentation*, *Collection and Handling of Samples*, *Collection and Preparation of Receiving Water*, *Instrument Calibration and Standardization*, and *Acquisition, Reduction, Validation and Reporting of Data*. General sample collection methods included in the PER QA Manual are superseded by any more specific collection methods for chemical analyses included or referenced in this Quality Assurance Project Plan.

bottle. If the performance requirements for specific samples are not met, the sample will be re-collected. If contamination of the sample container is suspected, a fresh sample container will be used.

2.2 Pathogens

Pathogen monitoring will include sampling for pathogen indicator organism (fecal and total coliform bacteria, *E. coli*, and *Enterococcus* bacteria). *Note*: Samplers must wear gloves when collecting any pathogen samples.

Bacteria

Samples analyzed for bacteria will be collected as near-surface grab samples. Sampling for bacteria will be performed according to the sampling procedures detailed for Standard Methods 9221B and 9221E (APHA *et al.* 1998). In brief, the sampling procedures are summarized as follows:

- Sample containers should be cleaned and sterilized using procedures described in Standard Methods 9030 and 9040.
- For waters suspected to contain a chlorine residual, sample bottles should contain a small amount of sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) sufficient to neutralize bactericidal activity. For water containing high concentrations of copper or zinc, sample bottles should contain sufficient EDTA solution to reduce metal toxicity. *Note*: These conditions are rare in surface waters.
- Sample bottles may be glass or plastic (e.g. polypropylene) with a capacity of at least 120 mL. After sterilization, sample bottles should be kept closed until they are to be filled.
- When removing caps from sample bottles, be careful to avoid contaminating inner surface of caps or bottles.
- Using aseptic techniques, fill sample bottles leaving sufficient air space to facilitate mixing by shaking. Do not rinse bottles.
- Recap bottles tightly.

If at any time the sampling crew suspects that the sample or sampling container has been contaminated, the sample should be re-collected into a new sample container.

After collection, store samples at 4°C until evaluation. Bacteriological tests must be set up within 24 hours of collection. The 20th edition of Standard Methods (APHA *et al.* 1998) recommends analysis of samples as soon as possible, but specifies that non-drinking water samples analyzed for non-compliance purposes may be held for up to 24 hours (below 10°C) until time of analysis. For this reason, data from SRWP samples should not be used for assessment of regulatory compliance.

2.3 Aquatic Toxicity

Collection of water samples for analysis of ambient water column toxicity will be performed in accordance with guidance for sampling and sample handling documented in *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (USEPA 1994a). In brief, the sampling requirements for toxicity testing are as follows:

- Water collected for toxicity tests will consist of grab samples.

- Samples will be collected directly into 4-L amber glass bottles, using the same equipment and procedures as for basic water quality samples (previously described in section 2.1).
- Sufficient volume will be collected to conduct the characterization and identification phases (Phase I and II) of chronic toxicity identification evaluation (TIE) procedures.
- Samples will be filtered in the laboratory as required for specific toxicity tests.
- After collection, samples will be chilled and maintained at 4°C until testing.
- Toxicity tests will be initiated within 48 hours of sampling.

In some cases where significant toxicity is observed during aquatic toxicity testing, samples may be analyzed for any of the chemical parameters included in this QAPP. The specific analyses to be performed will depend on the pattern of toxicity observed, including any decision to filter samples for chemical analysis. Every effort will be made to be consistent with the sample requirements documented herein for the specific analyte. Because requirements for sample and preservation holding times, filtration, and original sample containers may not be strictly met, the results of the analyses will be used primarily for determining or confirming causes of toxicity, and will be qualified for any other use. Laboratories selected to perform these analyses must meet the same QA performance criteria used to select other laboratories for this monitoring program.

2.4 Fish Tissue

Tissue monitoring will include sampling of fish for analysis of mercury and trace organic concentrations in tissue. Fish tissue samples will be collected by the California Department of Fish and Game (Moss Landing), using protocols detailed in *Contaminant Levels in Fish Tissue from San Francisco Bay* (SFRWQCB 1995). Details of the protocols are documented in Appendix G and summarized below.

Collection of fish for analysis of mercury, PCBs, and chlorinated pesticides in tissue may be accomplished by a variety of methods, including hook and line, seines, gill nets, and electroshocking. Species collected will be non-migratory species that are most representative of a given location. Efforts will be made to collect fish of a similar (medium) size for each composite. Fish will be wrapped in trace metal- and organic-free Teflon™ sheets and frozen for transportation to the laboratory. The tissue samples are prepared in the laboratory using non-contaminating techniques in a clean room environment. Equal-weight tissue samples will be removed from up to 40 fish of a similar size and combined into a single 200 g composite sample.

Collection, handling and storage of tissue samples will be performed in a manner consistent with Regional Monitoring Program (RMP) protocols (SFEI 1999, SFRWQCB 1995) to assure the collection of representative, uncontaminated tissue chemistry samples. Briefly, the key aspects of quality control associated with chemistry sample collection are as follows:

- Field personnel will be thoroughly trained in the proper use of sample collection gear and will be able to distinguish acceptable versus unacceptable samples in accordance with pre-established criteria.
- Field personnel will be thoroughly trained to recognize and avoid potential sources of sample contamination (e.g., engine exhaust, winch wires, deck surfaces, ice used for cooling).

- Samplers and utensils which come in direct contact with the sample will be made of non-contaminating materials (e.g., glass, high-quality stainless steel and/or Teflon™) and will be thoroughly cleaned between sampling stations.
- Sample containers will be pre-cleaned and of the recommended type.

If the performance requirements documented in the sampling protocols are not met, the sample will be re-collected.

2.5 Bioassessment

Bioassessment monitoring includes sampling of benthic invertebrates for bioassessment evaluations. The procedure for collecting samples of benthic invertebrates from wadable streams is based on the method detailed in *California Stream Bioassessment Procedures (Habitat Assessment and Biological Sampling)* (CDFG 1996a). Specific procedures are documented in Appendix F. The method can be briefly summarized as follows:

1. Reaches for benthic invertebrate sampling are selected after an initial reconnaissance of the section or stream. The overall goal is to select homogenous wadable reaches that best typify a riffle or run condition. Avoid walking in the stream when conducting a reconnaissance survey. Each riffle used for biological assessment must be approached from downstream and no portion of the riffle disturbed until all sampling is complete. Habitat assessment should be conducted after macroinvertebrates have been collected.
2. Fill out a field log sheet for each riffle section. Enter watershed name, station name, sample identification number, date, time and names of crew members.
3. To select a transect, place the measuring tape along the bank of the entire riffle section. Each meter (3 ft) mark represents a possible transect location. Select the transects from all possible meter marks along the measuring tape using the provided table of random numbers. If only one transect is to be sampled, then select one meter mark in the top one-third of the riffle. Record the meter mark in the field log for each transect.
4. Once transects have been selected, benthic macroinvertebrates are collected from several locations along the transect and combine them into one sample. If possible, choose three locations; the two side margins and the center of the stream. If the riffle is not ideal, then make adjustments to accommodate prevailing conditions. When making adjustments, such as increasing or reducing the number of locations for collecting organisms or sampling substrate that is not gravel/cobble, try to sample similar conditions at each reach. Record the number of locations per transect in the field log.
5. Starting from the transect furthest downstream, collect macroinvertebrates with a sampling device appropriate for stream conditions. Appropriate devices for wadable reaches include the D-shaped kick-net, Needham-type kick-screen, Surber bottom samplers, and the Hess bottom sampler. Appropriate devices for non-wadable reaches include Eckman and Ponar dredges, and drift nets. Combine the three collections. Measure and record stream temperature.
6. For wadable reaches, place the combined contents from the transect in a standard size 30 or 35 (0.6 or 0.5 mm, respectively) testing sieve. Large organic material is removed by hand while carefully inspecting for clinging organisms. All remaining material is placed with forceps in a 95% ethanol filled jar. If there is considerable debris in the net, inspect the sample in a white enameled pan and rinse material from the pan through the sieve before placing it in the jar.

7. Using a pencil, record the following information for each sample on a piece of water-proof paper and place in the jar:
 - sample identification number followed by -01, -02 (to identify each transect)
 - collection date and time
 - sampler type
 - sample area
 - habitat type
 - collectors name
 - comments

If the sample collection requirements above are not met, the sample will be re-collected, if it is possible to do so without compromising sample quality.

The procedures for collecting biological samples of benthic invertebrates from non-wadable streams generally follow *Methods For Collecting Benthic Invertebrate Samples As Part Of The National Water Quality Assessment Program* (USGS 1993a). Specific procedures and any modifications are documented in Appendix F.

Table B-2. Sampling Requirements

Parameter	Sample Container	Sample Volume ⁽¹⁾	Immediate Processing and Storage	Holding Time ⁽²⁾
Mercury				
Total Mercury	Teflon™, or glass w/ PTFE-lined cap	250 mL	Store at 4°C; Field-filtered; Preserve with HCl within 48 hours	28 days
Methylmercury		250 mL		6 months
Pesticides				
Organophosphates	Amber Glass	2 Liters	Store at 4°C; Extract within 7 days	40 days
Carbamates	Amber Glass	1 Liter	Store at 4°C; Extract within 7 days	40 days
Triazines	Amber Glass	1 Liter	Store at 4°C; Extract within 7 days	40 days
General Constituents				
Total Suspended Solids	Polyethylene	500 mL	Store at 4°C	7 days
Hardness	Polyethylene	125 mL	Store at 4°C; Preserve to ≤pH 2 with HNO ₃	6 months
Total Dissolved Solids	Polyethylene	500 mL	Filtered; Store at 4°C	7 days
Alkalinity	Polyethylene	500 mL	Store at 4°C	14 days
Total Organic Carbon	Amber Glass, PTFE-lined cap	125 mL	Preserve w/ H ₂ SO ₄ ; Store at 4°C;	7 days
Dissolved Organic Carbon	Amber Glass, PTFE-lined cap	125 mL	Field-filtered ⁽⁷⁾ ; Preserve w/ H ₂ SO ₄ ; Store at 4°C;	7 days
UVA ₂₅₄	Amber Glass, PTFE-lined cap	125 mL	Store at 4°C;	48 hours
Nitrogen and Phosphorus Compounds				
Ammonia, TKN, and Total Phosphorus	Polyethylene	1 Liter	Preserve to ≤pH 2 with H ₂ SO ₄ ; Store at 4°C;	28 days
Dissolved Orthophosphate	Polyethylene	250 mL	Field-filtered; Store at 4°C;	48 hours
Nitrate, Nitrite	Polyethylene	500 mL	Store at 4°C	48 hours
Pathogens				
Total & fecal coliforms, <i>E. coli</i> , <i>Enterococcus</i>	Polyethylene	250 mL	Store at 4°C	24 hours ⁽³⁾
Biota				
Benthic Invertebrates	Polyethylene	NA	95% EtOH	NA ⁽⁴⁾
Tissue				
Fish Tissue	Teflon	200 g	Freeze until processing	6 months
Toxicity				
Aquatic bioassays and chemistry ⁽⁶⁾	Amber Glass	16 L	Store at 4°C	48 hours ⁽⁵⁾
Trace metals ⁽⁶⁾	Polyethylene	500 mL	Filter as necessary; Preserve to ≤pH 2 with HNO ₃	40 days

1. Additional volumes may be required for QC analyses; NA = Not Applicable

2. Holding time after initial preservation or extraction.

3. Samples for bacteria analyses should be set up as soon as possible.

4. There is no maximum holding time for preserved benthic invertebrate identifications.

5. Aquatic toxicity bioassays should be initiated as soon as possible.

6. For interpretation of toxicity results, samples may be split from aquatic toxicity samples in the laboratory and analyzed for specific chemical parameters. All other sampling requirements (sample containers, filtration, preservation, holding times) for these samples are as specified in this document for the specific analytical method. Results of these analyses are qualified for any other use (e.g. characterization of ambient conditions) because of potential holding time exceedances and variance from sampling requirements.

7. Field-filtration and preservation is preferred, but DOC samples may be filtered and preserved in the laboratory within 48 hours, if field filtration is not practical.

3. Sample Handling and Custody

All samples will be packed in wet ice or frozen ice packs during shipment, so that they will be kept at approximately 4°C. Samples will be shipped in insulated containers. All caps and lids will be checked for tightness prior to shipping.

All samples will be handled, prepared, transported and stored in a manner so as to minimize bulk loss, analyte loss, contamination or biological degradation. Sample containers will be clearly labeled with an indelible marker. Where appropriate, samples may be frozen to prevent biological degradation. Water samples will be kept in Teflon™, glass, or polyethylene bottles and kept cool at a temperature of 4°C until analyzed. Maximum holding times for specific analyses are listed in Table B-2.

All samples remaining after successful completion of analyses will be disposed of properly. It is the responsibility of the personnel of each analytical laboratory to ensure that all applicable regulations are followed in the disposal of samples or related chemicals.

Chain-of-custody procedures require that possession of samples be traceable from the time the samples are collected until completion and submittal of analytical results. A complete chain-of-custody form is to accompany the transfer of samples to the analyzing laboratory.

A sample is considered under custody if:

- it is in actual possession;
- it is in view after in physical possession;
- it is placed in a secure area (accessible by or under the scrutiny of authorized personnel only after in possession)

With the exception of aquatic toxicity samples, samples will be kept for a minimum of 28 days after collection. The QA officer for each laboratory will evaluate the data before the end of the 28 day period. After this period, samples may be disposed of properly when all analyses have been completed, and data quality objectives have been met. Aquatic toxicity samples may be disposed of after initial testing is complete, if no further analyses are warranted.

Sample Holding Times

Data quality objectives for sample holding times conform to recommendations documented in the analytical methods for individual parameters. All samples will be analyzed by the contract laboratory before the maximum allowable holding time for any sample is exceeded. Holding times for specific parameters are presented in Table B-2.

Field Log

Field crews shall be required to keep a field log for each sampling event. The following items should be recorded in the field log for each sampling event:

- time of sample collection;
- sample ID numbers, including etched bottle ID numbers for Teflon™ mercury sample containers and unique IDs for any replicate or blank samples;

- the results of any field measurements (temperature, D.O., pH, conductivity, turbidity) and the time that measurements were made;
- qualitative descriptions of relevant water conditions (e.g. color, flow level, clarity) or weather (e.g. wind, rain) at the time of sample collection;
- a description of any unusual occurrences associated with the sampling event, particularly those that may affect sample or data quality.

Appropriate pages from the sampling log will be photo-copied and transmitted to the Quality Assurance Manager at the conclusion of each sampling run.

The field crews shall have custody of samples during field sampling. Chain of custody forms will accompany all samples during shipment to contract laboratories. All water quality samples will be transported to the analytical laboratory by the field crew or by overnight courier.

Laboratory Custody Log

Laboratories shall maintain custody logs sufficient to track each sample submitted and to analyze or preserve each sample within specified holding times.

4. Analytical Methods Requirements

4.1 Basic Water Chemistry Analyses

Water quality samples may be analyzed for filtered and unfiltered fractions of mercury and methylmercury, trace elements, pesticides, and conventional water quality constituents. Analytical methods are summarized in Tables B-3 through B-5.

Mercury and Trace Metals

Prior to analysis of any environmental samples for mercury, methylmercury, or other trace metals, the laboratory must have demonstrated the ability to meet the minimum performance requirements for each analytical method. Initial demonstration of laboratory capability includes the following:

- the ability to produce a detection limit equal to or less than the method detection limit (MDL) listed in Table B-3;
- the ability to generate acceptable precision and recovery, as defined by *s* and *X* in Table B-3;
- the ability to generate average recoveries within 15% of the stated concentration in a Standard Reference Material (SRM).

Procedures for demonstrating analytical performance requirements, extraction procedures, and waste disposal and pollution prevention requirements are detailed in the Standard Operating Protocols or EPA Method documents for each analytical method. EPA's recommended minimum performance requirements are summarized for each trace element in Table B-3.

Pesticides

Prior to analysis of any environmental samples for pesticides, the laboratory must have demonstrated the ability to meet the minimum performance requirements for each analytical method. Initial demonstration of laboratory capability includes the following:

- the ability to produce a reporting limit equal to or less than the reporting limit (RL) listed in Table B-4;
- the ability to generate acceptable precision and recovery, as defined by the specified method;

Procedures for demonstrating analytical performance requirements, extraction procedures, and waste disposal and pollution prevention requirements are detailed in the EPA Method documents for each analytical method. EPA's recommended minimum performance requirements are summarized in the method documents.

Conventional Constituents

Analyzing laboratories must demonstrate the ability to produce reporting limits approximately equal to or below the estimated reporting limits listed in Table B-5. Precision and replicate measurements in ambient waters should be less than 20% Relative Percent Difference for all constituents. Average recovery of appropriate reference materials should be between 80 and 120% for all constituents.

Table B-3. Trace Metals: Laboratory Performance Requirements for Analysis of Water Quality Samples for Trace Metals

Analyte	Method ⁽¹⁾	MDL ⁽²⁾ , µg/L	RL ⁽³⁾ , µg/L	Accuracy ⁽⁴⁾ , X	Precision ⁽⁵⁾ , s	MS Rec ⁽⁶⁾	MS/MSD RPD ⁽⁷⁾
Arsenic	EPA 1632, 1639	.002 2.0	.005 2.0	59-134% 56-131	< 42% 31	55-146% 56-131	20% 20
Cadmium	EPA 1639	.0024	.01	64-125	23	64-145	20
Chromium	EPA 1639	0.1	0.2	74-131	26	74-131	20
Copper	EPA 1639	.024	0.1	67-154	43	63-159	20
Lead	EPA 1639	.0081	.02	56-144	44	52-144	20
Mercury	EPA 1631	.00005	.0002	70-130	21	70-130	24
Methyl- mercury	EPA 1630	.00002	.00006	69-131	31	65-135	35
Nickel	EPA 1639	.029	0.1	65-145	27	65-145	20
Selenium	EPA 1639	.83	2.0	56-131	31	56-131	20
Silver	EPA 1639	.029	0.1	55-142	19	55-142	20
Zinc	EPA 1639	.14	0.5	67-142	43	46-146	20

(1) SOP or EPA Method number

(2) Method Detection Limit: minimum concentration that can be reported with 99% confidence that the analyte is greater than zero.

(3) Target Project Reporting Limit: MDL multiplied by 3.18 and rounded to the nearest multiple of 1, 2, 5, 10, 20, 50, etc.,

(4) X = Average recovery for demonstration of initial performance

(5) s = standard deviation of recovery for demonstration of initial performance

(6) Percent recovery of matrix spike

(7) Relative percent difference of matrix spike duplicates

Table B-4 Pesticides: Analytical Methods and Estimated Reporting Limits

Analyte	RL ¹	Analyte	RL ¹
<i>Organophosphate and urea pesticides by EPA Method 8141a</i>			
Azinphosmethyl	1.0	Fenthion	0.10
Bolstar	0.10	Malathion	0.10
Chlorpyrifos	0.05	Merphos	0.10
Coumaphos	0.20	Mevinphos	0.70
Def	0.10	Naled	0.50
Demeton-S	0.20	Parathion, ethyl	0.10
Diazinon	0.05	Parathion, methyl	0.10
Dichlorovos	0.20	Phorate	0.10
Dimethoate	0.10	Prowl	0.10
Disulfoton	0.10	Ronnel	0.10
EPN	0.10	Stirophos	0.10
EPTC	0.10	Tokuthion	0.10
Ethion	0.10	Trichloronate	0.10
Ethoprop	0.10	Trifluralin	0.10
Fensulfotion	0.50		
<i>Carbamate pesticides by EPA Method 8321</i>			
Aldicarb	0.8	Linuron	0.8
Aminocarb	0.8	Methiocarb	0.8
Barban	7.0	Methomyl	7.0
Benomyl (Carbendazim)	0.8	Mexacarbate	0.8
Bromacil	0.8	Monuron	0.8
Carbaryl	0.14	Neburon	0.8
Carbofuran	0.14	Oxamyl	7.0
Chloropropham	7.0	Propachlor	7.0
Chloroxuron	0.8	Propoxur	0.8
Diuron	0.8	Siduron	0.8
Fenuron	0.8	Tebuthiuron	0.8
Fluometuron	0.8		
<i>Triazine pesticides by EPA Method 619</i>			
Ametryn	0.5	Propazine	0.5
Atraton	0.5	Simetryn	0.5
Atrazine	0.5	Simazine	0.5
Cyanazine	0.5	Terbuthylazine	0.5
Prometon	0.5	Terbutryn	0.5
Prometryn	0.5		

(1) Reporting Limit for project, based on detection limits achievable by analyzing laboratory. Because detection limits are affected by differences in sample matrices, the RLs listed are estimates.

**Table B-5 General Constituents:
Analytical Methods and Project Reporting Limits**

Constituent	Fractions	Method # (1)	RL, mg/L (2)
Alkalinity	Total	SM 403	10
Chloride	Dissolved	EPA 300	1.0
Iron	Dissolved	EPA 6010A	0.01
Manganese	Dissolved	EPA 6010A	0.01
Calcium	Dissolved	EPA 6010A	0.2
Magnesium	Dissolved	EPA 6010A	0.1
Silica	Dissolved	EPA 200.7	0.1
Sodium	Dissolved	EPA 6010A	1.0
Sulfate	Dissolved	EPA 300	1.0
Potassium	Dissolved	EPA 6010A	0.1
Suspended Solids, Total	Total	EPA 160.2	5.0
Hardness	Total, as CaCO ₃	EPA 130.2	5.0
Turbidity	Total	EPA 180.1	1.0 NTU
Dissolved Solids, Total	Total	EPA 160.1	5.0
Nitrate	Dissolved	EPA 300	.05
Nitrite	Dissolved	EPA 300	.02
Ammonia N	Dissolved	EPA 350.3	0.2
Total Kjeldahl N	Total	EPA 351.3	0.5
Orthophosphate	Dissolved	EPA 300	0.01
Phosphorus	Total	EPA 365.3	0.02
Organic Carbon	Total, Dissolved	SM 5310 C	0.2
UVA ₂₅₄	Filtered	5910B	NA ⁽³⁾

(1) Standard Methods (SM), EPA Method number, or reference.

(2) Reporting Limit for project, based on detection limits achievable by analyzing laboratory

(3) Detection limit for UVA₂₅₄ not be rigorously determined because it is a “non-specific” method (APHA *et al.* 1995)

4.2 Pathogen Analyses

Water quality samples will be analyzed for fecal and total coliform bacteria, *E. coli*, and *Enterococcus*. Analysis for coliform bacteria must be performed in accordance with the methods referenced in Table B-6. The laboratory must demonstrate the ability to meet the performance requirements described in this method.

**Table B-6 Pathogens:
Analytical Methods, and Estimated Project Reporting Limits**

Constituent	Method (1)	RL (2)
Total Coliform	SM 9221B	2 MPN 100 mL
Fecal Coliform	SM 9221E	2 MPN 100 mL
<i>E. coli</i>	SM 9221B/E mod. MUG	2 MPN 100 mL
<i>Enterococcus</i>	SM 9230C	1 colony/100 mL

(1) Standard Methods (SM) number or method reference.

(2) Reporting Limit for project.

4.3 Aquatic Toxicity Analyses

Water quality samples will be analyzed for toxicity to *Ceriodaphnia dubia*. Determination of chronic toxicity shall be performed generally as described in *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (USEPA 1994a). The only modification to these procedures is that test containers are grouped by treatment instead of being randomly arranged. This modification is not expected to have any impact on the toxicity test results.

If initial testing indicates the presence of significant and consistent toxicity, Toxicity Identification Evaluation (TIE) procedures may be initiated. Because factors responsible for chronic toxicity may not be stable for extended periods, TIE procedures may be initiated prior to completion of initial chronic toxicity testing if early responses of test organisms suggest that toxic conditions are probable, and if there is a history of toxicity at the site. The decision to initiate TIE procedures will be a consensus decision made by the Toxicity Testing Focus Group (comprised of members of the Toxics and Monitoring Sub-Committees of the Sacramento River Watershed Program). When deciding whether to initiate TIE procedures for a specific site and sample event, the Focus Group will consider a number of different factors including the history of toxicity at the site, the level of toxicity, and the species and endpoints exhibiting toxic effects. The rationale for initiating TIE procedures for a specific sample will be clearly documented in subsequent data reports. TIE methods will generally adhere to EPA procedures documented in conducting TIEs (USEPA 1991, 1992, 1993a-b). For samples exhibiting toxic effects consistent with carbofuran, diazinon, or chlorpyrifos, TIE procedures will follow those documented in Bailey *et al.* (1996). Laboratory Standard Operating Procedures for conducting TIEs are documented in Appendix D. Any project-specific modifications to these methods will be documented in future amendments to this QAPP.

4.4 Fish Tissue

Fish tissue samples will be analyzed for total mercury, PCBs, and chlorinated pesticides. Laboratories will use the protocols referenced in Table B-7 for analysis of mercury, chlorinated pesticides, and PCBs in fish tissue. These protocols are documented in Appendix G. Prior to analysis of any tissue samples, the laboratory must demonstrate the following:

- the ability to produce a detection limit equal to or less than the method detection limit (MDL) listed in Table B-7;
- the ability to generate acceptable precision and recovery, as defined in Table B-11;
- the ability to generate acceptable recoveries of a Standard Reference Material (SRM) within the limits cited in Table B-11.

Table B-7 Fish Tissue: Analytical Methods, Method Detection Limits, and Estimated Project Reporting Limits

Constituent and Method ⁽¹⁾	MDL ⁽²⁾ ng/g w.w.	RL ⁽³⁾ ng/g w.w.	Constituent and Method ⁽¹⁾	MDL ⁽²⁾ ng/g w.w.	RL ⁽³⁾ ng/g w.w.
Mercury by CVAA (SFBRWQCB 1995; Appendix G)	10	20	PCBs by ECD/GC (Appendix G)	0.2	0.5
Chlorinated pesticides by ECD/GC (Appendix G)					
Aldrin	0.26	1.0	Endosulfan sulfate	1.6	5.0
Chlordane, cis	0.68	2.0	Endrin	0.71	2.0
Chlordane, trans	0.40	2.0	Ethion	1.9	6.0
Chlordene, alpha	0.26	1.0	HCH, alpha	0.36	1.0
Chlordene, gamma	0.25	1.0	HCH, beta	0.56	2.0
Chlorpyrifos	0.81	2.0	HCH, gamma	0.27	1.0
Dacthal	0.58	2.0	HCH, delta	0.33	2.0
DDD, o,p'	0.71	2.0	Heptachlor	0.51	2.0
DDD, p,p'	0.84	2.0	Heptachlor epoxide	0.37	1.0
DDE, o,p'	0.53	2.0	Hexachlorobenzene	0.10	0.3
DDE, p,p'	0.56	2.0	Methoxychlor	1.3	5.0
DDMU, p,p'	1.1	3.0	Mirex	0.93	3.0
DDT, o,p'	1.0	3.0	Nonachlor, cis	0.96	2.4
DDT, p,p'	2.0	5.0	Nonachlor, trans	0.35	1.0
Diazinon	6.4	20	Oxadiazon	0.88	3.0
Dichlorobenzo- phenone, p,p'	5.0	20	Oxychlordane	0.29	1.0
Dicofol (Kelthane)	5.0	10	Parathion, ethyl	0.64	2.0
Dieldrin	0.40	2.0	Parathion, methyl	1.2	4.0
Endosulfan I	0.74	2.0	Tetradifon (Tedion)	0.54	2.0
Endosulfan II	0.70	2.0	Toxaphene	20	50

(1) CVAA = Cold Vapor Atomic Absorption

ECD/GC = Electron Capture Detection/Gas Chromatography

(2) Method Detection Limit: minimum concentration that can be reported with 99% confidence that the analyte is greater than zero; units are ng/g wet weight

(3) Target Project Reporting Limit: MDL multiplied by 3.18 and rounded to the nearest multiple of 1, 2, 5, 10, 20, 50, etc.; units are ng/g wet weight.

4.5 Biota

Analysis of benthic invertebrates for community abundance and diversity parameters will adhere to the protocols described in *California Stream Bioassessment Procedures (Macroinvertebrate Laboratory and Data Analyses)* (CDFG 1996) in Appendix G. This document describes sorting and identification procedures used to identify and quantify benthic invertebrate samples, and various community metrics calculated for each sample.

5. Quality Control Requirements

The types of quality control assessments used in the SRWP monitoring program are discussed below. Quality control requirements and schedules are summarized in Tables B-8 through B-11. Detailed procedures for preparation and analysis of quality control samples are provided in the analytical method documents.

Qualitative Objectives

Comparability

Comparability of the data can be defined as the similarity of data generated by different monitoring programs. For the purpose of the SRWP Monitoring Program, this objective is addressed primarily by using standard sampling and analytical procedures where possible. Additionally, comparability of analytical data is addressed by analysis of standard reference materials (discussed subsequently in this document).

Representativeness

Representativeness can be defined as the degree to which the environmental data generated by the monitoring program accurately and precisely represent actual environmental conditions. For the SRWP, this objective is addressed by the overall design of the monitoring program. Specifically, assuring the representativeness of the data is addressed primarily by selecting appropriate locations, methods, times, and frequencies of sampling for each environmental parameter, and by maintaining the integrity of the sample after collection. Each of these elements of the quality assurance program are addressed elsewhere in this document.

Completeness

Data completeness is a measure of the amount of successfully collected and validated data relative to the amount of data planned to be collected for the project. Completeness is usually expressed as a percentage value. A project objective for percent completeness is typically based on the percentage of the data needed for the program or study to reach valid conclusions. Because the SRWP is intended to be a long term monitoring program, data that are not successfully collected for a specific sample event or site can typically be recollected at a later sampling event. For this reason, most of the data planned for collection can not be considered absolutely critical, and it is difficult to set an meaningful objective for data completeness. However, some reasonable objectives for data are desirable, if only to measure the effectiveness of the Monitoring Program. The following program goals for data completeness are based on the planned sampling frequency and a subjective determination of the relative importance of the monitoring element within the Monitoring Program:

Monitoring Element	Completeness Objective
Mercury and methylmercury	90%
Pesticides	90%
General Water Quality Constituents	90%
Pathogens	90%
Aquatic Toxicity	90%
Benthic Invertebrates	95%
Fish Tissue	85%

Field Procedures

For basic water quality analyses, quality control samples to be prepared in the field will consist of field blanks and field duplicates. The number of field duplicates and field blanks are set to achieve an overall rate of at least 10% of all analyses for a particular parameter. The external QA samples are rotated among sites and events to achieve the overall rate of 10% field duplicate samples and 10% field blanks (as appropriate for specific analyses).

Field Blanks

The purpose of analyzing field blanks is to demonstrate that sampling procedures do not result in contamination of the environmental samples. Field blanks will be prepared and analyzed for all analytes of interest at the rate of one per sample event, along with the associated environmental samples. Field blanks will consist of laboratory-prepared blank water processed through the sampling equipment using the same procedures used for environmental samples. If any analytes of interest are detected at levels greater than the Reporting Limit (RL) for the parameter, the sampling crew should be notified so that the source of contamination can be identified (if possible) and corrective measures taken prior to the next sampling event. If the concentration in the associated samples is less than five times the value in the field blank, the results for the environmental samples may be unacceptably affected by contamination and should be qualified as an *upper limit* (UL) at the reported value.

Field Duplicates

The purpose of analyzing field duplicates is to demonstrate the precision of sampling and analytical processes. Field duplicates will be prepared at the rate of one per sampling event, and analyzed along with the associated environmental samples. Field duplicates will consist of two aliquots from the same composite sample, or of two grab samples collected in rapid succession. If the relative Percent Difference (RPD) of field duplicate results is greater than 25% and the absolute difference is greater than the RL, both samples should be reanalyzed. If an RPD greater than 25% is confirmed by reanalysis, environmental results will be qualified as *estimated*. The sampling crew should be notified so that the source of sampling variability can be identified (if possible) and corrective measures taken prior to the next sampling event.

Laboratory Analyses

For basic water quality analyses, quality control samples prepared in the contract laboratory(s) will typically consist of equipment blanks, method blanks, standard reference materials, laboratory duplicates, matrix spikes, and matrix spike duplicates. Laboratory analyses for bacteria will include negative and positive quality control samples, as specified in the method documents.

Equipment Blanks

The purpose of analyzing equipment blanks is to demonstrate that sampling equipment is free from contamination. Prior to using sampling equipment for the collection of environmental samples, the laboratory responsible for cleaning and preparation of the equipment will prepare bottle blanks and sampler blanks. These will be prepared and analyzed at the rate of one each per batch of bottles or sampling equipment. The blanks will be analyzed using the same analytical methods specified for environmental samples. If any analytes of interest are detected at levels greater than the MDL, the source(s) of contamination should be identified and corrected, the affected batch of bottles or

equipment should be re-cleaned, and new equipment blanks should be prepared and analyzed.

Bottle blanks will consist of one of each type of sample container required for water quality analyses, selected randomly from the set of available bottles. The bottles will be filled with laboratory-prepared blank water (acidified to $\text{pH} < 2$ for metals samples) and allowed to stand for a minimum of 24 hours before analysis.

Sampler blanks will consist of laboratory-prepared blank water processed through the sampling equipment using the same procedures used for environmental samples.

Method Blanks

The purpose of analyzing method blanks is to demonstrate that the analytical procedures do not result in sample contamination. Method blanks will be prepared and analyzed by the contract laboratory at a rate of at least one for each analytical batch. Method blanks will consist of laboratory-prepared blank water processed along with the batch of environmental samples. The method blank should be prepared and analyzed before analysis of the associated environmental samples. If the result for a single method blank is greater than the MDL, or if the average blank concentration plus two standard deviations of three or more blanks is greater than the RL, the source(s) of contamination should be corrected, and the associated samples should be reanalyzed. If reanalysis is not possible, the associated sample results should be qualified as an *upper limit* (UL) at the reported value.

Laboratory Control Samples

The purpose of analyzing laboratory control samples is to demonstrate the accuracy of the analytical method. Laboratory control samples will be analyzed at the rate of one per sample batch. Laboratory control samples will consist of laboratory fortified method blanks. If recovery of any analyte is outside the acceptable range for accuracy, the analytical process is not being performed adequately for that analyte. In this case, the sample batch should be prepared again, and the laboratory control sample should be reanalyzed. If reanalysis is not possible, the associated sample results should be qualified as *low or high biased*.

Laboratory Duplicates

The purpose of analyzing laboratory duplicates is to demonstrate the precision of the analytical method. Laboratory duplicates will be analyzed at the rate of one pair per sample batch. Laboratory duplicates will consist of duplicate laboratory fortified method blanks. If the Relative Percent Difference (RPD) for any analyte is greater than the precision criterion *and* the absolute difference between duplicates is greater than the RL, the analytical process is not being performed adequately for that analyte. In this case, the sample batch should be prepared again, and laboratory duplicates should be reanalyzed. If reanalysis is not possible, the associated sample results should be qualified as *not reproducible* due to analytical variability.

Matrix Spikes and Matrix Spike Duplicates

The purpose of analyzing matrix spikes and matrix spike duplicates is to demonstrate the performance of the analytical method in a particular sample matrix. Matrix spikes and matrix spike duplicates will be analyzed at the rate of one pair per sample batch. Each matrix spike and matrix spike duplicate will consist of an aliquot of laboratory-fortified environmental sample. Spike concentrations should be added at between 2 to 10 times the expected sample value.

If matrix spike recovery of any analyte is outside the acceptable range, the results for that analyte have failed the acceptance criteria. If recovery of laboratory control samples is acceptable, the analytical process is being performed adequately for that analyte, and the problem is attributable to the sample matrix. Attempt to correct the problem (by dilution, concentration, etc.) and re-analyze the samples and the matrix spikes. If the matrix problem can't be corrected, qualify the results for that analyte as appropriate (*low or high biased*) due to matrix interference.

If matrix spike duplicate RPD for any analyte is greater than the precision criterion, the results for that analyte have failed the acceptance criteria. If the RPD for laboratory duplicates is acceptable, the analytical process is being performed adequately for that analyte, and the problem is attributable to the sample matrix. Attempt to correct the problem (by dilution, concentration, etc.) and re-analyze the samples and the matrix spike duplicates. If the matrix problem can't be corrected, qualify the results for that analyte as *not reproducible*, due to matrix interference.

Aquatic Toxicity Quality Control

For aquatic toxicity tests, the acceptability of test results is determined primarily by performance-based criteria for test organisms, culture and test conditions, and the results of control bioassays. Control bioassays include testing with reference toxicants, and negative and solvent controls. Test acceptability requirements are documented in the method documents for each bioassay method and are included in Appendices D.

In addition to the QA requirements for the toxicity testing methods, a minimum of ten percent of the samples collected for aquatic toxicity testing will be reserved for other QC analyses. These analyses will consist of interlaboratory splits, field duplicates, or spiked samples. At least six interlaboratory split analyses will be performed during the monitoring year, *if possible*. If no appropriate laboratories are willing to perform these analyses, these QA samples will be analyzed as field duplicates by Pacific EcoRisk. Field duplicate samples analyzed for aquatic toxicity will also serve as field duplicates for alkalinity and hardness analyses. Although the laboratory has no formal limit of acceptability for analysis of spiked samples, the pattern and progress of toxic responses are evaluated subjectively for consistency with expected responses for the level of the spiked compound. Acceptable results for tests with blanks are no significant toxicity.

Benthic Invertebrates Processing and Analysis

Accuracy of identifications and precision of enumeration of benthic invertebrate collections are assessed by re-analysis of samples at the rate of one for every ten samples analyzed. This consists of complete re-examination of the organisms in the archived original sample, including remnants from the sorting process. If any additional organisms are identified in the "remnant" fraction of the archived sample, the numbers of taxa and organisms are recorded. The total number of organisms and enumeration of individual taxa for the re-examined sample should be within 5% of the original total. Discrepancies in taxonomic identification or enumeration should be resolved as soon as possible.

Fish Tissue

Quality control requirements and assessment procedures for analysis of contaminants in fish tissue are generally similar to those for water quality samples (documented above). However, for analysis of PCBs and chlorinated pesticides, surrogate compounds (internal standards) are added to each sample to assess analytical accuracy of classes of similar compounds. The acceptable range for recovery of surrogate compounds is set by the analyzing laboratory. If surrogate recoveries are outside the defined range, the sample batch should be prepared again and reanalyzed. If reanalysis is not possible, the

associated environmental data for all analytes by the specific method should be qualified as *low or high biased*, consistent with the surrogate recovery bias. If surrogate recovery bias is inconsistent for different surrogate compounds, qualify the associated environmental data as *biased* due to indeterminate surrogate recovery bias.

Table B-8a. Project Quality Control Requirements for Analysis of Water Quality Samples: Frequency¹ and Numbers of Field Quality Assurance Samples for Mercury, Organic Carbon, General Water Quality Constituents, and Pesticides.

Parameter(s)	Field Duplicates	Field Blanks	Total QA Samples
Mercury	12 (>1 per event)	12 (>1 per event)	24
Methylmercury	12 (>1 per event)	12 (>1 per event)	24
TSS	9 (>1 per event)	0	9
Hardness ⁽²⁾	No Field QA Samples		0
Alkalinity ⁽²⁾	No Field QA Samples		0
TOC and DOC	12 (1 each per event)	12 (1 per event)	24
UVA ₂₅₄	6 (1 per event)	6 (1 per event)	12
TDS	6 (1 per event)	0	6
N and P compounds ⁽³⁾	6 (1 per event)	6 (1 per event)	12
OP Pesticides	6 (1 per event)	6 (1 per event)	12
Carbamate Pesticides	6 (1 per event)	6 (1 per event)	12
Triazine Pesticides	6 (1 per event)	6 (1 per event)	12

- (1) External QA samples are rotated among sites to provide at least one field duplicate sample and one field blank per event for a particular parameter (as appropriate for specific analyses).
- (2) Evaluation of sampling precision for alkalinity and hardness will be assessed from analysis of field duplicate aquatic toxicity samples for these parameters.
- (3) Ammonia, nitrate, nitrite, total Kjeldahl nitrogen (TKN), total phosphorus, and dissolved orthophosphate.

Table B-8b. Project Quality Control Requirements for Analysis of Water Quality Samples: Trace Metals, Organic Carbon, and General Water Quality Constituents.

QA Procedure	QA Parameter	Frequency ¹	Criterion	Corrective Action
Equipment Blanks: • bottle blanks • sampler blanks	Contamination	1 per bottle lot, reagent lot, or equipment lot	< MDL	Identify contamination source. Reclean equipment. Reanalyze blank(s).
Field Blanks	Contamination	Various, see Table B-8a	< RL <i>or</i> < sample ÷ 5	Examine field log. Identify contamination source. Qualify data as needed.
Field Duplicate	Precision	Various, see Table B-8a	RPD ≤ 25% if Difference ≥ RL	Reanalyze both samples. Identify variability source. Qualify data as needed.
Method Blank	Contamination	≥1 per batch, (trace metals and OC)	< MDL <i>or</i> , if n ≥ 3, avg ± 2 s.d. < RL	Identify contamination source. Reanalyze method blank and all samples in batch.
LCS or SRM	Accuracy	1 per batch	80-120% REC	Recalibrate and reanalyze LCS or SRM and samples
Lab Duplicate	Precision	1 per batch	RPD ≤ 20% if Difference ≥ RL	Recalibrate and reanalyze.
Matrix Spike	Accuracy	1 per batch	80-120% REC	Check SRM recovery. Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Matrix Spike Duplicate	Precision	1 per batch	RPD ≤ 20%	Check lab dup RPD. Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per event	90%	Reschedule sample events as necessary or appropriate.

Notes: MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference;

RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample;

SRM = Standard Reference Material (=Certified Reference Material)

(1) The term “lot” refers to a set of bottles or reagents identifiable by a common production lot number, or to sampling equipment subjected to the same cleaning procedures as a set.

The term “batch”, as used in this document, refers to an uninterrupted series of analyses.

Table B-8c. Project Quality Control Requirements for Analysis of Water Quality Samples: Requirements for Triazine Pesticide Analyses by EPA Method 619.

QA Procedure	QA Parameter	Frequency ¹	Criterion	Corrective Action
Equipment Blanks: • bottle blanks • sampler blanks	Contamination	1 per bottle or reagent lot	< MDL	Identify contamination source. Reclean equipment. Reanalyze blank(s).
Field Blanks	Contamination	1 per event	< RL or < (sample ÷ 5)	Examine field log. Identify contamination source. Qualify data as needed.
Field Duplicate	Precision	1 per event	RPD ≤ 25% if Difference ≥ RL	Reanalyze both samples. Identify variability source. Qualify data as needed.
Matrix Spike & LCS Atrazine Terbutryn Tributylphosphate Triphenylphosphate	Accuracy	1 per batch	28-163% REC 60-117% REC 60-150% REC 76-140% REC	Check SRM recovery. Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Matrix Spike & LCS Duplicates: Atrazine Terbutryn	Precision	1 per batch	31% RPD 25% RPD	Check lab dup RPD. Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per event	90%	Reschedule sample events as necessary or appropriate.

Notes: MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference; RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample; SRM = Standard Reference Material (=Certified Reference Material)

- (1) The term “lot” refers to a set of bottles or reagents identifiable by a common production lot number, or to sampling equipment subjected to the same cleaning procedures as a set.
The term “batch”, as used in this document, refers to an uninterrupted series of analyses.

Table B-8d. Project Quality Control Requirements for Analysis of Water Quality Samples: Requirements for Organophosphorus Pesticide Analyses by EPA Method 8141A.

QA Procedure	QA Parameter	Frequency ¹	Criterion	Corrective Action
Equipment Blanks: • bottle blanks • sampler blanks	Contamination	1 per bottle or reagent lot	< MDL	Identify contamination source. Reclean equipment. Reanalyze blank(s).
Field Blanks	Contamination	1 per event	< RL or < (sample ÷ 5)	Examine field log. Identify contamination source. Qualify data as needed.
Field Duplicate	Precision	1 per event	RPD ≤ 25% if Difference ≥ RL	Reanalyze both samples. Identify variability source. Qualify data as needed.
Matrix Spike & LCS Phorate Diazinon Disulfoton Methyl Parathion Stirophos Ethion Tributylphosphate Triphenylphosphate	Accuracy	1 per batch	22-96% REC 57-130% REC 47-117% REC 55-164% REC 68-128% REC 65-134% REC 60-150% REC 76-140% REC	Check SRM recovery. Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Matrix Spike & LCS Duplicates: Phorate Diazinon Disulfoton Methyl Parathion Stirophos Ethion	Precision	1 per batch	24% RPD 21% RPD 22% RPD 24% RPD 25% RPD 20% RPD	Check lab dup RPD. Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per event	90%	Reschedule sample events as necessary or appropriate.

Notes: MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference;

RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample;

SRM = Standard Reference Material (=Certified Reference Material)

(1) The term “lot” refers to a set of bottles or reagents identifiable by a common production lot number, or to sampling equipment subjected to the same cleaning procedures as a set.

The term “batch”, as used in this document, refers to an uninterrupted series of analyses.

Table B-8e. Project Quality Control Requirements for Analysis of Water Quality Samples: Requirements for Carbamate Pesticide Analyses by EPA Method 8321.

QA Procedure	QA Parameter	Frequency ¹	Criterion	Corrective Action
Equipment Blanks: • bottle blanks • sampler blanks	Contamination	1 per bottle or reagent lot	< MDL	Identify contamination source. Reclean equipment. Reanalyze blank(s).
Field Blanks	Contamination	1 per event	< RL or < (sample ÷ 5)	Examine field log. Identify contamination source. Qualify data as needed.
Field Duplicate	Precision	1 per event	RPD ≤ 25% if Difference ≥ RL	Reanalyze both samples. Identify variability source. Qualify data as needed.
Matrix Spike & LCS Methomyl Bromacil Neburon Oryzalin	Accuracy	1 per batch	37-113% REC 58-111% REC 55-132% REC 40-140% REC	Check SRM recovery. Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Matrix Spike & LCS Duplicates: Methomyl Bromacil Neburon	Precision	1 per batch	25% RPD 25% RPD 25% RPD	Check lab dup RPD. Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per event	90%	Reschedule sample events as necessary or appropriate.

Notes: MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference; RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample; SRM = Standard Reference Material (=Certified Reference Material)

- (1) The term “lot” refers to a set of bottles or reagents identifiable by a common production lot number, or to sampling equipment subjected to the same cleaning procedures as a set.
The term “batch”, as used in this document, refers to an uninterrupted series of analyses.

Table B-9. Project Quality Control Requirements for Analysis of Water Quality Samples for Pathogens and Pathogen Indicators.

QA Procedure	Parameter	Frequency ¹	Criterion	Corrective Action
<i>Coliform and Enterococcus Bacteria Analyses</i>				
Field Blanks	Contamination	1 per event	< RL or < sample ÷ 5	Examine field log. Identify contamination source. Qualify data as needed.
Method Blanks (Sterility Checks)	Contamination	1 per batch	< RL	Identify contamination source. Clean equipment and slides. Check reagents. Re-analyze blank.
Lab Duplicate	Precision ²	1 per 10 samples, and at least 1 per batch	$R_{log} \leq 3.27 \cdot \text{mean } R_{Log}$	Recalibrate and reanalyze.
Negative Control Samples	Contamination	1 per culture medium or reagent lot	< RL	Identify source. Clean equipment and prepare new media. Re-examine negative control
Positive Control Samples	Assay function	1 per culture medium or reagent lot	\geq RL	Identify and correct problem. Re-examine positive control.
Assess percent of data successfully collected	Data Completeness	1 per planned sample event	90%	Reschedule sample events as necessary or appropriate.

Notes: MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference; RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample; SRM = Standard Reference Material (=Certified Reference Material)

- (1) The method documentation defines an analytical batch as an “uninterrupted series of analyses”.
 (2) R_{log} is the absolute difference between logarithms of coliform counts for duplicate analyses. The mean R_{log} is determined by performing duplicate analyses on the first 15 positive sample analyzed for each matrix type.

Table B-10. Project Quality Control Requirements for Analysis of Benthic Invertebrates.

QA Procedure	Parameter	Frequency	Criterion	Corrective Action
Re-examination of sample	Accuracy	1 per 10 benthic invertebrate samples	$\leq 5\%$ difference	Resolve differences in identification and enumeration.
	Precision		$\leq 5\%$ difference	
Assess percent of data successfully collected	Data Completeness	1 per planned sample event	100%	Reschedule sample events as necessary or appropriate.

Table B-11a. Project Quality Control Requirements for Analysis of Fish Tissue for Mercury.

QA Procedure	Parameter	Frequency	Criterion	Corrective Action
Method Blank (a.k.a. analytical blank or lab reagent blank)	Contamination	1 per batch	< MDL <i>or</i> < 10% of lowest sample	Identify contamination source. Reanalyze method blank and all samples in batch.
SRM (a.k.a. certified reference material)	Accuracy	1 per batch of 20 or fewer samples	Within 20% of the certified 95% confidence interval, <i>or</i> within 20% of the certified mean	Review raw data quantitation reports Check instrument response using calibration standard Recalibrate and reanalyze SRM and samples Repeat analysis until control limits are met
SRM (a.k.a. certified reference material)	Precision	1 per batch of 20 or fewer samples	RPD \leq 35%, <i>or</i> RSD \leq 30%	Recalibrate and reanalyze. If problem persists eliminate source of imprecision and reanalyze.
Field Duplicate (two aliquots from same composite sample: RMP calls this a lab duplicate)	Precision	1 per batch	RPD \leq 35%	Recalibrate and reanalyze. If problem persists eliminate source of imprecision and reanalyze.
Matrix Spike	Accuracy	1 per batch	> 50% REC	Check SRM or LCS recovery. Review raw data quantitation reports Check instrument response using calibration standard Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Matrix Spike Duplicate	Precision	1 per batch	RPD \leq 35%	Check lab duplicate RPD. Review raw data quantitation reports Check instrument response using calibration standard Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per planned sampling event	85%	Reschedule sampling as necessary or appropriate.

MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference; RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample; SRM = Standard Reference Material (=Certified Reference Material)

**Table B-11b. Project Quality Control Requirements for Analysis of Fish Tissue
for Organochlorine Pesticides and PCBs.**

QA Procedure	Parameter	Frequency	Criterion	Corrective Action
Method Blank (a.k.a. analytical blank or lab reagent blank)	Contamination	1 per batch	< MDL <i>or</i> < 10% of lowest sample	Identify contamination source. Reanalyze method blank and all samples in batch.
SRM (a.k.a. certified reference material)	Accuracy	1 per batch of 20 or fewer samples	As a group: 70% of the analytes within 35% of the 95% confidence interval Individually: No analyte >30% of 95% confidence interval for 2 consecutive analyses	Review chromatograms and raw data quantitation reports Check instrument response using calibration standard Recalibrate and reanalyze SRM and samples Repeat analysis until control limits are met
SRM (a.k.a. certified reference material)	Precision	1 per batch of 20 or fewer samples	RPD \leq 35%, <i>or</i> RSD \leq 30%	Recalibrate and reanalyze. If problem persists eliminate source of imprecision and reanalyze.
Field Duplicate (two aliquots from same composite sample)	Precision	1 per batch	RPD \leq 35%	Recalibrate and reanalyze. If problem persists eliminate source of imprecision and reanalyze.
Matrix Spike	Accuracy	1 per batch	> 50% REC	Check SRM or LCS recovery. Review chromatograms and raw data quantitation reports Check instrument response using calibration standard Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Matrix Spike Duplicate	Precision	1 per batch	RPD \leq 35%	Check lab duplicate RPD. Review raw data quantitation reports Check instrument response using calibration standard Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Surrogate Spike	Accuracy	1 per batch	set by analyzing laboratory	Check SRM or LCS recovery. Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per planned sampling event	85%	Reschedule sampling as necessary or appropriate.

MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference; RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample; SRM = Standard Reference Material (=Certified Reference Material)

6. Instrument and Equipment Preventive Maintenance

Sample Equipment Cleaning Procedures

Equipment used for sample collection (peristaltic pump tubing, carboys and carboy caps, and sample bottles) will be cleaned according to the specific procedures documented for each analytical method. Clean sample containers will be provided by the laboratories performing the analyses. Clean peristaltic pump tubing, carboys and carboy caps used for collecting mercury and methylmercury samples will be provided by the Department of Fish and Game Moss Landing Marine Lab. Note that the same pump tubing and carboys may also be used to collect samples for analysis of other parameters. The cleaning procedures for equipment used to collect water quality samples are documented in Appendices C and D, and E. The cleaning procedure for equipment used to collect fish tissue samples is documented in Appendix G.

At least one equipment blank will be generated and analyzed for mercury and methylmercury prior to initiating monitoring for the current program year, and additional equipment blanks will be analyzed for new lots of critical cleaning reagents. In addition, for all analytes where contamination is considered a significant concern, field blanks will be collected and analyzed as directed in Section B-5 of this document. If the results of these analyses indicate any contamination, the source will be identified and corrected, and the equipment will be re-cleaned and re-tested. The combined regimen of equipment blanks and field blanks is considered to provide adequate control against potential systematic equipment contamination problems.

Analytical Instrument and Equipment Testing Procedures and Corrective Actions

Testing, inspection, maintenance of analytical equipment used by the contract laboratory, and corrective actions are documented in the Quality Assurance manuals for each analyzing laboratory. Laboratory QA Manuals are made available for review at the analyzing laboratory.

7. Calibration Procedures and Frequency

Laboratory Analytical Equipment

Frequency and procedures for calibration of analytical equipment used by each contract laboratory is documented in the Quality Assurance Manual for each contract laboratory. Laboratory QA Manuals are made available for review at the analyzing laboratory.

Field Instruments

Calibration of all instruments used for measurement of field parameters (temperature, pH, dissolved oxygen, and electroconductivity) are performed as described in the owner's manuals for individual instruments. Instruments used to measure pH, dissolved oxygen, and electroconductivity should be calibrated prior to taking field measurements at each site for each event. Typical field instrument calibration procedures are as follows:

- Temperature calibration is factory-set and requires no subsequent calibration.
- Calibration for pH measurement is accomplished using standard buffer solutions.
- Calibration for dissolved oxygen measurements is accomplished using an oxygen-saturated water sample.
- Calibration for electroconductivity measurements is generally accomplished using potassium chloride standard solutions.

8. Inspection/Acceptance Requirements for Supplies and Consumables

Gloves, sample containers, and any other consumable equipment used for sampling will be inspected by the sampling crew on receipt and will be rejected/returned if any obvious signs of contamination (torn packages, etc.) are observed. Inspection protocols and acceptance criteria for laboratory analytical reagents and other consumables are documented in the Quality Assurance Manuals for individual laboratories. Laboratory QA Manuals are made available for review at the analyzing laboratory.

9. Quality Control Requirements for Indirect Measurements

Water quality data collected by this monitoring program is intended to complement data collected by several other programs: the National Water Quality Assessment program (NAWQA), the Sacramento Coordinated Water Quality Monitoring Program, and monitoring efforts by the Department of Water Resources, Department of Pesticide Regulation, U.S. Bureau of Reclamation, the City of Sacramento, and City of Redding. Each of these programs has stringent quality assurance and quality control elements comparable to those described in this document. It is anticipated that data reported by these programs can be used without limitation for the purposes of the SRWP monitoring program. It is the responsibility of the Quality Assurance Manager to acquire, validate, and compile the necessary data from these programs.

10. Data Management

Copies of field logs, copies of chain of custody forms, original preliminary and final lab reports, and electronic media reports will be sent to the Quality Assurance Manager. Each type of report will be stored separately and ordered chronologically. Original field logs will be retained by the field crew. Original chain of custody forms will be retained by the contract laboratory. Copies of the preliminary and final data reports will be retained by the contract laboratory(s).

Concentrations of chemicals and toxicity endpoints, and all numerical biological parameters will be calculated as described in the laboratory Standard Operating Procedures or referenced method document for each analyte or parameter.

The various data and information generated from the SRWP monitoring program will be stored and maintained at the Monitoring Program Manager's offices. The data generated from the monitoring program will be transmitted to the Quality Assurance Manager in various formats and converted to a standard database format maintained on personal computers in the Monitoring Program Manager's offices. After data entry or data transfer procedures are completed for each sample event, data will be inspected for data transcription errors, and corrected as appropriate. After the final QA checks for errors are completed, the data are added to the final database. The production of data tables are generated from this database.

In cases where environmental results are less than the reporting limit for a parameter, the results will be reported as "less than" the reporting limit; e.g. an analytical result of 4 µg/L for an analyte with a reporting limit of 5 µg/L will be reported as <5 µg/L.

In cases where field blank results exceed the acceptance criteria listed in Table B-0.1, data collected during the associated sample run will be qualified and reported as follows:

- Measured environmental sample concentrations greater than or equal to 5 times the field blank level will be reported with no qualification.
- Measured environmental sample concentrations less than 5 times the field blank level will be qualified as "less than" the measured value, e.g. if a field blank is equal to 1.5 µg/L, a measured environmental concentration of 4.0 µg/L will be reported as <4.0 µg/L.
- Any data qualifications resulting from QC analyses will be reported with the environmental data as appropriate.

C. ASSESSMENT AND OVERSIGHT

1. Assessments and Response Actions

Assessments of compliance with quality control procedures will be undertaken on a routine basis during the data collection phase of the project:

- Performance assessments of sampling procedures will be performed by the field sampling crews. Corrective actions shall be carried out by the field sampling crew and reported to the Quality Assurance Manager.
- Assessment of laboratory QC results and implementation of corrective actions will be the responsibility of the QA officer at each laboratory and shall be reported to the Quality Assurance Manager as part of any data reports.
- Assessment of field QC results and implementation of corrective actions shall be the responsibility of the Quality Assurance Manager.

Routine procedures to assess precision and accuracy, criteria for success, and corrective actions have been discussed previously (Section B) and are summarized in Table B-8 through B-11.

Quarterly status reports will be produced by the Monitoring Program Manager to document project status, results of performance evaluations, data quality assessments, and any significant QA problems and recommended solutions. Quarterly project status reports will be distributed to the SRCSD Project Manager and the EPA Project Officer.

2. Quality Assurance Reports to Management

A quality assurance report will be prepared by the Quality Assurance Manager following each year of monitoring, as part of the annual report produced for the SRWP. The quality assurance report will summarize the results of QA/QC assessments and evaluations, including precision, accuracy, comparability, representativeness, and completeness of the monitoring data. The annual report will be distributed to the project managers, as well as to all other program participants and interested parties.

D. DATA VALIDATION AND USABILITY

1. Data Review, Validation, and Verification

In addition to the data quality objectives presented in Tables B-8 through B-11, the standard data validation procedures documented in the contract laboratory's Quality Assurance Manuals will be used to accept, reject, or qualify the data generated by the laboratory. Each laboratory's QA officer will be responsible for validating data generated by the laboratory. The primary monitoring contractor (Pacific EcoRisk) will be responsible for initial verification of data submitted by analyzing labs, including electronic data reports. The Quality Assurance Manager will be responsible for final validation and for qualifying all data based on the evaluation of field and laboratory quality control samples.

2. Data Reporting

Laboratory personnel will verify that the measurement process was "in control" (i.e., all specified data quality objectives were met or acceptable deviations explained) for each batch of samples before proceeding with the analysis of a subsequent batch. In addition, each laboratory will establish a system for detecting and reducing transcription and/or calculation errors prior to reporting data.

Only data which have met data quality objectives, or data which have acceptable deviations explained, will be submitted by the laboratory. When QA requirements have not been met, the samples will be reanalyzed when possible and only the results of the reanalysis will be submitted, provided they are acceptable.

E. REVISIONS TO THE QUALITY ASSURANCE PROJECT PLAN

The purpose of this section is to document significant additions, deletions, and revisions to the approved QAPP for this project, and to provide the rationale for these changes. The history of significant changes to the QAPP are summarized below.

1. Revisions for Fish Tissue Monitoring Performed in 1998

The QAPP was updated to reflect information specific to sampling and analyses performed for the fish tissue element of the Year II monitoring program. The changes to the QAPP were required for two reasons: (1) additional sites were monitored for contaminants in fish tissue in Year II, and (2) the analytical laboratory and protocols were changed for some analyses. Significant changes required to specific sections of the QAPP are listed in Table E-1. The rationale for these changes is summarized below.

Fish tissue monitoring was added at 3 new sites: Sacramento River near Hamilton City, Natomas East Main Drain, and the American River at J Street. The Hamilton City site was added to better characterize the long stretch of the mainstem Sacramento River between Red Bluff and Colusa. The Natomas East Main Drain site and the American River at J Street site were added to provide additional monitoring detail near the American River at Discovery Park site, due to relatively high tissue contaminant concentrations observed at this site.

For Year II, the laboratory selected to perform analyses for organic contaminants in fish tissue was changed to the California Department of Fish and Game Water Pollution Control Laboratory. This change was made primarily to provide better detection limits for a variety of organic analytes in fish tissue. The change in laboratories and analytical protocols also resulted in the reporting of results for several additional analytes: toxaphene, dicofol, endosulfan I and II, mirex, and diazinon.

These changes were provisionally approved by EPA prior to sampling in September, 1998. Final approval of the revisions was granted in March, 1999.

Table E-1. Revisions to Sacramento River Watershed Program QAPP Specific to Fish Tissue Monitoring Performed in 1998

Section	QAPP Element	Description of Revision
A.6.	Project Description	<ul style="list-style-type: none">Table A-3 was updated with new sites.
B.1.	Sampling Design	<ul style="list-style-type: none">Table B-1 and Figure B-1 were updated with new sites.
B.4.	Analytical Methods Requirements	<ul style="list-style-type: none">Toxaphene, dicofol, endosulfan I, endosulfan II, mirex, and diazinon were added to Table B-7.Method detection limits and project reporting limits in Table B-7 were revised for the new analytical laboratory (CDFG WPCL).
App. I.	Analytical Protocols: Analysis Of Extractable Synthetic Organic Compounds In Tissue	<ul style="list-style-type: none">Methods from the new analytical lab (CDFG WPCL) were added to supporting documentation.

2. Revisions for Monitoring Performed in 1999-2000

The QAPP was updated for monitoring planned for 1999-2000. Revisions to the QAPP are required for two principal reasons: (1) additional sites are being monitored for water chemistry parameters and fish tissue, and (2) some new parameters are being monitored. In addition, protocols have been added or changed slightly for some parameters. Changes required to specific sections of the QAPP are listed in Table E-2. The rationales for these changes are briefly discussed below.

Monitoring for several parameters has been added at 2 new sites: Sacramento River near Hamilton City, and at Putah Creek. The Hamilton City site was added to better characterize the long stretch of the mainstem Sacramento River between Red Bluff and Colusa. Fish tissue monitoring has been added at one new site (Putah Creek) to better characterize the human health risks from relatively high concentrations of mercury and organochlorine pesticides at this site. Fish tissue monitoring was discontinued at 3 upper watershed sites (the Pit River above Shasta, the McCloud river above Shasta, and the Sacramento River above Shasta) because (1) concentrations of pollutants in trout caught from these sites did not appear to warrant continued monitoring for potential human health risks, and (2) the program has shifted focus to largemouth bass and white catfish, which tend to accumulate higher concentrations of pollutants than trout, and are typically caught only in the lower watershed.

For the 1999-2000 monitoring year, three protocols have been added for analysis of pesticides in water: EPA Method 8141A for organophosphorus pesticides, EPA Method 8321 for carbamate pesticides, and EPA Method 619 for triazine pesticides. The analytical protocols were added to the QAPP to allow monitoring of pesticides at sites with evidence of (or significant potential for) water quality degradation due to these parameters.

There are two other significant changes in analytical protocols: (1) analysis of protozoan organisms in water, and (2) analysis of organic carbon in water. The ICR method for the protozoans *Giardia* and *Cryptosporidium* has been replaced with EPA's Method 1623. This method was recently approved for both *Giardia* and *Cryptosporidium* and released in April 1999. This method provides significant improvements in analytical accuracy and precision over the ICR method. The method for analysis of organic carbon has been changed to the method used by the USGS NAWQA program. This revision was made primarily because the USGS method provides a lower detection limit than the previous method (EPA 415.1). The lower detection limit (0.2 mg/L) is expected to provide better characterization of the organic carbon concentrations in ambient waters monitored by this program, and is also expected to result in an overall improvement in precision and accuracy for analyses of this parameter.

For the 1999-2000 program, monitoring for toxicity to the fathead minnow, *Pimephales promelas*, is continued under a program funded by a CALFED grant. Because this monitoring is no longer performed under the management of the Sacramento River Watershed Program, information unique to this monitoring element has been removed from the QAPP.

Additional revisions to the QAPP protocols are summarized in Table E-2.

Table E-2. Revisions to Sacramento River Watershed Program QAPP For Monitoring Year 1999-2000

Section	QAPP Element	Description of Revision
A.6.	Project Description	<ul style="list-style-type: none"> • <i>Pesticides in Water</i> was added to the list of measurements. • <i>Pimephales</i> (Aquatic toxicity) was deleted from Table A-1 • Table A-3 was updated for new fish tissue site. • Discussion of rationale(s) for monitoring was updated for new parameters
B.1.	Sampling Design	<ul style="list-style-type: none"> • Table B-1 and Figure B-1 were updated with new sites • Text summary of sampling design was updated
B.2.	Sampling Methods Requirements	<ul style="list-style-type: none"> • <u>Section B.2.1</u>, text was added re: <i>pesticides in water</i> • <u>Section B.2.1</u>, revised to specify field-filtration for organic carbon samples by USGS NAWQA methods. • <u>Section B.2.2</u>, updated for protozoan sampling by EPA method 1623 • <u>Section B.2.2</u>, revised to be consistent with 24-hour allowable holding time for bacteriological samples • <u>Section B.2.4</u>, revised to be more consistent with modifications in NAWQA methods, and to allow use of modified Van Veen grabs for deep channels. Added text re: sample requirements for follow-up analyses. • <u>Section B.2.5</u>, updated references to revised method document for stream bioassessment; updated reference to SFEI 1999 QAPP for fish tissue sampling. • <u>Table B-2</u>, revised for lab analysis of turbidity. • <u>Table B.2</u>, updated for sampling method changes described.
B.4.	Analytical Methods Requirements	<ul style="list-style-type: none"> • <u>Section B.4.1</u>, Text and table(s) were added for analysis of pesticides in water. • <u>Section B.4.1</u>, In Table B-5, methods for most constituents were amended to functionally equivalent EPA methods. The EPA methods adequately serve the needs of the monitoring program, and are comparable in accuracy and precision to the Standard Methods that they replaced. • <u>Section B.4.2</u>, Changed to EPA Method 1623 for protozoa • <u>Section B.4.3</u>, Deleted references to Pimephales tests. Revised to include analysis of water chemistry by methods for water quality samples documented herein. • <u>Section B.4.4</u>, Revised to include follow-up analyses of bulk chemistry by USGS NAWQA methods, and elutriates by methods for water quality samples documented herein. • <u>Section B.4.5</u>, Revised to refer to original CDFG method documents for Macroinvertebrate analyses (CDFG 1996), instead of derivative DWR methods. These methods are essentially equivalent and this change does not indicate a real change in sampling or analytical methods.

Table E-2. (Continued from previous page)

Section	QAPP Element	Description of Revision
B.5.	Quality Control Requirements	<ul style="list-style-type: none"> Table B-9: Updated for EPA 1623, and revised to delete field duplicates for pathogens and field blanks for protozoa (These external QA elements are not appropriate for the specific methods). Updated field QA frequencies in all tables for desired numbers of QA samples for 1999-2000 monitoring.
B.6.	Instrument and Equipment Preventive Maintenance	<ul style="list-style-type: none"> Revised to read as follows: <i>“Equipment used...cleaned according to the specific procedures documented for each analytical method. At least one equipment blank will be generated prior to initiating monitoring for the current program year. In addition, field blanks will be collected and analyzed as directed in Section B-5 of this document. If the results of these analyses indicate...”</i>
B.7.	Calibration Procedures and Frequency	<ul style="list-style-type: none"> Revised as follows: “Instruments used to measure pH, dissolved oxygen, and electroconductivity should be calibrated prior to taking field measurements at each site for each event.”
E.	References	<ul style="list-style-type: none"> Updated to include references for new or changed methods discussed above.
App. A	Analytical Labs and Contacts	<ul style="list-style-type: none"> Updated for new laboratories
App. D	Modifications to Standard EPA Test Methods	<ul style="list-style-type: none"> Updated to reflect the following revisions in UCD ATL testing protocols: <ol style="list-style-type: none"> (1) Feeding will follow EPA protocols for <i>Ceriodaphnia</i>; (2) <i>Ceriodaphnia</i> test containers will be 30 ml glass; (3) Statistical testing utilizes modified EPA protocols.
App. D	Toxicity Test Acceptability Requirements	<ul style="list-style-type: none"> The separate section for Toxicity Test Acceptability Requirements was removed because it duplicated information in the previous section (the UCD Aquatic Toxicity Lab QAPP).
App. I	Analytical Protocols: Analysis Of Extractable Synthetic Organic Compounds In Tissue	<ul style="list-style-type: none"> Updated with CDFG WPCL methods.
Various	Forms: Labels, Log Sheets, and Data Reports	<ul style="list-style-type: none"> Updated label and field log examples for several appendices.

3. Revisions for Monitoring Performed in 2000–2001

The QAPP was amended for monitoring planned for 2000-2001. Revisions to the QAPP are required for several reasons:

- Changes in sampling and analytical contractors;
- changes in monitoring locations for bioassessment parameters, and 1 new location for coordination with a CALFED Mercury Study;
- Changes in monitoring frequency,
- some monitoring elements were discontinued, and
- some new parameters are being monitored. In addition, protocols have been added or changed slightly for some parameters (aquatic tox, organic carbon). Changes required to specific sections of the QAPP are listed in Table E-3. The rationales for these changes are briefly discussed below.

Changes in sampling and analytical contractors. In 1999, the contracts for monitoring performed in 2000-2001 for the SRWP were put out to public bid. The overall monitoring contract was awarded to a new prime contractor, Pacific EcoRisk of Martinez, California, on the basis of their experience and the abilities of Pacific EcoRisk and its subcontractors to meet the needs of the SRWP monitoring program. As a result of awarding the monitoring contract to Pacific EcoRisk, there were several changes in the contractors performing sampling and analysis for the SRWP in 2000-2001:

- Pacific EcoRisk will collect all water samples with the following exceptions: (1) event-based samples for mercury from the Sacramento River at Greene's Landing, will be collected by California Department of Fish and Game staff (Moss Landing Marine Lab), and (2) samples from the Sacramento River at Veterans Bridge, Freeport and River Mile 44, and from the American River at Discovery Park, will be collected by Sacramento River Coordinated Monitoring Program (Sacramento Regional County Sanitation District staff).
- Pacific EcoRisk will perform analyses for aquatic toxicity, suspended and dissolved solids, hardness, and alkalinity in water;
- Sierra Foothill Laboratory will analyze water samples for dissolved and total organic carbon;
- Frontier GeoScience will analyze water samples for methylmercury (a new parameter for the SRWP monitoring program).

As part of the proposal review and selection process, all laboratories were evaluated to determine whether they were capable of providing the analytical services required by the SRWP. Evaluations included (but were not limited to) consideration of certifications for analytes of interest, monitoring/analytical experience, an in-place QA plan, statements of qualifications, and references for related projects. In addition, after the contract was awarded, the new laboratories were requested to provide the following information to confirm their ability to meet SRWP data needs:

- a copy of the laboratory Quality Assurance plan,
- Standard Operating Protocols for the analyses of interest,
- copies of certifications for analyses of interest,
- documentation of Quality Assurance performance for analyses of interest,
- data from participation in any performance evaluation studies, and

- the results of any external audits.

Each of the three new analytical laboratories provided the requested information and, after review, were determined to have appropriate accreditation, adequate analytical performance, and a sufficient Quality Assurance program in place to provide analytical services for the SRWP monitoring program. This information is on file with the monitoring program managers (LWA) and is available for review on request.

Changes in monitoring locations. For the 2000-2001 monitoring year, bioassessment monitoring has been initiated in three new tributary watersheds (Cow Creek, Battle Creek, and Stony Creek), and discontinued or reduced in four tributary watersheds (McCloud River, Mill Creek, Deer Creek, Big and Chico Creek). The changes in bioassessment monitoring locations are simply the implementation of the existing strategy to rotate monitoring into new tributary watersheds on a two year cycle. This strategy was developed as a compromise between the need to provide baseline information in tributaries throughout the watershed, and the need to provide longer term and more in-depth monitoring data for individual tributary watersheds.

Monitoring for mercury and methylmercury will be conducted at one additional new location (Sacramento River at Greene's Landing). This site was added to SRWP monitoring to coordinate with a significant CALFED-funded study of mercury loading in the Sacramento River. This location is also long-standing monitoring location for the Central Valley Regional Water Quality Control Board.

Fish tissue monitoring was also added at Stony Creek because it is considered to have the potential for high mercury concentrations.

Discontinued monitoring elements. For the 2000-2001 monitoring year, monitoring for nutrients, minerals, turbidity, and trace metals in water (except for mercury), sediment toxicity, and algal bioassessment was discontinued. Organic carbon, TDS, and TSS monitoring were also discontinued at upper watershed sites. All of these elements were discontinued in part as a result of budget constraints and prioritization of the remaining available monitoring budget. There were also additional rationales specific to each monitoring element:

- Review of the 1998-1999 SRWP monitoring results and recently available data from other programs (USGS NAWQA) for nutrients, minerals, turbidity, and trace metals monitoring by the SRWP and other programs indicate that these parameters are probably causing little, if any, impairment of beneficial uses in the Sacramento River watershed. These same results indicated that organic carbon, TDS, and TSS were unlikely to be causing impairment to beneficial uses in the upper watershed.
- Sediment toxicity monitoring was implemented largely as a pilot program to evaluate whether this type of monitoring was useful for identifying impairments due to sediment-associated toxic pollutants, and the sources of those pollutants. It was determined that the results of the monitoring were difficult to interpret on a local or regional scale, and that sediment monitoring would not provide the type of information needed by the SRWP monitoring program.
- Algal bioassessment monitoring was implemented to provide baseline data for algal community parameters (e.g. diversity, species richness, abundance and presence of sensitive species) and algal biomass in the mainstem Sacramento River and major tributaries. This data was collected for the first two years of the program, but has not yet been interpreted and reported. The SRWP Monitoring Sub-Committee decided to suspend this monitoring element until the current data set could be interpreted and evaluated.

Changes in monitoring frequency. The basic monitoring frequency was changed from monthly to 9 events per year. This change was primarily a response to budget constraints. In order to best satisfy the monitoring goals and priorities of the SRWP, some reductions in monitoring frequency were considered preferable to discontinuing monitoring for additional parameters or at existing monitoring locations. Monitoring reductions were implemented during periods of expected relatively constant water quality (dry season, low flows), and in December (due to logistical constraints of analytical holding times and lab holiday schedules).

New parameters being monitored. For the 2000-2001 monitoring year, analysis of methylmercury in water was added to the monitoring program. Methylmercury is the most bioavailable form of mercury, and has been identified as an important factor in understanding potential human health risks due to mercury pollution in the Sacramento River watershed. Monitoring for methylmercury was added to support Water Quality Management Strategies being developed by the SRWP to control the risks due to mercury pollution in the watershed, and augments and coordinates with several other significant monitoring programs. Analysis for methylmercury will be performed by Frontier Geosciences Laboratory, and protocols for sampling and analysis of methylmercury have been added to the QAPP.

Changes in analytical and sampling protocols. There was one significant change in analytical protocols for the 2000-2001 monitoring year. The method for analysis of organic carbon has been changed from the method used by the USGS NAWQA program to Standard Method 5310C (APHA *et al.* 1995). This revision was made primarily because SM 5310C analysis provides accuracy, precision, and detection limits comparable to the USGS method at a lower cost to the program. In addition, the sampling requirements for SM 5310C are less complicated and require less time in the field. Finally, because SM 5310C is available from commercial analytical laboratories, the results of monitoring will be available for review sooner than results from the USGS laboratory. Overall the change in methods are expected to provide more timely results that are adequate for the needs of the monitoring program and comparable to results from the previous monitoring year (1999-2001).

All samples will be collected as grab samples for the 2000-2001 monitoring year. This change was made for a combination of reasons: (1) At mainstem sites where cross-sectional samples were previously collected, conditions were typically well-mixed, so that grab samples would provide comparable data. (2) Cross-sectional samples were collected primarily to support mass-loading assessments of trace metals, and trace metals monitoring was discontinued for the 2000-2001 season (except for mercury). (3) Grab samples are consistent with the methods of a major new monitoring program (CALFED) with which the SRWP is coordinating monitoring efforts focused on mercury.

Additional revisions to the QAPP protocols are summarized in Table E-3.

Table E-3. Revisions to Sacramento River Watershed Program QAPP For Monitoring Year 2000-2001

Section	QAPP Element	Description of Revision
A.1.	Project Management	<ul style="list-style-type: none"> Title page and approvals list revised for changes to project management and contractors.
A.2.	Table of Contents	<ul style="list-style-type: none"> Amended to reflect changes in QAPP documentation
A.3-4.	Distribution List, Project Organization and Responsibility	<ul style="list-style-type: none"> Amended to reflect changes in SRWP management, participation, and contractors
A.6.	Project Description	<ul style="list-style-type: none"> <i>Mercury and Methylmercury in Water</i> was added to the list of measurements. <i>Trace Metals in Water, Sediment Toxicity, and Algae</i> were deleted from the list of measurements. Turbidity, minerals, and nutrients were deleted from the list of <i>General Constituents</i> measured in water. <u>Table A-1</u> and the discussion of rationale(s) for monitoring was updated for new and discontinued parameters. <u>Table A-2</u> (Project Implementation Schedule) was revised for 2000 – 2001 monitoring. <u>Sampling Schedule</u> section (including Table A-3) was modified to reflect changes in parameters measured, reduced sampling frequency for most parameters, and changes in sampling strategy (from scheduled to episodic) for pesticides and aquatic toxicity.
B.1.	Sampling Design	<ul style="list-style-type: none"> <u>Table B-1</u>, <u>Figure B-1</u>, and the text were amended to reflect new and discontinued sampling locations.
B.2.	Sampling Methods Requirements	<ul style="list-style-type: none"> <u>Section B.2.1</u>, text revised for new and discontinued parameters; all samples collected as grab samples; organic carbon sampling method changed from USGS procedure to protocols consistent with analysis by Standard Method 5310C. <u>Section B.2.1</u>, changed to specify collection of samples analyzed for protozoa as 10-liter water samples top be filtered by the analyzing laboratory (as allowed by the EPA Method 1623 used). <u>Section B.2.4</u>, Fish Tissue sampling was moved to its own section from B.2.5. Sediment Toxicity was deleted (this monitoring element was discontinued). <u>Section B.2.5</u> (now Biota), the section on Algae was deleted (this monitoring element was discontinued). Table B-2 was modified to reflect new (MeHg) and discontinued parameters (metals, minerals, nutrients, algae, sediment toxicity), and to reflect change in organic carbon method.

Table E-3. (continued from previous page)

QAPP Section	QAPP Element	Description of Revision
B.4.	Analytical Methods Requirements	<ul style="list-style-type: none"> • <u>Section B.4.1</u>, Text was added for analysis of methylmercury in water. Methylmercury was added in Table B-3. In Table B-5, the method for organic carbon was changed to Standard Method 5310C. This method adequately serves the needs of the monitoring program, and is comparable in accuracy and precision to the USGS method it replaces. Methods for other parameters were retained in Tables B-3 and B-5 in the event that analysis of these parameters is necessary for aquatic toxicity follow-up. • <u>Section B.4.3</u>, was revised to specify that the only modification from EPA methods is non-random placement of aquatic toxicity test chambers. A paragraph discussing chemical analysis of 10% of aquatic toxicity samples was deleted (discontinued for 2000-2001). <u>Rationale</u>: These analyses were performed at the suggestion of the California Department of Pesticide Regulation (DPR) to allow some regulatory use of the data. DPR later indicated that SRWP aquatic toxicity results were of little value for regulatory purposes, and the analyses did not provide useful QA data, the random chemical analyses were subsequently discontinued. • <u>Section B.4.4</u>, Fish Tissue Analyses was moved to its own section. The Sediment Toxicity Analyses section was deleted (this monitoring element was discontinued). • <u>Section B.5.5</u>, the section on Algae was deleted (this monitoring element was discontinued).
B.5.	Quality Control Requirements	<ul style="list-style-type: none"> • References to discontinued monitoring elements (sediment toxicity, algae) were deleted. • Regular interlab splits of aquatic toxicity samples were discontinued, with the exception of several splits analyzed early in the monitoring year to assess adequate comparability of results from new analytical contractor(s). <u>Rationale</u>: Split analyses performed in previous monitoring years did not provide any useful quality assurance information. • Methylmercury and pesticides were added to Table 8a (Summary of frequency of field QA samples). • <u>Table B-8a</u>, field duplicate samples were discontinued for alkalinity and hardness. <u>Rationale</u>: Replicate aquatic toxicity samples will be analyzed for alkalinity and hardness and provide adequate assessment of sampling precision for these parameters. Replicate samples analyzed for TDS and EC will also provide additional assessment of sampling precision.

Table E-3. (continued from previous page)

QAPP Section	QAPP Element	Description of Revision
B.5.	Quality Control Requirements	<ul style="list-style-type: none">• <u>Table B-9</u>, corrected to read “Positive Control Samples” as QA Procedure to check for Assay Function (<i>All Pathogen Analyses</i>).• <u>Table B-10</u>, “Split Samples” QA Procedure deleted (only relevant to discontinued algae monitoring element).
B.6.	Instrument and Equipment Preventive Maintenance	<ul style="list-style-type: none">• Reference to sediment sample equipment cleaning procedure deleted (monitoring element was discontinued).
D.	Data Validation and Usability	<ul style="list-style-type: none">• Modified to specify that the primary monitoring contractor (Pacific EcoRisk) will be responsible for initial verification of data submitted by analyzing laboratories.
App. A	Sampling and Analytical Responsibilities and Contacts	<ul style="list-style-type: none">• Updated for new sampling and analytical contractors, and changes in monitoring elements.
App. C	Supporting Documents for Chemical Water Quality Monitoring	<ul style="list-style-type: none">• Protocols for sampling and analysis of methylmercury were added.• USGS sampling and analytical protocols for organic carbon were deleted.
App. D	Supporting Documents for Aquatic Toxicity Monitoring	<ul style="list-style-type: none">• QA/QC Manual and SOPs for UCD Aquatic Toxicology Lab were replaced with QA/QC Manual and SOPs for Pacific EcoRisk.
App. E and H (old)	Sediment Toxicity, Algal Monitoring	<ul style="list-style-type: none">• Deleted (monitoring elements were discontinued).

4. Revisions for Monitoring Performed in 2001–2002

The QAPP was amended for monitoring planned for 2000-2001. Revisions to the QAPP are required for several reasons:

- Changes in sampling and analytical contractors;
- Changes in monitoring scope for bioassessment;
- New monitoring locations for mercury and aquatic toxicity, and some changes in fish tissue monitoring locations;
- Changes in monitoring frequency and basis;
- Monitoring for *Cryptosporidium* and *Giardia* has been suspended, and some new parameters are being monitored.

Changes required to specific sections of the QAPP are listed in Table E-4. The rationales for these changes are briefly discussed below.

Sampling and analytical contractors. There are two significant changes in sampling and analytical contractors for 2001-2002. Sampling for fish will be conducted by Applied Marine Sciences (AMS). AMS will be assisted by the primary monitoring contractor, Pacific EcoRisk. AMS is experienced and has demonstrated the ability to achieve high quality sampling results in freshwater, estuarine, and marine environments for the San Francisco Bay's Regional Monitoring Program (SFEI 1999). AMS was also responsive to the need to perform the sampling on a "time and materials" basis, a factor which is important for optimal use of the limited SRWP budget. Fish tissue sampling was previously performed by the California Department of Fish and Game Moss Landing Marine Lab.

Methylmercury in water will be analyzed by Battelle Marine Science Laboratory in 2001-2002. The primary reason for this change in contractors was a significant cost savings for the program. Battelle has demonstrated the ability to reliably analyze methylmercury using EPA method 1630 (*draft*) to achieve the low detection limits needed to meet SRWP objectives. EPA method 1630 was developed by Frontier Geosciences under contract to U.S. EPA and is identical to the method used by Frontier (FGS 070.1 and 013.2) to analyze methylmercury for the SRWP in the previous monitoring year.

Bioassessment scope. The focus of the SRWP 2001-2002 bioassessment monitoring effort will be on identifying reference conditions in the Sierra Nevada foothill region. The Sierra foothill region was selected for the initial focus of this effort because this region is undergoing rapid development and urbanization. The identification of reference sites and conditions are critical for interpreting bioassessment monitoring results and for developing biocriteria. The process developed for identifying and selecting reference sites should have application throughout the watershed and the state. This effort will be conducted by the same laboratory that has performed bioassessment monitoring for the SRWP in previous years (California Department of Fish and Game's Water Pollution Control Laboratory). A significant part of CDFG's scope will be documentation of the process and criteria for selecting reference sites. The prospective reference sites identified by this effort are expected to be sampled for the fall 2002 bioassessment monitoring. No sampling and analysis of benthic macroinvertebrates is planned for 2001, but physical habitat assessments will be performed at selected prospective reference sites.

Monitoring locations. The following locations have been added for mercury monitoring in 2001-2002: Cottonwood Creek (3 or 4 locations), Battle Creek (3 or 4 locations), Thomes Creek (3 or 4 locations), Dry Creek (one site), and Little Chico Creek (one site).

All of these locations have been added to provide a better understanding of the mercury sources in the Sacramento River Watershed. Cottonwood Creek, Battle Creek, and Thomes Creek are relatively large tributary watersheds for which there are little or no mercury data, and Dry Creek and Little Chico Creek may be affected by significant historical mining operations in that watershed.

Ceriodaphnia toxicity monitoring will be performed at three new locations (the Pit River above Shasta, Cottonwood Creek at the mouth, and Cache Creek at Rumsey).

- The Pit River site was added because it is one of the major sources of flow in the watershed, and sporadic toxicity has been observed in the past. The SRWP and local watershed groups actively working in this watershed are interested in assessing whether toxicity continues to be a significant problem in this watershed.
- The Cottonwood Creek site was added because mining historically conducted in this watershed and CVRWQCB metals analyses data indicate a significant potential for aquatic toxicity.
- The Cache Creek site was added because it is on the 303(d) list for unknown toxicity. The Regional Board has conducted additional monitoring at this site, but chronic TIE work is needed to characterize the causes of toxicity.

Fish tissue monitoring will be conducted at 9 locations, compared to the 15 locations monitored in 2000-2001. The primary reason for the decrease in the number of locations is decreased available budget. The sites selected by the SRWP Fish Tissue Focus Group for monitoring include six previously monitored sites considered to be the highest priority for continued monitoring, and three new sites. The rationales for these site selections are summarized below:

Table E-4. SRWP Fish Tissue Monitoring for 2001-2002

Location	Rationale for Site Selection
Sacramento River below Keswick	PCB concentrations lower in 2000 than observed previously
Colusa Basin Drain	Elevated levels of organochlorine pesticides observed in carp in 2000
Feather R. between Yuba and Bear rivers	<u>New site</u> —Useful for tracking bioavailable mercury sources in the Feather River
Feather River near Nicolaus	Elevated mercury concentrations with high inter-annual variability
American River above J Street	Useful for tracking bioavailable mercury sources
American River at Discovery Park	Elevated mercury and PCB concentrations
Sacramento River At RM44	Long-term tracking site
Cache Creek	<u>New site</u> —High water column mercury concentrations and potentially high tissue mercury concentrations
Prospect Slough	<u>New site</u> — potentially high tissue mercury concentrations (receives high mercury concentration flows from Cache Creek and Yolo Bypass)

Monitoring frequency and basis. The base monitoring frequency for 2001-2002 has been reduced to 6 events per year (from 9 events per year for 2000-2001). This change in monitoring frequency has been made to accommodate a significant decrease in the SRWP budget for 2001-2002 monitoring. In order to best satisfy the monitoring goals

and priorities of the SRWP, some reductions in monitoring frequency were considered preferable to discontinuing monitoring for additional parameters or at existing monitoring locations. The basis for planning sample events was also changed to “episodic” (event-based) for all parameters in 2001-2002. This change was made to allow the program to focus on specific hydrological conditions and other events relevant to water quality (low and high flows, storm events, pesticide application seasons and events, spills, etc.).

Monitoring parameters. For monitoring being performed in 2001-2002, analyses were added for ultraviolet absorbance at 254 nm (UVA₂₅₄), *E. coli* bacteria, and *Enterococcus* bacteria. Some organic compounds commonly found in wastewaters and natural surface waters (lignin, humic and fulvic acids, and some aromatic compounds) strongly absorb ultraviolet radiation. Strong correlations have been demonstrated with organic carbon and precursors of trihalomethanes and other disinfection by-products (APHA *et al.* 1998), and UVA₂₅₄ is a useful surrogate measure for these parameters. UVA₂₅₄ will be analyzed by Standard Method 5910 (*ibid.*) by Sierra Foothill Laboratory.

Coliform bacteria are considered indicators of fecal contamination and the possible presence of enteric pathogens such as *Cryptosporidium* and *Giardia*. The USEPA recommends monitoring *Escherichia coli* and *Enterococci* as the preferred indicators of pathogen organisms. *E. coli* will be analyzed by BioVir Laboratory by Standard Method 9221F EC-MUG method, and *Enterococci* will be analyzed by Standard Method 9230C (APHA *et al.* 1998).

Monitoring for *Cryptosporidium* and *Giardia* has been suspended for the 2001-2002 effort. Although the analytical method used to monitor *Giardia* and *Cryptosporidium* in 1999-2001 is much improved (compared to the ICR method used previously), there remains a high degree of uncertainty associated with data for these pathogens. Recoveries of *Cryptosporidium* are lower than desirable, and recoveries of both organisms are lower in turbid waters. In addition, there are currently no regulatory limits or meaningful environmental benchmarks for surface waters for these pathogens. Due to the uncertainties associated with the analytical method and interpretation of the results, monitoring of these pathogens has been temporarily suspended by the SRWP. Monitoring may be resumed in subsequent years after further assessment of the results from monitoring conducted in 1999-2001.

Nitrogen and phosphorus compounds (ammonia, nitrate, nitrite, total Kjeldahl nitrogen, total phosphorus, and dissolved orthophosphate) will be monitored again for 2001-2002. These compounds were monitored in 1998-2000, but were not monitored during the 2000-2001 monitoring effort. Monitoring for these parameters was resumed primarily due to the expected implementation of national nutrient criteria by the U.S. Environmental Protection Agency, and will be conducted at _ sites. Analysis of nitrogen and phosphorus compounds will be performed by Sierra Foothill Laboratory.

Table E-5. Revisions to Sacramento River Watershed Program QAPP For Monitoring Year 2001-2002

QAPP Section	QAPP Element	Description of Revision
A.1.	Project Management	<ul style="list-style-type: none"> Title page and approvals list revised for changes to project management and contractors.
A.2.	Table of Contents	<ul style="list-style-type: none"> Amended to reflect changes in QAPP documentation
A.3-4.	Distribution List, Project Organization and Responsibility	<ul style="list-style-type: none"> Amended to reflect changes in SRWP management, participation, and contractors
A.6.	Project Description	<ul style="list-style-type: none"> Nitrogen and phosphorus compounds and UVA₂₅₄ were added to the list of <i>General Constituents</i> monitored in water. <i>Enterococcus</i> and <i>E. coli</i> were added to the list of <i>Pathogens</i> monitored in water. <i>Giardia</i> and <i>Cryptosporidium</i> were deleted from the list of pathogens monitored in water. <u>Table A-1</u> and the discussion of rationale(s) for monitoring was updated for new and discontinued parameters. <u>Table A-2</u> (Project Implementation Schedule) was revised for 2001–2002 monitoring. <u>Sampling Schedule</u> section (including Table A-3) was modified to reflect changes in parameters measured, reduced base sampling frequency for most parameters, and the change to an “event-based” sampling strategy for all parameters.
B.1.	Sampling Design	<ul style="list-style-type: none"> <u>Table B-1</u>, <u>Figure B-1</u>, and the text were amended to reflect new and discontinued sampling locations.
B.2.	Sampling Methods Requirements	<ul style="list-style-type: none"> <u>Section B.2.1</u>, text revised for new parameters (nitrogen and phosphorus compounds, UVA₂₅₄) <u>Section B.2.2</u>, text deleted for protozoa sampling; text added for <i>E. coli</i> and <i>Enterococcus</i> bacteria. Table B-2 was modified to reflect new parameters (nitrogen and phosphorus compounds, UVA₂₅₄).

Table E-5. (continued from previous page)

B.4.	Analytical Methods Requirements	<ul style="list-style-type: none">• <u>Section B.4.1</u>, Text was added for analysis of new parameters. In Table B-5, the method for UVA₂₅₄ was added (SM 5910). Methods for trace metals were retained in Tables B-3 in the event that analysis of these parameters is necessary for aquatic toxicity follow-up. The method for methylmercury was changed to EPA 1630. Methods for nitrogen and phosphorus compounds were already included in Table B-5 from the previous QAPP, and were retained.• <u>Section B.4.2</u>, text and tables were revised to reflect suspension of protozoan analyses and addition of analyses for <i>E. coli</i> and <i>Enterococcus</i>.• <u>Section B.4.5</u>, describing analysis of benthic invertebrates was retained to allow analysis of selected samples for development of reference sites and conditions.
B.5.	Quality Control Requirements	<ul style="list-style-type: none">• Tables B-8a and B-8b were revised to reflect new sampling schedule and to include UVA₂₅₄ and nitrogen and phosphorus compounds. Scheduling of external QA samples) was changed to provide at least one field duplicate and blank per event per parameter.• References to suspended monitoring elements (protozoa) were deleted in text and Table B-9. References to analyses of benthic macroinvertebrates were retained to allow for analysis of some samples from selected potential reference sites.
App. A	Sampling and Analytical Responsibilities and Contacts	<ul style="list-style-type: none">• Updated for new sampling and analytical contractors, and changes in monitoring elements.
App. C	Supporting Documents for Chemical Water Quality Monitoring	<ul style="list-style-type: none">• SOPs for analysis of methylmercury by FGS-013.2 and FGS-070.1 were replaced with EPA Method 1630 (DRAFT) for methylmercury.
App. B, D-H		<ul style="list-style-type: none">• No changes were made to these appendices.

F. REFERENCES

- Alpers, C, H Taylor, and J Domagalski. 1999. Metal Transport in the Sacramento River, California, 1996-97: Part 1. Methods and Data. U.S. Geological Survey Water Resources Investigations Open File Report 99-4286. U.S. Geological Survey, Sacramento, California.
- APHA, AWWA, and WEF 1995. Standard Methods for the Examination of Water and Wastewater, 19th Edition. American Public Health Association (APHA), American Waterworks Association (AWWA), and Water Environment Association (WEF). Washington, DC.
- ASTM 1995. Standard guide for conducting sediment toxicity tests with freshwater invertebrates. ASTM 1995 Annual Book of Standards Vol. 11.04, E1706-95. American Society for Testing and Materials (ASTM), Philadelphia, PA.
- Bailey H, C DiGiorgio, K Kroll, J Miller, D Hinton, and G Starrett. 1996. Development of procedures for identifying pesticide toxicity in ambient waters: Carbofuran, diazinon, and chlorpyrifos. Environmental Toxicology and Chemistry 15: 837-845.
- Brenton and Arnett 1993. Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory - Determination of dissolved organic carbon by UV-promoted persulfate oxidation and infrared spectrometry. U.S. Geological Survey Open-File Report 92-480, 12 p.
- CDFG 1990. Laboratory Quality Assurance Program Plan. California Department of Fish and Game (CDFG), Environmental Services Division.
- CDFG 1996a. California Stream Bioassessment Procedure for Habitat Assessment and Biological Sampling. California Department of Fish and Game, Aquatic Bioassessment Laboratory and Water Pollution Control Laboratory, Rancho Cordova, California.
- CDFG 1996b. California Stream Bioassessment Procedure (Macroinvertebrate Analyses and Data Analyses). California Department of Fish and Game, Aquatic Bioassessment Laboratory and Water Pollution Control Laboratory, Rancho Cordova, California.
- CDFG 1996c. California Stream Bioassessment Procedure (Field and Laboratory Quality Assurance/Control). California Department of Fish and Game, Aquatic Bioassessment Laboratory and Water Pollution Control Laboratory, Rancho Cordova, California.
- Connor 1991. A laboratory Manual for the Preparation and Use of Ion Exchange Resins to Determine the Concentration and Biotoxicity of Dissolved Trace Metals in Freshwater Samples. California Regional Water Quality Control Board (RWQCB), Central Valley Region. Sacramento, California.
- Cuffney T, M Gurtz, and M Meador. 1993. Methods for Collecting Benthic Invertebrate Samples as part of the National Water Quality Assessment Program. Open-File Report 93-406, U.S. Geological Survey.
- Deanovic, L, K Cortright, K Larsen, H Bailey, D Hinton, V Connor. 1998. Guidelines for conducting Toxicity Identification Evaluation Procedures in Urban Runoff: A

Laboratory Manual. Aquatic Toxicology Laboratory, University of California Davis.
Prepared for the Central Valley Regional Water Quality Control Board.

- Norberg-King, T, D Mount, E Durham, G Ankley, L Burkhard. 1991. Methods for Aquatic Toxicity Identification Evaluations: Phase 1 Toxicity Characterization Procedures (Second Edition). EPA-600/6-91/003. U.S Environmental Protection Agency, Environmental Research Laboratory, Duluth, Minnesota.
- Plafkin *et al.* 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish. EPA/444/4-89-001. U.S. EPA, Office of Water. Washington, DC.
- RWQCB 1991. The Use of Ion Exchange Resins to Determine the Biototoxicity and Concentration of Dissolved Trace Metals in Natural Waters. California Regional Water Quality Control Board (RWQCB), Central Valley Region. Sacramento, California.
- SFBRWQCB 1995. Contaminant Levels in Fish Tissue from San Francisco Bay. San Francisco Bay Regional Water Quality Control Board (SFBRWQCB), Oakland, California.
- SFEI 1999. 1999 Quality Assurance Project Plan: Regional Monitoring Program for Trace Substances. San Francisco Estuary Institute (SFEI), Richmond, CA.
- Shelton 1994. Field guide for collecting and processing stream-water samples for the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 94-455, 42 p.
- Slotton D, S Ayers, J Reuter, and C Goldman. 1995. Gold Mining Impacts on Food Chain Mercury in Northwestern Sierra Nevada Streams, Technical Completion Report [DRAFT]. Division of Environmental Studies and Institute of Ecology, University of California, Davis.
- USEPA 1979. Handbook for Analytical Quality Control in Water and Wastewater Laboratories. U.S. Environmental Protection Agency (USEPA). EPA 600-4-79-019.
- USEPA 1979. Methods for Chemical Analysis of Water and Wastes (EPA 600-4-79-020). U.S. Environmental Protection Agency (USEPA).
- USEPA 1991. Methods for Aquatic Toxicity Identification Evaluations: Phase I Toxicity Characterization Procedures. EPA 600/6-91-003. U.S. Environmental Protection Agency (USEPA), Office of Research and Development.
- USEPA 1992. Toxicity Identification Evaluation: Characterization of Chronically Toxic Effluents, Phase I. EPA 600/6-91-005F. U.S. Environmental Protection Agency (USEPA), Office of Research and Development.
- USEPA 1993. Method 619: Determination Of Triazine Pesticides In Industrial And Municipal Wastewater. EPA-821-R-93-010-A.
- USEPA 1993a. Methods for Aquatic Toxicity Identification Evaluations: Phase II Toxicity Identification Procedures for Samples Exhibiting Acute and Chronic Toxicity (EPA 600/R-92-080). U.S. Environmental Protection Agency (USEPA), Office of Research and Development.
- USEPA 1993b. Methods for Aquatic Toxicity Identification Evaluations: Phase I and III Toxicity Identification Procedures for Samples Exhibiting Acute and Chronic

Toxicity (EPA 600/R-92-081). U.S. Environmental Protection Agency (USEPA), Office of Research and Development.

USEPA 1993c. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms. Fourth Edition, EPA-600/4-90-027F. U.S. Environmental Protection Agency (USEPA), Office of Research and Development, Cincinnati, OH.

USEPA 1994. Method 8141a: Organophosphorus Compounds By Gas Chromatography: Capillary Column Technique. U.S. Environmental Protection Agency, Office of Water.

USEPA 1994. Method 8321: Solvent Extractable Non-Volatile Compounds By High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TSP/MS) Or Ultraviolet (UV) Detection. U.S. Environmental Protection Agency, Office of Water.

USEPA 1994a. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms (EPA 600/4-91-002). U.S. Environmental Protection Agency (USEPA), Office of Research and Development. July 1994.

USEPA 1994b. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates. EPA-600/R-94/024. U.S. Environmental Protection Agency (USEPA), Office of Research and Development, Washington DC.

USEPA 1995. Guidance on the Documentation and Evaluation of Trace Metals Data Collected for Clean Water Act Compliance Monitoring. EPA 821-B-95-002. U.S. Environmental Protection Agency, Office of Water, Washington DC.

USEPA 1995. Method 1631: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry. U.S. Environmental Protection Agency (USEPA), Office of Water. EPA 821-R 95-027.

USEPA 1995. Method 1632: Determination of Inorganic Arsenic in Water by Hydride Generation Flame Atomic Absorption. U.S. Environmental Protection Agency (USEPA), Office of Water. EPA 821-R-95-028.

USEPA 1995. Method 1638: Determination of Trace Elements in Ambient Waters by Inductively Coupled Plasma-Mass Spectrometry. U.S. Environmental Protection Agency (USEPA), Office of Water. EPA 821-R-95-031.

USEPA 1995. Method 1639: Determination of Trace Elements in Ambient Waters by Stabilized Temperature Graphite Furnace Atomic Absorption. U.S. Environmental Protection Agency (USEPA), Office of Water. EPA 821-R-95-032.

USEPA 1995. Method 1640: Determination of Trace Elements in Ambient Waters by On-Line Chelation Preconcentration and Inductively Coupled Plasma-Mass Spectrometry. U.S. Environmental Protection Agency (USEPA), Office of Water. EPA 821-R-95-033.

USEPA 1995. Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels. U.S. Environmental Protection Agency (USEPA), Office of Water. EPA 821-R-95-034.

USEPA 1996. ICR Microbial Laboratory Manual. U.S. Environmental Protection Agency, Office of Research and Development. EPA/600/R-95/178. Washington DC.

- USEPA 1999. Method 1623: *Cryptosporidium* and *Giardia* in Water by Filtration/IMS/FA. U.S. Environmental Protection Agency, Office of Water. EPA 821-R-99-006.
- USEPA 2001. Method 1630 (*DRAFT*): Methyl Mercury in Water by Distillation, Aqueous Purge and Trap, and CVAFS. EPA-821-R-01-020. U.S. Environmental Protection Agency, Office of Water, Washington, DC.
- USGS 1993a. Method For Collection Of Benthic Invertebrate Samples As Part Of The National Water-Quality Assessment Program. Open-File Report 93-406. U.S. Geological Survey, Raleigh, NC.
- USGS 1993b. Method For Collection Of Algal Samples As Part Of The National Water-Quality Assessment Program. Open-File Report 93-409. U.S. Geological Survey, Raleigh, NC.
- USGS 1994. Guidelines for Collecting and Processing Samples of Stream Bed Sediment for Analysis of Trace Elements and Organic Contaminants for the National Water-Quality Assessment Program. Open-File Report 94-458. U.S. Geological Survey, Sacramento, CA.
- USGS 1997. Laboratory Manual for Analysis of Algal Samples (*DRAFT*). U.S. Geological Survey (USGS).
- Wershaw *et al.* 1987. Methods for the determination of organic substances in water and fluvial sediments. Techniques of Water-Resources Investigations of the United States Geological Survey. Book 5, Chapter A3, 80 p.