QUALITY ASSURANCE MANAGEMENT PLAN FOR PROJECTS FUNDED BY U.S. ENVIRONMENTAL PROTECTION AGENCY DEVELOPMENT GRANTS FOR BEACH WATER QUALITY AND PUBLIC NOTIFICATION PROGRAMS

PREPARED BY:

THE CALIFORNIA DEPARTMENT OF HEALTH SERVICES

June 20, 2002

California
Department of
Health Services

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INTRODUCTION

This Quality Assurance Management Plan (QAMP) was developed by the California Department of Health Services (DHS) as part of the development and implementation of beach water quality monitoring and public notification programs funded by development grants from the U.S. Environmental Protection Agency. The Beaches Environmental Assessment and Coastal Health Act, signed into law on October 10, 2000, authorized EPA to award program development and implementation grants to eligible states to support microbiological testing and monitoring of coastal recreation waters that are adjacent to beaches or similar points of access used by the public. It is anticipated that the grant to be awarded to the state of California in the year 2002 will be $535,643.

This QAMP provides documentation of how DHS will plan, implement, and assess the effectiveness of quality assurance and quality control operations of individual beach water quality monitoring and public notification programs which may receive funding from this grant. Specifically, this QAMP provides assurance that:

- Water quality and other environmental data collected by the individual programs are of the appropriate type and quality, and
- Technology used for monitoring and analyses is designed, constructed, and operated according to defined specifications and protocols.

The format and guidelines for developing individual Quality Assurance Project Plans (QAPPs) has been standardized by the State Water Resources Control Board. These guidelines are widely used by various monitoring projects throughout the state of California, and were developed to meet EPA quality assurance/quality control requirements as specified in 40 CFR Part 30. An example of SWRCB's model for developing a QAPP has been included in this QAMP.

The overall purpose for a QAPP is to describe project management, measurement and data acquisition activities, and review, validation, and reporting of data to users. The objective of a QAPP is to ensure that the quality of the data collected is known and is appropriate for the objectives of the monitoring program. Collecting, analyzing, and evaluating environmental data are complex activities. To be successful in such operations requires a systematic, structured process that give data users the necessary confidence in the quality of data that support their decisions. The QAPP is a document that explains the quality assurance/quality control (QA/QC) requirements to the sampling team, analytical laboratory, management, and other interested parties.

PURPOSE AND SCOPE

Water quality and other environmental data are critical inputs to decisions involving the protection of the public and the environment from the adverse effects of pollutants from natural and man-made sources. As key inputs to the decision-making process, environmental data must be accurate and reliable. Compliance with QA/QC practices will ensure that the environmental data are accurate and reliable.

This QAMP is a management tool that defines how DHS will attain its quality management objectives for compliance with QA/QC practices and assurance of data that are accurate and reliable for beach water quality monitoring and public notification programs funded by development grants from EPA. Areas addressed within this QAMP include:

- Organization and Management
- Roles and Responsibilities
- Personnel Qualifications and Training
- QA/QC Requirements
- Documentation and Records
- Data Management
- Planning and Implementation
- Assessment and Response

It is anticipated that variations in beach water quality monitoring projects may occur due to differences in topography, population, climate, and usage of the beaches throughout the coastline of California. However, despite the possible differences that may occur, it is the intent of DHS to ensure that data from all monitoring projects are accurate and reliable.

ORGANIZATION AND MANAGEMENT

DHS will provide oversight on the development and implementation of QA/QC elements for beach water quality monitoring and public notification programs funded by development grants from EPA. DHS' program representative is:

Raymond Tom, Environmental Scientist
Department of Health Services
601 North 7th Street
Sacramento, California 95814
(916) 327-5590

ROLES AND RESPONSIBILITIES

To ensure that EPA QA/QC requirements are met by beach water quality monitoring and public notification programs funded by development grants from EPA, DHS will provide oversight on the following:

- Integration of quality control procedures into beach water quality monitoring activities, including collection, analysis, validation, reporting, storage (retention), and dissemination of data.
- Consistent production of environmental data of a quality which is known and quantifiable.
- Review of QAPPs developed by individual beach water quality monitoring programs to ensure that QA/QC elements of the monitoring program meet EPA requirements.
- Assurance that all laboratory analytical procedures are EPA approved procedures or equivalent, and that all laboratories providing analytical services are certified by the state of California through the Environmental Laboratory Accreditation Program.
- Assurance of compatibility and compliance of QA/QC activities with federal and State QA/QC requirements.

PERSONNEL QUALIFICATIONS AND TRAINING

All personnel involved in beach water quality monitoring programs are expected to be familiar with and comply with the principles in the respective QAPPs.

Field sampling teams should be adequately trained to follow appropriate procedures for field sampling and analysis, to know what documentation is required, and to know when a corrective procedure is necessary. The project manager of the individual beach water quality monitoring program is responsible for ensuring that members of the sampling team are adequately trained.

Laboratory personnel should have the appropriate education, training, and experience in the specific area of work. The laboratory director or manager is responsible for ensuring that all laboratory personnel are adequately trained.

Project managers of each beach water quality monitoring program should maintain adequate records and documentation of training for each employee of the program. In addition, project managers should regularly assess employees' knowledge and competence in the use of appropriate QA/QC procedures and determine employees' training needs.

QA/QC REQUIREMENTS

It is anticipated that variations in beach water quality monitoring projects may occur due to differences in topography, population, climate, and usage of the beaches throughout the coastline of California. As a result, specific QA/QC elements in QAPPs may vary between individual monitoring projects.

The format and guidelines for developing individual QAPPs has been standardized by SWRCB. These guidelines are widely used by various monitoring projects throughout the state of California, and were developed to meet EPA quality assurance/quality control requirements as specified in 40 CFR Part 30. This QAMP includes an example of SWRCB's model for developing a QAPP in Appendix A. The example included is the QAPP model used by citizen monitoring projects, and can be downloaded from SWRCB's website at http://www.swrcb.ca.gov/nps/docs/model_qapp32701.doc. Instructions for the use of the QAPP model are included in Appendix B. These instructions can be downloaded from SWRCB's website at http://www.swrcb.ca.gov/nps/docs/mod_qapp_instr_deg1101.doc.

DOCUMENTATION AND RECORDS

Project managers of each beach water quality monitoring program are responsible for ensuring that all documentation and records pertaining to their monitoring program are maintained and properly stored so that the information is readily retrievable for review and inspection. Records and documents which should be retained include, but are not limited to:

- Laboratory data reports
- Laboratory quality control reports
- Chain of custody forms
- Field logs
- Instrument printouts
- Results of calibration and QC checks
- Field sampling case narratives
- Laboratory analysis case narratives
- All information and records which are included in a project-specific data report package
- QAPPs
- Sampling and analysis plans
- Standard operating procedures
- Personnel training records
- Results of audits and reviews

All laboratories providing analytical services for beach water quality monitoring programs are responsible for retaining all appropriate records and documents which include, but are not limited to:

- Quality assurance manuals
- Personnel training records
- Results of certification surveys and evidence of certification by appropriate regulatory or accreditation agencies
- Standard operating procedures
- Receiving documents such as chain of custody records and sample integrity reports
- Stock standard logs
- Calibration records for analytical instruments, balances, thermometers, and other equipment
- Internal quality control checks such as laboratory control samples, method blanks, matrix spikes, and surrogate recoveries
- Analytical control charts and out-of-control reports
- Results of performance and system audits

DATA MANAGEMENT

All laboratories providing analytical services for beach water quality monitoring programs are responsible for providing all necessary data, including all quality control data, which may include but are not limited to:

- Precision of replicate measurements
- Accuracy of measurements
- Descriptions of analytical methods and reporting limits
- Blank and recovery measurements
- Sample handling documentation to ensure adherence to method holding-time limits

Each project manager is responsible for ensuring that all appropriate field data are documented in appropriate field or log sheets utilized by the water quality monitoring program. QAPPs should indicate how specific types of data will be stored with respect to the type of media, conditions, location, retention time, and access.

Each project manager is also responsible for ensuring that data are validated through a systematic process of reviewing data against established criteria. This process is conducted to ensure the validity of the data prior to its use, and consists of evaluating the quality and reliability of data from both field measurements and laboratory analyses. Validation of field data involves verification of appropriate collection, preservation and transport protocols, and the use of duplicates and reference samples. Validation of laboratory data involves review of checks on precision and accuracy (such as duplicate sample analyses, reference samples, matrix spike samples, and laboratory control samples), evaluation of blanks, interlaboratory comparisons, and instrument calibration data.

Finally, each project manager is responsible for correct processing of acceptable data, using appropriate mathematical, statistical, and graphical procedures to convert raw environmental data into usable information. This data reduction process may consist of changes in form or expression of the data, quantity of data values, or numbers of data items. Errors in data reduction should be eliminated through use of appropriate quality control procedures, including procedures for reviewing and checking data.

PLANNING AND IMPLEMENTATON

Project managers are responsible for ensuring that beach water quality monitoring programs are systematically planned and implemented, and that the planning and implementation process is documented in QAPPs. The planning process must ensure that all parties who contribute to the quality of the monitoring program or use the results are identified and that they participate in the planning process. That process should include direct communications to ensure that all participants clearly understand the needs and expectations of the end users and the results.

The four basic elements for planning and implementing environmental monitoring projects that should be included in QAPPs include:

- Project management
- Measurement/data acquisition
- Assessment and oversight
- Data validation and usability

ASSESSMENT AND RESPONSE

Assessments of each beach water quality monitoring programs should be conducted periodically to examine the level of performance and quality within each program, and to provide a basis for improving the program. Assessment tools which may be used include:

- Management system reviews
- Surveillances
- Quality audits
- Performance evaluations
- Audits of data quality
- Peer reviews and technical reviews
- Readiness reviews
- Data quality assessments

Project managers are responsible for ensuring that their beach water quality monitoring programs are periodically reviewed and assessed using one or more of the assessment tools listed above. Corrective actions should be taken when a performance failure is discovered or when quality audits reveal deficiencies. Corrective actions may include identifying faulty equipment or procedures, providing additional training to personnel, and resampling and reanalysis of samples. Each project manager is responsible for implementing corrective actions, and should maintain appropriate documentation of quality assurance problems, corrective actions taken, and their results or outcomes.

APPENDIX A

**QAPP MODEL
DEVELOPED BY
SWRCB**

1. Title and Approval Page

(Note: Instructions are given in bold type. Make sure to complete all underlined sections and remove the underlining upon completion. Also, erase the instructions and any irrelevant sections of the plan as you complete the QAPP for your specific project.)

(Insert your organization's name here in place of "The Clean Water Team Model")

THE CLEAN WATER TEAM MODEL
QUALITY ASSURANCE PROJECT PLAN

OUTLINE PREPARED BY:
First Edition: Gwen Starrett, SWRCB, 1998
Second Edition: Dominic Gregorio, SWRCB, 2001

COMPLETED PLAN PREPARED BY:
____

Refer correspondance to:
(give name, organization, address, telephone, and email)

Approvals:

Agency / Organization: ______________________

Signature: ______________________ Date: __________

Agency / Organization: ______________________

Signature: ______________________ Date: __________

Agency / Organization: ______________________

Signature: ______________________ Date: __________

Agency / Organization: ______________________

Signature: ______________________ Date: __________

2. Table of Contents

Appendices

3. Distribution List

All group leaders, and technical advisors will receive copies of this Quality Assurance (QA) plan, and any approved revisions of this plan. Once approved, this QA plan will be available to any interested party by requesting a copy from **the project management.**

4. Project Organization

Option 1. Multi-Organizational Citizen Monitoring Projects. Use the following approach if the QAPP will represent the combined efforts of more than one citizen monitoring organization. Remember to erase all of Option 2, at the bottom of Section 4, if this course of action is followed.

This QAPP is a multi-organization project. The following citizen monitoring groups will cooperate to monitor and assess the streams, storm drains, lakes, bays, etc. in the _________watershed(s):

1.
2.
3.

This QA plan reflects the diversity of monitoring and organizational support involved in this project. For the elements of this QA plan, we have addressed aspects that are shared with all groups as well as those aspects that are unique to individual groups. While the goals of monitoring may vary, the data quality objectives are consistent allowing us to compare data collected by different organizations. The specific organizational structure for each of the participating organizations is given below.

4.1 Name of Organization #1

Briefly describe the nature of the organization and the waterbodies/watershed that will be monitored.
This organization should identify personnel/positions whose responsibility it will be to perform the following functions:

4.1.1 Management (Monitoring Leaders and Trainers)
4.1.2 Field Monitors and Team Captains (Volunteers and Staff)
4.1.3 Data Managers
4.1.4 Quality Assurance Personnel
4.1.5 Technical Advisors (provide at least three advisors and give some statement of their qualifications or specialty , e.g., college degree, job title, etc.)

Refer to other sections of this QAPP to further understand these different roles or functions within your group.

4.2 Name of Organization #2

Briefly describe the nature of the organization and the waterbodies/watershed that will be monitored.
This organization should identify personnel/positions whose responsibility it will be to perform the following functions:

4.2.1 Management (Monitoring Leaders and Trainers)
4.2.2 Field Monitors and Team Captains (Volunteers and Staff)
4.2.3 Data Managers
4.2.4 Quality Assurance Personnel
4.2.5 Technical Advisors (provide at least three advisors and give some statement of their qualifications or specialty , e.g., college degree, job title, etc.)

Refer to other sections of this QAPP to further understand these different roles or functions within your group.

4.3 Name of Organization #3

Briefly describe the nature of the organization and the waterbodies/watershed that will be monitored.
This organization should identify personnel/positions whose responsibility it will be to perform the following functions:

4.3.1 Management (Monitoring Leaders and Trainers)
4.3.2 Field Monitors and Team Captains (Volunteers and Staff)

4.3.3 Data Managers
4.3.4 Quality Assurance Personnel
4.3.5 Technical Advisors (provide at least three advisors and give some statement of their qualifications or specialty , e.g., college degree, job title, etc.)
Refer to other sections of this QAPP to further understand these different roles or functions within your group.

Option 2. Single Organization Citizen Monitoring Project. Use the following approach if the QAPP will represent only one citizen monitoring organization. Remember to erase all of Option 1, above, if this course of action is followed.

Briefly describe the nature of the organization and the waterbodies/watershed that will be monitored.
This organization should identify personnel/positions whose responsibility it will be to perform the following functions:
4.1 Management (Monitoring Leaders and Trainers)
4.2 Field Monitors and Team Captains (Volunteers and Staff)
4.3 Data Managers
4.4 Quality Assurance Personnel
4.5 Technical Advisors (provide at least three advisors and give some statement of their qualifications or specialty , e.g., college degree, job title, etc.)
Refer to other sections of this QAPP to further understand these different roles or functions within your group.

5. Problem Definition/Background

5.1. Problem Statement

Provide your own problem statement here based on your understanding of local circumstances and conditions. The following general example may be useful in helping you formulate your statement.
There is insufficient information to adequately assess the status of aquatic resources in **the_______ watershed**. There are concerns over the status and maintainance of the quality of water resources in this watershed. Citizen monitoring organizations have been formed in local watersheds to address these water quality concerns. If quality assurance is adequate, valuable information will be provided for watershed management and pollution prevention.

5.1.1. Citizen Monitoring Mission and Goals

5.1.1.1. Mission

The mission of citizen monitoring is to produce environmental information which is needed to protect California's watersheds and aquatic resources. Citizen monitoring will also inform and engage the community in effective watershed stewardship.

5.1.1.2. Program Goals

The general goals of citizen monitoring are:

- Identifying valued resources and watershed characteristics for setting management goals,
- Identifying physical watershed characteristics influencing pollutant inputs, transport and fate,
- Identifying the status and trends of biological resources in and around an aquatic environment,
- Screening for water quality problems,
- Identifying pollution sources and illegal activities (spills, wetland fill, diversions, discharges),
- Establishing trends in water quality for waters that would otherwise be un-monitored,
- Evaluating the effectiveness of restoration or management practices,
- Evaluating the effect of a particular activity or structure, and
- Evaluating the quality of water compared to specific water quality criteria.

In addition, citizen monitors build awareness of water quality issues, aquatic resources and pollution prevention.

This project will supplement existing agency information by monitoring streams in the ________watershed. The focus of the project is on habitat and chemical, physical and biological water quality measures that will identify the status of these aquatic resources. This information obtained will be provided to the regulatory agencies. It is the responsibility of the regulatory agencies to ensure that adequate and valid data are collected to meet their regulatory requirements.

Note: If Option 1 is followed (i.e., if this QAPP represents a multi-organizational approach) then the additional specific missions and goals of each participating group should be identified here. If Option 2 is followed, then the following section (5.1.1.3) should be erased.

5.1.1.3. The following paragraphs identify the specific additional missions and goals of the citizen monitoring organizations taking part in this project.

5.1.1.3.1. The additional mission of **"organization #1"** is _________. The additional goals of "organization # 1" are as follows _____________________.

5.1.1.3.2. The additional mission of **"organization #2"** is ________. The additional goals of "organization # 2" are as follows _____________.

5.1.1.3.3. The additional mission of **"organization #3"** is ________. The additional goals of "organization # 3" are as follows _____________.

5.2. Intended Usage of Data

The data will be used by the **your group** for general watershed assessment purposes. This assessment of this data will be useful in providing information for watershed management and pollution prevention. The data will be made available to the public for purposes of watershed education. It will also be made available to the regulatory and resource management agencies to supplement their existing data collection efforts. One potential application of the data will be to provide information to the Regional and State Boards for their use, if they so choose, in Section 305(b) reporting.

Option 1. Multi-Organizational QAPP. Use the following example if there is more than one participating group. If you follow this course of action then erase the version for Option 2.

Data will be compiled by **"organization #1" at** _________. Data will be compiled by **"organization #2" at** ________. Data will be compiled by **"organization #3"** at ________ .The information will be collated and shared with the State Water Resources Control Board, the __________ Regional Water Quality Control Board, and upon request to other state, federal, and local agencies and organizations. The main database will be maintained at _______.

Option 2. Single Organizational QAPP. Use the following example if there only one participating group. If you follow this course of action then erase the version for Option 1.

Data will be compiled and maintained at **(locaion and address)**. The information will be shared with the State Water Resources Control Board, the __________ Regional Water Quality Control Board, and upon request to other state, federal, and local agencies and organizations.

6. Project/Task Description

6.1. General Overview of Monitoring

Option 1. Multi-Organizational QAPP. Use the following example if there is more than one participating group. If you follow this course of action then erase the version for Option 2.

The citizen monitoring organizations are monitoring water quality in **the ________ watershed**. Physical, chemical and biological parameters are measured, although not all groups are measuring all parameters. Table 6.1 summarizes the monitoring design that relates to each of the participating groups, including the physical, chemical and biological parameters to be measured, whether the samples will be analyzed by the monitoring group or sampled for later analysis by a professional lab, and the frequency of measurement.

Table 6.1 Summary of Monitoring Design (version for Option 1)

Parameter	Org.#1, type & frequency	Org.#2, type & frequency	Org.#3, type & frequency
Flow			
Temperature			
Dissolved Oxygen			
pH			
Conductivity (fresh water) or Salinity (marine))			
Turbidity			
Ammonia			
Nitrate			
Ortho-Phosphate			
Chlorine			
Phenols			
Copper			
Detergents			
Total Organic Carbon			
Metals			
Oil and Grease			
Pesticides			
Bacteria			
Benthic Macroinvertebrates			
Odor and Visual Observations			

Codes for Table 6.1:
Type: F: field analysis, L: in-house lab analysis, P: sample only, send to outside professional lab
Frequency: M: monthly, S: seasonal, X: irregular

Option 2. Single Organizational QAPP. Use the following example if there is only one participating group. If you follow this course of action then erase the version for Option 1.
The citizen monitors are monitoring water quality in the ______ watershed. Table 6.1 summarizes the monitoring design, including the physical, chemical and biological parameters to be measured, whether the samples will be analyzed by the monitoring group or sampled for later analysis by a professional lab, and the frequency of measurement.

Table 6.1 Summary of Monitoring Design (version for Option 2)

Parameter	Type of monitoring	Frequency of monitoring
Flow		
Temperature		
Dissolved Oxygen		
pH		
Conductivity (fresh water) or Salinity (marine)		
Turbidity		
Ammonia		
Nitrate		
Ortho-Phosphate		
Chlorine		
Phenols		
Copper		
Detergents		

Total Organic Carbon		
Metals		
Oil and Grease		
Pesticides		
Bacteria		
Benthic Macroinvertebrates		
Odor and Visual Observations		

Codes for Table 6.1: Type: F: field analysis, L: in-house lab analysis, P: sample only, send to outside professional lab; **Frequency**: M: monthly, S: seasonal, X: irregular

All of the water quality data will be compared to the Regional Water Quality Control Board Basin Plan. For results that are not comparable to the Basin Plan we will review those data with our Technical Advisors.

This QA plan only addresses data quality objectives for the following parameters:

Temperature
Dissolved Oxygen
pH
Conductivity
Salinity
Turbidity
Ammonia (nitrogen)
Nitrate (nitrogen)
Ortho-Phosphate
Chlorine
Phenols
Copper
Detergents
Total Coliform Bacteria
E. coli Bacteria
Enterococcus Bacteria
Benthic Macroinvertebrates

Chemistry, physical, and bacterial parameters will be monitored using protocols outlined in the ___________ **Watershed Monitoring Manual** . Benthic macro-invertebrate monitoring will be performed according to the **California Stream Bioassessment Procedure**. This program has a systematic method for visual and other sensory observations. A Stream/Shore Walk Visual Assessment observation sheet, with instructions, is included in the **___________ Watershed Monitoring Manual.** Observations using the Stream/Shore Walk Visual Assessment observation sheet will be made, at a minimum, on a monthly basis. Observational data include color, Secchi depth, odor, presence of oil or tar, trash, foam, and algae. In addition, the stream habitat quality will be assessed, at least once per year, using the **California Dept. of Fish and Game Physical Habitat Assessment Form.** Observational data include epifaunal substrate/available cover, embeddedness, velocity/depth regimes, sediment deposition, channel flow status, channel alteration, frequency of riffles, bank stability, vegetative protection, and riparian vegetative zone width. For stream and urban storm drain environments flow will be determined by using the protocol described in the ___________ **Watershed Monitoring Manual.**

Section 10 of this plan contains references and instructions for the collection of samples for the following substances: Total Organic Carbon, Metals, Oil and Grease, PAH's, Pesticides and other synthetic organic compounds, and Toxicity. It has been determined that there will be no project-specific quality assurance and data quality objectives developed for the data generated. Samples may be sent to any laboratory capable of performing analysis. The project accepts the data generated that is within the analyzing laboratory's internal quality assurance program and the project will not comment on its quality relative to data from the same test generated by other laboratories.

6.2. Project Timetable

Table 6.2 identifies the schedule of major activities associated with this project.

Note: If you are following Option 1, and if the different cooperating groups will be following slightly different schedules, then incorporate those differences into Table 6.2. If their milestone activities and schedules are considerably different from each other then you will need to provide a table for each group.

Table 6.2 Project Schedule

Activity	Date
Identify monitoring leaders	
Obtain training for monitoring leaders	
Recruit monitors	
Obtain and check operation of instruments	
Train monitors	
Initiate monitoring	
Initiate data entry	
Calibration and quality control sessions	
Review data with technical advisors	

7. Data Quality Objectives

This section identifies how accurate, precise, complete, comparable, sensitive and representative our measurements will be. These data quality objectives were derived by reviewing the QA plans and performance of other citizen monitoring organizations (e.g. Chesapeake Bay, Texas Watch, Coyote Creek Riparian Station, Southern California Citizen Monitoring Steering Committee, Heal the Bay Malibu StreamTeam), by considering the specifications of the instruments and methods which we will employ, and by considering the utility of the data. For purposes of this QAPP the data quality is considered adequate for the determination of general water quality conditions, with a potential application of the data to Section 305(b) reporting purposes.

Data quality objectives are summarized in Tables 7-1 to 7-5. Whenever possible the methods with the greatest sensitivity and lowest detection limit will be employed as the primary methods. Methods with lesser sensitivity and higher detection limits will be used for field confirmations or as back-up methods in the case that the primary methods are not available or functioning properly for a particular sampling event. Specific DQOs were not given for in-situ continuous monitoring devices. See Section 14 for quality control protocols to be followed when continuous monitoring devices are employed.

Table 7.1. Data Quality Objectives for Conventional Water Quality Parameters

Parameter	Method/range	Units	Detection Limit	Sensitivity*	Precision	Accuracy	Complete-ness
Temperature	Thermometer (-5 to 50)	^{o}C	-5	$0.5\ ^{o}C$	$\pm 0.5\ ^{o}C$	$\pm 0.5\ ^{o}C$	80%
Dissolved oxygen	Electronic meter/probe	mg/l	0.1 mg/l	0.1 mg/l	± 10%	± 10%	80%
Dissolved oxygen	Micro-Winkler Titration	mg/l	0.2 mg/l	0.2 mg/l	± 10%	± 10%	80%
Dissolved oxygen	Vacuum ampoule Indigo carmine	mg/l	1.0 mg/l	1.0 (1.0-6.0) 2.0 (6.0-12.0)	± 1.0 mg/l	± 1.0 mg/l	80%
pH	pH meter	pH units	2.0	0.1 unit	± 0.2 units	± 0.2 units	80%
pH	Non-bleeding strips (range 4.5-10.0)	pH units	4.5	0.5 unit	± 0.5 units	± 0.5 units	80%

Conductivity	conductivity meter	µS/cm	10	10 µS/cm	± 10%	± 10%	80%
Turbidity	Nephelometer	NTUs	0.1	0.1	± 10%	± 10%	80%
Turbidity	Dual Tube Optical	JTUs	5	5 JTUs	± 5 JTUs	NA	80%

NA: not applicable
* Note: Some test kits vary in sensitivity over the range of detection. The specific range of readings is noted in parentheses.

Table 7.2. Data Quality Objectives for Nutrients Using Colorimeters or Spectrophotometers

Parameter	Method/range	Units	Detection Limit	Sensitivity	Precision	Accuracy	Completeness
Ammonia Nitrogen	Nessler method	mg/l	0.05	0.01	±0.2 (<2.0) ±10% (>2)	±0.2 (<2.0) ±10% (>2)	80%
Nitrate Nitrogen	Cadmium reduction	mg/l	0.05	0.01	±0.2 (<2.0) ±10% (>2)	±0.2 (<2.0) ±10% (>2)	80%
Ortho-Phosphate	Ascorbic acid	mg/l	0.07	0.01	±0.2 (<2.0) ±10% (>2)	±0.2 (<2.0) ±10% (>2)	80%

Table 7.3. Data Quality Objectives for Nutrients Using Comparators

Parameter	Method/range	Units	Detection Limit	Sensitivity*	Precision	Accuracy	Completeness
Ammonia Nitrogen	Salicylate method	mg/l	0.25	0.25 (0-0.5) 0.5 (0.5-1.0) 1.0 (1.0-2.0) 2.0 (2.0-4.0)	± 0.5(<2.0) ± 1.0(>2.0)	± 1.0	80%
Nitrate Nitrogen	Zinc reduction	mg/l	1.0	1.0	± 1.0	± 1.0	80%
Ortho-Phosphate	Ascorbic acid	mg/l	0.2	0.2 (0-1.0) 0.5 (1.0-2.0)	± 0.5	± 1.0	80%

* Note: Some test kits vary in sensitivity over the range of detection. The specific range of readings is noted in parentheses.

Table 7.4. Data Quality Objectives for Urban Pollutants Using Field Kits

Parameter	Method/range	Units	Detection Limit	Sensitivity*	Precision	Accuracy	Completeness
Total Residual Chlorine	Colorimetric (0.2 - 3.0)	mg/l	0.2	0.2 (0.2-1.0) 0.5 (1.0-2.0) 1.0 (2.0-3.0)	± 0.5(<2.0) ± 1.0(>2.0)	± 0.5(<2.0) ± 1.0(>2.0)	80%
Phenols	Direct Photometric (0.5 - 5.0)	mg/l	0.5	0.5 (0.5-3.0) 1.0 (3.0-5.0)	± 0.5(<3.0) ± 1.0(>3.0)	± 0.5(<3.0) ± 1.0(>3.0)	80%
Total Copper	Neocuproine (0.25 - 4.0)	mg/l	0.25	0.25 (0-0.5) 0.5 (0.5-2.0) 1.0 (2.0-4.0)	± 0.5(<2.0) ± 1.0(>2.0)	± 0.5(<2.0) ± 1.0(>2.0)	80%
Detergents	Anionic Surfactants as MBAS (≥0.1)	mg/l	0.1	0.1	± 0.1	± 0.1	80%

* Note: Some test kits vary in sensitivity over the range of detection. The specific range of readings is noted in parentheses.

Table 7.5. Data Quality Objectives for Biological Parameters

Parameter	Method/range	Units	Detection Limit	Sensitivity	Precision	Accuracy	Completeness
Benthic Macro-invertebrates	Calif. Stream Bioassessment Protocol	N/A	Family level	N/A	≤ 5% difference	≤ 5% difference	80%
Total Coliform Bacteria	Colilert 18 hour	MPN / 100ml	10	See IDEXX quantitray tables	Duplicates within 95% confidence limits	Positive standard within ½ of an order of magnitude	80%
E. coli Bacteria	Colilert 18 hour	MPN / 100ml	10	See IDEXX quantitray tables	Duplicates within 95% confidence limits	Positive standard within ½ of an order of magnitude	80%
Entero-coccus Bacteria	Enterolert 24 hour	MPN / 100ml	10	See IDEXX quantitray tables	Duplicates within 95% confidence limits	Positive standard within ½ of an order of magnitude	80%

7.1. Accuracy

7.1.1. Chemical and Physical Parameters

Accuracy describes how close the measurement is to its true value. Accuracy is the measurement of a sample of known concentration and comparing the known value against the measured value. The accuracy of chemical measurements will be checked by performing tests on standards at the quality control sessions **held twice a year**. A standard is a known concentration of a certain solution. Standards can be purchased from chemical or scientific supply companies. Standards might also be prepared by a professional partner, e.g. a commercial or research laboratory. The concentration of the standards, known to the volunteer leader, will be unknown to the monitors until after measurements are determined. The concentration of the standards should be within the mid-range of the equipment. The Data Quality Form: Accuracy, found in Appendix 1, will be used to record accuracy.

7.1.2. Biological Parameters

Accuracy for bacteria will be determined by analyzing a positive control sample twice annually. A positive control is similar to a standard, except that a specific discreet value is not assigned to the bacterial concentrations in the sample. This is due to the fact that bacteria are alive and capable of mortality and reproduction. Instead of a specific value, an approximate target value of the bacterial concentration is assigned to the sample by the laboratory preparing the positive control sample.

For benthic macroinvertebrate analysis, accuracy will be determined by having 20% of the samples (annually) re-analyzed and validated to CSBP Level 3 (genus level) by a professional taxonomist.

7. 2. Comparability

Comparability is the degree to which data can be compared directly to similar studies. Citizen monitoring groups will use the methods described in the following resource documents to ensure that their data can be compared to others:

- U.S. EPA's Volunteer Monitoring Manuals for Streams, Lakes or Estuaries,
- SWRCB Clean Water Team Compendium for Water Quality Monitoring and Assessment, and
- California's Department of Fish and Game's (CDFG) California Stream Bioassessment Protocol (CSBP) for Citizen Monitors.
- Heal the Bay's Malibu Creek Stream Team Pilot Project, Shattering the Myths of Volunteer Monitoring

- San Francisco Estuary Institute's Volunteer Monitoring Protocols.

Before modifying these methods, or developing alternative or additional methods, technical advisors will evaluate and review the effects of the potential modification. It will be important to address their concerns about data quality before proceeding with the monitoring program.

7. 3. Completeness

Completeness is the fraction of planned data that must be collected in order to fulfill the statistical criteria of the project. Volunteer data will not be used for legal or compliance uses. There are no statistical criteria that require a certain percentage of data. However, it is expected that 80% of all measurements could be taken when anticipated. This accounts for adverse weather conditions, safety concerns, and equipment problems.

We will determine completeness by comparing the number of measurements we planned to collect compared to the number of measurements we actually collected that were also deemed valid. An invalid measurement would be one that does not meet the sampling methods requirements and the data quality objectives. Completeness results will be checked quarterly. This will allow us to identify and correct problems. The Data Quality Form: Completeness, found in Appendix 1, will be used to record completeness.

7. 4. Precision

7.4.1. Chemical and Physical Parameters

The precision objectives apply to duplicate and split samples taken as part of a QC session or as part of periodic in-field QC checks. Precision describes how well repeated measurements agree. The evaluation of precision described here relates to repeated measurements taken by either different volunteers on the same sample (at quality control sessions) or the same volunteer analyzing replicate samples (in the field). Sampling variability will not be covered in this section. The Data Quality Form: Precision, found in Appendix 1, will be used to record precision.

7.4.2. Biological Parameters

Precision for bacterial parameters will be determined by having the same analyst complete the procedure for laboratory duplicates of the same sample. At a minimum this should be done once per day, or run duplicates on a minimum of 5% of the samples if there are over 20 samples run per day. The results of the duplicates should be within the confidence limits supplied by the manufacturer.

For benthic macroinvertebrate analysis, precision will be determined by having the technical advisor annually perform an evaluation on the citizen analysts as discussed in Section 14.2 of this QAPP.

7. 5. Representativeness

Representativeness describes how relevant the data are to the actual environmental condition. Problems can occur if:

- Samples are taken in a stream reach that does not describe the area of interest (e.g. a headwaters sample should not be taken downstream of a point source),
- Samples are taken in an unusual habitat type (e.g. a stagnant backwater instead of in the flowing portion of the creek),
- Samples are not analyzed or processed appropriately, causing conditions in the sample to change (e.g. water chemistry measurements are not taken immediately).

Representativeness will be ensured by processing the samples in accordance with Section 10, 11 and 12, by following the established methods, and by obtaining approval of this document.

7. 6. Method Detection Limit and Sensitivity

The Method Detection Limit is the lowest possible concentration the instrument or equipment can detect. This is important to record because we can never determine that a pollutant was not present, only that we could not detect it. Sensitivity is the ability of the instrument to detect one concentration from the next. Detection Limits and Sensitivities are noted in Tables 7.1. - 7.5.

8. Training Requirements

All citizen monitoring leaders must participate in a minumum of three days of hands-on training sessions on water quality monitoring conducted by the Clean Water Team of the State Water resources Control Board.

For macroinvertebrate bioassessment citizen monitoring leaders must also participate in a three day training course provided by the California Department of Fish and Game, the Sustainable Lands Stewardship Institute, the American Fisheries Society, or the State Water Resources Control Board.
Trained citizen monitoring leaders may then train their rank-and-file volunteers. Individual trainees are evaluated by their performance of analytical and sampling techniques, by comparing their results to known values, and to results obtained by trainers and other trainees.

In addition to completion of the above described training course, the citizen monitoring leaders must participate in **semi-annual** Quality Control Sessions. These Quality Control Sessions will be supervised by Quality Control Trainers and will provide an opportunity for citizen monitors to check the accuracy and precision of their equipment and techniques. Quality Control Trainers are defined as water quality professionals from the U.S. Environmental Protection Agency, the State Water Resources Control Board, and the Regional Water Quality Control Boards. Additional qualified trainers may be recruited and designated by the above agencies from experienced citizen monitoring organizations, universities and colleges, commercial analytical laboratories, and other federal, state, and local agencies.

The monitor will bring his/her equipment to the Quality Control Session. The monitor will conduct duplicate tests on all analyses and meet the data quality objectives described in Section 7. If a monitor does not meet the objectives, the trainers will re-train and re-test the monitor. If there is insufficient time at the QC session to re-train and re-test monitors, the monitor will be scheduled for an additional training session. The monitor will be encouraged to discontinue monitoring for the analysis of concern until training is completed.

The Quality Control Trainers will examine kits for completeness of components: date, condition, and supply of reagents, and whether the equipment is in good repair. The Trainers will check data quality by testing equipment against blind standards. The trainers will also ensure that monitors are reading instruments and recording results correctly. Sampling and safety techniques will also be evaluated. The trainer will discuss corrective action with the volunteers, and the date by which the action will be taken. The citizen monitoring leader is responsible for reporting back that the corrective action has been taken. Certificates of completion will be provided once all corrective action has been completed.

9. Documentation and Records

All field results will be recorded at the time of completion, using the field data sheets (see Appendix 2). Data sheets will be reviewed for outliers and omissions before leaving the sample site. Data sheets will be signed after review by the citizen monitoring leader. Data sheets will be stored in hard copy form at the location specified in Section 5.2. Field data sheets are archived for three years from the time they were collected. If data entry is ever performed at another location, duplicate data sheets will be used, with the originals remaining at the headquarters site. Hard copies of all data as well as computer back-up disks are maintained at headquarters.

All voucher collections, completed data quality control forms and maintenance logs will also be kept at the headquarters location specified in Section 5.2. The mainenance log details the dates of equipment inspection, battery replacement and calibrations, as well as the dates reagents and standards are replaced.

10. Sampling Process Design

10.1. Rationale for Selection of Sampling Sites

Sampling sites are indicated on the maps in Appendix 3. The following criteria were evaluated when choosing sampling locations:

- access is safe,
- permission to cross private property is granted,
- sample can be taken in main river current or where homogeneous mixing of water occurs,
- sample is representative of the part of the water body of interest,
- location complements or supplements historical data,
- location represents an area that possesses unique value for fish and wildlife or recreational use.

Any reference sites are chosen upstream of any potential impact. A site chosen to reflect the impact of a particular discharge, tributary or land use is located downstream of the impact where the impact is completely integrated with the water, but upstream of any secondary discharge or disturbance.

Prior to final site selection, permission to access the stream was obtained from all property owners. If access to the site becomes a problem, the citizen monitoring leader will select a new site. Safety issues are included in the ___________ **Watershed Monitoring Manual**.

Sample sites will be reviewed by the leader before sending volunteers out to the site. The monitoring leader will document permission and terms obtained from landowners, and will complete and file a Stream/Shore Walk form for the site, which will include a map and photographs.

10.2. Sample Design Logistics

Volunteers are instructed to work in teams of at least two people. If a scheduled team cannot conduct the sampling together, the team captain is instructed to contact the citizen monitoring leader so that arrangements can be made for a substitute trained volunteer.

Prior to final site selection, permission to access the stream is obtained from all property owners. If access to the site is a problem, the citizen monitoring leader will select a new site following the site selection criteria identified in Section 10.1.

Safety measures will be discussed with all volunteers. No instream sampling will be conducted if there are small creek flood warnings or advisories. It is the responsibility of the citizen monitoring organization to ensure the safety of their volunteer monitors. Safety issues are included in the ___________ **Watershed Monitoring Manual**.

11. Sampling Method Requirements

The ___________ Watershed Monitoring Manual describes the appropriate sampling procedure for collecting samples for water chemistry. Water sampling apparatus may include Van Dorn Samplers, Niskin Bottles, Kemmerer Tubes, LaMotte Oxygen Samplers, DH 48 Sediment Samplers, extension pole type sampling devices, and hand held plastic containers. Benthic invertebrates will be collected with a D shaped kick net (0.5 mm mesh) mounted on a pole. In those cases where glass bottles are required in Table 11.1, plastic samplers are allowed as long as the hold time in the sampling device is minimal before transfer to the glass sample bottle. Sampling devices and sample bottles (that are not pre-sterilized and do not contain preservatives/fixing agents) will be rinsed three times with sample water prior to collecting each sample. For sterile bottles, whirl-paks, and sample bottles which do contain preservatives/fixing agents (e.g., acids, etc.) never rinse with sample water prior to collecting the sample. Also, never use a sample bottle containing preservatives/fixing agents for sampling; in these cases always use a sampling device to collect the sample prior to transferring the sample into the bottle.

Whenever possible, the collector will sample from a bridge so that the water body is not disturbed from wading. All samples are taken approximately in mid-stream, at least one inch below the surface. If it is necessary to wade into the water, the sample collector stands downstream of the sample, taking a sample upstream. If the collector disturbs sediment when wading, the collector will wait until the effect of disturbance is no longer present before taking the sample.

The following table describes the sampling equipment, sample holding container, sample preservation method and maximum holding time for each parameter.

Table 11.1 Sampling Method Requirements

Parameter	Sample Bottle	Preferred / Maximum Holding Times
	Conventional Parameters	
Temperature	clear plastic bottle or sample directly	immediately
Dissolved oxygen	plastic bottle or sample directly	immediately / for wet chemistry fix per protocol instructions, continue analysis within 8 hr.
pH	plastic bottle or sample directly	immediately
conductivity	plastic bottle or sample directly	immediately / refrigerate up to 24 hours

turbidity	plastic bottle	immediately / store in dark for up to 24 hr.
Nutrients		
Ammonia N	plastic bottle	immediately / up to 8 hours if the sample is acidified with sulfuric acid to less than 3.0 pH
Nitrate N	plastic bottle	immediately / refrigerate in dark for up to 48 hours.
Ortho-Phosphate	plastic bottle	immediately / refrigerate in dark for up to 8 hours
Urban Pollutants – Field Measurements		
Total Residual Chlorine	glass bottle	immediately
Phenols	glass bottle	immediately
Total Copper	plastic bottle	immediately
Detergents	glass bottle	immediately
Laboratory Analysis of Chemical Parameters		
Total Organic Carbon	acid and d.i. water rinsed glass sampling bottle, teflon liner in lid	refrigerate to 4 degrees C, send to lab immediately
Metals	acid and d.i. water rinsed plastic sampling bottle	fix with Ultrapure (or comparable) nitric acid, send to lab immediately
Oil and Grease	Solvent rinsed and dried glass sampling bottle, teflon liner in lid	refrigerate to 4 degrees C, send to lab immediately
PAH's	Solvent rinsed and dried glass sampling bottle, teflon liner in lid	refrigerate to 4 degrees C, send to lab immediately
Pesticides and other synthetic organic compounds	Solvent rinsed and dried glass sampling bottle, teflon liner in lid	refrigerate to 4 degrees C, send to lab immediately
Toxicity	acid and d.i. water rinsed glass sampling bottle, teflon liner in lid	refrigerate to 4 degrees C, send to lab immediately
Biological Samples		
Bacteria	sterile plastic sampling bottle or whirl-pak	Refrigerate to 4 degrees C in the dark; deliverd to the lab within 4 hours, start analysis within 6 hours
Benthic macroinvertebrates	wide mouth plastic bottles	Fixed with ethanol immediately

12. Sample Handling and Custody Procedures

12.1. Sample Handling

Identification information for each sample will be recorded on the field data sheets (see Appendix 2) when the sample is collected. Samples that are not processed immediately in the field will be labeled with the waterbody name, sample location, sample number, date and time of collection, sampler's name, and method used to preserve sample (if any).

12.2. Custody Procedures

The conventional water quality monitoring tests do not require specific custody procedures since they will, in most cases, be conducted immediately by the same person who performs the sampling. In certain circumstances (such as driving rain or extreme cold), samples will be taken to a nearby residence for analysis. Samples requiring chemical preservation will be fixed prior to transport.

When samples are transferred from one volunteer to another member of the same organization for analysis, or from the citizen monitoring group to an outside professional laboratory, then a Chain of Custody form should be used. This form identifies the waterbody name, sample location, sample number, date and time of collection, sampler's name, and method used to preserve sample (if any). It also indicates the date and time of transfer, and the name and signature of the sampler and the sample recipient. In cases where the sample remains in the custody of the monitoring organization, then the field data sheet may be allowed to double as the chain of custody form. It is recommended that when a sample leaves the custody of the monitoring group, then the Chain of Custody form used be the one provided by the outside professional laboratory. Similarly, when quality control checks are performed by a professional lab, their samples will be processed under their chain of custody procedures with their labels and documentation procedures. For benthic macroinvertebrate samples, the **California Department of Fish and Game Aquatic Bioassessment Laboratory Chain of Custody** form will be used.

12.3. Disposal

All analyzed samples or spent chemicals (except for waste from the nitrate/cadmium reduction test and the Nessler ammonia test) including used reagents, buffers or standards will be collected in a plastic bottle clearly marked "Waste" or "Poison". This waste material will be disposed of according to appropriate state and local regulations. This will usually mean disposal into a drain connected to a sewage treatment plant.

Liquid waste from the cadmium reduction nitrate test will be kept separate and disposed of at a facility that is permitted to handle, transport, or dispose Cd waste. Liquid waste from the Nessler ammonia test (which contains mercury) will likewise be kept separate and disposed of at a facility that is permitted to handle, transport, or dispose Hg waste. Waste from the zinc reduction nitrate test and the salicylate ammonia test can be held in the regular waste container and disposed of as described in the previous paragraph.

Whenever possible, if waste includes reagents from the detergent test, these wastes will be poured down a drain underneath a flume hood.

13. Analytical Methods Requirements

Water chemistry is monitored using protocols outlined in **the ___________ Watershed Monitoring Manual**. The methods were chosen based on the following criteria:

- capability of volunteers to use methods,
- provide data of known quality,
- ease of use,
- methods can be compared to professional methods in *Standard Methods*.

If modifications of methods are needed, comparability will be determined by side-by-side comparisons with a US EPA or APHA Standard Method on no less than 50 samples. If the results meet the same precision and accuracy requirements as the approved method, the new method will be accepted.

Table 13.1 outlines the methods to be used, any modifications to those methods, and the appropriate reference to a standard method.

Table 13.1 Analytical Methods for Water Quality Parameters

Parameter	Method	Modification	Reference (a)
Temperature	Thermometric	Alcohol-filled thermometer marked in 0.5°C increments	2550 B.
Dissolved Oxygen	Winkler Method, Azide Modification	Prepackaged reagents, 20 ml sample size	4500-O C.
Dissolved Oxygen	Membrane Electrode	none	4500-O G.
Dissolved Oxygen	Colorimetric indigo carmine	Vacuum ampoules	ASTM D 888-87
pH	Electrometric	none	4500-H B.
pH	Litmus indicator strips	Non-bleeding	Whatman Co.
Conductivity	Electrometric	none	2520 B.
Turbidity	Dual tube optical comparisons	none	None
Turbidity	Nephelometric	none	

Ammonia N	Phenate	Salicylate with Color Comparator	4500 - NH3 F.
Ammonia N	Nessler or Phenate/Salicylate	prepackaged reagents, colorimeter or spectrophotometer	4500 – NH3 C 18th edition only (1992)
Nitrate N	Cadmium Reduction or Zinc reduction	Color Comparator	4500 – NO_3^- E.
Nitrate N	Cadmium Reduction or Zinc Reduction	prepackaged reagents, colorimeter or spectrophotometer	4500 – NO_3^- E.
Ortho-Phosphate	Ascorbic acid	Color Comparator	4500 – P E.
Ortho-Phosphate	Ascorbic acid	prepackaged reagents, colorimeter or spectrophotometer	4500 – P E.
Total Residual Chlorine	DPD Colorimetric	none	4500 - Cl G.
Phenols	Direct Photometric	Color Comparator	5530 D.
Total Copper	Neocuproine	Color Comparator	3500 -Cu D.
Detergents	Anionic Surfactants as MBAS	none	5540 C.
Total Coliform Bacteria	Colilert 18 hour	none	9223
E. coli Bacteria	Colilert 18 hour	none	9223
Enterococcus Bacteria	Enterolert 24 hour	none	IDEXX Corp.
Benthic Macroinvertebrates	California Stream Bioassessment Protocol	Level 2 (to family only)	Harrington, Jim, CDFG, 1997

(a) All of the above methods, with the exception of dissolved oxygen via indigo carmine, pH via non-bleeding indicator strips, turbidity via dual tube (JTUs), enterococcus bacteria, and benthic macroinvertebrates are described in Standard Methods for the Examination of Water and Wastewater 20th Edition. American Public Health Association et al, 1998.

14. Quality Control Requirements

Quality control samples will be taken to ensure valid data are collected. Depending on the parameter, quality control samples will consist of blanks, replicate samples, and split samples. In addition, quality control sessions (a.k.a. intercalibration exercises) will be held twice a year to verify the proper working order of equipment, refresh volunteers in monitoring techniques and determine whether the data quality objectives are being met.

14.1. Cautions Regarding Test Procedures

14.1.1. Winkler Method for Dissolved Oxygen

The Winkler method is not appropriate for highly alkaline waters.

Other citizen monitoring groups have noted problems with short shelf-life of the sodium thiosulfate reagent. Field measurements should be evaluated immediately to determine whether they are reasonable.
The validity of the dissolved oxygen test will also be assured by taking these steps:

- Care is taken not to aerate water samples during collection,
- Water is added gently to the dissolved oxygen bottle,
- No air bubbles are present in the sample,
- The titration sample will be measured carefully with a graduated cylinder,
- The sample is swirled thoroughly after each drop of titrant,

If the endpoint is overrun, another 20 ml. of the sample will be titrated.

14.1.2. Nutrients

The nitrate test measures nitrite as well as nitrate. Therefore the results for the nitrate test are actually mg/l Nitrite + Nitrate Nitrogen. When mixing nitrate reagents take care not to agitate aggressively. The LaMotte phosphate reagents have been shown to degrade well within their listed shelf life once opened.

14.1.3. Urban Pollutants

The tests for detergent, chlorine and phenol should not be conducted on saline waters. Suspended matter and algae may give false positive results for detergent. The low sensitivity of the copper test may preclude detecting copper as most falls out of solution forming copper carbonate.

14.2. Blanks, Replicates, Split Samples, and Standardization

Field/Laboratory Blanks: For all conventional water quality analyses, except temperature, dissolved oxygen and pH, field blanks will be analyzed once daily. For nutrients using comparators, a field blank will be analyzed every sampling trip. Color can sometimes appear in these nutrient blanks, suggesting that the real samples may be overestimating the true nutrient concentration. When colorimeters or spectrophotometers are used at the group's facility for nutrient analysis, a laboratory reagent blank will be analyzed and recorded for each day of analysis. For urban pollutants field blanks will be run daily. For bacterial analysis performed at a group's facility, a laboratory blank will be performed for each sampling/analysis event. Blanks do not apply to benthic macroinvertebrate sampling. (see Table 14.1)

Instructions for Field and Lab Blanks: Distilled water is taken into the field or used in the laboratory and handled just like a sample. It will be poured into the sample container and then analyzed. When reagents are used in a test method, then the reagents are added to the distilled water and these types of blanks are referred to as reagent blanks. Field blanks are recorded on the field data sheet. For nutrients measured with comparators, results from the field reagent blanks should be "not detected". If nutrients are detected, corrective action will be taken to eliminate the problem. For nutrients measured with colorimeters, the lab reagent blanks should be less than 0.05 ppm and the specific value should be recorded and subtracted from the field sample result. For bacterial analysis, the reagents are added to distilled water (in the same manner as for a field sample) and that blank is then sealed in a quantitray and incubated along with the field samples. The blank should be below detection limits (i.e., no positive wells) at the end of the incubation period.

Field Confirmations: When a second method for measuring temperature, dissolved oxygen, and pH is available in the field, then the monitors are encouraged to perform both measurements on a split sample at least once daily. Examples of this sort of redundant measurement would be:

- for temperature, the use of an electronic thermometer (such as those that are built into dissolved oxygen meters) and an armored thermometer;
- for dissolved oxygen, the use of an oxygen meter and an indigo carmine colorimetric kit;
- for pH, a meter and a non-bleeding indicator strip.

This will serve to provide backup capability if the more sensitive electronic meters fail, and will provide additional confidence as to the quality of the data. The results of both measurements will be recorded along with the procedure used on the field data sheet. If both results are comparable then the result produced using the method of greater sensitivity will be the one entered in the final data set by the data manager in consultation with the monitoring leader. If the two results are inconsistent, then the monitoring leader will note on the data sheet which of the results will be entered on the final data set by the data manager.

Replicate Samples: Replicate samples are two or more samples collected at the same time and place. When there are only two replicates then these are referred to as duplicates. For conventional water quality, nutrients, and urban pollutant analyses duplicate field samples will be taken once every 20 samples, or quarterly whichever comes first. Duplicate samples will be collected as soon as possible after the initial sample has been collected, and will be subjected to identical handling and analysis. For bacterial analysis lab duplicates will be run at least once per sampling day, and when there are more than 20 samples run per day then there will be a minimum 5% of the samples analyzed in duplicate. For benthic macroinvertebrate sampling, instead of duplicate sampling, each sampler will be evaluated annually by measuring the area sampled upstream of the net. The area should be two square feet and should be verified by using a two square foot pvc frame.

Split Samples: Twice a Year, split spiked samples (standards) will be analyzed as part of the Quality Control Session. The split standard is one sample, containing a known concentration of an analyte, that is divided equally into two or more sample containers. Split standards will be analyzed by the volunteers, and sent to a professional laboratory (except for dissolved oxygen, temperature, and pH), before the maximum sample handling time is exceeded. Volunteers will analyze the split standard normally and will perform at least three analyses on that same sample. From these results accuracy and precision will be determined. The professional laboratory will analyze the sample using the method referenced in Table 13.1

For turbidity using the dual tube (JTU) method, split field samples will be analyzed as part of the Quality Control Session. The laboratory receiving the split sample will analyze it using the nephelometric method, even though these results are not strictly comparable to the visual JTU comparators. The results of turbidity using the two methods will be plotted to determine if there is a linear correlation. If this correlation is significant, then it will be used to estimate and compare results of the turbidity tubes with nephlometric results. The Technical Advisory Committee for all groups will use the product-moment correlation coefficient (r) to determine the adequacy of the correlation.

For bacteria, split field samples or split positive controls will be analyzed by the citizen monitoring group and an outside professional laboratory twice annually. In addition, at the quality control session different analysts from the citizen monitoring group(s) will each read a minimum of the three quantitrays and compare their results. These results should be within $\pm$ one well for concentrations of less than 1000 MPN/100 ml, and within $\pm$ two wells for concentrations of greater than 1000 MPN/100ml.

A minimum 20% of the benthic macroinvertebrate samples will be subjected to validation by a outside professional taxonomist. Following analysis by the citizen group the selected samples will be reconstituted and sent out for professional level 3 taxonomic analyses. Reconstituted means opening the vials containing the 100 identified specimens, pouring the specimens back into the original sample jar, and gently stirring the contents. In addition, once a year citizen macroinvertebrate analysts will participate in an intercalibration exercise in which their subsampling/sorting and taxonomic skills will be evaluated. A minimum of two teams of analysts will each inspect each other's processed grids immediately following completion of the subsampling procedure. There should be no more than 10% missed organisms. A technical advisor should then evaluate each of the citizen analysts by testing their identification to order and family level on at least 20 specimens, including at least one representative from each of the major orders and families as determined by the technical advisor for that watershed. Accuracy and precision can be determined by the results of these validation and evaluation measures.

Standardization of Instruments and Procedures: At the Quality Assurance Sessions the temperature measurements will be standardized by comparing our thermometers to a NIST-certified or calibrated thermometer in ice water and ambient temperature water. All meters (pH, conductivity, oxygen) will be evaluated at the Quality Assurance Session using standards provided with the assistance of a professional laboratory and/or the technical advisors. For oxygen meters the standard will be distilled water saturated with oxygen. The Winkler kits for dissolved oxygen will be checked by standardizing the sodium thiosulfate solution in the test kit, and/or by comparing the entire kit to a saturated oxygen standard. Instructions for checking the sodium thiosulfate are included in the test kit. (Additional reagents and glassware must be purchased separately however.) If the result is unsatisfactory, as indicated in the instructions, the sodium thiosulfate and/or other reagent will be discarded and replaced with new reagents.

Continuous Monitoring Devices: Should continuous monitoring devices be used for any parameters then such devices must be calibrated and deployed according to the manufacturer's specifications and field confirmation will be performed using replicate sampling (for laboratory analysis) or standardized instruments. For example, there is the possibility of using in-situ continuous monitoring devices for flow or temperature measurements. Confirmations using a flow meter or a standardized field thermometer will be perfomed at the time of deploying and retrieving the device. This will serve to determine the accuracy of the continuous monitoring device.

Table 14.1 summarizes the quality control regimen.

Table 14.1 Summary of Quality Control Requirements

Parameter	Blank	Duplicate Sample	Split Sample to lab	QC session
		Water quality		
Temperature	none	5% or a minimum of once a year	none	twice a year
Dissolved oxygen	none	5% or a minimum of once a year	none	twice a year
pH	none	5% or a minimum of once a year	none	twice a year
conductivity	daily	5% or a minimum of once a year	twice a year	twice a year
turbidity	daily	5% or a minimum of once a year	twice a year	twice a year
		Nutrients (comparators)		
Ammonia	daily	5% or a minimum of once a year	twice a year	twice a year
Nitrate	daily	5% or a minimum of once a year	twice a year	twice a year
Ortho-Phosphate	daily	5% or a minimum of once a year	twice a year	twice a year

Nutrients (colorimeters or spectrophotometers)				
Ammonia	daily	5% or a minimum of once a year	twice a year	twice a year
Nitrate	daily	5% or a minimum of once a year	twice a year	twice a year
Ortho-Phosphate	daily	5% or a minimum of once a year	twice a year	twice a year
Urban Pollutants				
Total Residual Chlorine	daily	5% or a minimum of once a year	twice a year	twice a year
Phenols	daily	5% or a minimum of once a year	twice a year	twice a year
Total Copper	daily	5% or a minimum of once a year	twice a year	twice a year
Detergents	daily	5% or a minimum of once a year	twice a year	twice a year
Biological Parameters				
Total Coliform and *E. coli* Bacteria	daily	5% or a minimum of once per day	twice a year	twice a year
Enterococcus Bacteria	daily	5% or a minimum of once per day	twice a year	twice a year
Benthic Invertebrates	none	None, instead conduct evaluation of sampling area annually	20% per year	once a year

15. Instrument/Equipment Testing, Inspection and Maintenance

A maintenance log is kept by the monitoring group leader. This log details the dates of instrument and sampling gear inspection, calibrations performed in the laboratory, battery replacement, the dates reagents and standards are replaced, and any problems noted with instruments, samplers, or reagents.

15.1. Temperature

Before each use, thermometers are checked for breaks in the column. If a break is observed, the alcohol thermometer will be placed in nearly boiling water so that the alcohol expands into the expansion chamber, and the alcohol forms a continuous column. verify accuracy by comparing with a calibrated or certified thermometer.

15.2. Dissolved oxygen

Dissolved Oxygen Winkler Titration: Before each use, bottles, droppers, and color comparators are checked to see if they are clean and in good working order. Reagents are replaced annually according to manufacturer's recommendation.

Dissolved Oxygen Meters: Membranes and solutions should be replaced according to manufacturer's specifications, but no less frequently than quarterly. Membranes should be checked for bubbles after replacement. Before each use, D.O. meters are checked to see if they are clean and in good working order.

15.3. Conductivity and pH

Before each use, conductivity and pH meters are checked to see if they are clean and in good working order. Conductivity and pH meters are calibrated before each use. Conductivity standards and pH buffers are replaced at least annually. Conductivity standards are stored with the cap firmly in place and in a dry place kept away from extreme heat. Do not re-use pH or conductivity standards.

15.4. Turbidity

Dual Tube Turbidity (JTU's): Before each use, turbidity tubes are checked to ensure that they are clean. The turbidity standard will be replaced annually.

Nephelometers: Meters and tubes should be checked for cleanliness and proper operation. The tubes should not be smudged or scratched.

15.5. Nutrients and Urban Pollutants

Before each use, test kits are checked to ensure that droppers, sample containers, and color comparators are clean and in working condition. Colorimeter tubes should be checked to make sure they are clean and are not scratched. Reagents are replaced annually according to manufacturer's instructions.

16. Instrument Calibration / Standardization and Frequency

Instruments will be calibrated and reagents checked against standards accordingly to the following schedule. Standards will be purchased from a chemical supply company or prepared by (or with the assistance of) a professional laboratory. Calibration records will be kept in the maintenance log at the headquarters location (described in Section 5.2.) where it can be easily accessed before and after equipment use. Calibrations that are performed by monitors in the field are recorded on the field data sheets, also archived at the headquarters. The frequency of calibration is described in Table 16.1.

Table 16.1 Instrument Calibration and Frequency

Conventional Water Quality Parameters		
Equipment Type	**Calibration Frequency**	**Standard or Calibration Instrument Used**
Temperature	Every 6 months	NIST calibrated or certified thermometer
Dissolved Oxygen (Winkler)	Every 6 months	Check sodium thiosulfate and/or against a saturated oxygen standard every 6 months.
Dissolved Oxygen meter	Every sampling day	At a minimum, water saturated air, according to manufacturer's instructions.
pH	Every sampling day	pH 7.0 buffer and one other standard (4 or 10)
conductivity	Every sampling day	Conductivity standard and distilled water
Turbidity meter (nephelometer)	Every sampling day	For clear ambient conditions use an 1.0 NTU standard, for turbid conditions use an 10.0 NTU standard
Dual TubeTurbidity	Every sampling day	Distilled water

Nutrients (using comparators)		
Equipment type	**Checked against Standard**	**Standard Used**
Ammonia	every 6 months or when reagents replaced	ammonia standard
Nitrate	every 6 months or when reagents replaced	nitrate standard
Ortho-Phosphate	every 6 months or when reagents replaced	phosphorous standard

Nutrients (using colorimeters or spectrophotometers)		
Equipment type	**Checked against Standard**	**Standard Used**
Ammonia	Every day of analysis	ammonia standard
Nitrate	Every day of analysis	nitrate standard
Ortho-Phosphate	Every day of analysis	ortho-phosphate standard

Urban Pollutants		
Equipment type	**Checked against Standard**	**Standard Used**
Total Residual Chlorine	every 6 months or when reagents replaced	sodium hypochlorite
Phenols	every 6 months or when reagents replaced	phenol standard
Total Copper	every 6 months or when reagents replaced	copper standard
Detergents	every 6 months or when reagents replaced	MBAS surfactant standard

17. Inspection/Acceptance Requirements

Upon receipt, buffer solutions, standards, and reagents used in the field kits will be inspected by the citizen monitoring leader for leaks or broken seals, and to compare the age of each reagent to the manufacturer's recommended shelf-life. All other sampling equipment will be inspected for broken or missing parts, and will be tested to ensure proper operation.

Before usage, thermometers are inspected for breaks. Breaks can be eliminated by heating (see Section 15.1). If not, they will be returned to the manufacturer.

Reagents are replaced before they exceed manufacturer's recommended shelf life. These shelf lives are typically one to two years. However, specific replacement dates can determined by providing the reagent lot number to the manufacturer. Reagent replacement dates are noted in the maintenance log.

18. Data Acquisition Requirements

18.1. Professional Analytical Data

Only certified analytical laboratories or academic laboratories (with approval of State and/or Regional Board staff) will be used for quality assurance checks and analysis of field samples. The Technical advisory Committee (TAC) or technical advisors will review these laboratories' data as well as the volunteers. They may also review the lab's own quality control data to ensure data validity.

18.2. Geographical Information/ Mapping

USGS maps will be used to verify watershed boundaries and river courses. NOAA navigation charts can be used for mapping marine sampling sites. Additional information on distribution of natural resources will be obtained from the National Park Service and the CDFG's Biodiversity database. Land use information will be obtained from local planning offices. When information is requested, the agency will be asked to provide appropriate megadata and any information on data limitations. This information will be maintained with the data files.

19. Data Management

Field data sheets are checked and signed in the field by the citizen monitoring leader. The citizen monitoring leader will identify any results where holding times have been exceeded, sample identification information is incorrect, samples were inappropriately handled, or calibration information is missing or inadequate. Such data will be marked as unacceptable by the monitoring leader and will not be entered into the electronic data base.

Independent laboratories will report their results to the citizen monitoring leader. The leader will verify sample identification information, review the chain-of-custody forms, and identify the data appropriately in the database. These data are also reviewed by the technical advisors quarterly.

The data management coordinator will review the field sheets and enter the data deemed acceptable by the citizen monitoring leader and the technical advisors. Upon entering the data the data management coordinator will sign and archive the field data sheets. Data will be entered into a spreadsheet (MS Excel) or a database (MS Access) in a way that will be compatible with EPA's STORET and the Regional WQCB's database guidelines. Following initial data entry the data coordinator will review electronic data, compare to the original data sheets and correct entry errors. After performing data checks, and ensuring that data quality objectives have been met, data analysis will be performed.

Raw data will be provided to the State WQCB and Regional WQCB in electronic form at least once every two years so that it can be included in the 305(b) report. Appropriate quality assurance information may be provided upon request.

20. Assessment and Response Actions

Review of all field and data activities is the responsibility of the citizen monitoring leader, with the assistance of the technical advisory committee. Volunteers will be accompanied by the citizen monitoring leader, or a technical advisor on at least one of their first 5 sampling trips. If possible, volunteers in need of performance improvement will be retrained on-site. All volunteers must attend a refresher course offered by the citizen monitoring group. If errors in sampling technique are consistently identified, retraining may be scheduled more frequently.

Within the first three months of the monitoring project, the State Water Board or Regional Board staff, or its designee, will evaluate field and laboratory performance and provide a report to the citizen monitoring group. All field and laboratory activities, and records may be reviewed by State and EPA quality assurance officers as requested.

21. Reports

The technical advisors will review draft reports to ensure the accuracy of data analysis and data interpretation. Raw data will be made available to data users per their request. The citizen monitoring organization(s) will report their data to its (their) constituents after quality assurance has been reviewed and approved by their technical advisors. Every effort will be made to submit data and/or a report to the State and/or Regional Board staff in a fashion timely for their data uses, e.g. 305(b) reports.

22. Data Review, Validation and Verification

Data sheets or data files are reviewed quarterly by the technical advisors to determine if the data meet the Quality Assurance Project Plan objectives. They will identify outliers, spurious results or omissions to the citizen monitoring leader. They will also evaluate compliance with the data quality objectives. They will suggest corrective action that will be implemented by the citizen monitoring leader. Problems with data quality and corrective action will be reported in final reports.

23. Validation and Verification Methods

As part of standard field protocols, any sample readings out of the expected range will be reported to the citizen monitoring leader. A second sample will be taken as soon as possible to verify the condition. If the data is invalid, then the data will be noted (flagged) on the data sheet. We will take further actions to trace the sources of error, and to correct those problems. If the error is a result of improper monitoring procedures, then we may re-train monitors until their performance is acceptable. It is the responsibility of the citizen monitoring leader to re-train volunteers until performance is acceptable.

24. Reconciliation with DQOs

The Technical Advisory Committee working with the monitoring leader(s) will review data quarterly to determine if the data quality objectives (DQOs) have been met. A quorum of 1/2+1of the technical advisory committee will be required for committee decisions. If a quorum is not met at the meeting, work will still proceed. The work product (e.g., review and comments on data or reports) will then be sent out to the whole technical advisory committee for approval with a 30-day review period.

If data do not meet the project's specifications, the following actions will be taken. First, the technical advisors working with the monitoring leader(s) will review the errors and determine if the problem is equipment failure, calibration/maintenance techniques, or monitoring/sampling techniques. They will suggest corrective action. If the problem cannot be corrected by training, revision of techniques, or replacement of supplies/equipment, then the technical advisors and the TAC will review the DQOs and determine if the DQOs are feasible. If the specific DQOs are not achievable, they will determine whether the specific DQO can be relaxed, or if the parameter should be eliminated from the monitoring program. Any revisions to DQOs will be appended to this QA plan with the revision date and the reason for modification. The appended QAPP will be sent to the quality assurance panel that approved and signed this plan. When the appended QAPP is approved, the citizen monitoring leader will work with the data coordinator to ensure that all data meeting the new DQOs are entered into the database. Archived data can also be entered.

APPENDIX 1. Data Quality Forms

Use these forms to keep records of your own quality assurance. There are data quality forms for accuracy, completeness and precision. Temperature, Dissolved Oxygen, pH, and Conductivity are already listed under Parameters/units. Additional space is available for other parameters.

Data Quality Form: Accuracy

Quality Control Session

Monitoring Group Name	Type of Session (field or lab)
Your Name	Quality Assurance Leader
Date	

Parameter/ units	Sensitivity	Accuracy Objective	Standard Conc.	Analytical Result	Estimated Bias	Meet Objective? Yes or No	Corrective action planned	Date Corrective Action taken
Temperature ^{o}C								
Dissolved Oxygen (mg/l)								
pH standard units								
Conductivity (umhos/cm)								

Comments:

Data Quality Form: Completeness

Quality Control Session

Monitoring Group Name	Type of Session (field or lab)
Your Name	Quality Assurance Leader
Date	

Parameter	**Collection Period**	**No. of Samples Anticipated**	**No. Valid Samples Collected and Analyzed**	**Percent Complete**
Temperature °C				
Dissolved Oxygen (mg/l)				
pH standard units				
Conductivity (umhos/cm)				

Comments:

Data Quality Form: Precision **Quality Control Sessioı**

Monitoring Group Name	Type of Session (field or lab)
Your Name	Quality Assurance Leader
Date	

Parameter/ units	Mean (x)	Standard Deviation (s.d.)	s.d./x	Precision Objective	Meet Objective? Yes or No	Corrective action planned	Date Corrective Action taken
Temperature °C							
Dissolved Oxygen mg/l							
pH standard units							
Conductivity (umhos/cm)							

Comments:

APPENDIX 2. Data and Observation Sheets

Design and insert your own forms here, based on the information discussed in your QAPP.

APPENDIX 3. Maps of Sampling Sites

Insert maps of your sampling sites here.

APPENDIX B

INSTRUCTIONS
FOR THE USE OF
SWRCB's QAPP MODEL

Instructions for the use of the Model Quality Assurance Project Plans (QAPPs)

1.0 Introduction

This Instruction manual describes an important tool that you can use in developing your own QA Program—the Quality Assurance Project Plan. It specifically explains the model Quality Assurance Project Plan (QAPP) provided herewith. The QAPP is a comprehensive planning document that sets the general framework and requirements for a monitoring project. It describes the scope of the project, the organization and individuals involved, the data quality objectives, the monitoring procedures, and the specific quality control measures to be employed. QAPPs are often modified as the monitoring project evolves and matures.

2.0 Do you need a QAPP?

If your organization will conduct a water quality monitoring program with funding from the State Water Resources Control Board, the Regional Water Quality Control Boards, the USEPA, or other government agencies you will usually be required to provide a QAPP as a contract requirement. A Model QAPP for Citizen Monitors, which addresses commonly used physical, chemical, and biological water quality parameters, has been provided herewith. You may use the Model QAPP as a template for satisfying your contract requirement.

If you are not receiving funding from one of the government agencies, and are not required to have a QAPP, then you may decide not to produce one. You may be able to produce good quality data without the use of a QAPP, if your data are obtained under a set of rigorous "rules" or guidelines. Nevertheless you may still use the guidelines found in the Model QAPP to improve the quality of your data and develop the appropriate documentation of your monitoring activities.

Whether you have a QAPP or not, you will still need to have a set of Standard Operating Procedures (SOPs) which your monitors must use in performing field and laboratory procedures. You may use an existing document such as those provided by the United States Environmental Protection Agency (USEPA) or the SWRCB's Clean Water Team, or you can develop your own based on these and other reference documents.

3.0 Review and approval process

Your QAPP should be approved by your group's monitoring leader, your group's quality assurance officer, any partner or academic organization on which you are relying for a significant portion of quality assurance assistance, and by a representative of the agency that is providing funding for the project.

- If your monitoring is performed under a contract managed by a State Water Resources Control Board (SWRCB) staff person, your QAPP must be reviewed and approved by the QA officer for the SWRCB.

- If your monitoring project is performed under a contract managed by a Regional Water Quality Control Board (RWQCB) staff person, the QA officer for that RWQCB must approve your QAPP. If that RWQCB does not have a QA officer then the SWRCB QA officer will approve the QAPP.
- If your QAPP has made reference to technical support from a member of the SWRCB Clean Water Team, then that Clean Water Team Regional Coordinator should also review and approve the QAPP.

2.4 The Model QAPP

The Model QAPP was derived from the Southern California Volunteer Monitoring QAPP (SWRCB, 1998). SWRCB staff developed that QAPP originally for the Los Angeles Volunteer Monitoring Steering Committee, which is composed of various agencies, institutions, and citizen monitoring organizations. The Southern California Volunteer Monitoring QAPP was itself based on the recommendations provided by the USEPA (1996). Since then other groups in California have used the Southern California Volunteer Monitoring QAPP as a template for developing their own QAPPs.

The Southern California Volunteer Monitoring QAPP covered only certain chemical and physical water quality methods, such as conventional water quality parameters (temperature, dissolved oxygen, pH, conductivity, and turbidity), nutrients (ammonia, nitrate, and phosphate) using comparators, and certain urban pollution field kits (for phenols, copper, chlorine, and detergents). The Model QAPP has been modified for some of these parameters (additional methods included, such as electronic colorimeters for nutrients and nephelometers for turbidity), and additional biological parameters (bacteria and benthic macroinvertebrate bioassessment) have been incorporated as well.

You may use the Model QAPP as a template for developing your own QAPP as provided, or obtain the color-coded version of the Model QAPP by contacting Dominic Gregorio of the SWRCB Clean Water Team at (916) 341-5488.

The following are descriptions of each section of the Model QAPP:

Title and Approval Page
You should include the Title of the QAPP, the author, the date and spaces for signatures and dates for those individuals approving the QAPP. This page (page 1) and all other pages should contain a header as shown on the Model QAPP. Your QAPP will likely be an evolving document. For this reason the header contains a line for Revision Number. When revisions are made you will need to have a new approval page with new signatures.

Table of Contents
You should use the Table of Contents to list each section, including the appendices, of your QAPP.

Distribution List
This is where you will identify the individuals or entities that will be receiving copies or revisions of your QAPP. You would also state here how other interested individuals could obtain a copy of the QAPP.

Organization of the Project

This is the place where you will describe the organizational framework for your monitoring project. You have two options to choose from in the Model QAPP. The first option is for a QAPP that collectively incorporates the monitoring activities performed by more than one organization. If your organization will be networking and cooperating with other citizen monitoring groups, then this is the option you should follow. You are encouraged to follow this option in planning and preparing your QAPP, since this sort of networking approach will result in greater collective resources and strengths.

If you really don't have anyone in your immediate area to network with, then follow the second option, which is to prepare a QAPP in which only one citizen monitoring organization will be involved. Regardless of which option you follow, you should identify the individuals (by name, to the extent that is practical) responsible for the various functions identified in the QAPP.

- Management (monitoring leaders and trainers)
- Field operators and team captains (volunteers and staff)
- Data managers and computer operators
- Quality assurance personnel
- Technical advisors

You are encouraged to obtain at least three but no more than eight technical advisors that will assist you in making technical decisions and in reviewing and analyzing your data. Each advisor should have a specialty listed in addition to their organization. For example: "Joe Smith, MS Chemistry, Instructor, Diamond Springs Community College." If you are developing a multi-organizational QAPP the monitoring leaders may be listed as technical advisors. However you should clearly state that such individuals have no "vote" on the review of their own group's data or procedures.

List of Technical Tasks in Monitoring Water Quality: Considering the steps, tasks, and procedures associated with an environmental monitoring project, keeping track of who is doing what is critical. *The Clean Water Team's List of Technical Tasks in Monitoring Water Quality* can serve as a guide to establishing your project's list of tasks and the individuals responsible for performing them. The list (Appendix B) walks you through a variety of tasks, including: question formulation, parameter selection, reconnaissance and monitoring station selection, development of DQOs and sampling design, method selection, equipment purchase and testing, training, data gathering, data management and entry, data validation and analysis, and reporting of project findings. The list also includes estimates for the level of effort required to complete each task, and placeholders for you to write in the proper titles and identification of individuals responsible for performing the task, the products resulting from each task, and a timeline for task completion.

The Clean Water Team created the *List of Technical Tasks in Monitoring Water Quality* using Microsoft EXCEL. Electronic versions of the list are available from the Clean Water Team upon request.

Problem Statement

You should provide your own problem statement here based on your understanding of local circumstances and conditions. An example is provided in the Model QAPP. This section should also include the goals of your project, who will use your data, and how will it be used. You may also briefly describe here any previous studies that support your problem statement.

Project/Task Description

This is the place where you should describe what will be monitored and how often will it be monitored. Describe the parameters that will be analyzed directly by your group members, and also describe separately those parameters sampled by your monitors but analyzed by a professional laboratory. In this section you should state how you will determine what your data means. For example, you may compare your findings to the Basin Plan Objectives or to a benthic macroinvertebrate reference site. The Project/Task Description should also include a timetable. This timetable should indicate dates for identifying monitoring leaders, training your leaders, recruiting volunteers, obtaining instruments, training volunteers, initiating monitoring and data entry, quality control sessions, and data reviews by the technical advisory committee.

This Project/Task Description of the Model QAPP covers a variety of different water quality parameters. As with other sections of the Model QAPP you should treat this as a menu; you may choose the parameters that you will be performing and discard the rest. You should only commit to what you feel is manageable and practical for your group. Your Project/Task Description should describe only those what parameters your group will perform. You should also identify the SOPs to be employed by your monitors. These SOPs may be the protocols described in the USEPA Volunteer Stream Monitoring Manual, USEPA Volunteer Estuary Monitoring Manual, USEPA Volunteer Lake Monitoring Manual, the SWRCB Clean Water Team's Compendium of Water Quality Monitoring and Assessment, and/or other protocols deemed appropriate by you and your technical advisors.

Data Quality Objectives

Data quality objectives (DQOs) specify how good your data needs to be in order to meet the goals of your project. You may refer to additional guidance for a more complete discussion of DQOs and how they are arrived at. The four steps include:

1. Formulating study questions.
2. Selecting parameters to be measured and developing spatial and temporal sampling designs.
3. Defining tolerable error and required sensitivity.
4. Selecting methods.

In the Model QAPP no single question was formulated to drive the selection of DQOs presented. It is after all an example intended for your modification and tailoring. The data quality elements are discussed alphabetically in terms of accuracy, completeness, comparability, precision, representativeness and sensitivity. Many of the DQOs in the Model QAPP will support regulatory decision-making.

Accuracy describes how close your measurement is to its true value. To determine accuracy you can measure a sample of known concentration (referred to as a *standard*) and compare the known value against the measured value (Box 2.1). In the Model QAPP the accuracy of chemical and physical measurements is determined by performing tests on standards at the *quality control sessions* (also sometimes referred to as intercalibration exercises) held twice a year. Accuracy for bacterial parameters will be determined by analyzing a *positive control sample*. A positive control is similar to a standard, except that a specific discreet value is not assigned to the bacterial concentrations in the sample. This is due to the fact that bacteria are alive and capable of mortality and reproduction. Instead of a specific value, an approximate target value of the bacterial concentration is assigned to the sample by the laboratory preparing the positive control sample. For benthic macroinvertebrate analysis, accuracy should be determined by having 20% of the samples re-analyzed and validated to Level 3 (genus level) by a professional taxonomist.

BOX 2.1: Example of Calculating Accuracy

During a recent training session, volunteer monitors each calibrated their individual pH meters (using their own standards) and then measured a common standard solution of pH 7.0. The following results were read:

7.5	7.2	6.5	7.0
7.4	6.8	7.2	7.4
6.7	7.3	6.8	7.2

Determine the mean result. Most calculators will determine a mean. To calculate:

Mean: $\bar{x} = \frac{1}{n}\sum_{i}^{n} x_i$

ACCURACY = mean value - true value

To obtain a percent reading: Divide the ACCURACY by the true value and multiply by 100.

The average of these measurements is equal to 7.08. Since we know that the reference or true value is 7.00, the difference between the mean pH value is off or biased by +0.08 units or 1%. This level of accuracy is within a data quality objective of ± 10 percent.

Comparability is the degree to which data can be compared directly to similar studies. Again, you may use the methods described in the following documents to ensure that your data can be compared to others:

- USEPA's Volunteer Monitoring Manuals for Streams, Lakes or Estuaries,
- SWRCB Clean Water Team's Compendium of Water Quality Monitoring and Assessment,
- San Francisco Estuary Institute's Citizen Monitoring Protocols,
- Heal the Bay's Malibu Creek Stream Team Pilot Project, Shattering the Myths of Volunteer Monitoring, and
- California Department of Fish and Game's (CDFG) Stream Bioassessment Protocol for Citizen Monitors.

Before modifying these methods, or developing alternative or additional methods, your technical advisors should evaluate and review the effects of the potential modification. It will be important for you to address their concerns about data quality before proceeding with the monitoring program.

Completeness is the fraction of valid data that you collected versus the amount of data that you originally planned to collect, expressed as a percent. An invalid measurement would be one that does not meet the sampling methods requirements and the other data quality objectives. The Model QAPP generally states that 80% of all measurements should be taken when anticipated. This accounts for adverse weather conditions, safety concerns, and equipment problems.

To determine the percent completed, divide the number of valid samples collected and analyzed by the number of samples anticipated in the monitoring design. Multiply by 100%. In the example below (Table 2.2), the volunteers met their objective of 80% completeness for temperature, but not dissolved oxygen. The volunteers reviewed their sampling methods and realized that some volunteers were not fixing the dissolved oxygen samples correctly. When they corrected this activity their completeness improved.

Table 2.2: Example of Completeness

Parameter	Collection Period	No. of Samples Anticipated	No. Valid Samples Collected and Analyzed	Percent Completed	Comments
Temperature	6/1/96 - 9/1/96	35	33	94.3%	
Dissolved Oxygen	6/1/96 - 9/1/96	35	27	77.1%	Volunteers were not fixing samples correctly in field.
Temperature	9/1/96 - 12/1/96	35	32	91.4%	
Dissolved Oxygen	9/1/96 - 12/1/96	35	32	91.4%	

Precision describes how well repeated measurements agree. In the Model QAPP, precision objectives refer to repeated measurements taken by different volunteers on the same sample (at the quality control sessions) and by the same volunteer on replicate water samples from the same location in the field. Box 2.2 provides an example of how precision may be calculated when there are more than two results for the same sample.

BOX 2.2: Example of Calculating Precision

During a recent training session, volunteer monitors checked their individual pH meters against a standard buffer solution of pH 7.0. The following results were read:

7.5	7.2	6.5	7.0
7.4	6.8	7.2	7.4
6.7	7.3	6.8	7.2

Determine the mean result. Most calculators will determine a standard deviation. To calculate:

standard deviation: $S = \sqrt{\frac{1}{n-1}\sum_{1}^{n}(x_i - \overline{x})^2}$

PRECISION = (standard deviation / mean) X 100

The standard deviation of these measurements is 0.32. The mean is 7.08. The PRECISION is 4.5%. This level of precision is within a data quality objective of 10 percent.

Precision for bacterial parameters is determined by having the same monitor complete the procedure for laboratory duplicates from the same sample. You should do this once for every 20 samples, and at a minimum once daily. You may also determine precision for benthic macroinvertebrate analysis at the quality control sessions. A minimum of two teams of monitors should inspect each other's processed grids immediately following completion of the subsampling procedure. There should be no more than 10% missed organisms. One of your technical advisors should then evaluate each of your monitors by testing their identification to order and family level on at least 20 specimens, including at least one representative from each of the major orders and families as determined by the technical advisor for your watershed.

Representativeness describes how relevant the data are to the actual environmental condition. Problems can occur if:

- Samples are taken in a stream reach that does not describe the area of interest (e.g. a headwaters sample should not be taken downstream of a point source),
- Samples are taken in an unusual habitat type (e.g. a stagnant backwater instead of in the flowing portion of the creek),
- Samples are not analyzed or processed appropriately, causing conditions in the sample to change (e.g. water chemistry measurements are not taken immediately).

Sensitivity is the ability of the instrument to detect one concentration from the next. The *method detection limit* is the lowest possible concentration the instrument or equipment can detect. This is important to record because you can never determine that a pollutant was not present, only that you could not detect it. The *resolution* of the method also describes sensitivity.

Training Requirements and Certification

Your monitoring leaders should participate in a hands-on water quality monitoring program conducted by the SWRCB's Clean Water Team Citizen Monitoring Coordinators, or their designees. For macroinvertebrate bioassessment your monitoring leaders must also participate in a course provided by the California Department of Fish and Game, the Sustainable Lands Stewardship Institute, the American Fisheries Society, or the State Water Resources Control Board. Trained leaders may then train their rank-and-file monitors.

Documentation and Records

This is where you should identify the records you need for your project, including field and laboratory data sheets, QC checks, calibration records, maintenance logs, voucher collections, and sampling location descriptions. Copies of the blank data sheets should be included in the QAPP appendix. The data sheet should include instrument and calibration information, spaces for the results of blanks, duplicates, etc., and spaces for signatures of field or lab analysts, the monitoring project manager who reviews/approves the data, and the data manager who transfers data to electronic form.

You should also describe how the records will be reviewed, handled, and stored. Data sheets should be reviewed for outliers and omissions before leaving the sample site. The monitoring leader should sign data sheets after review. Data sheets should be stored in hard copy form at a specified location unique to your group. You should archive field sheets for a minimum of three years from the time they were collected. If data entry is performed at another location, duplicate data sheets should be used, with the originals remaining at your headquarters. Hard copies of all data as well as computer back-up disks should be maintained at your headquarters.

Sampling Approach: Criteria for Selection of Sampling Sites

This is where you will outline the experimental design of your monitoring program. You should include a map, identifying sampling locations, in the QAPP appendix and refer to that map in this section. You should also describe how you decided on these sampling locations. The criteria used when choosing sampling locations should include the following considerations:

- access is safe,
- permission to cross private property is granted,
- sample can be taken in main river current or where homogeneous mixing of water occurs,
- sample is representative of that portion of the waterbody,

- location complements or supplements historical data,
- location represents an area that possesses unique value for fish and wildlife or recreational use.

If your monitoring program requires reference sites then these locations should be chosen upstream of any potential impact. A site chosen to reflect the impact of a particular discharge, tributary or land use should be located downstream of the impact, but upstream of any secondary discharge or disturbance. Remember that you must first obtain permission to access sampling locations from all pertinent property owners.

You should also use this section of the QAPP to describe the logistics of your program. You are recommended to have your monitors work in teams of at least two people, with one person designated as the team captain. If a scheduled team cannot conduct the sampling together, then the team captain should be instructed to contact the monitoring leader so that arrangements can be made for a substitute trained monitor. If a substitute is not found then the sampling effort should be terminated for that day. Remember that safety is of primary importance! For example, no in-stream sampling should be conducted if there are flood warnings or advisories.

Sampling Method Requirements

You will describe the sampling methods in this section. This includes samples that your monitors will analyze as well as those that will be sent elsewhere (e.g., a commercial lab) for analysis. Describe the procedure by which the samples are collected, and the sampling equipment to be used. Also describe the sample bottles, sample preservation and holding times for each parameter.

The Model QAPP describes the sampling equipment, sample holding container, sample preservation method and maximum holding time for each parameter. Again, as with other sections, you may use this as a menu to select the appropriate methods for the parameters you will be sampling.

Sample Handling and Custody Procedures

This section of the QAPP applies to samples that are collected in the field and brought to a lab for analysis, whether it is your citizen laboratory or that of another organization (e.g. a commercial lab) that will be performing the analysis. You should label samples with the waterbody name, sample location, sample number, date and time of collection, sampler's name, and method used to preserve sample (if any).

When samples are transferred from one volunteer to another, the field data form will likely suffice as a chain of custody form. When samples are transferred to an outside professional laboratory, then you should use a dedicated Chain of Custody form. This form identifies the waterbody name, sample location, sample number, date and time of collection, sampler's name, and method used to preserve sample (if any). It also indicates the date and time of transfer, and the name and signature of the sampler and the sample recipient. When you send samples to a certified commercial lab it is recommended that you use a Chain of Custody form provided by that laboratory. For benthic macroinvertebrate samples, you are recommended to use the California Department of Fish and Game Aquatic Bioassessment Laboratory Chain of Custody form.

The Model QAPP also uses this section to describe waste handling procedures. You must handle wastes with the utmost safety, and wastes should always be placed in containers that are clearly marked as waste containers. Always dispose of waste materials according to appropriate state and local regulations.

Analytical Methods Requirements

You should identify here the specific methods that you will use to analyze your samples. You may choose from the menu of methods provided in the Model QAPP or you may select your own methods. The analytical methods in the Model QAPP were chosen based on the following criteria, which you should consider as well when selecting methods:

- capability of volunteers to use methods,
- provide data of known quality,
- ease of use,
- methods can be compared to professional methods in *Standard Methods for the Examination of Water and Wastewater*, (APHA, AWWA, WEF, 1998).

Quality Control Requirements

Quality Control (QC) refers to the activities that are used to measure and maintain the program's data quality so that it meets the Data Quality Objectives (DQOs). You will measure Quality Control (QC) samples to ensure valid data are collected. Depending on the parameter, quality control samples should consist of *field blanks, replicate samples,* or *split samples* (Table 2.3). As mentioned previously, the Model QAPP commits to quality control sessions held twice a year to verify the proper working order of instruments, evaluate and refresh volunteers on their procedures and determine whether the data quality objectives are being met. The different kinds of QC samples identified in the Model QAPP are described briefly below:

Blanks samples are composed of distilled water and are used to determine if there are problems or errors with your analytical procedures or instruments. When wet chemistry procedures are used, blanks are referred to as *reagent blanks* because the reagents are added to the distilled water. *Field blanks* are initiated in the field at the time of sampling, and *laboratory blanks* are initiated in the laboratory prior to or during the analysis of samples.

The Model QAPP requires that blanks be performed each day sampling and analysis occur for all chemical, physical and bacterial parameters except temperature, pH, and dissolved oxygen. For analysis performed in the field it requires field blanks, and for analysis performed in the lab it requires lab blanks. Blanks are not appropriate for benthic macroinvertebrate analysis.

Replicate samples are defined as being separate samples taken at the same time and place but analyzed separately. When there are only two replicate samples, these are referred to as *duplicate samples.* Duplicate samples should be collected as soon as possible after the initial sample has been collected, and should be subjected to identical handling and analysis. *Laboratory replicates* are sub-samples from the same field sample. If there are two lab replicates (i.e., the sample is sub-sampled twice) then these are referred to as *laboratory duplicates* (Table 2.3).

The Model QAPP requires chemical, physical, and bacterial analysis to have duplicate samples analyzed once every 20 samples, or quarterly whichever comes first. In addition, for nutrient or bacterial analysis performed in the laboratory, laboratory duplicates must also be performed. For benthic macroinvertebrate sampling, instead of duplicate sampling, each sampler will be evaluated annually by measuring the area sampled upstream of the net. The area should be two square feet and should be verified by using a two square foot PVC frame.

Split samples are the result of dividing a single sample into two or more different sample containers. Split samples can be performed in the field (*field split*) or can be performed in the lab (*lab split*). Each of the split samples is then sent to different laboratories for analysis. *Spiked samples*, also known as *standards*, are samples with a known concentration of the chemical being analyzed. *Split standards* are lab splits of spiked samples produced in that laboratory.

Table 2.3: Types of Quality Control Samples

TYPE	SUB-TYPE	
Blanks: "Clean" samples used to detect problems in sampling, transport, and lab analysis.	Laboratory Reagent Blank	Initiated in the lab; includes reagents with H2O.
	Field Blank	Initiated in the field.
	Equipment or Rinsate Blank	To evaluate if there is carryover contamination from reuse of sampling equipment.
Replicates/Duplicates: Separate samples taken at same time and place and analyzed independently.	Laboratory Replicate	More than 2 subsamples from same field sample.
	Laboratory Duplicate	2 subsamples from same field sample.
	Field Replicate	More than 2 subsamples, same field sample.
	Field Duplicate	2 subsamples same field sample.
Splits: One sample divided equally into 2 or more containers and analyzed independently.	Laboratory Split	Measures analytical precision.
	Field Split	Measures analytical precision and field sampling precision.

According to the Model QAPP, standards should be analyzed semi-annually as part of the quality control session. Split standards should be prepared, analyzed by the monitors, and also sent to a professional laboratory before the maximum sample handling time is exceeded. The professional laboratory should analyze the sample using the referenced "standard method." Monitors should perform at least three analyses on that same sample. From these results accuracy and precision may be determined.

It is difficult to produce absolute standards for bacteria. Instead, split field samples or split positive controls, should be analyzed for bacteria by your group and an outside professional laboratory twice annually.

For validation of benthic macroinvertebrate samples, the Model QAPP requires that a minimum of 20% of your samples be sent to an outside professional taxonomist. Following analysis the selected samples will be reconstituted. Reconstituted means opening the vials containing the 100 identified specimens, pouring the specimens back into the original sample jar, and gently stirring the contents. In addition, the Model QAPP states that your group's sub-sampling/sorting and taxonomic skills will be evaluated annually. You will be able to determine accuracy and precision by the results of these evaluations.

Instrument/Equipment Testing, Inspection and Maintenance Requirements

Here you will describe your procedure for the inspection and maintenance of instruments and sampling gear. You should also describe the record keeping associated with that procedure. For example, you should keep a maintenance log that documents all of your instrument inspection, maintenance, and calibration activities.

Instrument Calibration and Frequency (chemical and physical parameters)

Describe your procedures, including the use of standards, for calibrating your instruments. Identify where your standards will be obtained. Also describe how frequently your instruments will be calibrated, and the record keeping associated with instrument calibration. In general, the Model QAPP requires that electronic instruments used for conventional water quality analyses be calibrated daily.

Inspection/Acceptance Requirements

This is where you can describe how your group inspects your instruments, sampling gear, and reagents upon receiving them from the manufacturer.

Data Acquisition Requirements

In this section you will identify the sources of analytical data that are not measured by your group. For example, you should identify the professional laboratory, or the procedure for selecting a laboratory, that will be analyzing samples that your monitors collect, including QC samples. Also identify the agency sources (e.g., United States Geologic Survey) of any maps, aerial photos, or other spatial information sources (e.g., GIS) that will used by your group.

Data Management

Here you should describe your procedures for recording, checking and electronically entering your data. Field data sheets should be checked and signed by the monitoring leader. Your monitoring project manager should flag any invalid results where holding times have been exceeded, sample identification information is incorrect, samples were inappropriately handled, or calibration information is missing or inadequate. Flagged data should not be entered as final results in the electronic data management system. Independent laboratories should report their results to your monitoring project manager. Your monitoring project manager should verify sample identification information, review the chain-of-custody forms, and identify the data appropriately in the database. Your technical advisors should also review these data.

Your data management coordinator should review the field sheets and enter only the valid data deemed acceptable by the monitoring project manager and the technical advisors. By now you have assembled a considerable amount of documentation on the project QA/QC activities. To improve the efficiency in managing this information, enter your data into a Microsoft EXCEL spreadsheet, Microsoft Access database, or other comparable system, using a format that is compatible with STORET, and the SWRCB's or the Regional WQCB's database guidelines. Following initial entry, your data manager should review electronic data, comparing it to the original data sheets and correct entry errors that may occur. Other Clean Water Team guidance materials describe how to create an information management system that can be integrated with this element of the QAPP.

Assessment and Response Actions
The review of all field procedures and data is the responsibility of your monitoring project manager, with the assistance of the technical advisory committee. Monitors should be accompanied by the monitoring project manager or a technical advisor on at least one of their first five sampling trips. Within the first three months of your monitoring project you may request that the State Water Board Clean Water Team evaluate your field and laboratory procedures. If possible, monitors in need of performance improvement will be retrained on-site. All volunteers should also attend a refresher course offered by your group. If errors in sampling technique are consistently identified, retraining may be scheduled more frequently.

Reports
Describe how frequently, and to whom you will report your data. Also specify whether your reports will contain only raw data. Have the technical advisors review draft reports to ensure the accuracy of data analysis and data interpretation.

Data Review, Validation and Verification
Your data should be reviewed quarterly by your technical advisors to determine if the data meet your DQOs. They may identify outliers, spurious results, or omissions to your monitoring project manager. They may also evaluate compliance with the data quality objectives. They can suggest corrective action that should be implemented by your monitoring project manager. Problems with data quality and corrective action should be reported in final reports. You should wait until your technical advisors have approved the data before it is released in raw form or in any reports.

Validation and Verification Methods
Here you can describe how you check your data. You may refer to the quality control and data management procedures described above, and explain what actions will be taken to address any problems discovered.

Unusual results, or sample readings out of the expected range should be reported to the monitoring project manager. A second sample should be analyzed as soon as possible to verify the condition. If you find that the data are invalid, then the data should be noted (flagged) on the data sheet. You should then take further actions to trace the sources of error, and to correct those problems. If the error is a result of improper monitoring procedures, then you may re-train monitors until their performance is acceptable.

Reconciliation with DQOs
This is where you should describe the procedure for assuring that your data meet the DQOs. Your technical advisors and monitoring leaders should work together to accomplish this, preferably on a quarterly basis. A quorum should be established (for example, 1/2+1) and used for technical advisory committee decisions. If a quorum does not show up at the meeting, work can still proceed. The work product (e.g., review and comments on data or reports) must then be sent out to the whole technical advisory committee for approval with a 30-day review period. This approach will prevent delays and make for efficient and timely feedback to the monitors.

If data do not meet the DQOs the technical advisory committee may suggest corrective action (e.g., replacing instruments or reagents, altering procedures, re-training monitors). In some cases the QAPP may need amendments, including possible changes to your DQOs.