Quality Assurance
Technical Document 6

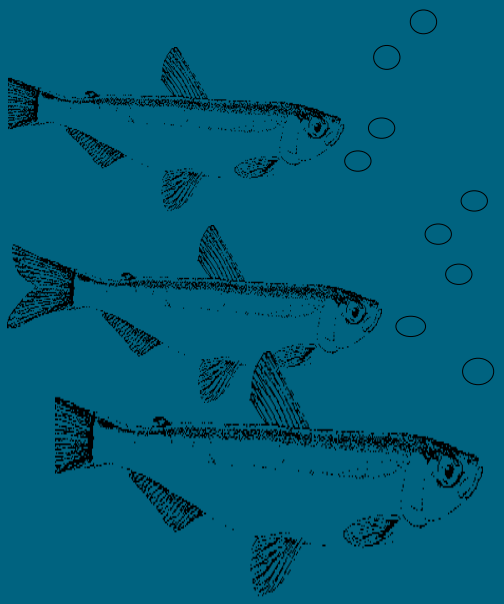
Guidelines for Preparing Quality Assurance Project Plans

August 1998

State of California The Resources Agency Department of Water Resources

Department of Water Resources
Quality Assurance/Quality Control Program

Environmental Assessment



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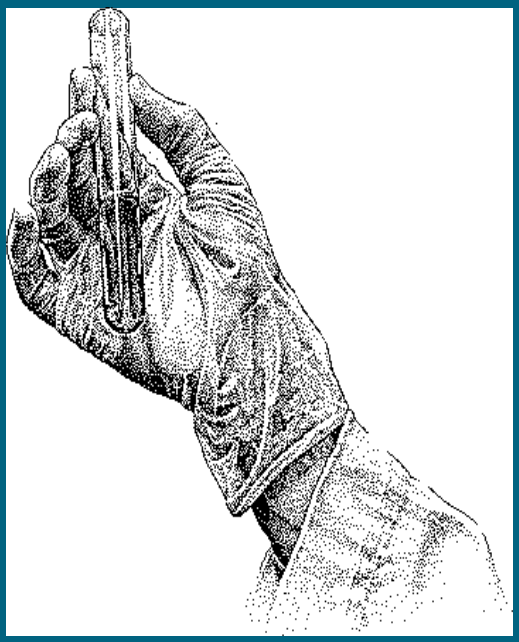

Analysis

Data Evaluation

State of California
The Resources Agency
Department of Water Resources
Division of Planning and Local Assistance

Guidelines for Preparing Quality Assurance Project Plans

for
Projects Involving Physical
and
Chemical Measurements of Water Quality

August 1998

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Introduction

Purpose

These guidelines describe requirements for preparing Quality Assurance Project Plans involving environmental measurement studies conducted by the Department of Water Resources. Specifically, this document focuses on projects involving physical and chemical measurements of water quality. This document was originally published as Quality Assurance Technical Document 6 (May 1994). Since then, the U.S. Environmental Protection Agency has revised its prescribed format for quality assurance plans. This revision is consistent with EPA's revisions.

A QA Project Plan is necessary for:

- Projects requiring environmental permits
- Large or complex scientific investigations
- Politically sensitive projects
- Monitoring data which will or could be used for regulatory purposes or DWR planning projects

The overall purpose of a QA Project Plan is to describe:

- Project management
- Measurement and data acquisition activities
- Assessment and oversight activities
- Review, validation, and reporting of data to users

These guidelines were developed to ensure that a QA Project Plan meets the minimum informational requirements. EPA's model was used as the basis for developing this document because it is widely accepted as the basis for an adequate plan. QA Project Plans should also conform with

the programs of other nonregulatory agencies in meeting DWR's need to adequately document the activities of its environmental measurement program.

Before disseminating data from monitoring studies, an agency must meet the minimum information requirements of:

- Documenting the quality of the data produced and
- Assuring that the data were generated reliably.

To assist DWR staff in meeting these requirements, DWR has a Quality Assurance/Quality Control Program with a system of methods to ensure reliable data.

The QA/QC Program is flexible, takes into account DWR needs, and will not require undue effort to implement as staff become trained and gain experience in preparing QA Project Plans. Incorporating QA/QC practices will help make data collection efforts more selective, reduce the need for resampling and reanalysis when bad data are obtained, and improve the efficiency of resource expenditures.

The objective of a QA Project Plan is to ensure that the quality of the data collected is known and is appropriate for the objectives of the investigation. Collecting, analyzing, and evaluating environmental data are complex activities. To be successful in such operations requires a systematic, structured process that gives data users the necessary confidence in the quality of data that support their decisions. The QA Project Plan is a document that explains the QA/QC requirements to the sampling team, analytical laboratory, management, and all interested parties. As such, it must be well organized and complete.

EPA requires (40 CFR Part 30 under the Clean Water Act) agencies that perform environmental measurement programs to have QA Project Plans for activities that receive federal moneys directly or indirectly. In addition, the State Water Resources Control Board requires that DWR perform contract work for the State Board in accordance with standard operating procedures as described in QA Project Plans.

The Program Manager has the responsibility to ensure that all data collected and analyzed are reliable for end users. Program Managers are responsible for producing the QA Project Plan but may delegate development of the plan to the Quality Control Coordinator or other staff. The Program Manager of the QA Project Plan must approve the completed plan. The DWR QA Officer is available to review QA Project Plans.

At the conclusion of this introductory section are templates for a DWR QA Project Plan and for a DWR short-term (episodic) QA Project Plan. This first template lists the basic sections that EPA suggests should be considered in a Project Plan. It also includes descriptions of terms and suggestions to make completing a QA Project Plan less burdensome. This format was developed to encourage Project Managers to provide documentation for typical DWR project QA activities. Some QA Project Plan elements have been combined for convenience in the DWR template, and a few elements described by EPA have not been included in the DWR format. These elements are explained elsewhere in these guidelines in case a project manager who has an involved environmental project needs to include them.

In addition, DWR's QA/QC staff has considered the potential for unique opportunities or crises that require short-term (episodic) QA Project Plans. To this end, a condensed QA Project Plan template has been developed for use where a manager may wish to pursue additional activities in conjunction with primary project activities or

new short-term project activities. These activities or events might include, but are not limited to, sampling efforts during such incidents as floods, short-term toxic spills, or any additional sampling efforts in the project area not covered by the original QA Project Plan.

The short-term QA Project Plan is to be drafted and filed with an original QA Project Plan, as an addition to the original document. It should be available for QA/QC purposes when data from the short-term event are analyzed and received by the project manager. Not all short-term event project components will be covered by a single existing QA Project Plan. In these cases, reference can be made to several existing or historical QA Project Plans, which cover the area or type of event.

The first section of the short-term QA Project Plan consists of a cover page that indicates the who, what, where, when, and why of the event. Following the cover page is a series of checklists which correspond to information available in other QA Project Plans or sampling/experimental plans filed for the project area.

For convenience, the DWR QA Project Plan templates have been formatted electronically in current versions of WordPerfect and Microsoft Word so that Program Managers can "fill in the blanks" as appropriate. Copies of electronic versions of the QA Project Plan templates can be downloaded from the DWR home page at http://wwwdpla.water.ca.gov/supply/sampling/mwq/main.htm.

Following the QA Project Plan templates is a more detailed discussion of each of the various sections that should be considered and addressed in a QA Project Plan. These details have been taken from the current, revised EPA Guidelines. Copies of some completed QA Project Plans are available for reference and are kept with the DWR QA Officer.

These guidelines were developed around the assumption that the project for which a plan is needed involves some physical or chemical measure of water quality. For those who wish to develop a QA Project Plan for a biologically oriented project, an additional resource is the EPA's *Generic Quality Assurance Project Plan Guidance for Programs Using Community Level Biological Assessment in Wadable Streams and Rivers*, EPA 841-B-95-004, July 1995.

This document is one of several DWR QA/QC Program technical documents. Other technical documents include:

- *Quality Assurance Guidelines for Analytical Laboratories* (Quality Assurance Technical Document 1)
- *Sampling Manual for Environmental Measurement Projects* (Quality Assurance Technical Document 2)
- *Compilation of Federal and State Drinking Water Standards and Criteria* (Quality Assurance Technical Document 3)
- *Compendium of Water Quality Investigations in the Sacramento-San Joaquin Delta* (Quality Assurance Technical Document 4)
- *Quality Assurance Management Plan for Environmental Monitoring Programs* (Quality Assurance Technical Document 5)
- *Compilation of Soil and Sediment Standards, Criteria, and Guidelines* (Quality Assurance Technical Document 7)

Copies of this document or any of the other technical documents can be obtained from DWR's Bulletins and Reports, Post Office Box 942836, Sacramento, California 94236-0001; telephone (916) 653-1097. ■

Quality Assurance Project Plan Components

A Quality Assurance Project Plan describes how quality assurance and quality control are included in an environmental data operation to assure that results obtained are of the type and quality needed and expected. EPA defines QA and QC as follows:

Quality Assurance

An integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.

Quality Control

The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality.

The following describes each of the sections that should be considered in each QA Project Plan. See the checklist for each of the elements on page 6.

Section A: Project Management

This group of QA Project Plan elements covers the area of project management. These elements include the project history, objectives, responsibilities of the participants, etc. to ensure that the project has a defined goal, an approach to be used, and documentation of planning outputs.

A1 - Title and Approval Page

The title page should include:

- Title of the plan

Example QA Project Plan Checklist

Elements of a Quality Assurance Project Plan

___ A1. Title and approval page
___ A2. Table of contents
___ A3. Distribution list
___ A4. Project/task organization
___ A5. Project definition and background
___ A6. Project/task description
___ A7. Quality objectives and criteria for measurement data
___ A8. Project narrative
___ A9. Special training requirements or certification
___ A10. Documentation and records
___ B1. Sampling process design (experimental design)
___ B2. Sampling methods requirements
___ B3. Sample handling and custody requirements
___ B4. Analytical methods requirements
___ B5. Quality control requirements
___ B6. Instrument and equipment testing, inspection, and maintenance requirements
___ B7. Instrument calibration and frequency
___ B8. Inspection and acceptance requirements for supplies and consumables
___ B9. Data acquisition requirements (nondirect measurements)
___ B10. Data management
___ C1. Assessments and response actions
___ C2. Reports to management
___ D1. Data review, validation, and verification requirements
___ D2. Validation and verification methods
___ D3. Reconciliation with user requirements

- Names of the organization(s) implementing the project

- Names, titles, signatures of appropriate approving officials—with dates. At a minimum, the QA Project Plan must be approved by the Program Manager.

Unless an emergency arises, environmental measurements should not be initiated until the QA Project Plan has received the necessary approvals. In emergencies, the Program Manager should consult with the QA Officer to identify an appropriate existing QA Project Plan which can be cited.

A2 - Table of Contents

The table of contents should have a serial listing of components, as well as a listing of figures, tables, and appendixes.

A3 - Distribution List

List individuals and organizations who will receive copies of the approved QA Project Plan and any subsequent revisions. The list should include all persons responsible for implementation of the project. The DWR QA Officer should also receive a copy.

A4 - Project/Task Organization

A table, chart, or flow diagram showing the project organization, line authority, and lines of communication among all project participants should be included. Contractors that are providing analytical services should be shown along with a list of the principal contacts. List the key individuals who are responsible for the collection and analysis of measurement data and QA/QC functions. Make sure that data provided through contract laboratories are directed to a Program Manager for review and evaluation.

A5 - Project Definition and Background

Describe the environmental system or site that is to be evaluated, the project objectives, the problem to be solved, or the decision to be made. Explain why the project is needed. Summarize the site use, the reason for environmental concern, and general conclusions of any relevant studies, including existing data of interest. The description of the site or environmental system could be shown as maps or charts with sampling locations indicated. Any constraints of time, resources, etc. on the measurement project should be listed.

A6 - Project/Task Description

Include a summary of the work to be done, the proposed project schedule, and a description of how the project will solve the problem or question stated in the previous section (A5).

Briefly describe:

- Measurements that will be made during the course of the project. Prepare a table listing the parameters, number of samples, sample preservation method, and sample holding times. An example of this information is given in Table A6 -1. DWR's QA Officer or the Chief of Bryte Laboratory can assist in identifying this information. DWR's Bryte Chemical Laboratory QA Manual lists analytical method references for many parameters. For information on obtaining a copy of this manual, contact Bill Nickels at the Bryte Chemical Laboratory at (916) 375-6008.

- Schedule of tasks and products that take place during the project. Describe the planned progress of the project from conception and implementation through completion and final reports. This information can be presented in a timeline graph that lists the project schedule. An example is presented in Table A6 - 2.

- Any special personnel and equipment required for the project.

Table A6-1
Example Parameter Table

Parameter	Number of Samples	Matrix	Sample Preservation	Holding Time
Arsenic	32	Water	Nitric Acid pH2	6 months
Cadmium	32	Water	Nitric Acid pH2	6 months
Total Chromium	32	Water	Nitric Acid pH2	6 months
Lead	32	Water	Nitric Acid pH2	6 months
Selenium	32	Water	Nitric Acid pH2	6 months
Mercury	32	Water	Nitric Acid pH2	6 months
Arsenic	96	Sediment/Soil	4°C	6 months
Total Chromium	96	Sediment/Soil	4°C	6 months
Lead	96	Sediment/Soil	4°C	6 months
Selenium	96	Sediment/Soil	4°C	6 months
Mercury	96	Sediment/Soil	4°C	6 months
Arochlor 1254	32	Water	GA*/4°C	7/**40 Days
Aldrin	32	Water	GA*/4°C	7/**40 Days
Chlordane	32	Water	GA*/4°C	7/**40 Days
Endosulfan 1	32	Water	GA*/4°C	7/**40 Days
4,4'DDT	32	Water	GA*/4°C	7/**40 Days
Arochlor 1254	96	Sediment/Soil	GA*/4°C	7/**40 Days
Chlordane	96	Sediment/Soil	GA*/4°C	7/**40 Days
4,4'DDT	96	Sediment/Soil	GA*/4°C	7/**40 Days
Toxaphene	96	Sediment/Soil	GA*/4°C	7/**40 Days

* Glass amber bottle with Teflon-lined cap.
** 7 days for extraction. Analysis within 40 days.

Table A6-2
Example of Timeline for QA Project Plan

	Task	Responsibility	Start Date	Completion Date
I.	Determine Data Quality Objectives	Program Manager, Field and Laboratory Personnel, QA Officer	2/15/94	3/15/94
II.	Develop Sampling Plan	Program Manager and Field Coordinator	2/20/94	3/20/94
III.	Select Analytical Procedures	Program Manager, Field Coordinator, Laboratory Personnel, QA Officer	2/20/94	3/20/94
IV.	Determine Quality Control Requirements	Program Manager, QA Officer	2/15/94	3/25/94
V.	Develop QA Project Plan	Program Manager and Designated Staff	4/1/94	4/21/94
VI.	Conduct Field Sampling	Field Coordinator	5/1/94	5/2/94
VII.	Sample Analysis	Laboratory Personnel	5/3/94	6/26/94
VIII.	Data Analysis and Data Validation	Program Manager, QA Officer	6/28/94	7/15/94
IX.	Write Report of Completed Study	Program Manager, Field Coordinator	7/15/94	9/15/94

- Assessment tools needed (i.e., program technical reviews, peer reviews, technical audits, etc.) for the project. These may be summarized in table form.

- Project and quality records required, including the types of reports needed during the project.

A7 - Quality Objectives and Criteria for Measurement Data

Describe the data needed and how they will be used. Describe the adequacy of the existing data, if any, and why new data are needed. The following points should be explained:

- Intended uses of data in order of importance

- Decisions to be made when data are obtained

- Decision makers who will use the data

Data quality objectives are developed to determine suitable sampling, analytical, and QA/QC protocols described in the overall QA Project Plan. DQOs are qualitative and quantitative statements of the quality of data needed to support specific decisions or actions. The project description lays the groundwork for DQOs by establishing the objectives of the measurement project, the data needed, the intended uses, the data users, and the strategy for achieving the objectives. EPA has provided a guidance document on the DQO process (EPA QA/G-4).

Development of DQOs is a joint responsibility of the Program Manager, QA Officer, technical staff, and laboratory staff. It occurs in three stages.

- First, the Program Manager states the purpose of data collection and provides some preliminary guidance on resources, time constraints, and the quality of data needed.

- Second, the technical staff, including the QA Officer, refines the data quality goals via discussion with the Program Manager. Based on the time frames, resources, and technological constraints of methodology to be used for sampling and analysis, the technical staff develops various approaches for the investigation.

- Third, the Program Manager selects the approach best suited for the project goal.

DWR Program Managers and other support personnel working with environmental measurement projects must acquire skills to develop DQOs. DWR QA/QC training for employees addresses the techniques for developing DQOs and provides suitable examples to clarify these concepts. Information on scheduled QA/QC training classes is available through the DWR Training Office and training coordinators, in addition to notices published in DWR's Job Opportunity Bulletin.

Quality assurance objectives are specifications of the level of precision, accuracy, representativeness, comparability, and completeness that are necessary to meet the goals of the investigation. These objectives must be defined in terms of project requirements. If they exceed the capabilities of available methods, the methods must be modified to compensate for these deficiencies. Nonstandard methods require validation.

QAOs are defined in quantitative and qualitative terms:

Quantitative QA Objectives

- Method Detection Limit - The method detection limit is defined as the lowest possible concentration of an analyte that can be detected in a sample or a blank with a 99 percent confidence level. In practice, laboratories

usually determine reporting levels, or practical quantitation levels, which are several times higher than the method detection limit. The method detection limit must be reliably lower than the required objectives for quantitation in the project.

- Precision - Precision is the degree to which measurements can be reproduced among duplicate or replicate observations. It is often expressed as relative percent difference between duplicates. Precision is expressed as relative standard deviation of the mean with more than two replicates.

- Accuracy - Accuracy refers to the difference between the measured result and the true value of the parameter being determined. Accuracy can be determined by comparison of the environmental sample results to certified reference samples or as percent recovery of matrix spikes.

- Completeness - Data completeness refers to the amount of data that is successfully collected and validated with respect to the amount intended in the project design. A certain percentage of the intended data must be successfully determined for valid conclusions to be reached. Completeness is usually expressed in percent.

Qualitative QA Objectives

- Representativeness - Representativeness is the degree to which the data accurately and precisely represent the population of samples. For example, the most critical factors necessary to achieve representativeness are appropriate points of sampling, time of sampling, frequency of sampling, and maintenance of the integrity of the sample.

- Comparability - Comparability refers to the similarity of data generated by different groups. If comparability is required, these different agencies or groups should use equivalent sampling procedures and analytical methods. Sometimes interlaboratory comparison studies can be used to establish comparability of analytical data.

Unless otherwise specified, all data must be calculated and reported in units consistent with use of other organizations both within and outside DWR. DWR's QA Officer will be the final arbiter of the reporting units. QAOs should be presented in a summary table with other information to clarify the details. Example QAOs are shown in Table A7 - 1. This format is not rigid and can be adjusted to suit the needs of the project.

A8 - Project Narrative

This section, which is a narrative summary of the entire project, should demonstrate to technical and QA reviewers that the project will achieve its stated quality objectives. This narrative addresses a number of QA Project Plan elements covered in depth elsewhere; include references to those sections for more details. Items to be covered in this section are:

- Work to be performed

- Anticipated use(s) of the data

- How the success or failure of the project will be determined

- Survey design requirements and description

- Sample type and sampling location requirements

Table A7-1
Example QA Objectives Table

Measurement Parameter	Matrix	Method[1]	Concentration Units	MDL[2]	Reporting Level	Precision [RPD of Duplicates][3]	Accuracy (% Recovery)	Completeness[5]
Arsenic	Water	206.3	mg/l	.0005	.001	12	77-121	95%
Cadmium	Water	213.2	mg/l	.001	.005	5	87-119	95%
Total Chromium	Water	218.2	mg/l	.001	.005	8	86-122	95%
Lead	Water	239.2	mg/l	.001	.005	5	79-121	95%
Selenium	Water	270.3	mg/l	.0005	.001	8	74-121	95%
Mercury	Water	245.1	mg/l	.0002	.001	4	78-121	95%
Arochlor 1254	Water	608	mg/l	.065	.35	10	85-115	95%
Aldrin	Water	608	mg/l	.014	.07	10	85-115	95%
Chlordane	Water	608	mg/l	.014	.07	10	85-115	95%
Endosulfan 1	Water	608	mg/l	.014	.07	10	85-115	95%
44' DDT	Water	608	mg/l	.012	.06	10	85-115	95%
Arsenic	Sediment/Soil	7060	mg/kg	5	25	35	75-125	90%
Total Chromium	Sediment/Soil	6010	mg/kg	1	5	35	75-125	90%
Lead	Sediment/Soil	6010	mg/kg	10	50	35	75-125	90%
Selenium	Sediment/Soil	7740	mg/kg	5	25	35	75-125	90%
Mercury	Sediment/Soil	7471	mg/kg	.02	.10	35	75-125	90%
Arochlor 1254	Sediment/Soil	8080	mg/kg	70	350	25	25-140[4]	90%
Chlordane	Sediment/Soil	8080	mg/kg	20	100	25	25-140[4]	90%
44' DDT	Sediment/Soil	8080	mg/kg	20	10	25	25-140[4]	90%
Toxaphene	Sediment/Soil	8080	mg/kg	30	150	25	25-140[4]	90%

1 - USEPA Methodology.
2 - MDL is Method Detection Limit.
3 - Precision is usually related to concentration. The concentration range used to determine precision is defined by the laboratory. RPD is Relative Percent Difference.
4 - Surrogate recovery range.
5 - Based on the number of valid measurements compared to the total number of measurements.

- Selection of analytical methods and instrumentation requirements
- Calibration and replicate/performance evaluation samples for sampling and analytical methods used
- Standard operating procedures for field sampling activities
- Plans for peer reviews prior to data collection, and
- Ongoing assessments during actual operations (oversight)

A9 - Special Training Requirements or Certification

Identify specialized training or certification needed by personnel to carry out the project tasks. Describe how such training/certification shall be accomplished and documented.

A10 - Documentation and Records

Describe the information that must be included in data reports, along with the reporting format (including any explanatory information). Documentation can include raw data or QC checks. Specify required laboratory turnaround time and whether a field sampling and/or laboratory analysis "case narrative" is required to provide a complete description of any difficulties encountered during sampling or analysis.

Specify requirements for the final disposition of documents and records, including the location and duration of storage.

Section B: Measurement/Data Acquisition

All aspects of measurement systems design and implementation are covered in this section to ensure that appropriate sampling, analysis, data handling, and QC methods are followed and documented.

B1 - Sampling Process Design (Experimental Design)

Monitoring Network Design and Rationale:

- Describe the scope of the project in terms of the geographical area, the environmental medium being investigated, and the time period for the study. The description of the site or environmental system could be shown as maps or charts with sampling locations indicated. Any constraints of time, resources, etc. on the measurement project should be listed.
- Explain the rationale for the selection of the sampling location and the number of sampling locations, and present any statistical approach used to select these sampling locations. Most sampling protocols should have a statistical design to prove that the samples represent the matrix to be evaluated. Specifically, indicate whether the sampling locations were selected on a random, judgmental, or systematic basis, or a combination of these.

Appendix C lists bibliographic sources for sampling design references. Especially useful are the publications authored by Lawrence H. Keith. Program Managers and their QA Coordinators will develop experience in using these techniques; the QA Officer can assist in applying the techniques. Use of these techniques will be incorporated into DWR training courses.

Sampling Plan Summary Table

- A sampling plan summary table that lists pertinent information for each sampling site should be prepared. An example of this table is provided in Table B1 - 1. The subject headings included in the table should be categorized to reflect the sampling criteria specific to each Project Plan. Table B1 - 1 is only an example of some of the categories that can be included in the table.

Table B1-1
Example Sampling Plan Summary

Site Location	Sample Matrices	Sampling Stations per Site	No. of Samples per Station	Sampling Method	Sample Type	Sample Parameters	Frequency of Sampling	QC Samples
Location A	Surface Water	2	2	Random	Grab	Trace Metals, Minerals, Pesticides	Monthly	Duplicates, Trip Blanks, Field Blanks
	Soil	3	3	Grid	Composite	Trace Metals, Pesticides	3 times/year	Duplicates, Equipment Blanks
Location B	Surface Water	1	2	Judgmental	Grab	Trace Metals, Volatile Organics	Weekly	Duplicates, Trip Blanks, Field Blanks, Equipment Blanks
Location C	Surface Water	3	3	Random	Composite	Trace Metals, Pesticides	Once	Duplicates, Trip Blanks, Field Blanks
	Sediment	2	3	Judgmental	Grab	Trace Metals, TBT, Pesticides	Once	Duplicates, Equipment Blanks
Location D	Groundwater	2	2	Established (monitoring well)	Grab	TPH, PCBs, Volatile Organics	4 times/year	Duplicates, Trip Blanks, Field Blanks
Location E	Surface Water	5	3	Random	Composite	Trace Metals, Chlorinated Herbicides, Organo-Phosphorus Pesticides	2 times/month	Duplicates, Trip Blanks, Field Blanks, Equipment Blanks

B2 - Sampling Methods Requirements

- Include a description of specific sampling procedures to be used. Reference the latest DWR *Sampling Manual for Environmental Measurement Projects*, or provide a description of the entire procedure in the case of non-standard procedures. See Appendixes D and E for bibliographic sources for sampling and field measurements, and biological sampling, respectively.

- Describe procedures for cleaning and preparing sampling equipment and containers to avoid sample contamination. For example, containers for organics should be solvent rinsed. Containers for trace metals should be acid rinsed.

- List methods of sample preservation, maximum holding times, and procedures to transport samples to the laboratory within allowable time limits. An example list is shown in Table A6 - 1.

- Describe the forms, notebooks, logbooks, and procedures for recording field analyses, sample history, field equipment problems, sampling conditions, and sample station access information.

B3 - Sample Handling and Custody Requirements

Procedures to track samples require that possession of samples be traceable from the time samples are collected until completion and submittal of analytical results. The following sample tracking procedures should be addressed in the QA Project Plan. Where possible, refer to existing procedures described in the DWR sampling manual or the laboratory QA manuals referred to above.

Field Sampling Operations

- Describe procedures and forms for recording the exact sampling location and specific considerations associated with sample acquisition.

- Indicate any use of preprepared sample labels; give all information necessary to track samples effectively and to meet laboratory requirements.

- Describe the use of standardized field tracking reporting forms to establish sample custody in the field prior to transport. Examples of these forms are found in the appendixes to the DWR sampling manual mentioned above.

Laboratory Operations

- Identify the "sample custodian" at the laboratory who is authorized to sign for incoming field samples, obtain documents of shipment (e.g., bill of lading number or mail receipt), and verify the data entered onto the sample custody records.

- Specify laboratory sample tracking procedures for sample handling, storage, disbursement for analysis, and any provision for sample tracking logs. The laboratory standard operating procedures (adopted for repetitive use when performing a specific measurement or sampling operation) may be referenced.

B4 - Analytical Methods Requirements

For each measurement parameter, reference the analytical method being used or provide a written description of the analytical procedures to be

used in the case of nonstandard methods. Officially approved methods (EPA, ASTM, Standard Methods) must be used unless an equivalent method is available. Bibliographic references of analytical methods are found in Appendix F. The information on laboratory analytical methods can be provided as shown on Table A7 - 1. A similar table should be developed for field analytical procedures.

B5 - Quality Control Requirements

The QA Project Plan should describe QC procedures used with sampling operations, field measurements and analyses, and laboratory analytical techniques. Identify quality control samples and standard protocols used to control the precision and accuracy of a measurement process. Quality control checks can include the following:

- Replicate analyses
- Spiked samples
- Split samples
- Control charts
- Blanks
- Internal standards
- Performance evaluation samples
- Surrogate samples
- Calibration standards and devices
- Periodic calibrations
- Reagent checks

A table, such as the example shown in Table B5 - 1, should be included in this section to describe the QC protocols used for each parameter analyzed. In general, information in the laboratory QA manuals or specific SOPs should be used to reference the laboratory quality control procedures.The corrective action required when control limits are exceeded should also be stated. DWR's QA Officer is available to help in determining basic QA protocols.

B6 - Instrument and Equipment Testing, Inspection, and Maintenance Requirements

Testing and preventive maintenance applies both to field and laboratory operations.

- Describe how inspections and acceptance testing of sampling and measurement systems will be performed and documented. Also describe how deficiencies will be resolved and reinspections performed.
- Describe preventive maintenance procedures and schedules to minimize downtime of sampling and measurement equipment. Information on critical spare parts and contingency plans for equipment back-up in case of failure should also be described.
- Descriptions of the laboratory testing and preventive maintenance procedures are usually in the laboratory QC manuals and can be referenced in the QA Project Plan.

B7 - Instrument Calibration and Frequency

Valid scientific measurements require that instruments function properly. Proper functioning is accomplished by regular calibrations and maintenance. Document or reference calibration procedures both for field sampling equipment and laboratory analytical equipment. Various calibration procedures, frequency of recalibration, and sources of calibration standards should be noted. Standards should be traceable to a source such as the National Institute of Standards and Technol-

Table B5-1
Example Quality Assurance Protocols in the Laboratory

Measurement Parameter	Sample Matrix	QA Protocol (Precision, Accuracy, Blanks)
Arsenic	Water	1 Duplicate per 10 Samples, 1 Spike per 10 Samples, 1 Method Blank per Set
Cadmium	Water	1 Duplicate per 10 Samples, 1 Spike per 10 Samples, 1 Method Blank per Set
Chromium	Water	1 Duplicate per 10 Samples, 1 Spike per 10 Samples, 1 Method Blank per Set
Lead	Water	1 Duplicate per 10 Samples, 1 Spike per 10 Samples, 1 Method Blank per Set
Selenium	Water	1 Duplicate per 10 Samples, 1 Spike per 10 Samples, 1 Method Blank per Set
Mercury	Water	1 Duplicate per 10 Samples, 1 Spike per 10 Samples, 1 Method Blank per Set
Arochlor 1254	Water	1 Blank per Set, 1 Surrogate Spike per Sample, 1 Surrogate Spike recovery from Blank per Set, Recovery and Precision of LCS* duplicates for each series
Aldrin	Water	1 Blank per Set, 1 Surrogate Spike per Sample, 1 Surrogate Spike recovery from Blank per Set, Recovery and Precision of LCS* duplicates for each series
Chlordane	Water	1 Blank per Set, 1 Surrogate Spike per Sample, 1 Surrogate Spike recovery from Blank per Set, Recovery and Precision of LCS* duplicates for each series
Endosulfan 1	Water	1 Blank per Set, 1 Surrogate Spike per Sample, 1 Surrogate Spike recovery from Blank per Set, Recovery and Precision of LCS* duplicates for each series
4, 4' DDT	Water	1 Blank per Set, 1 Surrogate Spike per Sample, 1 Surrogate Spike recovery from Blank per Set, Recovery and Precision of LCS* duplicates for each series
Arsenic	Sediment/Soil	1 Duplicate per 10 Samples or Batch or Matrix, 1 Spiked Sample per 10 Samples or Batch or Matrix, 1 Method Blank per Set or Matrix
Chromium	Sediment/Soil	1 Duplicate per 10 Samples or Batch or Matrix, 1 Spiked Sample per 10 Samples or Batch or Matrix, 1 Method Blank per Set or Matrix
Lead	Sediment/Soil	1 Duplicate per 10 Samples or Batch or Matrix, 1 Spiked Sample per 10 Samples or Batch or Matrix, 1 Method Blank per Set or Matrix
Selenium	Sediment/Soil	1 Duplicate per 10 Samples or Batch or Matrix, 1 Spiked Sample per 10 Samples or Batch or Matrix, 1 Method Blank per Set or Matrix
Mercury	Sediment/Soil	1 Duplicate per 10 Samples or Batch or Matrix, 1 Spiked Sample per 10 Samples or Batch or Matrix, 1 Method Blank per Set or Matrix
Arochlor 1254	Sediment/Soil	1 Method Blank per Set, 1 Surrogate Spike Recovery per Sample, 1 Surrogate Spike Recovery from Method Blank, Recovery and Precision of LCS* Duplicates for each Series
Chlordane	Sediment/Soil	1 Method Blank per Set, 1 Surrogate Spike Recovery per Sample, 1 Surrogate Spike Recovery from Method Blank, Recovery and Precision of LCS* Duplicates for each Series
4, 4' DDT	Sediment Soil	1 Method Blank per Set, 1 Surrogate Spike Recovery per Sample, 1 Surrogate Spike Recovery from Method Blank, Recovery and Precision of LCS* Duplicates for each Series
Toxaphene	Sediment/Soil	1 Method Blank per Set, 1 Surrogate Spike Recovery per Sample, 1 Surrogate Spike Recovery from Method Blank Recovery and Precision of LCS* Duplicates for each Series

*LCS is “Laboratory Control Sample” which is a standard reference solution or a spiked clean sediment, prepared and utilized by the laboratory.

ogy or EPA certified vendors. Calibration procedures can be referenced in the QA Project Plan.

B8 - Inspection and Acceptance Requirements for Supplies and Consumables

Discuss how and by whom supplies and consumables, such as sample bottles, reagents, etc., will be inspected and accepted for use in the project. Identify the acceptance criteria for such supplies in order to satisfy the technical and quality objectives of the project.

B9 - Data Acquisition Requirements (Nondirect Measurements)

Identify the types of data that will likely be acquired from nonmeasurement sources such as computer databases, spreadsheets, and literature files. Define acceptance criteria for the use of these data in the project. Discuss any limitations on the use of these data based on uncertainty in their quality.

B10 - Data Management

Outline the project data management scheme, tracing the path from data generation in the field or laboratory to final use or storage. Describe standard record keeping procedures and the document control system to be used, as well as the approach to be used for data storage and retrieval on electronic media.

Explain the control mechanism used for detecting and correcting paperwork errors and for preventing loss of data during data reduction (calculations), data reporting, and data entry to forms, reports, and databases. Provide samples or examples of any forms or checklists to be used.

Identify and describe all data handling equipment and procedures to process, compile, and analyze data generated and from other sources. Include computer hardware and software used for these purposes. Describe the procedures followed to demonstrate acceptability of the hardware/software configuration.

Section C: Assessment and Oversight

This section covers the methods to be used for assessing how effectively the project was implemented. This assessment will include a variety of QC activities.

C1 - Assessments and Response Actions

Assessment activities help to validate the capability and performance of a measurement system and to identify problems which warrant correction. These assessments can occur by physically auditing field and laboratory procedures (a systems audit) and by providing reference samples, split samples, and blind samples to the laboratory (a performance audit). DWR's *Quality Assurance Guidelines for Analytical Laboratories* explains performance evaluation methods. The QA Project Plan should describe any assessment activities and an approximate schedule for carrying these out over the lifetime of the project.

- *Performance audit* - Data are collected using performance evaluation samples. These samples are certified reference samples obtained from sources such as NIST, National Research Council of Canada, United States Geological Survey, and EPA certified vendors. The Program Manager can obtain appropriate reference samples from DWR's QA Officer. The samples may be used during the life of the project to monitor analytical performance; they are especially useful when QC problems arise.

- *System audit* - The total data production process is reviewed. A qualified auditor reviews, on-site, the laboratory's operational systems and physical facilities and evaluates sampling, calibration, and measurement protocols. Field audits can be performed by knowledgeable project persons or outside agency auditors with appropriate experience. The DWR QA Officer has the major responsibility for arranging systems audits and obtaining qualified auditors.

Define the authorities of the assessors to take corrective action if bad data or incorrect procedures occur. For example, if the assessors should order a work suspension upon finding a significant condition, this section clearly states their authority to do so.

Each QA Project Plan must incorporate a corrective action plan. Describe procedures that will be implemented when data results fall into the "unacceptable" range. Identify the project personnel responsible for implementing the corrective action. Routine QC activities are normally successful in eliminating most data quality problems before data are received by the project. A flowchart showing step-by-step procedures for handling problem data is in Appendix I.

C2 - Reports to Management

QA Project Plans should describe the procedure for reporting on the status of the project, performance of measurement systems, and data quality. The reporting mechanism may be a section in the periodic project progress report to management.

QA topics to be discussed should include:

- Results of the assessment of measurement data accuracy, precision, and completeness
- Results of performance and system audits
- Significant quality assurance problems and documentation of solutions

DWR's QA Officer is available to review QA sections of investigative reports to management. A final copy of these reports should be sent to the DWR QA Officer for tracking of QA procedures.

Section D: Data Validation and Usability

This section describes the QA activities that will occur after the data collection phase of the project is completed.

D1 - Data Review, Validation, and Validation Requirements

The purpose of this section is to ensure good data by maintaining quality throughout data reduction, transfer, storage, retrieval, and reporting. For each step in the data handling, state the criteria used to review and validate data—that is, accept, reject, or qualify data—objectively and consistently.

Describe the equations and statistical procedures used to calculate the value of the measured parameter and to convert these values to the final form. The final form must be compatible with the intended data uses. Include procedures for entry into any computer database program.

Appendix G contains bibliographic sources for statistical procedures. Most of these publications are available in libraries, and some can be borrowed from the QA Officer's reference library. Any equations for determining precision, accuracy, and completeness of the measurement data, such as those shown in Appendix H, should be presented.

If not already included in the "Project/Task Organization" section, identify key individuals who will handle this data flow.

D2 - Validation and Verification Methods

After the laboratory provides analytical data to the Program Manager, the data must be reduced, validated, and processed for reporting in the appropriate format. The following topics should be addressed in the QA Project Plan:

- Describe techniques to trace the data from receipt to use and storage in the final reported form. A flow chart can be used for clarification. Include the record keeping procedures, any document control system, any data control mechanism for detecting and correcting paperwork errors and preventing loss of data, and the means of data storage and retrieval.

- Describe the criteria used by the project to review and validate (i.e., accept, reject, or qualify) data. The process can include checks on the following: transmittal errors, field and laboratory QC data, detection limits, instrument calibrations, special sampling or analysis conditions, any performance (or systems) audits conducted during the project, and statistical data treatments such as evaluation of outliers (outliers are data which fall into an unexpected and unlikely range).

- Describe how the results are conveyed to data users.

D3 - Reconciliation with User Requirements

The QA Project Plan should describe the procedures used to reconcile the results in terms of the outcomes from the DQO process. Discuss how limitations on the use of the data will be reported to decision makers. Consult the DWR QA Officer if assistance is needed.

Appendixes

APPENDIX A

DEPARTMENT OF WATER RESOURCES

TEMPLATE FOR QA PROJECT PLANS

A QA Project Plan is needed for projects that involve some physical, chemical, or biological measure of water quality. These guidelines were developed using EPA's "Requirements for Quality Assurance Project Plans for Environmental Data Operations" EPA QA/R-5, August 1994. For those who wish to develop a QA Project Plan for a biologically oriented project, an additional resource is the EPA's *Generic Quality Assurance Project Plan Guidance for Programs Using Community Level Biological Assessment in Wadable Streams and Rivers*, EPA 841-B-95-004, July 1995.

This format was developed to aid Project Managers in providing documentation for QA activities in typical DWR environmental projects. Such a QA Project Plan: (1) contains information regarding the project technical and quality objectives, (2) demonstrates that all planned measurements are suitable for achieving the objectives of the project, (3) describes the assessment procedures that ensure data quality, and (4) describes a process that will identify and document any limitations on the use of data generated in the project.

This template is set up so that a project manager can fill in appropriate details in each of the following QA Project Plan sections. For convenience, an electronic version of this form is available. The electronic template provides the same guidance as presented below, but can be printed without the instructions and hints being included (the shaded and colored sections of this template).

For short-term or episodic type events or studies, project managers can generally refer to an existing QA Project Plan that fits the requirements of the project and just add specific details. An outline template for such a project is available in the Guidelines for Preparing Quality Assurance Project Plans. This template is also available in electronic versions.

Project Title: **Date:**

Section A: Project Management

From a management perspective, this section covers the project history, objectives, responsibilities of the participants, etc. to ensure that the project has a defined goal, an approach to be used, and documentation of planning outputs.

(Corresponds to EPA Section A1) *Project Management Information*

Unit:

Name of DWR unit in charge of project. Also include names of other agencies involved in project.

Project Manager:
QA Coordinator:

EPA requires a Section A2, Table of Contents. If your project plan is involved enough to require a table of contents, please insert one here.
EPA also requires Section A3, Distribution List. This can be a useful feature if your QA Project Plan is distributed broadly and may go through several revisions.

2. (Corresponds to EPA Section A4) *Project/Task Organization and Responsibilities* (organizational chart)This is where you describe the project organization, line authority, and lines of communication among all project participants. An organizational chart or flow diagram is a good way to do this. Contractors who are providing analytical services should be shown along with a list of the principal contacts. List the key individuals--decision makers--who are responsible for the collection and analysis of measurement data and QA/QC functions. Also include who the principal data users will be.

3.(Corresponds to EPA Section A5) *Project Definition and Background:*

Describe the environmental system or site that is to be evaluated, the project objectives, the problem to be solved, or the decision to be made. Explain why the project is needed.
From a historical perspective, summarize the site use and the reason for environmental concern. Be sure to describe existing data and the general conclusions from any relevant studies. Also describe the adequacy of these existing data and why new data are needed.

The description of the site or environmental system can be shown as maps or charts with sampling locations indicated.

Any constraints of time, resources, etc. on the measurement project should be listed.

4. (Corresponds to EPA Section A6) *Project/Task Description:*

Describe the work to be done and a time line for the project. Overall this description should allow the reader to see how the work tasks in the project will solve the problem or question stated in the previous section. Your work description should include whatever measurements will be made, what special personnel and equipment requirements are involved, and what regulatory or technical quality standards that will apply to your measurements and project. Among the tasks also include descriptions of the assessment tools you will use throughout the

project (peer reviews, technical audits, etc.) and descriptions of the records and reports needed. The following task list and parameter tables are one way to summarize some of the tasks and measurement details involved in the project.

Provide a schedule of tasks and products that take place during the project. This list should include sample gathering and analysis tasks plus those involving assessment activities. It also should include a list of reports (data, quality assessment, interim, final, etc.) that will be generated throughout the project. Additional rows can be added to the table using the "Table" pull-down menu on the toolbar.

PROJECT TASK LIST AND TIME LINE

Task No.	Task	Responsibility	Start Date	Completion Date

Provide a list of measurement parameters and appropriate details for samples that will be collected and analyzed during the project. Additional rows can be added to the table using the "Table" pull-down menu on the toolbar.

PARAMETER TABLE

Parameter	Number of Samples	Matrix	Sample Preservation	Holding Time

Describe any special personnel and equipment requirements.

5. (Corresponds to EPA Section A7) *Data Quality Requirements*

In this section, you are to include a brief description of the project data quality objectives.

Based on the clearly stated objective(s) of your project (section 2) you can now define what are the most appropriate data to collect and under what conditions. The following points should be kept in mind when you talk about your data quality requirements: (1) the intended uses of data, (2) the decisions to be made when data are obtained, and (3) the decision makers who will use the data.

Data to be collected:

Conditions under which data are to be collected:

Since the ability to use data in a decision-making process also includes knowledge about "how good" these data are, you should also provide the QA objectives for precision, accuracy, completeness, representativeness, and comparability for each measurement or value. The first three of these can be simply presented in tabular form, as shown in the tables below. Bryte Laboratory management can provide the specifics required by the table. The same information is also available through DWR's Field and Laboratory Information Management System.

Parameter	Detection Limit	Reporting Limit	Estimated Accuracy	Accuracy Protocol*	Estimated Precision	Precision Protocol**

*Accuracy Protocol Formula - %Recovery is the protocol used.

$$\%R = \frac{Su}{Csa} x100$$

Where S is the measured concentration in the spiked aliquot, u is the measured concentration in the unspiked aliquot, and C_{sa} is the actual concentration of the spike added.

**Precision Protocol Formula - Relative percent difference is used when duplicate samples are collected for QC purposes.

$$RPD = \frac{(C_1 C_2)}{(C_1 + C_2)/2} x100$$

Where C_1 is the larger of the two observed values and C_2 is the smaller of the two values. (Or Relative Standard Deviation, Range of measurement values, etc. if you use some other precision parameter.)

DATA COMPLETENESS

Parameter	Number of Valid Sample Results	Number of Valid Samples Collected and Analyzed	Percent Complete

Data Representativeness:

Data representativeness is the degree to which the data accurately and precisely represent the population of samples. Critical factors include appropriate points of sampling, time of sampling events, and frequency of sampling. These sampling parameters have all been specified in the sampling plan above and are representative in respect to project geography, temporality, and frequency of sampling. Provide a simple statement here that describes your rationale for concluding that your data are representative of the proper sample population.

Data Comparability:

This is a measure of the confidence with which one data set can be compared to another, possibly historical set. If no previous study has been conducted, or you do not intend to compare old and new data, then this section does not apply and you can state that. If you do plan to compare current data to previously obtained data, then you should provide some idea of the general quality of the older data and to what extent you can accept values that may differ from those you will obtain.

EPA requires Section A8: Project Narrative in some plans. This narrative allows technical and QA readers to look at a single section to relate the project to the data quality objectives and to the problem definition. In general, you should be including all of the components of this narrative in various other sections of this QA Project Plan. Therefore, if you do not need this summary narrative section for review purposes, it can be ignored. You should still look at Section A8 - Project Narrative in the Guidelines to see whether all aspects mentioned are covered somewhere else in your plan and, if not, add them to the appropriate section.

6. (Corresponds to EPA Section A9) *Special Training Requirements/Certification*

Identify any specialized training or certification needed by personnel to carry out the project tasks. Describe how such training/certification shall be accomplished and documented

Position Title Requirements Date of Training/Certification

7. (Corresponds to EPA Section A10) *Documentation and Records*

Describe information that must be included in data reports, along with the reporting format. This documentation can include raw data, QC checks, required laboratory turnaround times, and whether a field sampling and/or laboratory analysis "case narrative" is required to provide a complete description of any difficulties encountered during sampling or analysis.

Section B: Measurement/Data Acquisition

You should include all aspects of your measurement system design and implementation strategy in this section. This should help ensure that appropriate sampling, analysis, data handling, and QC methods are followed and documented in your project.

8. (Corresponds to EPA Sections B1 and B2) *Sampling Process Design and Rationale*
Rationale for Selection of Sampling Locations:

Sampling protocols generally should have a statistical design to prove that the samples represent the matrix to be evaluated. Include any statistical approach used to select your sampling locations.

Sampling Design:
Provide information on the location of your sampling stations and the samples you will be collecting. Much of this can be summarized in tabular form. If necessary, add more rows to your table using the "Table" menu.

Site Location	Sample Matrix	Sampling Stations per Site	No. of Samples per Station	Sampling Method	Sample Type	Sample Parameters	Frequency of Sampling	QC Samples

9. (Corresponds to EPA Section B3) *Sample Handling and Custody Procedures*

Make reference to the *Sampling Manual for Environmental Measurement Projects* for detailed procedures and standard operating procedures on (1) tracking samples and maintaining custody records, and (2) preparation of sample containers. If Bryte Laboratory's standard procedures are going to be used, just state that here.

10. (Corresponds to EPA Section B4) *Analytical Method Requirements*

For each measurement parameter, reference the analytical method being used. Bibliographic references to analytical methods are found in Appendix F The DWR's Field and Laboratory Information Management System database also contains information on laboratory analytical methods.

Sample Parameter	Matrix	Analytical Method Reference*

* If any methods used are not EPA or State certified lab standard methods, then provide a descriptive paragraph describing each of those methods. Field analytical procedures can also be entered in this table.

11. (Corresponds to EPA Section B5) *Quality Control Requirements*

Your QA Project Plan should describe QC procedures used with sampling operations, field measurements and analyses, and laboratory analytical techniques.

QC Procedures:

Field QC checks:

Involves collection of replicate samples at various stations and trip (travel) or equipment blanks. See next item for descriptions of various QC samples and blanks.

*Laboratory QC checks:*In general, the laboratory quality assurance manual and SOPs should reference what in-house quality control procedures and samples are used by the laboratory. You should be able to just state that the laboratory's QA manual will be followed with regard to QC samples being used.

Should you need to provide a list of the QC samples being used, here are definitions of typical quality control samples: *Blanks* [Various blanks (field blanks, nutrient blanks, trip blanks, etc.) used to determine levels of contamination in the samples]; *Replicate analyses* [Analyses duplicated in order to assess precision]; *Spiked samples* [A sample to which a known amount of standard material is added prior to sample preparation and analysis, to document the precision and bias of a method in a specific matrix]; *Split samples* [Subsample of a total sample. Split samples are obtained from the environment and then split into differing containers]; *Internal standards* [A known reference material added to the matrix to calculate the concentration of an analyte. The calculation is based on the ratio of the internal standard response to that of the analyte] *performance evaluation samples* [Samples sent blind to the laboratory to examine the ability of an analytical system to obtain reliable data]; *Surrogate samples* [A compound which is similar to the target analyte(s) in chemical composition and behavior in the analytical process but which is not normally found in the environment]; *Calibration standards and devices* [Standards published by the National Institute of Standards and Technology or the American Society for Testing and Materials to establish requirements for instrument calibration]; *Periodic calibrations* [A predetermined schedule of calibrations documented in hardcover format for reference]; *Reagent checks* [Double distilled water processed through the analytical procedure as a normal sample is processed to determine levels of contamination]; and *Control charts* [Charts generated from control limits specified for analytes of interest. Control limits are available from the laboratory performing the analyses].

*Corrective action*Describe what actions will be taken to correct QC data check problems (should they occur). These actions can involve reanalysis of samples (if problems were discovered in a timely manner), resampling to collect new samples, or use of ancillary information to validate original data.

12. (Corresponds to EPA Section B6) *Instrument and Equipment Testing, Inspection, and Maintenance Requirements*

Testing and preventive maintenance applies both to field and laboratory operations. Describe how inspections and acceptance testing of sampling and measurement systems will be performed and documented. Describe preventive maintenance procedures and schedules to minimize downtime of sampling and measurement equipment. Descriptions of the laboratory testing and preventive maintenance procedures are usually in the laboratory QA manuals and can be referenced in the QA Project Plan. Similarly, there may be existing standard operating procedures for any field equipment used and these may be referenced.

13. (Corresponds to EPA Section B7)*Instrument Calibration and Frequency*

Valid data require that instruments function properly. Proper functioning is accomplished by regular calibrations. Document or reference various calibration procedures, frequency of recalibration, and sources of calibration standards both for field sampling equipment and laboratory analytical equipment. Standards should be traceable to a source such as the National Institute of Standards and Technology or EPA certified vendors. As above, descriptions of the laboratory instrument calibration procedures and frequencies are usually in the laboratory QC manuals and can be referenced here. Similarly, there may be existing

SOPs for calibrations of field equipment used, and these also may be referenced.

14. (Corresponds to EPA Section B8) *Inspection/Acceptance Requirements for Supplies and Consumables*

Discuss how and by whom supplies and consumables, such as sample bottles, reagents, etc., will be inspected and accepted for use in the project. Identify the acceptance criteria for such supplies in order to satisfy the technical and quality objectives of the project. This may be as simple as having copies of packing slips (showing that the bottles are cleaned, or reagents are a specific grade, etc.) logged into a project notebook for "SUPPLIES."

15. (Corresponds to EPA Section B9) *Data Acquisition Requirements (Nondirect Measurements)*

Identify the types of data that will likely be acquired from nonmeasurement sources such as computer databases, spreadsheets, and literature files. Define acceptance criteria for the use of these data in the project. Discuss any limitations on the use of these data based on uncertainty in their quality. For most projects, this section will not apply.

16. (Corresponds to EPA Section B10)*Data Management*

In most instances, DWR data will be processed using the DWR's Field and Laboratory Information Management which will automatically record field and lab data and performs QC checks on those data. Similarly, data will usually be stored in an approved DWR database or data library. These can be referenced in this section.

What this section requires is an outline of the project data management scheme, tracing the path from data generation in the field or laboratory to final use or storage.

Describe standard record keeping procedures, the document control system, and the approach to be used for data storage and retrieval on electronic media.

Explain the control mechanism used for detecting and correcting paperwork errors and for preventing loss of data during data reduction, data reporting, and data entry to forms, reports, and databases.

Section C: Assessment and Oversight

In this section, you should cover the methods used for assessing how effectively the project was implemented. This assessment can include a variety of QC activities, as described below.

17. (Corresponds to EPA Section C1) *Assessments and Response Actions*

Describe the type of assessment activities (such as management site visit, a performance audit of the laboratory doing project sample analyses, or an independent audit of the data produced, etc.). If applicable, provide a time schedule for whatever assessment activities are planned. Identify to whom the results of data assessments are reported and who is responsible for instituting any response to a specific assessment activity.

18. (Corresponds to EPA Section C2) *Reports to Management*

Formal QA reports should be issued to inform appropriate management on the performance and progress of the project work plan. These reports, which may be part of periodic progress reports, present the QC data so that management can monitor the data quality effectively.

QA topics to be discussed should include: Results of the assessment of measurement data accuracy, precision, and completeness; results of performance and system audits; changes in the QA Project Plan; summary of QA training; and significant quality assurance problems and documentation of solutions. Finally, there needs to be reporting on whether the QA objectives are being met and the resulting impact on decision making.

Section D: Data Review, Validation, and Validation Requirements

This section describes the QA activities that will occur after the data collection phase of the project is completed. The purpose of this section is to ensure good data by maintaining quality throughout data reduction, transfer, storage, retrieval, and reporting.

19. (Corresponds to EPA Section D1) *Data Review, Validation, and Validation Requirements*

For each step in the data handling, state the criteria used to review and validate data - that is, accept, reject, or qualify data objectively and consistently. Recall that the data parameters you can use are accuracy, precision, completeness, representativeness, and comparability.

Describe the equations and statistical procedures used to calculate the value of the measured parameter and to convert these values into their final form. The final form must be compatible with the intended data uses. Include procedures for entry into any computer database program.

20. (Corresponds to EPA Section D2) *Validation and Verification Methods*

Describe the methods used by the project manager to review and validate (i.e., accept, reject, or qualify) data. The process can include checks on the following: transmittal errors, field and laboratory QC data, detection limits, instrument calibrations, special sampling or analysis conditions, any performance (or systems) audits conducted during the project, and statistical data treatments such as evaluation of outliers.

Describe techniques to trace the data from receipt to use and storage in the final reported form. A flow chart can be used for clarification. Include the record keeping procedures, any document control system, any data control mechanism for detecting and correcting paperwork errors and preventing loss of data, and the means of data storage and retrieval.

Describe how the results are conveyed to data users.

21. (Corresponds to EPA Section D3) *Reconciliation with User Requirements*

Describe how the results obtained from the project will be reconciled with the project data objectives. Discuss how limitations on the use of data will be reported to decision makers.

APPENDIX B

TEMPLATE FOR CONDENSED VERSION OF

QA PROJECT PLANS

INTRODUCTION

This template for a condensed version of a QA Project Plan was developed for unique opportunities or crisis events that require QA Project Plans. In consideration of the potential for unique opportunities or crisis events that require QA Project Plans, QA/QC staff has developed this template for a condensed version of a QA Project Plan. Episodic event/short-term environmental measurement studies conducted by DWR may include additional activities that a manager may wish to pursue in conjunction with primary project activities or new short-term project activities. These activities or events might include sampling efforts during such incidents as floods, short-term toxic spills, or any additional sampling efforts in the project area not covered by the original QA Project Plan.

The short-term QA Project Plan should be drafted and filed with an original QA Project Plan, as an addition to the original document. It should be available for QA/QC purposes when data from the short-term event are analyzed and received by the project manager. Not all short-term event project areas will be covered by a single existing QA Project Plan. In these cases, reference should be made to other existing or historical QA Project Plans (or sampling plans), which cover the area or type of event.

The first section of the short-term QA Project Plan template consists of a cover sheet which indicates the who, what, where, when, and why of the event. Following this cover sheet is a series of checklists that correspond to information available from other QA Project Plans (or sampling plans) filed for the project area.

DEPARTMENT OF WATER RESOURCES

SHORT-TERM EPISODIC EVENT QA PROJECT PLANS

Fill in appropriate information in Section A of the short-term QA Project Plan. Subsequent sections consist of checklists which refer to available project QA Project Plans and/or work plans. Electronic versions of this form are available in current versions of Microsoft Word and WordPerfect for Windows.

PROJECT INFORMATION

Project Title: **Date:**
Unit:

Name of DWR unit responsible for sampling the short-term event. Also include names of other agencies or units involved in the study.

Project Manager:
QA Coordinator:

1. Type of event or episode:

Describe the category or type of short-term event to be studied, what type and how many samples will be collected, and how samples are to be processed.

2. Physical location of the short-term event: Indicate the location of the event. Maps or site plans for sampling, etc. may be used.

3. Schedule of completion:

Indicate duration of the event and an estimated schedule for completion.

4. Significance of the short-term event and what report or deliverable will result from this study:

Provide a brief description of the significance of the event, what special information it will provide, and where or how the results of the study will be reported.

CHECKLISTS

Complete the following checklists by referring back to the original QA Project Plans or work plans for the project or event study area. Under each checklist item, name the referenced QA Project Plan or work plan that provides the information.

SECTION A: PROJECT MANAGEMENT CHECKLIST

1. Quality Objectives and Criteria for Measurement Data:

a. ☐ *Quantitative QA Objectives*

Provide a QA Project Plan reference for the following quantitative QA objectives:

Reporting limits: Laboratories usually determine reporting levels which are several times higher than the method detection limit. The method detection limit must be reliably lower than the required objectives for quantification in the project.

Precision: Precision is the degree to which measurements can be reproduced among duplicate or replicate observations. It is often expressed as relative percent difference between duplicates. Precision is expressed as relative standard deviation of the mean with more than two replicates.

Accuracy: Accuracy refers to the difference between the measured result and the true value of the parameter being determined. Accuracy can be determined by comparison of the environmental sample results to certified reference samples or as percent recovery of matrix spikes.

Completeness: Data completeness refers to the amount of data that is successfully collected and validated with respect to the amount intended in the project design. A certain percentage of the intended data must be successfully determined for valid conclusions to be reached. Completeness is usually expressed in percent.

b. ☐ *Qualitative QA Objectives*

Provide a reference for the following qualitative QA objectives:

Representativeness: Representativeness is the degree to which the data accurately and precisely represent the population of samples. For example, the most critical factors necessary to achieve representativeness are appropriate sampling locations, sampling times, the frequency of sampling, and maintenance of the integrity of the sample.

Comparability: Comparability refers to the similarity of data generated by different groups. If comparability is required, these different agencies or groups should use equivalent sampling procedures and analytical methods. Sometimes interlaboratory comparison studies can be used to establish comparability of analytical data.

c. ☐ *Documentation and records*

Provide a QA Project Plan reference for the information that must be included in data reports, along with the reporting format (including any explanatory information). Documentation should include raw data or QC checks. Requirements for the final disposition of documents and records, including the location and duration of storage, should be specified.

SECTION B: MEASUREMENT/DATA ACQUISITION CHECKLIST

1. Station selection and design:

a. ☐ *Rational:*

Provide a QA Project Plan reference for the rationale for the selection of the sampling locations, the number of sampling locations, and any statistical approach used to select sampling locations. If not the same as in the original QA Project Plan, indicate whether the sampling locations were selected on a random, judgmental, or systematic basis, or a combination of these.

2. Sampling procedures plan:

a. ☐ *Methodology*

Provide a QA Project Plan reference for a description of specific sampling procedures used.

b. ☐ *Sample Preservation*

Provide a QA Project Plan reference for methods of sample preservation, maximum holding times, and procedures to transport samples to the laboratory within allowable time limits.

c. ☐ *Sample Containers*

Provide a reference for what sample containers are to be used with the specific methods utilized in the study.

d. ☐ *Preparation of Equipment*

Reference procedures for cleaning and preparing sampling equipment and containers to avoid sample contamination.

e. ☐ *Training*Provide a reference for your usual training requirements for field personnel. Describe any training unique to this study.

3. Sample handling and custody requirements:

a. ☐ *Identification of custodians*

Provide a QA Project Plan reference for the "sample custodian" at the laboratory who is authorized to sign for incoming field samples, and obtain documents of shipment (e.g., bill of lading number or mail receipt).

b. ☐ *Tracking forms*

Reference laboratory sample tracking procedures for sample handling, storage, disbursement for analysis, and any provision for sample tracking logs. If this information is not in an existing QA Project Plan (due to use of a different lab etc.), you may reference the laboratory standard operating procedures.

c. ☐ Sample records

Describe or reference the standard record-keeping procedures, document control system, and the approach used for data storage and retrieval on electronic media. Also reference the control mechanism for detecting and correcting errors and for preventing loss of data during data reduction (i.e., calculations), data reporting, and data entry to forms, reports, and databases. (The proposed Field and Laboratory Information Management System developed at DWR's Bryte Laboratory will, in the future, cover the above-mentioned parameters of record reduction, correction, reporting and database storage).

4. Sample processing and analysis (standard/nonstandard methods)

For each measurement parameter provide a QA Project Plan reference for the analytical method being used. If method is not in an existing QA Project Plan, provide a written description of the analytical procedures to be used. If the methods used are standard methods from a state certified lab, then provide the method code number. If any methods used are not EPA or state certified lab standard methods, then provide a descriptive paragraph describing each of those methods.

5. Instrument calibration procedures and frequency:

Provide a QA Project Plan reference for calibration procedures both for field sampling equipment and laboratory analytical equipment. The original QA Project Plan should list or reference various calibration procedures, frequency of recalibration, and sources of calibration standards. Standards should be traceable to a source such as the NIST or EPA certified vendors.

6. Data reduction and analysis (calculations and statistics):

Provide a QA Project Plan reference for the criteria used to reduce and/or validate (accept, reject, or qualify) data in an objective and consistent manner. Identify any project specific calculations and/or algorithms utilized in this activity.

7. QC data checks, quality control requirements:

a. ☐ QC Requirements

Provide a QA Project Plan reference for QC procedures used with sampling operations, field measurements and analyses, and laboratory analytical techniques.

b. ☐ Typical quality control samples and protocols

The checklist provided here should be similar to what is referenced in your QA Project Plan. If not, then use the examples given to list what you are utilizing for your QC data checks. Typical quality control samples include: Blanks [Various blanks (field blanks, nutrient blanks, trip blanks, etc.) used to determine levels of contamination in the samples]; Replicate analyses [Analyses duplicated in order to assess precision]; Spiked samples [A sample to which a known amount of standard material is added prior to sample preparation and analysis, to document the precision and bias of a method in a specific matrix]; Split samples [Subsample of a total sample. Split samples are obtained from the environment and then split into differing containers]; Internal standards [A known reference material added to the matrix to calculate the concentration of an analyte. The calculation is based on the ratio of the internal standard response to that of the analyte] performance evaluation samples [Samples sent blind to the laboratory to examine the ability of an analytical system to obtain reliable data]; Surrogate samples [A compound which is similar to the target analyte(s) in chemical composition and behavior in the analytical process but which is not normally found in the environment]; Calibration standards and devices [Standards published by NIST or ASTM to establish requirements for instrument calibration]; Periodic calibrations [A predetermined schedule of calibrations documented in hardcover format for reference]; Reagent checks [Double distilled water processed through the analytical procedure as a normal sample is processed to determine levels of contamination]; and Control charts [Charts generated from control limits specified for analytes of interest. Control limits area available from the laboratory performing the analyses].

c. ☐ Corrective action

Provide a QA Project Plan reference for actions taken to correct QC data check problems. If these usual actions do not apply due to specific time constraints of this study, describe what additional or alternative actions will be taken.

SECTION C: ASSESSMENT AND OVERSIGHT CHECKLIST

1. ☐ Assessment and response actions

Provide a QA Project Plan reference for the type of assessment activities (such as management site visit, a performance audit of the laboratory doing project sample analyses, or an independent audit of the data produced, etc.). If applicable, provide a time schedule for whatever assessment activities are planned. Identify to whom the results of data assessments are reported and who is responsible for instituting any response to a specific assessment activity.

2. ☐ *Reports to management*

Generally interim reports are not required for a short-term, episodic project and the response here is that “A final report containing...(study findings, limitations to use of the results, etc.)...will be developed by the project manager(s) and provided to .....(whom, or what agencies)”. However, if such interim project reports are required, describe the contents of such reports and list individuals to whom the reports are made. Typically, such interim reports describe the status of the project, the results of any performance evaluations and system audits, the results of periodic data assessments, and a discussion of any quality assurance problems and recommended solutions.

SECTION D: DATA VALIDATION AND USABILITY CHECKLIST

1. ☐ *Data review*

Provide a QA Project Plan reference for methods used to review sample data after analysis and initial QC reports have been completed.

2. ☐ *Data limitations*

Provide a QA Project Plan reference for how any data limitations identified or that are inherent to the study will be transmitted to data users.

APPENDIX C
BIBLIOGRAPHIC SOURCES FOR SAMPLING DESIGN

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APPENDIX H
CALCULATION OF DATA QUALITY INDICATORS

This Appendix describes how data quality indicators will be calculated and reported. At a minimum, equations must be provided for precision, accuracy, completeness, and method detection limits. In addition, equations must be given for other project-specific calculations, such as confidence ranges, etc.

This complements Section A7, "Quality Objectives and Criteria for Measurement Data," and Section B5, "Quality Control Requirements," of the QA Project Plan. Section A7 specifies which particular data quality indicators will be used. Section B5 then uses these specific indicators to generate acceptance criteria. Because different equations can be used to calculate data quality indicators, QA Project Plans should provide the exact equations to avoid misunderstandings among data users.

Listed below are general guidelines for calculating the more common data quality indicators.

COMMON DATA QUALITY INDICATORS

Precision

Precision is a measure of the degree to which data generated from replicate or repetitive measurements differ from one another. If calculated from duplicate measurements, relative percent difference is the normal measure of precision:

$$RPD = \frac{(C_1 C_2)}{(C_1 + C_2)/2} x100 \qquad (1)$$

where:

RPD	=	relative percent difference
C_1	=	larger of the two observed values
C_2	=	smaller of the two observed values

Example: Results from analysis of selenium in a water sample and its field duplicate are given as 5.9 and 7.4 _g/L. Calculation of RPD by equation 1 gives the following result:

$$RPD = \frac{(7.45.9)}{(7.4 + 5.9)/2} x100 = 22.5\%$$

Better values for precision can be obtained using more replicates. If precision is calculated from three or more replicates, determine the standard deviation and use the relative standard deviation (RSD) rather than RPD :

$$RSD = \left[\frac{s}{\bar{x}}\right] x100 \qquad (2)$$

where: RSD = relative standard deviation
s = standard deviation
$\bar{x}$ = arithmetic mean (average) of replicate measurements

Standard deviation is defined as follows:

$$S = \sqrt{\frac{\sum_{i=1}^{n} [X_i - \bar{X}]^2}{n-1}} \qquad (3)$$

where: s = standard deviation
X_i = measured value of the i^{th} replicate
$\bar{x}$ = arithmetic mean (average) of replicate measurements
n = number of replicates

Example: A laboratory measures three replicates of a water sample to evaluate the in-laboratory precision for selenium. The replicate values are 7.4, 5.9, and 6.6. The mean value is 6.6. The standard deviation is:

x_i	$(x_i - x)$	$(x_i - x)^2$
7.4	0.8	0.64
5.9	-0.7	0.49
6.6	0.0	0.00
$\bar{x}$ = 6.6		Σ = 1.13

n = 3

$$s = \sqrt{\frac{1.13}{2}} = 0.75$$

$$RSD = \frac{0.75}{6.6} x100 = 11.4\%$$

Range is often used as an index of precision. For measurements such as pH, where the absolute variation is more appropriate, precision is usually reported as the absolute range of duplicate measurements:

$$D = |m_1 - m_2| \quad (4)$$

where: D = absolute range
m_1 = first measurement
m_2 = second measurement

Accuracy

Accuracy is the degree of agreement of a measured value with the true or expected value of the constituent of concern. Accuracy is normally measured using matrix spikes or standard reference materials. An analytical laboratory is required to provide spike recovery data as part of its in-laboratory QC procedures. Spike recoveries must fall into an established acceptable range. Standard reference materials or performance evaluation samples can be used to evaluate the analytical capabilities of a laboratory.

Where matrix spikes are used, calculate percent recovery as follows:

$$\%R = \frac{Su}{Csa} x100 \quad (5)$$

where: %R = percent recovery
S = measured concentration in spiked aliquot
u = measured concentration in unspiked aliquot
C_{sa} = actual concentration of spike added

Example: The laboratory spiked a duplicate environmental sample to measure the matrix effects and quantitative recovery of selenium in water. The concentration of Se in the unspiked sample was 3.2 µg/L. A 10 µg/L spike was added to the duplicate and the measured value of this sample for Se was 12.3 µg/L:

$$\%R = \frac{12.3 - 3.2}{10} x100 = 91\%$$

When a standard reference material (SRM) or PE sample is used:

$$\%R\,(certified\ value) = \frac{C_m}{C_{srm}} x100 \qquad (6)$$

where: %R = percent recovery or percent of certified value
C_m = measured concentration of SRM
C_{srm} = certified concentration of SRM

Example: A NIST certified water sample (SRM) contains 9.7 µg/L selenium. The laboratory measures 8.7 µg/L selenium in an analysis of the SRM. The %R value is:

$$\%R = \frac{8.7}{9.7} x100 = 89.7\%$$

Completeness

Completeness is a measure of all information necessary to validate a scientific study. A useful way to evaluate completeness is to compare the project objectives with the data acquired. If this indicates incomplete valid data, then the completeness requirement is not met. In many cases, this will mean resampling and analysis to obtain sufficient valid data. Completeness can be defined as the number of measurements judged valid compared to the total number of measurements taken. A simple equation for completeness is defined as:

$$\%C = \frac{V}{T} x100 \qquad (7)$$

where: %C = percent completeness
V = number of measurements judged valid
T = total number of measurements

Method Detection Limit (MDL)

The method detection level is defined as the minimum concentration that can be measured with a 99 percent confidence that the analyte concentration is greater than zero. Values for MDLs are required to define the limitations of the method and instrumentation being used. MDLs should be from 5 to 10 times lower than the environmental values being reported. Ideally, a laboratory should establish and periodically reevaluate its own analyte MDLs for each matrix type by analysis of seven or more replicates of spiked matrix samples. MDL is defined as follows:

$$MDL = t_{(n-1) \text{ at the 99\% confidence level}} \times s \qquad (8)$$

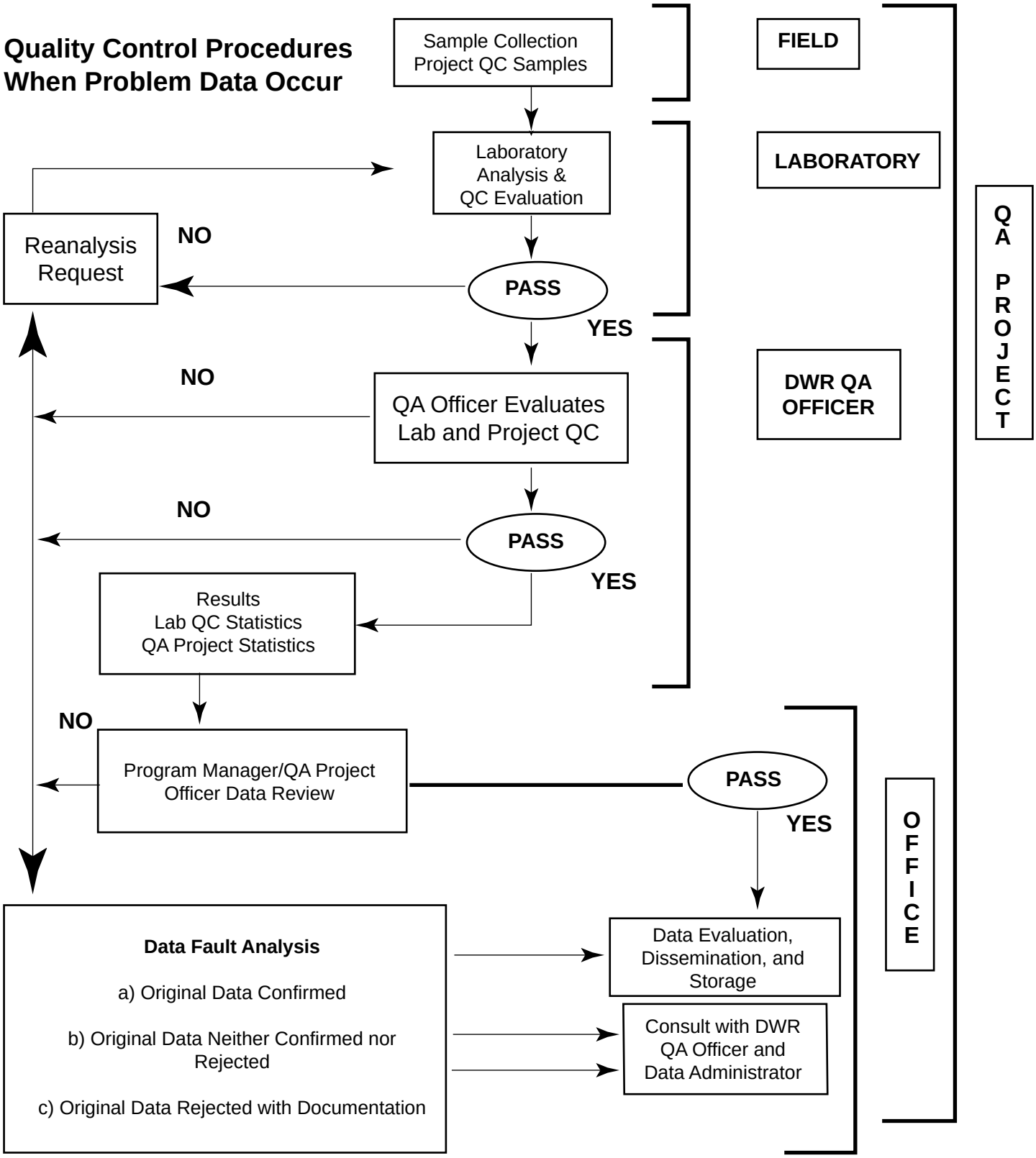
where:

MDL = method detection limit
s = standard deviation of the replicate measurements
t = Students' t-value for a one-sided 99 percent confidence level and a standard
n = number of samples
n-1 = degrees of freedom

Example: A laboratory is evaluating the MDL for a parameter at the 0.02 mg/L level. Eight spikes were measured giving values of 0.032, 0.016, 0.021, 0.022, 0.024, 0.017, 0.025, and 0.019 mg/L. The arithmetic mean of these samples is 0.022 mg/L with a standard deviation of 0.005 _g/L (calculated using Equation #3). Going to a table of "t" values, for a 99 percent confidence level and 8 analyses (7 degrees of freedom) the "t" value is 2.998.

The MDL estimate is 2.998 x 0.005 = 0.015 mg/L

APPENDIX I
PROBLEM DATA FLOWCHART



Footnotes to Problem Data Flowchart

(1) Program Manager QC Evaluation:

- Compares data with historical data
- Verifies correct data entry
- Checks reasonableness of results

(2) Data Fault Analysis:

- Reviews other data for corroboration
- Evaluates possible sources of sample contamination
- Evaluates possible sampling, preservation, transportation, and holding time error
- Evaluates performance of laboratory
- Reanalyzes original sample (if possible)
- Collects and analyzes new sample

Note: If original data indicate a public health threat, notification requirements may be necessary.

(3) Notification Requirements:

If upon reanalysis, the original data are confirmed and the data indicate a public health threat, notification requirements may be necessary.

(4) Original Data Rejected:

- Reanalysis indicates original value cannot be confirmed
- Contamination is identified
- Holding time error was found

Note: Data that are verified to be in error should be rejected with documentation and should not be entered into the database. Data that remain questionable even after the validation procedure should be tagged and a footnote entered into the database. Data should not be rejected until the verification and validation procedures occur.

(5) Consult with DWR QA Officer on options for corrective action:

- Sample analysis by independent laboratory
- Increased frequency of monitoring
- Replacement of equipment
- Independent QC audit of field and/or laboratory

APPENDIX J
PROJECT PLAN GLOSSARY

Accuracy: The degree of agreement of a measured value with the true or expected value of the quantity of concern.

Analyte: The specific component measured in a chemical analysis.

Bias: The systematic or persistent distortion of a measurement process in which the expected sample measurement is different than the sample's true value. Bias can be both positive and negative.

Blank: A clean sample of sample matrix processed to measure artifacts in the sampling and analysis process.

Comparability: The degree to which different methods, data sets, and results agree or can be represented as similar.

Completeness: A measure of the amount of data that is successfully collected and validated compared to the amount intended in the project design.

Data Reduction: The process of transforming raw data by arithmetic statistical calculations, standard curves, or concentration factors into the final use form.

Data Validation: A systematic process of reviewing a body of data against a set of established criteria to establish the usefulness of the data for a specific purpose.

Data Quality Objectives: Qualitative and quantitative statements developed by data users to specify the quality of data needed from a particular data collection activity.

Duplicate (sample): A second sample randomly selected from a population of interest to assist in the evaluation of sample variance. Duplicate samples are often taken from the same container to measure analytical precision.

Holding Time: The maximum amount of time that can elapse between obtaining the sample and laboratory analysis before potential for significant deterioration occurs.

Internal Standard: A known reference material added to the matrix in order to calculate the concentration of an analyte. The calculation is based on the ratio of the internal standard response to that of the analyte.

Method Detection Limit: The lowest concentration that can be measured with a 99 percent confidence that the analyte concentration is greater than zero.

Performance Audit: An examination of the ability of an analytical system to obtain reliable data. This examination or audit obtains measurement data using performance evaluation samples.

Precision: The degree of mutual agreement characteristic of independent measurements as the result of repeated application of the process under specified conditions. It is concerned with the closeness of the measurements.

QC Sample: A sample of known composition or concentration used to evaluate the quality of field or laboratory measurements.

Reference Sample: A material or substance, one or more properties of which are established well enough to be used for the calibration of an apparatus, the assessment of a measurement method, or for assignment of values to materials.

Replicate: A counterpart or repeat of another, usually referring to an analytical sample or measurement.

Representativeness: The degree to which the data accurately and precisely represent the frequency distribution of a specific variable in the population.

Sample Matrix: The substrate (e.g., surface water, ground water, soil, or sediment) that contains the analyte of interest.

Spiked Sample: A sample to which a known amount of standard material is added (spiked), prior to sample preparation and analysis, to document the precision and bias of a method in a given sample matrix.

Split Sample: A subsample of a total sample.

Standard Operating Procedures: Procedures adopted for repetitive use when performing a specific measurement or sampling operation. It may be an existing standard procedure or one developed by the user.

Surrogate Sample: A compound (usually organic) which is similar to the target analyte(s) in chemical composition and behavior in the analytical process but which is not normally found in environmental samples.

System Audit: An examination of the total data production process of a laboratory or field activity. It includes on-site reviews of laboratory and field operational systems and physical facilities for sampling, calibration, and measurement protocols.

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