
Delta Regional Monitoring Program

Quality Assurance Program Plan

Prepared by

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Title and Approval

For

PROJECT NAME: Delta Regional Monitoring Program

Date: June 19, 2015

NAME OF RESPONSIBLE ORGANIZATION: San Francisco Estuary Institute – Aquatic Science Center (SFEI-ASC)

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1. Project Task/Organization

1.1. Roles

An organizational chart, with monitoring responsibilities noted, is provided in Figure 1-1.

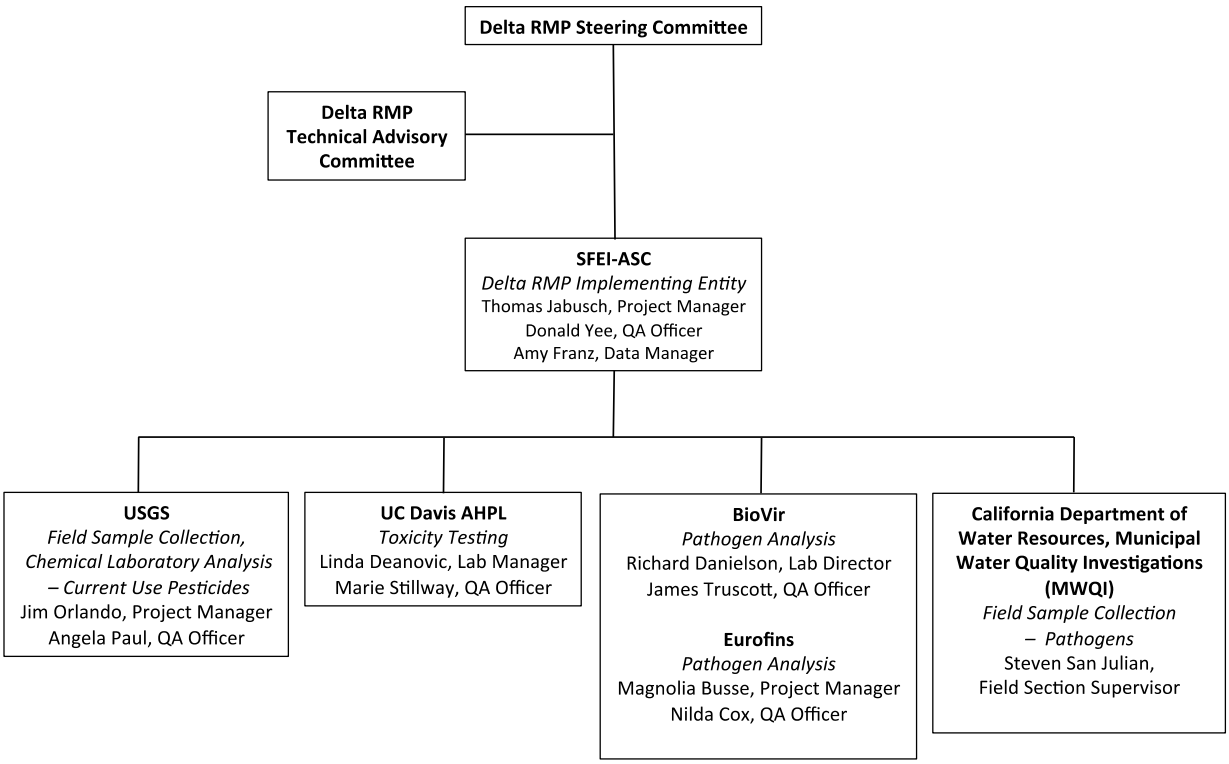

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Figure 1.1. Project Organization Chart.

Under the direction of the Delta Regional Monitoring Program (Delta RMP) Steering Committee, the Technical Advisory Committee (TAC) provides technical oversight of the Delta RMP and San Francisco Estuary Institute – Aquatic Science Center (SFEI-ASC) manages and operates the program as the implementing entity.

The SFEI-ASC Project Manager is responsible for all aspects of monitoring components of this project including the organization of field sampling, scheduling of sampling days, and interactions with the contract laboratories. The SFEI-ASC Project Manager reports directly to the Delta RMP Steering Committee.

The SFEI-ASC Regional Data Center Manager will ensure that data submitted by subcontractor labs are timely, complete, and properly incorporated into the Regional Data Center database, for use by statewide compilations of data, such as CEDEN or My Water Quality Estuary Portal.

SFEI-ASC's Quality Assurance Officer (QAO) role is to establish and oversee the quality assurance and quality control (QA/QC) procedures found in this QAPP, which include field and laboratory activities. The SFEI QAO will work with the Quality Assurance Officers for contracted analytical laboratories, reviewing and communicating all QA/QC issues contained in this QAPP to the laboratories. Contact information for key staff is listed in Table 0-1.

Laboratories contracted by SFEI-ASC provide high quality analytical services. The analytical laboratories will act as a technical resource to SFEI-ASC staff and management. The responsible personnel and contact information are listed above in Table 0-1.

Table 1.1. Analytical laboratories.

Analytical laboratory	Lab abbrev.	Matrix	Analytical Services
BioVir Laboratories	BioVir	Water	Cryptosporidium/Giardia
Eurofins	Eurofins	Water	Cryptosporidium/Giardia
U.S. Geological Survey Organic Chemistry Research Laboratory	USGS-OCRL	Water	Field Measurements, Pesticides
U.S. Geological Survey National Water Quality Laboratory	USGS-NWQL	Water	Copper (dissolved), dissolved and particulate organic carbon
University of California Davis-Aquatic Health Program Laboratory	UCD-AHPL	Water	Toxicity, TIEs, alkalinity, ammonia, hardness

1.2. Persons Responsible for QAPP Update and Maintenance

Changes and updates to this QAPP may be made after a review of the evidence for change by SFEI-ASC's Project Manager and QAO, and with the concurrence of the Delta RMP Technical Advisory Committee. SFEI-ASC's QAO will be responsible for making the changes, submitting drafts for review, preparing a final copy, and submitting the final for signatures. Changes are expected year to year in the early years of Delta RMP implementation.

2. Problem Definition/Background

The Delta RMP was initiated in 2008 by the Central Valley Regional Water Quality Control Board (Regional Water Board) with the primary goal of tracking and documenting the effectiveness of beneficial use protection and restoration efforts through comprehensive monitoring of water quality constituents and their effects in the Delta. The development of the Delta RMP was initially prompted by the collapse of the populations of several species of fish in the early 2000s, an event that triggered new inquiries into the potential role of contaminants in what is now termed the Pelagic Organism Decline (POD). However, these inquiries highlighted shortcomings of existing monitoring efforts to address questions at the scale of the Delta. The

recognition that data from current monitoring programs were inadequate in coverage, could not easily be combined, and were not adequate to support a rigorous analysis of the role of contaminants in the POD persuaded regulatory agencies to improve coordination across multiple monitoring programs.

In addition, the Delta RMP reflects an increasing desire among water quality and resource managers throughout the state for more integrated information about patterns and trends in ambient conditions across watersheds and regions. Many stressors on beneficial uses are interrelated and must be addressed more holistically. The Delta RMP complements existing larger-scale collaborative monitoring efforts throughout the state that attempt to address questions and concerns about regional conditions and trends (e.g., San Francisco Bay RMP, Southern California Bight Monitoring Program, Surface Water Ambient Monitoring Program).

The Delta RMP Steering Committee is the decision-making body of the Delta RMP. The Steering Committee is responsible for establishing the Delta RMP's strategic direction and the policies and procedures that govern its operation. The Steering Committee may direct Delta RMP staff and advisory committees to assist in meeting the objectives and may delegate day-to-day functions of the Delta RMP to the Delta RMP's implementing entity.

The Steering Committee authorizes the implementation of agreements among the participating members and, specifically:

Directs the fiscal/operating agent to request and receive federal, state, local, and private funds from any source and to expend those moneys to accomplish the Delta RMP's goals

1. Approves budgets and expenditures
2. Directs the fiscal/operating agent to enter into partnerships, contracts, and other legal agreements on behalf of the Delta RMP, as necessary to fulfill the Delta RMP's mission
3. Approves Delta RMP work products and any other plans, products, or resolutions of the Delta RMP
4. Sets priorities and oversee the activities of the Stakeholder and Technical Advisory Committees
5. Establishes and oversees the implementation of policies and procedures necessary to the day-to-day functioning of the Delta RMP

The Delta RMP Steering Committee decided the initial Delta RMP would include monitoring for mercury/methylmercury, nutrients, pathogens, and current use pesticides. Management questions to be answered by the monitoring were developed and provided to the Delta RMP TAC to design a monitoring program that would answer the management questions posed by the Steering Committee. This QAPP is only addressing pathogens and pesticides/toxicity due to limited funding. When funding is available to conduct mercury and nutrient monitoring, this QAPP will be updated to include those constituents.

3. Program Tasks Description

3.1. Work Statement and Products

To address the management questions posed (Appendix A), the Delta RMP will conduct water sampling monthly. This work is planned and performed under the guidance of the Delta RMP Steering Committee with technical advice on monitoring design from the Technical Advisory Committees, which are composed of state and federal regulators, permittees, water supply, and coordinated monitoring program representatives.

Data from Status and Trends monitoring efforts will be made available annually for download via the SFEI-ASC Contaminant Data, Display and Download tool (CD3) (http://cd3.sfei.org), incorporated annually into Delta RMP reports for non-technical (e.g., Pulse of the Delta) and technical audiences (e.g., Annual Monitoring Results report), and used for published manuscripts in the peer reviewed literature. These data are subsequently incorporated into the California Environmental Data Exchange Network (CEDEN) and the California Estuaries web portal.

Table 4-1 provides a summary of key products of the Delta RMP. The Pulse of the Delta will be the main interpretive reporting vehicle for Delta RMP results. The audience of this report will be local, state, and federal decision-makers and the interested public. The data will be interpreted to answer Delta RMP management and assessment questions, based on the most appropriate statistical analyses to be used for evaluating the data in relation to a question, as guided by the TAC. Both the TAC and the SC will provide review of the Pulse of the Delta. Prior to release of the Pulse of the Delta, SFEI-ASC will provide basic annual data reports (Annual Monitoring Results Report) for review by the TAC and SC. Monitoring results will be one of the main decision factors for adaptive changes to the monitoring program. An annual SC planning meeting/workshop will identify adaptations needed to the monitoring program and will be informed by monitoring results. In addition, the TAC will have access to preliminary data through the TAC website and the password-protected data-sharing workspace of the California Estuaries web portal.

Table 3.1. Summary of deliverables.

Deliverable	Frequency	Relative due date
Annual Monitoring Results (including QA report)	Annually	October 1
Pulse of the Delta	Annually	May 1
CD3	Annually	January 1
CEDEN	Annually	May 1
California Estuaries web portal	Annually	May 1

3.2. Constituents to be Monitored and Reported

Delta RMP monitoring will include the collection, measurement, and reporting of many parameters. The following information will be included with each sample collection:

- Station location (latitude and longitude) (Tables 7-1 and 7-2)
- Station sampling date and time (Tables 7-1 and 7-2)
- Matrix sampled (water)
- Parameter measurements (Table 3-2)
- Collection and analytical methods (Table 4-6)
- Qualifiers and comments (applied by analytical labs or by Delta RMP staff in data review)(Table 6-1)

The initial implementation of the Delta RMP includes monitoring for current use pesticides (CUPs) and pathogens. Thus, the QAPP only addresses the CUPs and pathogens monitoring elements. The CUP monitoring element includes chemical analyses and toxicity testing. The chemical analyte groups for this monitoring element include several current use pesticide groups, dissolved copper, and ancillary parameters such as dissolved/particulate organic carbon and hardness. Table 4-2 provides a complete list of target parameters for the initial implementation of the Delta RMP. When funding is available to conduct mercury and nutrient monitoring, this QAPP will be updated to include additional information for mercury and nutrient constituents.

Table 3.2. Delta RMP target parameters and reporting units. All parameters listed under current use pesticide sampling will be analyzed for each sampling site at each sampling event. Pathogen monitoring parameters will be analyzed for each pathogen monitoring site at each monthly sampling event.

Current Use Pesticides Sampling		
Constituent	**Reporting Group**	**Unit**
Oxygen, Dissolved	Field Parameters	mg/L
Oxygen, Dissolved	Field Parameters	% saturation
pH	Field Parameters	pH
Specific Conductivity	Field Parameters	uS/cm
Temperature	Field Parameters	°C
Turbidity	Field Parameters	NFU
Current Use Pesticide Sampling – Toxicity Testing Laboratory Analysis		
Constituent	**Reporting Group**	**Unit**

Alkalinity as $CaCO_3$	Conventional[1]	mg/L
Ammonium as N	Conventional	mg/L
Electrical Conductivity	Conventional	uS/cm
Hardness as $CaCO_3$	Conventional	mg/L
Oxygen, Dissolved	Conventional	mg/L
pH	Conventional	pH
Specific Conductivity	Conventional	uS/cm
Temperature	Conventional	°C
Ceriodaphnia dubia (Reproduction)	Water Column Toxicity	young/surviving female
Ceriodaphnia dubia (Survival)	Water Column Toxicity	%
Hyalella azteca[2] (Survival)	Water Column Toxicity	%
Pimephales promelas (Larval biomass)	Water Column Toxicity	mg/surviving fish
Pimephales promelas (Larval survival)	Water Column Toxicity	%
Selenastrum capricornutum (Growth)	Water Column Toxicity	cells/mL
Current Use Pesticide Sampling – Chemical Analysis Laboratory		
Constituent	**Reporting Group**	**Unit**
Dissolved Organic Carbon (DOC)	Conventional	ug/L
Particulate Organic Carbon (POC)	Conventional	ug/L
Total Suspended Solids (TSS)	Conventional	mg/L
Copper (dissolved)	Metals	ug/L
Carbaryl	Carbamates	ug/L
Carbofuran	Carbamates	ug/L
p,p'-DDD	DDTs	ug/L
p,p'-DDE	DDTs	ug/L
p,p'-DDT	DDTs	ug/L
Desulfinylfipronil	Fipronils	ug/L
Fipronil	Fipronils	ug/L
Fipronil sulfide	Fipronils	ug/L
Fipronil sulfone	Fipronils	ug/L
(E)-Dimethomorph	Fungicides	ug/L
Azoxystrobin	Fungicides	ug/L
Boscalid	Fungicides	ug/L

[1] "Conventional" water quality parameters generally describe basic physical-chemical water quality characteristics that were established prior to the advent of instrumental chemical analysis in the early 1970s. The Surface Water Ambient Monitoring Program (State Water Resources Control Board) Quality Assurance Program Plan (QAPrP) provides a Reference Table for Conventional Parameters in Fresh and Marine Waters.

[2] Inclusion of *Hyalella* water toxicity testing is pending a final decision by the SC.

Carbendazim	Fungicides	ug/L
Chlorothalonil	Fungicides	ug/L
Cyazofamid	Fungicides	ug/L
Cymoxanil	Fungicides	ug/L
Cyproconazole	Fungicides	ug/L
Cyprodinil	Fungicides	ug/L
Desthio-Prothioconazole	Fungicides	ug/L
Difenoconazole	Fungicides	ug/L
Ethaboxam	Fungicides	ug/L
Famoxadone	Fungicides	ug/L
Fenarimol	Fungicides	ug/L
Fenbuconazole	Fungicides	ug/L
Fenhexamide	Fungicides	ug/L
Fluazinam	Fungicides	ug/L
Fludioxinil	Fungicides	ug/L
Fluoxastrobin	Fungicides	ug/L
Flusilazole	Fungicides	ug/L
Flutriafol	Fungicides	ug/L
Imazalil	Fungicides	ug/L
Iprodione	Fungicides	ug/L
Kresoxim-methyl	Fungicides	ug/L
Mandipropamide	Fungicides	ug/L
Metconazole	Fungicides	ug/L
Myclobutanil	Fungicides	ug/L
Propiconazole	Fungicides	ug/L
Pyraclostrobin	Fungicides	ug/L
Pyrimethanil	Fungicides	ug/L
Tebuconazole	Fungicides	ug/L
Tetraconazole	Fungicides	ug/L
Thiabendazole	Fungicides	ug/L
Triadimefon	Fungicides	ug/L
Triadimenol	Fungicides	ug/L
Trifloxystrobin	Fungicides	ug/L
Triflumizole	Fungicides	ug/L
Triticonazole	Fungicides	ug/L
Zoxamide	Fungicides	ug/L
3,4-DCA	Herbicides	ug/L
3,5-DCA	Herbicides	ug/L
Alachlor	Herbicides	ug/L
Atrazine	Herbicides	ug/L
Butylate	Herbicides	ug/L
Clomazone	Herbicides	ug/L
Cycloate	Herbicides	ug/L

DCPA	Herbicides	ug/L
DCPMU	Herbicides	ug/L
DCPU	Herbicides	ug/L
Diuron	Herbicides	ug/L
EPTC	Herbicides	ug/L
Ethalfluralin	Herbicides	ug/L
Fluridone	Herbicides	ug/L
Hexazinone	Herbicides	ug/L
Metolachlor	Herbicides	ug/L
Molinate	Herbicides	ug/L
Napropamide	Herbicides	ug/L
Oryzalin	Herbicides	ug/L
Oxyfluorfen	Herbicides	ug/L
Pebulate	Herbicides	ug/L
Pendimethalin	Herbicides	ug/L
Penoxsulam	Herbicides	ug/L
Prometon	Herbicides	ug/L
Prometryn	Herbicides	ug/L
Propanil	Herbicides	ug/L
Propyzamide	Herbicides	ug/L
Simazine	Herbicides	ug/L
Thiobencarb	Herbicides	ug/L
Trifluralin	Herbicides	ug/L
Chlorantraniliprole	Insecticides	ug/L
Cyantraniliprole	Insecticides	ug/L
Flonicamid	Insecticides	ug/L
Methoprene	Insecticides	ug/L
Methoxyfenozide	Insecticides	ug/L
Tolfenpyrad	Insecticides	ug/L
Acetamiprid	Neonicotinoids	ug/L
Clothianidin	Neonicotinoids	ug/L
Dinotefuran	Neonicotinoids	ug/L
Imidacloprid	Neonicotinoids	ug/L
Thiacloprid	Neonicotinoids	ug/L
Thiamethoxam	Neonicotinoids	ug/L
Pentachloroanisole (PCA)	Organochlorines	ug/L
Pentachloronitrobenzene (PCNB)	Organochlorines	ug/L
Chlorpyrifos	Organophosphates	ug/L
Diazinon	Organophosphates	ug/L
Malathion	Organophosphates	ug/L
Methidathion	Organophosphates	ug/L
Methylparathion	Organophosphates	ug/L
Phosmet	Organophosphates	ug/L

Allethrin	Pyrethroids	ug/L
Bifenthrin	Pyrethroids	ug/L
Cyfluthrin	Pyrethroids	ug/L
Cyhalothrin	Pyrethroids	ug/L
Cypermethrin	Pyrethroids	ug/L
Deltamethrin	Pyrethroids	ug/L
Esfenvalerate	Pyrethroids	ug/L
Etofenprox	Pyrethroids	ug/L
Fenpropathrin	Pyrethroids	ug/L
Permethrin	Pyrethroids	ug/L
Phenothrin	Pyrethroids	ug/L
Resmethrin	Pyrethroids	ug/L
t-Fluvalinate	Pyrethroids	ug/L
Tefluthrin	Pyrethroids	ug/L
Tetramethrin	Pyrethroids	ug/L
Piperonyl butoxide	Synergists	ug/L
Pathogen Monitoring		
Constituent	**Reporting Group**	**Unit**
Cryptosporidium	Pathogens	oocysts/L
Giardia	Pathogens	cysts/L

3.3. Geographical and Temporal Setting

The geographic scope of the Delta RMP encompasses the legal Delta (as defined by section 12220 of the Water Code), including water bodies that directly drain into the Delta, Yolo Bypass, and Suisun Bay. In addition, the base monitoring and special studies of the Delta RMP may extend upstream or downstream, if required to address specific management questions.

Monitoring sites for current use pesticides[3] and pathogens are described in this section. Additional information for mercury and nutrients monitoring sites will be added later.

Current Use Pesticides (CUPs)

The surface water samples for pesticide analyses are collected from fixed stations representing key inflows to the Delta. There are two types of sites: 5 baseline sites and 4 additional "targeted" sites for targeted events-sampling only. Baseline sites are visited monthly. Targeted event sampling in any given month may be conducted in lieu of scheduled monthly sampling. Sites targeted for event sampling only are visited 5 times/year for two wet events (1st seasonal

[3] Current use pesticide monitoring includes chemical pesticide analysis, toxicity testing, and the analysis of dissolved copper and relevant field and conventional water quality parameters at all sites.

flush, 2nd significant storm in winter) and three dry events (early spring, irrigation season sampling late spring/early summer, irrigation season sampling late summer).

Figures 3-1 shows the water sampling sites for the first year of monitoring. Table 3-3 provides an overview of the sampling schedule for current use pesticides. The CUP monitoring element includes chemical analyses and toxicity testing. The chemical analyte groups for this monitoring element include several current use pesticide groups, dissolved copper, and filed parameters and "conventional" parameters (ancillary parameters measured in the laboratory, such as dissolved/particulate organic carbon and hardness).

Table 3.3. List of site type sampling frequencies and associated parameter groups.

Parameter Group	Baseline site sampling frequency	Event site sampling frequency	Matrix
Conventional parameters	Monthly	2 wet events and 3 dry events	Water
Field parameters	Monthly	2 wet events and 3 dry events	Water
Metals (dissolved Copper only)	Monthly	2 wet events and 3 dry events	Water
Pesticides	Monthly	2 wet events and 3 dry events	Water
Water column toxicity	Monthly	2 wet events and 3 dry events	Water

Pathogens

Ambient pathogen monitoring sites are co-located with existing sites of the Municipal Water Quality Investigations (MWQI) program (Figure 3-2). Some of these sites are upstream of the Delta, but could influence water quality at the drinking water intakes or are representative of larger areas with the same land uses. Additional samples will be collected at various Delta water supply intakes (7 drinking water intake sites with a single source, plus 2 facilities with blending from 4 drinking water intakes) in coordination with these ambient sites.

3.4. Constraints

The ability to measure some of the target compounds at the ultra-trace levels found in the ambient environment may be constrained by the detection limits routinely achievable by analytical laboratories. Target detection limits in this document represent those achieved by laboratories contracted by the Delta RMP or levels needed to obtain quantitative measurements of ambient concentrations in a majority of samples.

Another constraint is that discrete samples represent only a moment in time and may therefore not always be representative of conditions during other time periods.

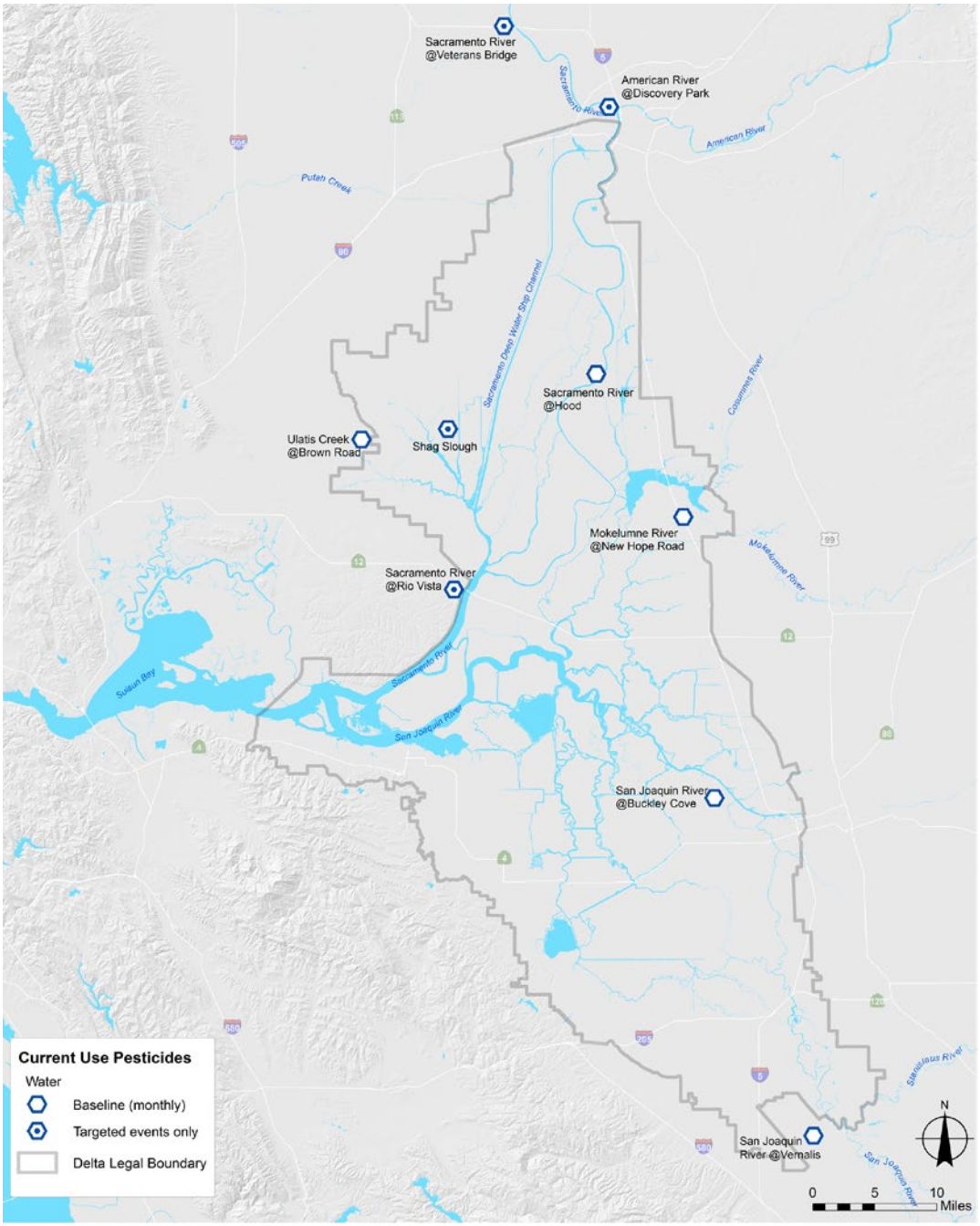

Figure 3.1. FY 2014-16 Current Use Pesticide Water Sampling Sites[4].

[4] Current use pesticide monitoring includes chemical pesticide analysis, toxicity testing, and the analysis of dissolved copper and relevant field and conventional water quality parameters at all sites.

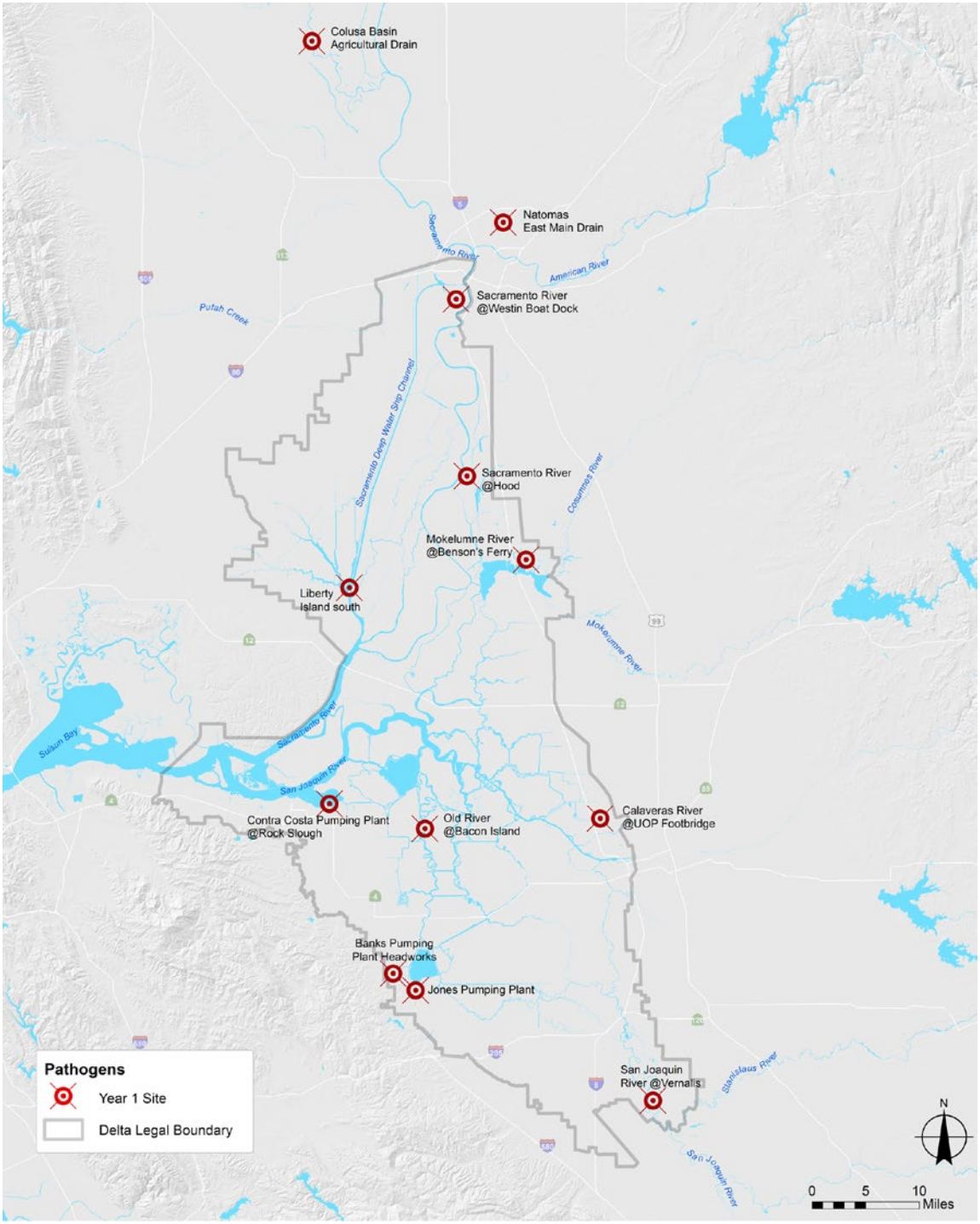

Figure 3.2. FY 2014-16 Ambient Pathogen Monitoring Sites.

4. Quality Objectives, Criteria, and Control Procedures for Measurement Data

Data quality indicators (DQIs) for field and laboratory measurements evaluate the following:

- Field measurements – sensitivity, precision, accuracy, completeness
- Laboratory chemical analyses – sensitivity, precision, accuracy, completeness, contamination
- Toxicity testing – precision, completeness, representativeness

The discussion in this section reviews the measurements and procedures expected to demonstrate the quality of reported data. Table 4-1 provides an overview of quality control (QC) sample types that are applicable to the Delta RMP and their purpose. The quality assessment process that is used after the data have been collected to evaluate whether the DQOs have been satisfied is described and illustrated in Section 17, Verification and Validation Methods.

Table 4.1. Purposes of field and laboratory QC sample types and data quality indicators applicable to the Delta RMP

QC Sample Type	Data Quality Indicator/Purpose
Calibration	Accuracy of measurement (field parameters, laboratory chemical analysis).
Calibration Check	Accuracy of calibration (field parameters, laboratory chemical analysis).
Laboratory Blanks - Method Blanks	Contamination/confirm the absence of analytes introduced in the lab (laboratory chemical analysis).
Laboratory Blanks - Instrument Blanks	Contamination/Assess the presence or absence of instrument contamination (laboratory chemical analysis).
CRM (Reference Material)	Accuracy of measurement (primarily); precision/most robust indicator of measurement accuracy; may also be used to evaluate replicate precision and recovery where average values for field samples are expected (based on historical or literature results) to fall in a non-quantitative range (laboratory chemical analysis).
Laboratory Duplicates - Matrix Spikes (MS)/Matrix Spike Duplicates (MSD)	Accuracy and precision/evaluate the effect of the sample matrix on the recovery of the compound(s) of interest and providing an estimate of analytical precision when measured in duplicate (laboratory chemical analysis).
Laboratory Duplicates - Matrix Duplicates	Precision of intra-laboratory analytical process (laboratory chemical analysis)
Surrogate Spikes	Accuracy of analytical method/assess the efficiency of the extraction method for organic analytes (laboratory chemical analysis).
Internal Standards	Accuracy of analytical method/enable optimal quantitation, particularly of complex extracts subject to retention time shifts or instrument interferences relative to the analysis of standards. Internal standards can also be used to detect and correct for problems in the injection port or other parts of the instrument (laboratory chemical analysis).
Field Blanks	Contamination/To check cross- contamination during sample collection, field sample processing, and shipment. Also to check sample containers (laboratory chemical analysis). Field crews will need to include filtration in processing blanks

QC Sample Type	Data Quality Indicator/Purpose
	for applicable sample types.
Field Duplicate/Replicate	Precision/Check reproducibility of field procedures. To indicate non-homogeneity. (Field Duplicate: n = 2; Field Replicate: n > 2). This sample is to be collected in the field in tandem with a regular environmental sample. To be preserved, handled and processed as a unique sample. Lab precision is covered below (laboratory chemical analysis).
Instrument Replicates	Precision of instrument (laboratory chemical analysis).
Method Detection Limit (MDL)	(Field parameters, laboratory chemical analysis).
Reporting Limit (RL)	(Field parameters, laboratory chemical analysis).
Travel/bottle blanks	Contamination/To account for contaminants introduced during the transport process between the laboratory and field site, in addition to any contamination from the source solution and container (laboratory chemical analysis).
Equipment blanks	Contamination/To account for contamination introduced by the field sampling equipment (laboratory chemical analysis).
Negative Control	Laboratory toxicity testing.
Reference toxicant testing	Sensitivity, precision and accuracy of toxicity tests performed in the laboratory/Determine the sensitivity of the test organisms over time; assess comparability within and between laboratory test results; identify potential sources of variability, such as test organism health, differences among batches of organisms, changes in laboratory water or food quality, and performance by laboratory analysts (laboratory toxicity testing).

4.1. Field QC Procedures

4.1.1. Field Performance Measurements

Sensitivity is the ability of a measurement to detect small quantities of the measured component. The sensitivity of field measurements is generally determined by the output of the analytical instrument. Appropriate instruments and/or instrument settings should be chosen that generally allow differences between sites or within a site at different times being reported. Resolution on the order of approximately 1% of the maximum or range of measurements likely to be encountered is desired.

Precision of field measurements is determined by repeated measurement of the same parameter within a single sample, or samples taken in rapid succession (only when conditions are not dynamically variable). Approximately 10% of measurements, a minimum of one measurement per event, should be repeated for all measured parameters. Repeated measurement may also be accomplished by continuous logging of *in situ* probes or meters.

Accuracy of field measurements is established by periodic measurement of known standards or by recalibration to known standards. Instrument recalibration should be performed prior to each sampling day or event for user-calibrated instruments (e.g. daily for handheld field meters

(pH, conductivity, DO, etc.)), or at the manufacturer-specified interval for instruments requiring factory servicing or otherwise incapable of field recalibration.

Completeness of field measurement is evaluated as a percentage of usable measurements out of the total number of measurements desired. More than 90% of field measurements should be usable. If a lower percentage is achieved for any sampling event or time period, causes shall be investigated and fixed where possible, through instrument maintenance (e.g. defouling), recalibration, repair, or replacement (with the same or different instrument type) as needed.

If completeness targets are not achieved, instrument choice, settings, deployment method, maintenance, and/or other activities shall be adjusted to improve measurement reliability before the next sampling event or measurement period.

4.1.2. Field QC Measurements

Calibration of any field meters (pH, temperature, conductivity, DO, or other measurements) should be checked in the field at least once daily and recalibrated using certified standards or procedures where possible. Instruments will be recalibrated when significant drift or a calibration error is found.

Beyond initial calibration of handheld field instruments and periodic calibration checks in the field, QC measures taken for field instrument measurements should include reporting of replicates. The replicates will be taken at a minimum frequency of one per day or per 20 measurements, taken on a spatial and temporal scale at which measurements are expected to be relatively invariant, as the goal is to establish the precision of a measurement, rather than just characterize the variability of the ecosystem. Field measurement acceptance criteria are summarized in Table 4-2.

Table 4.2. Acceptance criteria for field measurements.

Method	Parameters	Sample type	Matrix	Frequency	Acceptable limits
YSI 6920 Water Quality Meter	DO, pH, SC, temperature, turbidity	Calibration	Water	Within 24 hrs before sampling as well as a mid-day check against the standards	Allowable drift ± 10% for DO and Specific Conductivity, ± 0.5 °C for temperature, ± 0.2 for pH
YSI 6920 Water Quality Meter	DO, pH, SC, temperature, turbidity	Instrument Blank	Water	1 per 20 site visits	<MDL for DO and SC, NA for pH and temperature

4.1.3. Field QC Samples

Field QC samples that are frequently collected for later lab analysis in sampling protocols are listed below. Field QC samples are analyzed for all target analytes of a sampling event. Field blanks and filed duplicates/replicates will be collected at every event:

1. Field Blanks: These account for all of the above sources of contamination that might be introduced to a sample as well as those due to the immediate field environment. Field blanks are generated under actual field conditions and are subjected to the same aspects of sample collection, field processing, preservation, transport, and laboratory handling as the environmental samples.
2. Field Duplicates/Replicates: These account for variability in the field collection and laboratory analysis combined.

Travel/bottle blanks may be collected at the discretion of the QOA, when an established procedure is changed or when problems are identified:

3. Travel/bottle Blanks: These account for contaminants introduced during the transport process between the laboratory and field site, in addition to any contamination from the source solution and container.
4. Equipment Blanks: These account for contamination introduced by the field sampling equipment in addition to the above sources.

Field blanks will routinely be collected and analyzed, as they will encompass all the possible contamination sources in container and equipment preparation, transport, handling, and sampling methodology. Unless otherwise specified, goals for field blanks are the same as for lab blanks, i.e., not detected.

If problems are found with field blanks, other blank sample types may be collected in follow-up sampling to try and determine the source of contamination.

Field blanks for water will be generated under actual field conditions at a minimum frequency of one per sampling event (e.g. a set of samples collected by the same methods over the duration of a sampling cruise) or approximately per 20 sites. They will be treated in both the field and laboratory procedures in as similar a manner as possible as the environmental field samples. Whole water field blanks will be taken by exposing sampling containers through a simulated process of collecting samples, without adding any water matrix, as “clean” lab water that might be used in a field blank could introduce contamination not present in any field samples taken (i.e., lab water is not normally mixed with site water in a sample).

In studies performed for other SFEI-ASC projects, travel/bottle blanks analyzed usually showed that they are not a significant source of contamination beyond that already included in laboratory blanks, so travel blanks are seldom collected. However, if continued contamination is identified in field blanks, travel blanks may be collected and analyzed to identify a potential source, at the discretion of the Delta RMP QAO.

Field duplicates/replicates of all types of samples to be analyzed will be routinely collected at a minimum frequency of 1 per 20 samples to evaluate variability including performance of the

sampling system and methodology. Unless otherwise specified, precision targets and acceptance criteria for field duplicates/replicates will be the same as those for lab replicates.

4.2. Laboratory Performance Measurements for Chemical Analyses

Laboratory performance measurements are included in the QA data review to check if measurement quality objectives are met. Results of analyses of QC samples are to be reported with results of field samples. Minimum frequencies and target performance requirements for QC measures of reported analytes are specified in Table 4-4.

QC measures typically used for evaluation of laboratory and field sampling performance include the following:

1. Method (or extraction/preparation) Blanks: samples of a clean or null (e.g., empty container) matrix taken through the entire analytical procedure, including preservatives, reagents, and equipment used in preparation and quantitation of analytes in samples.
2. Field (or equipment/collection) Blanks: samples of a clean or null matrix taken through the sampling procedure, then analyzed much like an ordinary field sample.
3. Surrogate (or internal) Standards: analytes (often isotopes or other substituted analogues of target compounds) introduced to samples to measure and correct for losses and errors introduced during analysis, with recoveries and corrections to reported values generally reported for each sample individually.
4. Matrix Spike Samples/Duplicates: field samples to which known amounts of target analytes are added, indicating potential analytical interferences present in field samples and errors or losses in analyses not accounted for by surrogate correction.
5. Certified Reference Materials (CRM): CRMs are created or collected samples containing analytes of interest that have been analyzed and reported by multiple labs using a variety of methods to arrive at a consensus “certified” or “reference” value. Certified analytes have a higher degree of certainty in reported values due to external validation.
6. Lab Reference Materials/Laboratory Control Samples: materials collected or created by a laboratory as internal reference samples, to track performance across batches. Unlike CRMs, LRMs and LCSs seldom have external validation (i.e., measurement by another method or another lab) and are thus less certain as measures of accuracy, but are good for day-to-day indication of process control.
7. Instrument Replicates: replicate analyses of extracted material or standards that measure the instrumental precision.
8. Laboratory Replicates: replicate sub-samples of field samples, standard reference materials, lab reference materials, matrix spike samples, or laboratory control samples, taken through the full analytical procedure including all lab processes combined.

Table 4.3. Laboratory chemical analytical QC[5]

Method	Sample type	Matrix	Frequency	Acceptable limits
Pesticides				
USGS TM-5-C2	Calibration	Water	At each instrument set up, major disruption, and when routine calibration check exceeds specific control limits.	Linear regression, $r^2 > 0.995$ using a 7 point calibration curve ranging from 0.01 to 1 ng/uL
USGS TM-5-C2	Calibration Check	Water	Every 6 samples.	Recovery = 75 -125%
USGS TM-5-C2	Laboratory Blanks	Water	1 per 20 or batch.	< MDL
USGS TM-5-C2	Outside laboratory spike	Water	1 per 20	Expected value +/- 10%
USGS TM-5-C2	Matrix Spikes/Duplicates	Water	1 per 20 or one batch	Recovery 70-130%, RPD < 25%
USGS TM-5-C2	Surrogate Spikes	Water	Every sample	Recovery = 70 -130%
USGS TM-5-C2	Internal Standards	Water	Every sample	Recovery = 70 -130%
USGS TM-5-C2	Field Blanks	Water	1 per 20	< MDL
USGS TM-5-C2	Field Duplicate/ Replicate	Water	1 per 20	RPD < 25%
USGS – SIR 2012-5026	Calibration	Water	At each instrument set up, major disruption, and when routine calibration check exceeds specific control limits.	Linear regression, $r^2 > 0.995$ using an 7 point calibration curve ranging from 0.01 to 1 ng/uL
USGS – SIR 2012-5026	Calibration Check	Water	Every 6 samples.	Recovery = 75 -125%
USGS – SIR 2012-5026	Laboratory Blanks	Water	1 per 20 or batch.	< MDL
USGS – SIR 2012-5026	Outside laboratory spike	Water	1 per 20	Expected value +/- 10%
USGS – SIR 2012-5026	Matrix	Water	1 per 20 or one	Recovery 70-130%, RPD < 25%

[5] Information for constituents related to mercury and nutrient monitoring will be added when funding for implementing these program elements will become available.

Method	Sample type	Matrix	Frequency	Acceptable limits
	Spikes/Duplicates		batch	
USGS – SIR 2012-5026	Surrogate Spikes	Water	Every sample	Recovery = 70 -130%
USGS – SIR 2012-5026	Internal Standards	Water	Every sample	Recovery = 70 -130%
USGS – SIR 2012-5026	Field Blanks	Water	1 per 20	< MDL
USGS – SIR 2012-5026	Field Duplicate/ Replicate	Water	1 per 20	RPD < 25%
USGS TM-5-B1	Instrument Blank	Water	Every 6 samples	Set by lab
Metals				
USGS TM-5-B1	Method Blank	Water	1 per 20 or batch.	< MDL
USGS TM-5-B1	CRM	Water	1 per 20	Expected value +/- 25%
USGS TM-5-B1	Matrix Spikes/Duplicates	Water	1 per 20 or one batch	Expected value +/- 25%
USGS TM-5-B1	Lab Duplicate	Water	1 per 20	RPD < 25%
USGS TM-5-B1	Instrument Blank	Water	Every 6 samples	Set by lab
USGS TM-5-B1	Field Duplicates	Water	5% of all samples	RPD < 25%
Conventional				
TM-O-1122-92	Method Blank	Water	1 per 20 or batch	< MDL
TM-O-1122-92	CRM	Water	1 per 20 or set	Expected value +/- 10%
TM-O-1122-92	Matrix Spikes/Duplicates	Water	1 per 20 or batch	Expected value +/- 10%
TM-O-1122-92	Lab Duplicate	Water	1 per 20 or batch	RPD < 10%
TM-O-1122-92	Instrument Blank	Water	12 hours	Set by lab
TM-O-1122-92	Field Duplicates	Water	5% of all samples	RPD < 25%
TM-O-1122-92	Filter Blank	Water	1 per lot of filters or higher frequency	<MDL
EPA 440	Method Blank	Water	1 per 20 or batch	< MDL
EPA 440	CRM	Water	1 per 20 or set	Expected value +/- 10%
EPA 440	Matrix Spikes/Duplicates	Water	1 per 20 or batch	Expected value +/- 10%
EPA 440	Lab Duplicate	Water	1 per 20 or batch	RPD < 10%
EPA 440	Instrument Blank	Water	12 hours	Set by lab
EPA 440	Field Duplicates	Water	5% of all samples	RPD < 25%

4.3. Laboratory Quality Control Procedures for Chemical Analyses

Prior to the initial analyses of samples for the project, each laboratory will demonstrate capability and proficiency for meeting MQOs for the Delta RMP. Performance-based measures for chemical analyses consist of two basic elements: initial demonstration of laboratory capability and on-going demonstration of capability during analysis of project samples. Initial demonstration includes documentation that sample analyses can be performed within the data quality objectives and method quality objectives listed in the QAPP (Tables 4-3, 4-4, and 4-5). On-going demonstration of capability during analysis of project samples includes laboratory participation in routine analyses (e.g. inter-comparison studies) to evaluate laboratory capabilities on a continual basis to meet MQOs listed in the QAPP.

4.3.1. Laboratory QC Measurements

Sensitivity

In this context, sensitivity refers to the capability of a method or instrument to detect a given analyte at a given concentration and reliably quantitate the analyte at that concentration. Achieving the desired sensitivity DQOs requires the selection of appropriate analytical methods. The key measurement quality objectives (MQOS) for achieving sensitivity are the desired Reporting Limit (RL) and Method Detection Limit (MDL) for analytes (Table 4-4) and the ranges and resolution of laboratory meters (Table 4-6). Additional QC information required to evaluate the sensitivity of data include method blanks and instrument blanks (Table 4-3).

Precision

Precision is the reproducibility of an analytical method and can be evaluated for any sample that is analyzed in replicate. In general, laboratory replicates of field samples are preferred as measures of precision, but in cases where average values for field samples are expected (based on historical or literature results) to fall in a non-quantitative range, other samples such as CRMs, LRMs, matrix spikes, or blank spikes can be analyzed in replicate to determine precision.

If samples other than field samples are used to evaluate precision, target concentrations should be at least high enough to be quantitative but less than 100 times those in field samples, as precision in high concentration samples is not likely representative for much lower ambient samples. When using MS/MSD, samples of a similar matrix are most relevant and thus preferred for evaluating precision.

A minimum of one field sample (or alternative sample type, e.g. MS, where sample material is insufficient or concentrations are largely not detected in field samples) per batch of samples submitted to the laboratory (minimum one per 20, or 5%, in large batches) will be processed and analyzed in replicate for precision. Previously analyzed material (e.g. from the same project in prior years, or from other projects) may also be analyzed as replicates to help ensure results

in a quantitative range. The relative percent difference (RPD) among replicate samples will be less than the MQO listed in Table 4-3 for each analyte of interest. RPD is calculated as:

$$\text{RPD} = \frac{\text{Difference (between replicate samples)}}{\text{Average (replicate samples)}} \times 100\%$$

Precision may be expressed relative to an MQO as a p-score:

$$p = |\text{RPD or RSD}|/\text{MQO}\%$$

If results for any analytes do not meet the MQO for precision (p-score > 1), calculations and instruments will be checked. Repeat analyses may be required to confirm the results and reduce uncertainty in the measurement. Results that repeatedly fail to meet the criteria indicate sample heterogeneity, unusually high contamination of analytes, or other causes of poor laboratory precision. If the variability is not reduced, the laboratory is obligated to halt the analysis of samples, identify the source of the imprecision, and notify the SFEI-ASC Project Manager and QAO before proceeding with further analysis. In some cases when the causes of imprecision cannot be corrected (particularly for less abundant or less important analytes in a large group reported by a single analytical method), and with the approval of the Project Manager and QAO, the results can be reported as-is and flagged for poor precision (p-score > 1) or censored if extremely poor (p-score > 2).

Accuracy

The accuracy of lab measurements will be evaluated based on date quality criteria (Table 4-3) for MS/MSD, CRM, internal standards, surrogate recoveries, initial calibration, and calibration checks.

The percent recovery for MS/MSD is calculated using the equation

$$\%\ \text{recovery} = \frac{(\text{observed} - \text{background})}{\text{theoretical}} \times 100$$

$$\%\ \text{recovery} = \ (\text{observed} - \text{background})\text{theoretical} \times 100$$

If insufficient sample is available, the analyst can run a LCS (Laboratory Control Sample) and a LCS duplicate. The calculation used is the same.

Completeness

Completeness is defined as “a measure of the amount of data collected from a measurement process compared to the amount that was expected to be obtained under the conditions of measurement” (Stanley and Verner 1985). The goal of the Delta RMP is to achieve >90% completeness for all analyses.

Completeness will be quantified as the total number of usable results divided by the total number of site visits, aggregated by all analytes of interest. However, additional factors may be considered on a case-by-case basis. For example, an analysis may result in 0% usable data for a minor group of analytes and potentially not meet the completeness goal of 90 % overall as a result, but may still provide valuable data and meet the completeness criteria for all the remaining analyte results combined. In contrast, if >90% completeness could not be obtained for a group of pesticide analytes that are the most abundant in the majority of studies in the literature, it would likely need to be seen as a failure that needed immediate correction.

Contamination

Laboratory method blanks (also called extraction blanks, procedural blanks, or preparation blanks) are used to assess laboratory contamination during all stages of sample preparation and analysis. For laboratory analyses, at least one laboratory method blank will be run in every sample batch. The method blank will be processed through the entire analytical procedure in a manner identical to the samples (i.e., using the same reagents and equipment). Method blanks should contain analyte concentration less than the MDL. A method blank concentration > 2× the MDL or > 30% of the lowest reported sample concentration for any analytes of interest will require corrective action (e.g., checking of reagents, re-cleaning and re-checking of equipment) to identify and eliminate the source(s) of contamination before proceeding with sample analysis. If eliminating the blank contamination and reanalysis is not possible, results for all impacted analytes in the analytical batch shall be flagged. In addition, a detailed description of the contamination sources and the steps taken to identify and eliminate/minimize them shall be included in the transmittal letter. Subtracting method blank results from sample results is not permitted.

Comparability

The Delta RMP adheres to EPA guidance, specified SOPs, and SWAMP-comparable QA measures. Therefore, results can be compared with other projects and laboratories that adhere to the same or compatible protocols and QA measures.

Data analysis

Data will be analyzed using appropriate graphical tools, spatial analyses, and statistical tests to be described in the Delta RMP Communications Plan.

Table 4.4. Summary of Reporting Limits (RL) and Method Detection Limits (MDL) of Delta RMP constituents.

Constituent	Matrix	Reporting group	RL	MDL	Unit	Analyzing laboratory	Method used
Oxygen, Dissolved	Water	Field Parameters	0.5	0.5	mg/L	USGS	National Field Manual for the

Constituent	Matrix	Reporting group	RL	MDL	Unit	Analyzing laboratory	Method used
pH	Water	Field Parameters	NA	NA	NA	USGS	Collection for Water-Quality Data, Chapter A6, Field Measure-ments
Specific Conductivity	Water	Field Parameters	10	10	uS/cm	USGS	
Temperature	Water	Field Parameters	NA	NA	NA	USGS	
TSS	Water	Field Parameters	0.5	0.5	mg/L	USGS	
Turbidity	Water	Field Parameters	1	1	NFU	USGS	
Alkalinity as $CaCO_3$	Water	Conventional	12	4	mg/L	AHPL	SM 2320B
Ammonia as N	Water	Conventional	0.15	0.05	mg/L	AHPL	SM 4500-NH3F
Hardness as $CaCO_3$	Water	Conventional	6	2	mg/L	AHPL	SM 2340C
Dissolved organic carbon	Water	Conventional	0.23	0.23	mg/L	USGS	TM O-1122-92
Particulate organic carbon	Water	Conventional	0.05	0.05	mg/L	USGS	EPA 440
Copper (dissolved)	Water	Metals	0.8	0.8	ug/L	USGS	TM-5-B1
Allethrin	Water	Pyrethroids	0.0041	0.0041	ug/L	USGS	TM-5-C2
Bifenthrin	Water	Pyrethroids	4.7	4.7	ng/L	USGS	TM-5-C2
Cyfluthrin, total	Water	Pyrethroids	5.2	5.2	ng/L	USGS	TM-5-C2
Cyhalothrin, total	Water	Pyrethroids	4.5	4.5	ng/L	USGS	TM-5-C2
Cypermethrin, total	Water	Pyrethroids	5.6	5.6	ng/L	USGS	TM-5-C2
Deltamethrin	Water	Pyrethroids	3.5	3.5	ng/L	USGS	TM-5-C2
Esfenvalerate	Water	Pyrethroids	3.9	3.9	ng/L	USGS	TM-5-C2
Etofenprox	Water	Pyrethroids	2.2	2.2	ng/L	USGS	TM-5-C2
Fenpropathrin	Water	Pyrethroids	4.1	4.1	ng/L	USGS	TM-5-C2
Permethrin, total	Water	Pyrethroids	3.4	3.4	ng/L	USGS	TM-5-C2
Phenothrin	Water	Pyrethroids	5.1	5.1	ng/L	USGS	TM-5-C2
Resmethrin	Water	Pyrethroids	5.7	5.7	ng/L	USGS	TM-5-C2
Tefluthrin	Water	Pyrethroids	4.2	4.2	ng/L	USGS	TM-5-C2
Tetramethrin	Water	Pyrethroids	2.9	2.9	ng/L	USGS	TM-5-C2
Fipronil	Water	Fipronils	2.9	2.9	ng/L	USGS	TM-5-C2
Fipronil Desulfinyl	Water	Fipronils	1.6	1.6	ng/L	USGS	TM-5-C2
Fipronil Sulfide	Water	Fipronils	1.8	1.8	ng/L	USGS	TM-5-C2
Fipronil Sulfone	Water	Fipronils	3.5	3.5	ng/L	USGS	TM-5-C2
Carbaryl	Water	Carbamates	6.5	6.5	ng/L	USGS	TM-5-C2

Constituent	Matrix	Reporting group	RL	MDL	Unit	Analyzing laboratory	Method used
Carbofuran	Water	Carbamates	3.1	3.1	ng/L	USGS	TM-5-C2
Pentachloroanisole (PCA)	Water	Organochlorines	6.5	6.5	ng/L	USGS	TM-5-C2
Pentachloronitrobenzene (PCN)	Water	Organochlorine	3.1	3.1	ng/L	USGS	TM-5-C2
Acetamiprid	Water	Neonicotinoids	3.3	3.3	ng/L	USGS	USGS – SIR 2012-5026
Clothianidin	Water	Neonicotinoids	3.9	3.9	ng/L	USGS	USGS – SIR 2012-5026
Dinotefuran	Water	Neonicotinoids	4.5	4.5	ng/L	USGS	USGS – SIR 2012-5026
Imidacloprid	Water	Neonicotinoids	3.8	3.8	ng/L	USGS	USGS – SIR 2012-5026
Thiacloprid	Water	Neonicotinoids	3.2	3.2	ng/L	USGS	USGS – SIR 2012-5026
Thiamethoxam	Water	Neonicotinoids	3.4	3.4	ng/L	USGS	USGS – SIR 2012-5026
Chlorpyrifos	Water	Organophosphates	2.1	2.1	ng/L	USGS	TM-5-C2
Diazinon	Water	Organophosphates	0.9	0.9	ng/L	USGS	TM-5-C2
Malathion	Water	Organophosphates	3.7	3.7	ng/L	USGS	TM-5-C2
Methidathion	Water	Organophosphates	7.2	7.2	ng/L	USGS	TM-5-C2
Methylparathion	Water	Organophosphates	3.4	3.4	ng/L	USGS	TM-5-C2
Phosmet	Water	Organophosphates	4.4	4.4	ng/L	USGS	TM-5-C2
Chlorantraniliprole	Water	Other Insecticides	4.0	4.0	ng/L	USGS	USGS – SIR 2012-5026
Cyantraniliprole	Water	Other Insecticides	4.2	4.2	ng/L	USGS	USGS – SIR 2012-5026
Flonicamid	Water	Other Insecticides	3.4	3.4	ng/L	USGS	USGS – SIR 2012-5026
Methoprene	Water	Other Insecticides	6.4	6.4	ng/L	USGS	TM-5-C2
Methoxyfenozide	Water	Other Insecticides	2.7	2.7	ng/L	USGS	USGS – SIR 2012-5026
Tolfenpyrad	Water	Other Insecticides	2.9	2.9	ng/L	USGS	USGS – SIR 2012-5026

Constituent	Matrix	Reporting group	RL	MDL	Unit	Analyzing laboratory	Method used
Alachlor	Water	Herbicides	1.7	1.7	ng/L	USGS	TM-5-C2
Atrazine	Water	Herbicides	2.3	2.3	ng/L	USGS	TM-5-C2
Butylate	Water	Herbicides	1.8	1.8	ng/L	USGS	TM-5-C2
Clomazone	Water	Herbicides	2.5	2.5	ng/L	USGS	TM-5-C2
Cycloate	Water	Herbicides	1.1	1.1	ng/L	USGS	TM-5-C2
DCPA	Water	Herbicides	2.0	2.0	ng/L	USGS	TM-5-C2
DCPU	Water	Herbicides	3.4	3.4	ng/L	USGS	USGS – SIR 2012-5026
EPTC	Water	Herbicides	3.01.5	1.5	ng/L	USGS	TM-5-C2
Ethalfluralin	Water	Herbicides	3.0	3.0	ng/L	USGS	TM-5-C2
Fluridone	Water	Herbicides	3.7	3.7	ng/L	USGS	USGS – SIR 2012-5026
Hexazinone	Water	Herbicides	8.4	8.4	ng/L	USGS	TM-5-C2
Metolachlor	Water	Herbicides	1.5	1.5	ng/L	USGS	TM-5-C2
Molinate	Water	Herbicides	3.2	3.2	ng/L	USGS	TM-5-C2
Napropamide	Water	Herbicides	8.2	8.2	ng/L	USGS	TM-5-C2
Oryzalin	Water	Herbicides	5.0	5.0	ng/L	USGS	USGS – SIR 2012-5026
Oxyfluorfen	Water	Herbicides	3.1	3.1	ng/L	USGS	TM-5-C2
Pebulate	Water	Herbicides	2.3	2.3	ng/L	USGS	TM-5-C2
Pendimethalin	Water	Herbicides	2.3	2.3	ng/L	USGS	TM-5-C2
Penoxsulam	Water	Herbicides	3.5	3.5	ng/L	USGS	USGS – SIR 2012-5026
Prometon	Water	Herbicides	2.5	2.5	ng/L	USGS	TM-5-C2
Prometryn	Water	Herbicides	1.8	1.8	ng/L	USGS	TM-5-C2
Propanil	Water	Herbicides	10.1	10.1	ng/L	USGS	TM-5-C2
Propyzamide	Water	Herbicides	5.0	5.0	ng/L	USGS	TM-5-C2
Simazine	Water	Herbicides	5.0	5.0	ng/L	USGS	TM-5-C2
Thiobencarb	Water	Herbicides	1.9	1.9	ng/L	USGS	TM-5-C2
Trifluralin	Water	Herbicides	2.1	2.1	ng/L	USGS	TM-5-C2
3,4-DCA	Water	Herbicides	3.2	3.2	ng/L	USGS	USGS – SIR 2012-5026
3,5-DCA	Water	Herbicides	7.6	7.6	ng/L	USGS	TM-5-C2
DCPMU	Water	Herbicides	3.5	3.5	ng/L	USGS	USGS – SIR 2012-5026
Diuron	Water	Herbicides	3.2	3.2	ng/L	USGS	USGS – SIR 2012-5026

Constituent	Matrix	Reporting group	RL	MDL	Unit	Analyzing laboratory	Method used
(E)-Dimethomorph	Water	Fungicides	6.0	6.0	ng/L	USGS	TM-5-C2
Azoxystrobin	Water	Fungicides	3.1	3.1	ng/L	USGS	TM-5-C2
Boscalid	Water	Fungicides	2.8	2.8	ng/L	USGS	TM-5-C2
Carbendazim	Water	Fungicides	4.2	4.2	ng/L	USGS	USGS – SIR 2012-5026
Chlorothalonil	Water	Fungicides	4.1	4.1	ng/L	USGS	TM-5-C2
Cyazofamid	Water	Fungicides	4.1	4.1	ng/L	USGS	USGS – SIR 2012-5026
Cymoxanil	Water	Fungicides	3.9	3.9	ng/L	USGS	USGS – SIR 2012-5026
Cyproconazole	Water	Fungicides	4.7]	4.7	ng/L	USGS	TM-5-C2
Cyprodinil	Water	Fungicides	7.4	7.4	ng/L	USGS	TM-5-C2
Desthio-Prothioconazole	Water	Fungicides	3.0	3.0	ng/L	USGS	USGS – SIR 2012-5026
Difenoconazole	Water	Fungicides	10.5	10.5	ng/L	USGS	TM-5-C2
Ethaboxam	Water	Fungicides	3.8	3.8	ng/L	USGS	USGS – SIR 2012-5026
Famoxadone	Water	Fungicides	2.5	2.5	ng/L	USGS	TM-5-C2
Fenarimol	Water	Fungicides	6.5	6.5	ng/L	USGS	TM-5-C2
Fenbuconazole	Water	Fungicides	5.2	5.2	ng/L	USGS	TM-5-C2
Fenhexamide	Water	Fungicides	7.6	7.6	ng/L	USGS	TM-5-C2
Fluazinam	Water	Fungicides	4.4	4.4	ng/L	USGS	TM-5-C2
Fludioxinil	Water	Fungicides	7.3	7.3	ng/L	USGS	TM-5-C2
Fluoxastrobin	Water	Fungicides	9.5	9.5	ng/L	USGS	TM-5-C2
Flusilazole	Water	Fungicides	4.5	4.5	ng/L	USGS	TM-5-C2
Flutriafol	Water	Fungicides	4.2	4.2	ng/L	USGS	TM-5-C2
Imazalil	Water	Fungicides	10.5	10.5	ng/L	USGS	TM-5-C2
Iprodione	Water	Fungicides	4.4	4.4	ng/L	USGS	TM-5-C2
Kresoxim-methyl	Water	Fungicides	4.0	4.0	ng/L	USGS	TM-5-C2
Mandipropamide	Water	Fungicides	3.3	3.3	ng/L	USGS	USGS – SIR 2012-5026
Metconazole	Water	Fungicides	5.2	5.2	ng/L	USGS	TM-5-C2
Myclobutanil	Water	Fungicides	6.0	6.0	ng/L	USGS	TM-5-C2
Propiconazole	Water	Fungicides	5.0	5.0	ng/L	USGS	TM-5-C2
Pyraclostrobin	Water	Fungicides	2.9	2.9	ng/L	USGS	TM-5-C2
Pyrimethanil	Water	Fungicides	4.1	4.1	ng/L	USGS	TM-5-C2

Constituent	Matrix	Reporting group	RL	MDL	Unit	Analyzing laboratory	Method used
Tebuconazole	Water	Fungicides	3.7	3.7	ng/L	USGS	TM-5-C2
Tetraconazole	Water	Fungicides	5.6	5.6	ng/L	USGS	TM-5-C2
Thiabendazole	Water	Fungicides	3.6	3.6	ng/L	USGS	USGS – SIR 2012-5026
Triadimefon	Water	Fungicides	8.9	8.9	ng/L	USGS	TM-5-C2
Triadimenol	Water	Fungicides	8.0	8.0	ng/L	USGS	TM-5-C2
Trifloxystrobin	Water	Fungicides	4.7	4.7	ng/L	USGS	TM-5-C2
Triflumizole	Water	Fungicides	6.1	6.1	ng/L	USGS	TM-5-C2
Triticonazole	Water	Fungicides	6.9	6.9	ng/L	USGS	TM-5-C2
Zoxamide	Water	Fungicides	3.5	3.5	ng/L	USGS	TM-5-C2
DDD (p,p')	Water	DDTs	6.1	6.1	ng/L	USGS	TM-5-C2
DDE (p,p')	Water	DDTs	6.9	6.9	ng/L	USGS	TM-5-C2
DDT (p,p')	Water	DDTs	3.5	3.5	ng/L	USGS	TM-5-C2
Piperonyl butoxide	Water	Synergists	2.3	2.3	ng/L	USGS	TM-5-C2

Table 4.5. Summary of Instrument Ranges and Resolution for Laboratory Meters.

Constituent	Matrix	Reporting group	Instrument Range	Resolution	Unit	Analyzing laboratory	Instrument used
Oxygen, Dissolved	Water	Conventional	0 to 20	0.1	mg/L	AHPL	YSI 58
pH	Water	Conventional	1 to 16	0.01	NA	AHPL	Beckman 255
Specific Conductivity	Water	Conventional	0 to 499.9 0 to 4999	0.1 1	uS/cm	AHPL	YSI 30
Electrical Conductivity	Water	Conventional	0 to 499.9 0 to 4999	0.1 1	uS/cm	AHPL	YSI 30
Temperature	Water	Conventional	-200 to 100	0.1	°C	AHPL	Onset HOBOware

4.3.2. Laboratory QC Samples

Data from the laboratory should include at the least the following QC data:

1. Surrogate Recovery (for all field and QC samples, if applicable)
2. Method Blank
3. Matrix Spike Recovery

4. Replicate precision:(field, CRM, matrix spike, blank matrix spike samples)
5. Certified/Lab Reference Material (CRM/LRM) Recovery

Surrogate spikes should be included in all samples where appropriate for the analysis. Although surrogate spike recoveries can be used to estimate and correct for losses of the target analytes in the analytical process, unusually low or high recoveries reflect analytical issues that are not overcome simply by surrogate correction, because at low recoveries, surrogate correction factors become inversely larger. It is generally left to the professional judgment of the lab's QAO to set appropriate control/acceptance limits and corrective actions for surrogate recoveries.

Method blanks should be run at a minimum frequency of one per analytical batch (for analytical batches consisting of up to 20 field samples) or per 20 (field) samples for larger analytical batches. Results for laboratory method blanks, combined with those for field blanks, can help identify whether probable causes of sample contamination originated in the field or in laboratory analyses. If both field and lab method blanks have similar levels of contamination, it is likely caused primarily in lab procedures. If field blanks have higher contamination, sample collection methods are likely the cause. Raw results for method blanks should be reported.

Matrix spikes (MS) should be run at a minimum frequency of one per batch or per 20 samples. Matrix spike results are to be reported, along with the expected result (unspiked sample concentration + spike concentration), and a recovery estimate. The spiking concentrations should be high enough to produce an expected result sufficiently over the analytical variability in quantifying the unspiked sample to quantify recovery (at least ~3 times the unspiked result), but also low enough to be a relevant accuracy indicator in the concentration range of field samples (below 100x and preferably nearer 10x the unspiked result). In cases where analytes are mostly not detected in unspiked samples, a concentration range of that magnitude (10-100x) over the MDL may be appropriate to use instead.

Precision can be determined with all sample types analyzed and reported in replicate. Lab replicates (split and analyzed in the laboratory) of field samples are generally the preferred indicator of precision for typical field samples, as the target analyte concentration range, matrix, and interferences are most similar to previous analyzed samples or samples from nearby sites. However, sometimes field sample concentrations are below detection limits for many analytes, so replicate results on CRMs, LRMs, MS/MSDs, or blank spikes (LCSs) may be needed to supplement and obtain quantitative precision estimates. These alternative sample types, in particular blank spikes (LCSs), should not serve as the primary or exclusive indicator of measurement precision without prior approval by the Project Manager and QAO. LCSs are often created from a clean laboratory matrix, so they are likely not representative of the measurement precision routinely achievable in more complex matrices of real field-originated samples. RPDs should be calculated as described previously and reported for all samples analyzed in replicate.

Certified reference material (CRM) or other externally established performance testing samples should be run at a frequency of one per 20 samples should be run at a minimum frequency of one per analytical batch (for analytical batches consisting of up to 20 field samples) or per 20 (field) samples for larger analytical batches. Results should be reported along with the expected values and recoveries (as % of the expected value), where available for target analytes in appropriate matrices. In some cases, no widely available reference materials have been established and laboratories maintain internal lab reference materials (LRM) to track the relative internal accuracy of an analytical method. CRMs are likely the most robust indicators of measurement accuracy, given requirements for consensus among labs as well as validation through different methods of measurement. Reference values for CRMs or internal LRMs, although less rigorous (fewer labs in consensus, or only one analytical method provided), provide at least some indicator of measurement accuracy. Although poor recoveries on these uncertified values may be used to flag potentially unreliable data for use in data analyses and decision-making, they should not be used to cite or sanction a lab for "failing" to meet MQO requirements.

Table 4-6 lists recovery surrogate standards used for pesticide analyses and associated data quality objectives.

Table 4.6. Recovery surrogate standards used for pesticide analyses and associated measurement quality objectives

Recovery surrogate standard	Matrix	Method	Acceptable limits (% recovery)
$^{13}C_3$-atrazine	Water	TM-5-C2	70-130%
Di-N-propyl-d_{14} trifluralin	Water	TM-5-C2	70-130%
Monuron	Water	USGS – SIR 2012-5026	70-130%
Imidacloprid-d_4	Water	USGS – SIR 2012-5026	70-130%

4.4. Data Quality Indicators and Test Acceptability Criteria for Toxicity Testing and Associated Water Quality Measurements

In the context of the RMP, toxicity monitoring should be viewed primarily as a set of tools to help identify current use pesticides that are causing significant aquatic toxicity in the Delta. Because toxicity testing is an integrative tool, it can determine effects of multiple constituents concurrently, and can be more cost-effective than chemical analysis of individual constituents.

Toxicity Identification Evaluations (TIEs) are planned for Delta RMP samples where there is > 50 percent effect within 96 hours of the test period. TIEs should be initiated within 48 hours of the observation of the TIE trigger being met in the initial sample screening (see also Section 8.3). The primary goal of Delta RMP TIE testing is to identify whether pesticides are causing or contributing to observed toxicity, and if so, which pesticides (or degradates, or any of the inert ingredients in the formulated product) are the drivers. A secondary goal is to identify other

factors (i.e., water quality conditions or other toxicants) contributing to reduced survival, growth, or reproduction.

Data quality objectives for toxicity testing and associated water quality measurements are outlined in Table 4-7, and test acceptability criteria are summarized in Table 4-8. Test results will be rejected when data quality objectives and test acceptability criteria are not met. However, the sample may be retested and qualified with an extended holding time if SFEI-ASC and the Delta RMP SC permit. Toxicity data will be qualified in instances where data does not meet accuracy and precision criteria below.

The water quality measurements specifically coupled to toxicity tests are intended to help interpret toxicity test data. Quality control practices and MQOs parallel those used for field meter instrumentation. Meters are calibrated at the beginning of each day and calibration checks are performed when measurements for the day exceed 20 readings for each meter. Meters are recalibrated when drift exceeds the DQO for accuracy in Table 4.7 below. Field duplicates are expected to fall within the precision DQOs below and data are qualified in instances when these DQOs are exceeded.

Table 4.7. Data quality objectives for toxicity testing and associated water quality measurements.

Toxicity Testing Laboratory Analysis			
Parameter	Accuracy	Precision	Completeness
pH	± 0.2	± 0.5 pH units	90%
Specific Conductance	± 0.5%	± 10%	90%
Temperature	± 0.1	± 10%	90%
Dissolved Oxygen	± 0.2	± 10%	90%
Ammonia	± 0.5%	± 10%	90%
Hardness	Standard Reference Material (SRM) within 80 to 120% recovery	RPD < 20%	90%
Alkalinity	SRM within 80 to 120% recovery	RPD < 20%	90%
Toxicity Testing	Meet all test acceptability criteria specified in method	RPD < 20% between sample duplicates	90%

Table 4.8. Summary of test acceptability criteria.

Species	Duration	Endpoint(s)	Method	Test acceptability criteria
S. capricornutum	4-days	Growth	UCD AHPL SOP1-1	Mean cell density of at least 2 X 10^5 cells/mL in the controls; and variability (CV%) among control replicates ≤20%
C. dubia	6-8 days	Survival, Reproduction	UCD AHPL SOP1-2	≥ 80% survival of all control organisms and an average of 15 or more young per surviving female in the control solutions. 60% of surviving control females must produce three broods (required)
H. azteca[6]	4-days	Survival	UCD AHPL SOP1-6	≥ 90% control survival
P. promelas	7-days	Survival, Biomass	UCD AHPL SOP1-3	≥ 80% survival in controls; average dry weight per surviving organism in control chambers equals or exceeds 0.25 mg/surviving fish

4.4.1. Quality Assurance Activities

All toxicity test protocols are based on methods outlined in "Summary of Test Conditions and Test Acceptability Criteria" tables in USEPA (2002 a and b). Deviations from protocols must be reported to the QAO, the project manager, and in interim and final reports. Data quality indicators for this project will consist of the following:

Test sensitivity

The Delta RMP utilizes the required minimum number of replicates specified by USEPA to ensure adequate test sensitivity. Test sensitivity is also evaluated through reference toxicant testing, which measures both the laboratory performance and the relative sensitivity of the test species over time.

[6] Initially not included. Inclusion of *Hyalella* water toxicity testing is pending a final decision by the SC.

Positive control tests. Reference toxicant tests will be performed concurrently for each event for *H.azteca* and *P. promelas*. Reference toxicant tests for *C. dubia* and *S. capricornutum* will be performed monthly according to EPA test method for in-house cultures.

Zinc chloride ($ZnCl_2$) will be used as the reference toxicant for *S. capricornutum*; sodium chloride (NaCl) will be the reference toxicant used for the *C. dubia, H. azteca*, and *P. promelas* species. The LC_{50} for survival or EC_{25} sublethal endpoints for each reference toxicant test is compared to the laboratory's running mean to ascertain whether it falls within the acceptable range. USEPA test method manuals include the added caution that reference toxicant test results should not be used as a *de facto* criterion for rejection of individual receiving water tests. Reference toxicant tests do provide information on trends in organism sensitivity and laboratory performance that can be useful in evaluating and interpreting effluent and receiving water tests results. For this reason, USEPA has recommended evaluating the following elements of reference toxicant test results in the review of the receiving water test data: the degree to which the reference toxicant tests result is outside of control chart limits: the width of the limits; the direction of a deviation (toward increased test organism sensitivity or toward decreased test organism sensitivity); the test conditions of both the effluent tests and the reference toxicant tests; and the objective of the test. The USEPA acceptable range is within two standard deviations of the running mean. If the LC_{50} and/or EC_{25} fall outside of the upper and lower two standard deviation limits, test organism sensitivity is considered atypical and results of ambient sample toxicity tests conducted temporally nearest to the reference toxicant test will be qualified as either more sensitive or less sensitive than usual. See USEPA 2002a for more information.

Precision

Precision is the degree to which independent analyses of a given sample agree with one another. It is the reproducibility, consistency and repeatability of results. UCD AHPL assesses precision through field duplicates. A field duplicate is a second sample collected in a separate container, immediately after the initial/primary test sample. Field duplicates are tested concurrently with its primary sample and the results are evaluated to determine precision of field and laboratory staff. Field duplicate samples are in agreement when they are both either statistically similar, or statistically different from the control. Field duplicates will be conducted at a rate of 5% of all samples.

The relative percent difference (RPD) between duplicates is calculated on water chemistry measurements using the following formula:

$$RPD = \left(\frac{\left[2 * \left| Dup1 - Dup2 \right| \right]}{\left[Dup1 + Dup2 \right]} \right) * 100$$

Accuracy

Accuracy of toxicity tests cannot be directly measured because of the lack of data to support a standard organism response against comparable test results. However, inferences can be made regarding accuracy from reference toxicant tests in order to assess the sensitivity of the organisms in a known concentration of toxicant, and to determine that the organisms' response is within acceptable limits. Accuracy of instruments will be evaluated using the formula for accuracy listed in Appendix A of the SWAMP QAPrP and will follow the MQOs listed in Table 4-7.

Completeness

The Delta RMP strives for a minimum of 90% completion of data. For toxicity tests, completeness is defined by the total number of samples that met Test Acceptability Criteria for each species divided by the total number of useable samples submitted to the laboratory for each species. An individual sample may not be usable if its conductivity is well above or below conductivities typically found in freshwater. These conductivity thresholds are different for each species. Toxicity completeness is assessed by the number of useable results divided by the total number of samples collected.

For water quality data associated with toxicity testing, data will be considered complete when each sample is measured within a sample batch that meets the accuracy requirements for the reference material (hardness, alkalinity and total ammonia), or meter drift (DO, EC and pH) is within acceptable limits.

Representativeness

In terms of laboratory toxicity testing of ambient samples, representativeness refers to the degree to which data accurately reflect the presence or absence of toxic contaminants in the environment at the sites where samples are collected. Location of sampling sites, sample preservation and appropriate species selection are important considerations for representativeness.

Comparability

The Delta RMP documents adhere to USEPA test methods, SOPs and QA measures specified in the QAPP, and acceptable reference toxicant test results. Therefore, results can be compared with other projects and laboratories that adhere to the same USEPA protocols and QA measures.

Data analysis

Toxicity tests will be conducting using a single-concentration test design, and results will be analyzed using the USEPA Test of Significant Toxicity (TST) statistical approach. This USEPA

method of data analysis involves the comparison of each sample (100% water) to one control (standard laboratory control and a conductivity control, if needed).

Comprehensive Environmental Toxicity Information System™ **(**CETIS) software will be used to calculate TST analyses and Effect Concentration and Lethal Concentration values (EC_{25} for sublethal endpoints and LC_{50} for survival endpoints) for reference toxicant tests.

4.4.2. Quality Control

Table 4.9 provides a summary of QC measures and MQOs related to toxicity testing, while Table XX lists the analytical endpoints that trigger a TIE. Section 8.3 Corrective Actions provides information on quality control actions when acceptance limits (i.e. "action limits") are exceeded.

Table 4.9. Measurement Quality Objectives for toxicity testing.

Method	Analyte/Test	Matrix	Frequency	Acceptability Limit
Conventional Parameters				
SM 2320B; UCD AHP SOP 6-5	Alkalinity (as $CaCO_3$)	Water	Per 20 samples or per analytical batch, whichever is more frequent	NA
SM 4500-NH3F; UCD AHP SOP 6-3	Ammonia	Water	Per 20 samples or per analytical batch, whichever is more frequent	< 5 mg/L
SM 2510B; UCD AHP SOP 8-7	Conductivity	Water	Per 20 samples or per analytical batch, whichever is more frequent	< 1500 μS/cm for *S. capricornutum*, > 100 or <1900 μS/cm for *C. dubia,* > 100 or <1900 μS/cm for *P. promelas*; and >100 mS/cm or <10,000 μS/cm for *H. azteca*.
SM 4500OG; UCD AHP SOP 8-9	Dissolved Oxygen	Water	Per 20 samples or per analytical batch, whichever is more frequent	< 8.6 mg/L (*H. azteca* < 8.9 mg/L)
SM 2340C; UCD AHP SOP 6-1	Hardness	Water	Per 20 samples or per analytical batch, whichever is more frequent	NA
SM 4500H+B; UCD AHP SOP 8-8	pH	Water	Per 20 samples or per analytical batch, whichever is more frequent	6-9
SM 2550B	Temperature	Water	Per 20 samples or	25 ± 1 °C

Method	Analyte/Test	Matrix	Frequency	Acceptability Limit
			per analytical batch, whichever is more frequent	(*H. azteca* 23 ± 1°C) Test temperatures must not deviate (i.e., maximum minus minimum temperature) by more than 3°C during the test
Water Toxicity				
USEPA 1003.0	*S. capricornutum*	Water	Each sample batch; monthly reference toxicant tests	Result of "fail": ≥ 50% effect in 96-hr; reference toxicant test LC_{50} and/or EC_{25} ± 2 SD of running mean
USEPA 1002.0	*C. dubia*	Water	Each sample batch; monthly reference toxicant tests	≥ 50% endpoint in 96-hr; 100% mortality in 48-hr; reference toxicant test LC_{50} and/or EC_{25} ± 95% C.I. of running mean
UCD AHP SOP 1-6	*H.azteca*	Water	Each sample batch; reference toxicant test for each event	≥ 50% endpoint in 96-hr; 100% mortality in 48-hr; reference toxicant test LC_{50} and/or EC_{25} ± 95% C.I. of running mean
USEPA 1000.0	*P. promelas*	Water	Each sample batch; reference toxicant test for each event	≥ 50% endpoint in 96-hr; 100% mortality in 48-hr; reference toxicant test LC_{50} and/or EC_{25} ± 95% C.I. of running mean

4.4.3. Project-specific corrective action limits

Individually results produced by the Delta RMP are not intended to trigger enforcement actions, even though collectively the data may guide management actions by other parties through planning. Consequently, there are no project-specific corrective actions limits required for the data. However, any corrective actions that are warranted shall be made at the discretion of the QAO.

4.5. Performance-based method concept for the determination of LT2 pathogens (Cryptosporidium and Giardia)

The Delta RMP pathogen (*Cryptosporidium* and *Giardia*) monitoring is designed as the ambient monitoring component of the Regional Board's Basin Plan Amendment to establish a Drinking Water Policy to protect source water, and is being conducted concurrently with the drinking

water agencies' required Long Term 2 (LT2) Enhanced Surface Water Treatment Rule monitoring (as described in the Delta RMP Pathogen Study Design Summary). The Pathogen Study is intended to satisfy data needs and monitoring for any follow-up required if Basin Plan trigger values are exceeded during LT2 monitoring. The direction from the Central Valley Drinking Water Policy Workgroup is that data collected for the RMP pathogen monitoring should be consistent with data collected during LT2 monitoring.

EPA Method 1623 was developed to support the support promulgation of EPA's LT2. Its purpose is to support the assessment of protozoan (*Cryptosporidium* and *Giardia*) pathogen occurrence in raw surface waters used as source waters for drinking water treatment plants. EPA Method 1623 provides quality control (QC) acceptance criteria for *Cryptosporidium* and *Giardia,* but notes that some sample matrices may prevent the acceptance criteria from being met. EPA notes that field samples with matrix spike recoveries below the QC acceptance criteria identified in Method 1623 (13%-111% for *Cryptosporidium* and 14%-100% for *Giardia*) are valid, and will be accepted for determining LT2 bin concentrations. To be consistent with the LT2 data, the RMP will consider data outside the acceptance criteria to be valid, but will flag such results.

The Pathogen Study may use EPA Method 1623.1, which is reported to have higher *Cryptosporidium* recoveries. The QC acceptance criteria identified in Method 1623.1 for matrix spike recoveries are 31%-100% for *Cryptosporidium* and 8%-100% for *Giardia*.

To be approved for LT2 protozoan testing using Method 1623 and 1623.1, laboratories are required to demonstrate acceptable performance for *Cryptosporidium* and *Giardia*. EPA Method 1623 and 1623.1 are performance-based methods applicable to the determination of *Cryptosporidium* and *Giardia* in aqueous matrices. Demonstration of acceptable performance includes initial and ongoing precision and recovery tests, which are conducted using spiked reagent water and matrix samples. Each laboratory that uses this method is required to operate a formal quality assurance (QA) program that addresses and documents data quality, instrument and equipment maintenance and performance, reagent quality and performance, analyst training and certification, and records storage and retrieval. The minimum analytical requirements of this program consist of an initial demonstration of laboratory capability (IDC) through performance of an initial precision and recovery (IPR) test, and ongoing demonstration of laboratory capability and method performance through a matrix spike (MS) test, the method blank test, an ongoing precision and recovery (OPR) test, staining controls, and analyst verification tests. Laboratory performance is compared to established performance criteria to determine if the results of analyses meet the performance characteristics of the method. A principal analyst verifies the quality and accuracy of all sample results. Laboratory performance is compared to established performance criteria to determine if the results of analyses meet the performance characteristics of the method. Table 4-10 summarizes the minimum QC requirements for Method 1623, and Table 4-11 summarizes the minimum QC requirements for Method 1623.1. Details are described in EPA Method 1623 and 1623.1.

Table 4.10. QC requirements and acceptance criteria for determination of *Cryptosporidium* and *Giardia* in aqueous matrices (EPA Method 1623)

QC sample or procedure	Frequency	Acceptable limits
Cryptosporidium		
IPR	Each equipment/supply change	Recovery = 38 -100%/RSD <37%
Method Blank	1 per 20 or week	No false positives
OPR	1 per 20 or week	Recovery = 22 -100%
Matrix Spikes	1 per 20	Recovery = 32 -100%/RSD < 46%
Matrix Spikes/Duplicates	Initial use and each procedural change	Recovery = 32 -100%/RSD < 46%
Positive staining control	Every batch	No false negatives
Negative staining control	Every batch	No false positives
Verification of analyst performance	Monthly	< 10% difference in counts
Giardia		
IPR	Each equipment/supply change	Recovery = 27 -100%/RSD <39%
Method Blank	1 per 20 or week	No false positives
OPR	1 per 20 or week	Recovery = 14 -100%
Matrix Spikes	1 per 20	Recovery = 32 -100%/RSD >97%
Matrix Spikes/Duplicates	Initial use and each procedural change	Recovery = 8 -100%/RPD > 97%
Positive staining control	Every batch	No false negatives
Negative staining control	Every batch	No false positives
Verification of analyst performance	Monthly	< 10% difference in counts

Table 4.11. QC requirements and acceptance criteria for determination of *Cryptosporidium* and *Giardia* in aqueous matrices (EPA Method 1623.1)

QC sample or procedure	Frequency	Acceptable limits
Cryptosporidium		
IPR	Each equipment/supply change	Recovery = 38 -100%/RSD <37%
Method Blank	Each IPR and OPR set	No false positives
OPR	1 per 20 or week	Recovery = 33 -100%
Matrix Spikes	1 per 20	Recovery = 32 -100%/RSD < 46%
Matrix Spikes/Duplicates	Initial use and each procedural change, and multi-lab validation of modification	Recovery = 32 -100%/RSD < 46%
Positive staining control	Every batch	No false negatives
Negative staining control	Every batch	No false positives
Verification of analyst performance	Monthly	< 10% difference in counts
Giardia		
IPR	Each equipment/supply change	Recovery = 27 -100%/RSD <39%
Method Blank	Each IPR and OPR set	No false positives
OPR	1 per 20 or week	Recovery = 22 -100%
Matrix Spikes	1 per 20	Recovery = 8 -100%/RSD >97%
Matrix Spikes/Duplicates	Initial use and each procedural change, and multi-lab validation of modification	Recovery = 8 -100%/RPD > 97%
Positive staining control	Every batch	No false negatives
Negative staining control	Every batch	No false positives
Verification of analyst performance	Monthly	< 10% difference in counts

5. Special Training Needs and Certification

5.1. Specialized Training or Certifications

Because the Delta RMP uses performance-based methods for laboratory evaluation, laboratory certifications (e.g. by NELAP/ELAP[7]) for the analyses planned are preferred but not required. The laboratory providing analytical support to the Delta RMP must have a designated on-site QA Officer for the particular analytical component(s) performed at that laboratory. This individual will serve as the point of contact for the SFEI-ASC QA staff in identifying and resolving issues related to data quality.

To ensure that the samples are analyzed in a consistent manner throughout the duration of the program, key laboratory personnel will participate in an orientation session conducted during an initial site visit or via communications with SFEI-ASC staff. The purpose of the orientation session is to familiarize key laboratory personnel with this QAPP and the Delta RMP QA/QC program. Participating laboratories may be required to demonstrate acceptable performance before analysis of samples can proceed, described in subsequent sections. Laboratory operations will be evaluated on a continual basis through technical systems audits, and by participation in laboratory inter-comparison programs.

Personnel in any laboratory performing analyses will be well versed in good laboratory practices (GLPs), including standard safety procedures. It is the responsibility of the analytical laboratory manager, and/or safety staff to ensure that all laboratory personnel are properly trained. Each laboratory is responsible for maintaining a current safety manual in compliance with the Occupational Safety and Health Administration (OSHA) or equivalent state or local regulations. The safety manual will be readily available to laboratory personnel. Proper procedures for safe storage, handling, and disposal of chemicals will be followed at all times; each chemical will be treated as a potential health hazard and GLPs will be implemented accordingly.

Personnel collecting samples must have been trained on the field sampling methods described in the QAPP. For current use pesticides monitoring, the USGS field sampling coordinator will be responsible for training the USGS field staff. For pathogen monitoring, MWQI will be responsible for training the field staff. The sign-in sheet of the training can be the documentation of the training.

[7]Environmental Laboratory Accreditation Program (ELAP). ELAP provides evaluation and accreditation of environmental testing laboratories to ensure the quality of analytical data used for regulatory purposes to meet the requirements of the State's drinking water, wastewater, shellfish, food, and hazardous waste programs

5.2. Training Certification and Documentation

Contractors performing sampling are responsible for providing training to their staff and maintaining records of all trainings. Those records can be obtained if needed from contractors through their respective QA or Safety Officers.

5.3. Training Personnel

Each contract laboratory's QA Officer and Safety Officer shall provide and/or designate staff to provide training to their respective personnel. All personnel responsible for sampling will be trained in field sample collection and safety prior to the first day they are schedule to sample for the Delta RMP.

6. Documents and Records

All Delta RMP documents will be provided to the Steering Committee, which includes the Regional Board.

SFEI-ASC will collect records for sample collection, field analyses, laboratory chemical analyses, toxicity testing, and pathogen analyses. Samples sent to analytical laboratories will include a Chain-of-Custody (COC) form. The analytical laboratories will maintain records of sample receipt and storage, analyses, and reported results.

SFEI-ASC will maintain hardcopy or scanned files of field notes and measurements, as well as laboratory submitted documentation and results at the SFEI-ASC main office. The SFEI-ASC Data Manager will be responsible for the storage and organization of information.

Contract laboratories will also be responsible for maintaining copies of project documentation originating from their respective laboratories, with backup archival storage offsite where possible. All SOPs used for the Delta RMP will be stored indefinitely in case future review is necessary.

Quality Assurance Documentation

All laboratories will have the latest revision of the Delta RMP QAPP. In addition, the following documents and information will be current and available to all laboratory personnel participating in the processing of Project samples, as well as to SFEI-ASC program officials:

1. Laboratory QA Plan: Clearly defined policies and protocols specific to a particular laboratory, including personnel responsibilities, laboratory acceptance criteria and corrective actions to be applied to the affected analytical batches, qualification of data, and procedures for determining the acceptability of results.
2. Laboratory Standard Operating Procedures (SOPs): Containing instructions for performing routine laboratory procedures, such as logging, labelling, and storage of samples, cleaning of equipment, checking of reagents, etc., that are not necessarily part of any analytical methodology for specific analytes or analyte types.

3. Laboratory Analytical Methods: Step-by-step instructions describing exactly how a method is implemented in the laboratory for a particular analytical procedure. Contains all analytical methods utilized in the particular laboratory for the Delta RMP.
4. Instrument Performance Information: Information on instrument baseline noise, calibration standard response, analytical precision and bias data, detection limits, etc. This information should be reported for the periods during which Delta RMP samples are analyzed.
5. Control Charts: Control charts are useful in evaluating internal laboratory procedures and are helpful in identifying and correcting systematic error sources. Contract laboratories are encouraged to develop and maintain control charts whenever they may serve in determining sources of analytical problems.

Copies of laboratory methods, SOPs, and QA plans are available by request from the SFEI-ASC QA Officer. Some laboratory methods and SOPs may be edited to exclude proprietary details about the analyses. Quality assurance documents are reviewed to assure conformance to program needs by the Delta RMP Project Manager and QAO or their designees.

Copies of all records will be maintained at SFEI-ASC and at the laboratory for a minimum five years after project completion, after which they may be discarded, except for the database at SFEI-ASC, which will be maintained without discarding. All data will be backed up and secured at a remote location (i.e., separate from the SFEI-ASC office). As needed, data recovery can be initiated by contacting the back-up facility for restoration and this will be covered through SFEI-ASC overhead.

All participants listed in Table 0-1 will receive the most current version of the Delta RMP QAPP, with signed copies only to the Approval Sheet signatories, and electronic copies provided to the remainder.

6.1. Report Package Information

Analytical results, including associated quality control samples, will be provided to SFEI-ASC by the analytical laboratories. Laboratory standard turn around time for report receipt is 90 days after receiving samples. The laboratories analyze samples according to the hold times listed in the Delta RMP QAPP, but the final report may not be finalized for review until 90 days after samples are received from the laboratory. Exceedances of the standard turnaround time should be discussed with and approved by the Delta RMP Program Manager and QAO.

Laboratory personnel will verify, screen, validate, and prepare all data, including QA/QC results, in accordance with the Delta RMP's QAPP and will provide (upon request) detailed QA/QC documentation that can be referred to for an explanation of any factors affecting data quality or interpretation. Any detailed QA/QC data not submitted as part of the reporting package (see below) should be maintained in the laboratory's database for future reference.

Laboratories will provide electronic copies of the cover letter and tabulated analytical data (including associated QA/QC information outlined below) in a format agreed upon with the Delta RMP Project/Data Manager or designee.

Each Electronic Data Deliverable (EDD) report will consist of the following: Analytical and QA data results in an appropriate CEDEN format, Case Narrative, and CRM certificates (when applicable).

Results should be flagged by the laboratory for exceedances of Delta RMP MQOs for completeness, sensitivity, precision, and accuracy, using data quality codes as defined by CEDEN's list of codes, which have been adopted by the Delta RMP for reporting data. The data quality codes should be provided in the LabResult table in the ResQualCode and QACode fields. A list of commonly used result qualifier codes and QA codes are provided in Tables 6-1 and 6-2, respectively. A completed list of codes is available on CEDEN's Controlled Vocabulary web page. Details on the measurements and procedures that are expected to be used to demonstrate the quality of reported data can be found in Section 4, Quality Objectives, Criteria, and Control Procedures for Measurement Data.

6.1.1. Analytical and QA data results

Toxicity data that is funded by SWAMP will be submitted to the Office of Information Management and Analysis (OIMA) by the data provider using SWAMP data templates, SWAMP formatting, completeness and business rules and through theSWAMP's Data Checker. This online tool alerts users to data that does not conform to the business rules outlined in the applicable SWAMP Data Management Plan or the values established in SWAMP's LookUp Lists. Data must be reviewed and verified for format, completeness, and quality control requirements, including result qualifications and appropriate sample and batch comments, prior to submission to OIMA. The laboratory must be reachable to answer questions regarding the data submittal if necessary. If the data is determined to be incomplete or requiring significant corrections, the data may be returned to the laboratory for correction and re-submission. Once these data have been approved by SWAMP, the appropriate SWAMP Data Manager will provide the data within the California Environmental Data Exchange Network's (CEDEN) electronic data deliverable (EDD) templates to SFEI/ASC for further processing. SFEI-ASC staff is encouraged to contact the OIMA Help Desk with any data questions they may have.

Results will be submitted in the EDD template supplied by SFEI-ASC. Tabulated data will include the following information for each sample (when applicable):

1. Sample identification: Unique sample ID, site code, site name, collection date, collection time, analysis date, sample type (field or QC types), and matrix (water).
2. Analytical methods: Preparation, extraction, and quantitation methods (codes should reference SOPs submitted with the data submission package). Also include preparation, extraction, and analysis dates.
3. Analytical results: Analyte name, fraction, result, unit, method detection limit (MDL), and reporting limit (RL) for all target parameters. The appropriate data qualifiers should be submitted with the results.

Required additional data include:

- Control results (for toxicity tests)
- Summary and individual replicate results, including water quality parameters (for toxicity tests)
- Lab replicate results (and field replicates, when sent for analysis)
- Quality assurance information for each analytical chemistry batch:
- CRM or LRM results: absolute concentrations measured, certified value, and % recovery relative to certified or expected value.
- Matrix (or blank) spike results: include expected value (native + spike) for each analyte, actual recovered concentrations, and calculated % recovery.
- Method blank sample results in units equivalent to field sample results (e.g., if the field samples are reported as ng/g, method blanks are given in the same units).
- Field and lab replicate results and calculated %RPD or %RSD.

6.1.2. Case Narrative

The following topics will be addressed in the narrative of the laboratory reports:

Laboratory Chemical Analysis and Pathogens

A. Overview of Work Performed, Analytical Methodology and Reporting

Number of samples received and analyzed.

Describe handling/storage/preparation of samples.

Summarize extraction method.

Summarize analysis method.

Include concentration range(s) used to generate calibration curves.

Reporting units and basis (all results should be in the same units and basis)

Are results for corrective actions (e.g. reanalysis results, contamination study, etc.)?

B. Completeness

Were all sample results reported?

Describe reason for any missing results.

C. Detection Limits

Provide detection and reporting limits and method of estimation.

Estimate proportion of unquantified results, given detection limits for target analytes

D. Batch Specific Discussion of Results

Provide a brief summary of results for each analytical batch.

Describe number and type of samples analyzed in each laboratory batch.

Indicate if results were blank or surrogate recovery corrected.

Discuss analytical problems and any corrective actions.

1. Laboratory Blanks - describe type(s) of blanks analyzed, summarize method blank results.
2. Accuracy - summarize accuracy achieved by parameter and method of measurement (matrix spikes, certified reference materials, etc.). Include a copy of the certification values for all certified reference materials used in the analysis. For matrix and blank spikes, note where expected values (native + spike concentration) and percent recovery calculations are included in the data tables.
3. Precision - summarize precision achieved from replicates and how measured (replicates of field samples, MS/MSDs, etc.). Note RPD (or RSD) calculations in data tables.

Toxicity Testing

A. Test Procedures
    1. Sample receipt and handling
    2. Toxicity testing: various species and parameters (growth, survival, reproduction)
    3. Reference toxicant testing for each species
B. Results
C. Data Quality Control
    1. Maintenance of Acceptable Test Conditions
    2. Negative Control Testing
    3. Positive Control Testing
D. Summary and Conclusions

6.1.3. Electronic Data Deliverable Template

SFEI-ASC is a Regional Data Center (RDC) for the state of California and uses templates, standardized vocabulary and business rules developed and maintained by CEDEN to manage data for field collection, chemistry, taxonomy, tissue, toxicity, and bioassessment sampling. SFEI-ASC will provide training and guidance to collection agencies and laboratories on how to use the CEDEN templates.

Prior to field collection, SFEI-ASC will provide the field collection agency a copy of the CEDEN Stations and Locations templates to be populated with information about the sample collection.

Prior to analyses, SFEI-ASC will provide the laboratory with a copy of the appropriate CEDEN template (populated by the field collection agency with information about the sample collection) and documentation for the sample type being analyzed. The documentation details attributes of each field including field name, data type, whether the field is required or not, the appropriate lookup list for approved vocabulary (See Table 6-1 for CEDEN controlled vocabulary result qualifiers and Table 6-2 for common QA codes) and a description of each field. The CEDEN templates and documentation are available on-line from CEDEN at http://www.ceden.org/ceden_datatemplates. Lookup list values are available on the CEDEN Controlled Vocabulary website.

Table 6.1. CEDEN controlled vocabulary for result qualifiers.

Result Qualifier Name	Result Qualifier Code
Absent	A
Colonial	COL
Confluent Growth	CG
Cw/C - Confluent Growth with Coliforms	w/C
Cw/oC - Confluent Growth without Coliforms	/oC
Detected Not Quantifiable	DNQ
Equal To	=
Field Estimated	JF
Greater Than	>
Greater than or equal to	>=
Less Than	<
Less than or equal to	<=
No Reportable Sum	NRS
No Reportable Total	NRT
No Surviving Individuals	NSI
Not Analyzed	NA
Not Detected	ND
Not Recorded	NR
Percent Recovery	PR
Present	P
Present/Absent	PA

Table 6.2 Common CEDEN QA Codes

QACode	QADescr
BRK	No concentration sample container broken
BRKA	Sample container broken but analyzed
BS	Insufficient sample available to follow standard QC procedures
DO	Coelution
DS	Batch Quality Assurance data from another project
H	A holding time violation has occurred
IL	RPD exceeds laboratory control limit
IP	Analyte detected in field or lab generated blank
IU	Percent Recovery exceeds laboratory control limit
J	Estimated value - EPA Flag
M	A matrix effect is present
NBC	Value not blank corrected
None	None - No QA Qualifier
R	Data rejected - EPA Flag
SC	Surrogate Corrected Value
Other QA Codes	
BB	Sample > 4x spike concentration
BE	Low surrogate recovery; analyzed twice
BLM	Compound unidentified or below the RL due to overdilution
BT	Insufficient sample to perform the analysis
BY	Sample received at improper temperature
BZ	Sample preserved improperly
CS	QC criteria not met due to analyte concentration near RL
CT	QC criteria not met due to high level of analyte concentration
D	EPA Flag - Analytes analyzed at a secondary dilution

DRM	Spike amount less than 5X the MDL
EU	LCS is outside of acceptance limits. MS/MSD are accept., no corr.
EUM	LCS is outside of control limits
FO	Estimated maximum possible concentration (EMPC)
GN	Surrogate recovery is outside of control limits
GR	Internal standard recovery is outside method recovery limit
H24	Holding time was > 24 hours for Bacteria tests only
H6	Holding time was > 6 hrs but < 24 hours for Bacteria tests only
HH	Result exceeds linear range; concentration may be understated
HR	Post-digestion spike
HT	Analytical value calculated using results from associated tests
IF	Sample result is greater than reported value
JA	Analyte positively identified but quantitation is an estimate
LC	Laboratory Contamination
N	Tentatively Identified Compound
NC	Analyte concentration not certifiable in Certified Reference Material
NMDL	No Method Detection Limit reported from laboratory
NRL	No Reporting Limit reported by the laboratory
PG	Calibration verification outside control limits
PJ	Result from re-extract/re-anal to confirm original MS/MSD result
PJM	Result from re-extract/re-anal to confirm original result
QAX	When the native sample for the MS/MSD or DUP is not included in the batch reported
RE	Elevated reporting limits due to limited sample volume
SCR	Screening level analysis

6.1.4. Standard Operating Procedures (SOPs)

The laboratory submitted SOPs for preparation, extraction, and analytical methods upon approving the QAPP. The SOPs are listed in Appendix C in this QAPP. The QA Officer/Project Manager will need to approve any changes in methods.

6.2. Data Reporting Requirements

Each laboratory shall establish a system for detecting and reducing transcription and calculation errors prior to reporting data.

Data will be reported in CEDEN templates or provided in a comparable format approved by SFEI's Data Manager. Data for pesticides, copper, suspended sediments, TOC, DOC, and pathogens will be reported in CEDEN's Water Quality (WQ) template. Toxicity data will be reported to SWAMP using the SWAMP toxicity template. The minimum fields required for data reported in the CEDEN WQ template for the Lab Results tab are: StationCode, SampleDate, ProjectCode, CollectionTime, CollectionMethodCode, SampleTypeCode, Replicate, CollectionDepth, UnitCollectionDepth, LabBatch, AnalysisDate, MatrixName, MethodName, AnalyteName, FractionName, UnitName, LabReplicate, Result, ResQualCode, MDL, RL, QACode. These fields should include true values (not nulls). Other fields such as preparation code and extraction method should be filled out to the extent possible. The minimum fields required for data reported in the CEDEN WQ template for the Lab Batch tab are: LabBatch and LabAgencyCode. Batches must be reviewed for QC completeness and any deviation in QC results should be documented in the accompanying case narrative. The required fields will be identified in the template in green font. The EDD template provided to the laboratory by SFEI will have the fields concerning field collection of the samples already populated.

Documentation containing definitions, field length, field requirement, and associated lookup lists (if applicable) for each field is available on the CEDEN website (CEDEN Water Quality Template Documentation). Fields that require controlled vocabulary can be identified by hovering over the field name in the template and referring to the lookup list that is referenced. Lookup lists are available on the CEDEN website at CEDEN Controlled Vocabulary.

Only data that have met MQOs or that have deviations explained appropriately will be accepted from the laboratory. When QA requirements have not been met, the samples will be reanalyzed when possible. Only the results of the reanalysis should be submitted, provided they are acceptable.

Reporting turnaround times for submission of results from sample analyses are specified in contracts with the analytical laboratories. However, samples should be extracted and analyzed within the holding times specified for the analytical methods used (Table 9-2). Turnaround time requirements specified in subcontracts are generally 90 days or less.

6.3. Data Storage/Database

Data are managed by SFEI-ASC Data Services as established in Section 14. Upon completion of QA/QC review and data validation, data are compiled into the SFEI-ASC RDC database and distributed to the project managers. For details on analytical requirements for QA/QC review, see Section 4. To evaluate data for QA/QC compliance, SFEI/ASC's QA officer or a designee runs a series of queries that check data for completeness, sensitivity, blank contamination, accuracy, and precision. Based on these queries, qualifiers are added to the data and a QA Summary Report is written up.

The QA Summary Report includes the following details:

Lab

Matrix

Analyte

Reporting Issues for Lab to Review

Formatting Issues for Data Manager to Review

QA Review

- *Dataset completeness*
- *Overall acceptability*
- *MDLs sensitivity*
- *QB averages (procedural, field blank)*
- *Average precision from replicate field sample*
- *Accuracy (using a variety of SRMs or Matrix spike QRECs)*
- *Comparison of dissolved and total phases*
- *Comparison to previous years*

Ratio Checking Summary

Sums Summary

Data that are approved for public release are available through SFEI-ASC's Contaminant Data Display and Download tool (CD3), usually within one year of sample collection. Data will also be made available through CEDEN's Advanced Query tool.

7. Sampling Process Design

7.1. Study Area and Period

Sample collection points and a justification for site selection for the different elements are described in the specific designs for each of the Delta RMP monitoring elements (Appendix B). The Delta RMP monitoring stations are located in and upstream of the Delta (Figures 3-1 and 3-2). The monitoring sites for current use pesticides surface water sampling represent key inflows to the Delta. Ambient pathogen monitoring sites are co-located with existing sites of the Municipal Water Quality Investigations program (Figure 3-2).

Sampling timing and frequency varies for the different elements of the monitoring program:

- There are two types of sites for current use pesticide monitoring: 5 baseline sites and 4 additional "targeted" sites for event-based sampling only. Baseline sites are visited monthly (monthly sampling at baseline sites would capture targeted events). Sites targeted for event-based sampling will be visited 5 times/year during two wet events (first fall rain, 2nd significant storm in winter) and three dry events (1st irrigation, 2nd irrigation, and snow melt/spring runoff).
- Pathogen ambient water monitoring occurs monthly at 12 stations during the first calendar year of monitoring. During the second year of the Pathogen Study, the same level-of-effort will continue, with the addition of special studies.

Collected data are used to evaluate future data needs and adjust the sampling and analysis plan as needed to optimize data collection in an adaptive manner. The program will be continually adjusted to optimize data collection. The initial monitoring design is described in the Monitoring Design Summary document.

7.2. Sampling Sites

Table 7.1. Sampling sites.

Station Name	Target Latitude	Target Longitude	Current Use Pesticides	Pathogens – Monthly Sampling
Colusa Basin Ag Drain	38.80197	-121.72552	Not sampled	Monthly
Natomas East Main Drainage Canal	38.61110	-121.467300	Not sampled	Monthly
American R @ Discovery Park	38.60094	-121.5055	Targeted events only	Not sampled
Sacramento R @ Veteran's Bridge	38.67460	-121.62817	Targeted events only	Not sampled
Sacramento R @ Westin Boat Dock	38.53003	-121.53091	Not sampled	Monthly
Sacramento R @ Hood	38.36691	-121.52037	Baseline- Monthly	Monthly
Sacramento R @ Rio Vista	38.36691	-121.68530	Targeted events only	Not sampled
San Joaquin R @ Vernalis/Airport Way	37.67556	-121.26417	Baseline- Monthly	Monthly
San Joaquin R @ Buckley Cove	37.97667	-121.37889	Baseline- Monthly	Not sampled
Shag Sl @ Liberty Island Bridge	38.30667	-121.69278	Targeted events only	Not sampled
Ulatis C @ Brown Rd	38.30667	-121.79472	Baseline- Monthly	Not sampled
Cache Slough nr Ryder Island	38.22500	-121.67481	Not sampled	Monthly
Mokelumne R @ Benson Ferry	38.25461	-121.43658	Not sampled	Monthly
Mokelumne R @ New Hope Road	38.23611	-121.41889	Baseline- Monthly	Not sampled
Calaveras R @ UoP Footbridge	37.98003	-121.33648	Not sampled	Monthly
Old R @ Bacon Island	37.96910	-121.57290	Not sampled	Monthly
Jones Pumping Plant	37.79690	-121.58550	Not sampled	Monthly
Banks Pumping Plant	37.81480	-121.61573	Not sampled	Monthly
Rock Slough @ CCWD Fish Facility	37.99550	-121.70180	Not sampled	Monthly

8. Sampling Methods

The quality of samples collected in the field is addressed through a number of procedures. Proper selection of equipment, supplies and training for use of those items ensures that collection procedures and materials do not or minimally affect samples. Collection and analyses of appropriate quality control samples allows measurement and assessment of artifacts or influences of sampling on sample characteristics, to differentiate uncertainties and variability

introduced by the sampling process from those inherent in the monitored system. This section will describe quality assurance and quality control procedures implemented for the Delta RMP.

8.1. Field Equipment and Supplies

Sampling equipment and supplies will vary depending on the project element. Sample containers appropriate to the matrices being sampled and the analyses to which they will be subjected will be chosen. All containers should meet or exceed the required trace limits established by the US EPA in the document EPA/540/R-93/051, Specifications and Guidance for Contaminant-Free Sample Containers. Chemical-resistant powder-free nitrile and polyethylene gloves will be worn and clean-hands dirty-hands protocols will be followed to minimize contamination of exposed samples. Field cleaning procedures of sampling equipment will be employed to minimize cross-contamination between samples for the parameters of interest.

Field personnel will refer to the detailed workplan for the appropriate Delta RMP sampling element to ensure that all equipment and supplies are brought in the field. However, at a minimum the following supplies are required for the respective project elements:

Water

Sampling containers and labels

Collection devices appropriate for site

Powder-free nitrile gloves

Field meters

Deionized water squirt bottle

Field sheet (see Appendix D)

Coolers and ice

Chain-of-custody form (see Appendix E)

8.2. Field Sample Collection and Quality Assurance Procedures

8.2.1. *Surface Water Sample Collection*

Samples for current use pesticide monitoring are collected monthly as grab samples 1 meter/3 feet below surface at baseline sites and during 5 annual targeted events at additional "targeted" sites. Monthly sampling at baseline sites will capture targeted events in lieu of samples collected at scheduled monthly intervals. The triggers and criteria for events sampling are summarized in Table 8-1.

The Delta RMP Pathogen Study Design Summary specifies monthly ambient monitoring sample collection for two years beginning in April 2015 to match the Long Term 2 Enhanced Surface Water Treatment Rule (LT2)-required water supply intake sample collection. MWQI will collect grab samples at each of the locations shown in Figure 7-2 during the first week of each month

on the site-specific day. The specified sample collection depth for the pathogen sampling is 1 meter/3 feet. MWQI may postpone or cancel sample collection due to safety or logistical concerns.

References and links for accessing SOPs for surface water sample collection are provided in Appendix C.

Table 8.1. Sampling event triggers for current use pesticide events sampling.

Event	**Sampling Triggers**	**Criteria**	**Notes**
Wet			
1st seasonal flush (Water Year)	• Guidance plots project significant increase (~25%) in flow at four stations: lower Sacramento River, lower American River, San Joaquin River at Vernalis, and Mokelumne River.	• Preceded by ≥30 days dry weather (Sac SW criteria).	• *Sample events to hit all sites in 1 to 2 days.* • *When favorable storm conditions and runoff are forecast coordinate directly with AHP lab.* • *Alert AHPL 7 days in advance of upcoming storm for organism preparation and 2 days in advance about likelihood of adequate precipitation*
Significant winter storm	• Guidance plots project significant increase (~25%) at four stations: lower Sacramento River, lower American River, San Joaquin River at Vernalis, and Mokelumne River.	• Minimum 2 weeks since 1st flush sample event.	• *If collect more than 1 event sample in the same month, do not sample in following month.* • *When favorable storm conditions and runoff are forecast coordinate directly with AHP lab.* • *Alert AHPL 7 days in advance of upcoming storm for organism preparation and 2 days in advance about likelihood of adequate precipitation*
Event	Sampling Triggers	Criteria	*Notes*

Event	Sampling Triggers	Criteria	Notes
Dry			
Early Spring	• No triggers, can sample in a particular month (March-April).	• None	• *Meant to capture snowmelt but recognize significant impact of upstream dams.* • *Coordinate sampling schedule with AHP lab 7 or more days in advance.*
1st irrigation season sampling (late spring/ early summer)	• No triggers, can sample in a particular month (May-June).	• None	• *Meant to capture late winter and spring pesticide applications (post storms).* • *Account for planting/ pesticide application timing.* • *Coordinate sampling schedule with AHP lab 7 or more days in advance.*
2nd irrigation season sampling (late summer)	• No triggers, can sample a particular month (August).	• None	• *Meant to capture summer pesticide applications (rice, etc.).* • *Account for planting/ pesticide application timing.* • *Coordinate sampling schedule with AHP lab 7 or more days in advance..*

Collection of water samples for analysis of pesticides and toxicity testing:

USGS personnel will collect water samples for analysis of pesticides, dissolved copper, and toxicity testing. At sites where streamflow is affected by tides, samples will be collected on the ebb tide. Due to the large volumes of water required per site, per event (40 liters for toxicity testing and 2-4 liters for pesticide analyses), all samples will be collected as grab samples. Water will be collected by submerging pre-cleaned 4 liter (toxicity), 1 liter (pesticides) combusted amber glass bottles, and acid rinsed 250 ml polyethylene bottles (copper) 0.5 meters below the water surface (Table 8-2). Sample bottles for dissolved copper will be rinsed three times with site water prior to filling, and containers will be filled completely, leaving no headspace, to minimize volatilization.

Sample for the DOC and POC analysis will be collected as aliquots from pesticide bottles. The amount of water to be filtered in order to obtain a sufficient quantity of material for the POC

analysis depends on the suspended-sediment concentration and/or the concentration of humic and other substances that cause colored water, such as organic and inorganic colloids. Approximate suspended-materials concentration (mg/L) volume of sample to be filtered (mL):

Suspended materials concentration (mg/L)	Volume of sample to be filtered (ml)
1 – 30	250
> 30 – 300	100
> 300 – 1,000	30
> 1,000	10

Number, type and timing of field collected QA/QC samples will be determined by the USGS OCRL and will meet or exceed SWAMP guidelines (http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/mqo/6_syn_water.pdf. Measurements of basic water parameters (temperature, pH, specific conductance, and dissolved oxygen concentration) will be made at the time of sample collection using a YSI 6920V2 multiparameter meter calibrated with appropriate standards.

Sample containers will consist of certified, pre-cleaned and baked, 1 L amber glass bottles with Teflon caps for pesticide samples, 4L pre-cleaned amber glass bottles for toxicity samples, 125 mL baked amber glass bottles for dissolved and particulate organic carbon samples, and 250 ml acid rinsed polyethylene bottles for copper samples.

Table 8.2. Sample container type and volume used for each parameter group for collection of water samples. (Section 9.1 provides more information on field sample handling and shipping procedures. Table 9-1 provides information about storage and hold time requirements for each parameter group.)

Program Element	Parameter Group	Bottle type*	Number of bottles/event	Sample Volume/Site
Current Use Pesticides	Water toxicity	Amber glass	9/targeted event 5/monthly baseline event	4L/bottle x 8 bottles
Current Use Pesticides	Pesticides	Amber glass	9/targeted event 5/monthly baseline event	1L
Current Use Pesticides	DOC/POC	Amber glass	9/targeted event 5/monthly baseline event	125 mL
Current Use Pesticides	Copper	Polyethylene	9/targeted event 5/monthly baseline event	250 mL
Pathogens	Pathogens	LDPE cubitainer	15	10 L

Collection of water samples for analysis of LT2 pathogens:

Samples will be collected for the Delta RMP Pathogen Study following the general field procedures described in the Municipal Water Quality Investigations (MWQI) Program Field Manual. Specific protocols for *Cryptosporidium* and *Giardia* sampling follow EPA Method 1623.

MWQI will collect one field duplicate sample per event on a sequentially rotating site schedule. MWQI will fill one 10-L cubitainer for each sample and shipped to the laboratory on ice for analysis by EPA Method 1623 (Hold time: 96 hours).

MWQI will use a stainless steel bucket and a stainless steel funnel for grab sampling. MWQI will rinse sampling devices twice with ambient water prior to sampling. Sampling devices will be decontaminated between stations by rinsing with de-ionized (DI) water. MWQI Sample Collection Teams will fill out field data sheets immediately after sample collection. All sample containers will be labeled with the date, location sampled or unique station ID, parameter to be measured, and sample preparation (unfiltered).

8.3. Corrective Action

Field Sampling

If goals stated for the collection of samples or the measurement of water quality parameters are not achieved, where possible, samples will be recollected or measurements repeated after necessary re-calibrations of equipment or re-evaluation of the sampling scenario. All necessary steps for corrective action will be documented on the field form and later on entered into the electronic version of the Field Sampling Report that is maintained by SFEI-ASC. The individuals responsible for assuring that the field staff are properly trained and implement the Field Sampling SOPs are the Field Collection Coordinators (i.e., MWQI Sample Collection Team Lead and USGS Sampling Coordinator), SFEI-ASC Project Manager, and the QA Officer.

Field sampling quality goals include the meeting of data quality objectives for:

- Completeness of sample collection
- Representativeness
- Accuracy and precision (as indicated by field duplicates)
- Avoidance of contamination (as indicated by field blanks, equipment blanks, and travel blanks)

If any data indicate that quality objectives are not being met, Field Collection Coordinators will consult with their PI (if applicable), Laboratory Manager and the SFEI-ASC QAO to determine if the failure is most likely due to field or laboratory procedures/methods. If it is determined that field methods are the likely cause, the PI will work with the field sampling team to ensure that protocols are being followed correctly and if any additional protocols (specific to this project) need to be implemented.

Laboratory Chemical Analyses

If chemical analytical laboratory results fail to meet the QA requirements outlined in the Delta RMP QAPP and it is determined that laboratory procedures are the likely cause, then the PI (if applicable) and Laboratory Manager will ensure that proper procedures as outlined in the QAPP are being implemented and to develop any additional procedures to bring QA sample results in line with data quality objectives. Corrective actions will be documented, resolved, and followed-up on following the process for corrective actions that is outlined by the SWAMP. The process is based on the SWAMP Corrective Action Form, and is applied to sample results that fail to meet the technical and non-technical requirements of SWAMP and its associated projects.

Toxicity Testing

Data Quality Indicators and test acceptability criteria for toxicity testing are listed in Tables 4-7 and 4-8, respectively. MQOs and TIE triggers are summarized in Table 4-9. The AHPL QAO will be alerted when these thresholds are exceeded. The AHPL QAO may take the following actions, if applicable:

Ammonia: When a sample's ammonia-nitrogen measurement exceeds 5 mg/L, the ambient sample may be retested at different pH levels to determine what effect ammonia-nitrogen levels have on test organisms. Commensurate controls will be included.

Conductivity: When a sample's conductivity meets or exceeds the acceptability threshold for each species, a high or low conductivity control will be included in the test to determine whether high or low conductivity may have a role in reduced mortality, growth or reproduction.

Dissolved Oxygen: When a sample's dissolved oxygen exceeds 8.6 mg/L (for *S. capricornutum*, *C. dubia* and *P. promelas*; 8.9 mg/L for *H. azteca*) following the sample warming period, the sample will be gently aerated prior to sample renewal, in order to degas harmful dissolved gases. If a sample's dissolved oxygen level is less than 4.0 mg/L, the ambient sample will be constantly aerated to ensure adequate oxygen levels for the duration of the test, as well as including a concurrent aeration control.

pH: When a sample's pH is below 6 or exceeds 9, the sample will be tested at its original pH and also adjusted to 7.5. A pH method blank will also be tested that includes an adjustment to the ambient sample's original pH and then returned to 7.5.

Temperature: Sample temperatures must not deviate by more than 3°C of the target test temperature for the duration of the test. If sample temperatures exceed this range, steps will be taken to minimize sample temperature deviations, such as adjusting environmental chamber temperatures to a tighter range or moving a test into a more temperature-regulated testing area.

Toxicity: If a sample test species exhibits $\geq$ 50% mortality within 96-hours, the AHPL QAO or Laboratory Manager will contact the SFEI-ASC Project Manager within 24 hours to discuss potential a follow-up with a toxicity identification evaluation in order to determine what class

of chemical(s) is causing toxicity. The Delta RMP TAC's TIE subcommittee will decide potential TIEs.

If a sample test species exhibits 100% mortality in 48 hours, the AHPL QAO or Laboratory Manager will contact the SFEI-ASC Project Manager within 24 hours, and a dilution series test will be set up as soon as organisms are available (potential courier limitations).

Tests are conducted according to procedures and conditions as described in the SOPs provide in Appendix C. Beyond those identified, deviations from these recommended conditions are reported to the UCD AHPL QAO. The PI and SFEI-ASC QAO and Project Manager will be notified of these deviations.

In the event of an SOP/QAPP deviation or corrective action, a deviation/corrective action form will be prepared, completed, signed and the SFEI-ASC QAO and Project Manager notified. Best professional judgment will be used in interpretation of results obtained when protocol deviations have occurred. All deviations and associated interpretations will be reported in interim and final laboratory reports. Protocol amendments will be submitted to the SFEI-ASC QAO and Project Manager. Upon approval, protocol amendments will be employed.

Pathogen Analysis

Failure to meet IPR or OPR quality control acceptance criteria indicates systemic problems the laboratory must address prior to processing any samples.

9. Sample Handling and Custody

9.1. Field Sample Handling and Shipping Procedures

Current Use Pesticides

Sample containers will be labeled with the location, date, and time collected and packed in ice chests with sufficient wet ice to maintain sample transport criteria. Field sheets and chain-of-custody forms (COC) will be filled out at the time of collection and will include site ID, site description, collection date/time, container type, sample preservation, field water chemistry measurements, sampler(s) name and requested analyses. All forms will be included with the appropriate samples during shipping. Samples for pesticide analysis will be delivered to the USGS OCRL laboratory in Sacramento California. If upon arrival at the OCRL samples are found to be warm (ice melted) or if sample containers are broken the Project Manager and Principal Investigator will be immediately notified. Ice chests are examined upon delivery to ensure that samples have been properly chilled (acceptable temperature range = 0 - 6 °C).

Water samples for pesticide analyses will generally be processed to extraction upon arrival at the OCRL. If this is not possible, the samples will be refrigerated at 0 - 6 °C in the dark for a period not to exceed the OCRL holding time requirement of 48 hours between sample collection and extraction. Upon arrival of samples, appropriate laboratory processing forms noting unique laboratory ID, site name, collection time and date, receiving technician's name,

requested analysis, and date and time of receipt will be filled out. Signed copies of COCs will be maintained with the appropriate OCRL field and laboratory forms.

Samples for dissolved copper analysis and DOC/POC analysis will be processed on site, immediately after collection. Samples for dissolved copper analysis will be filtered using 0.45-micrometer (µm) filters and acidified to pH less than 2 with 2 ml of 7.5N nitric acid. Samples for DOC analysis will be filtered using 0.7-um pore size, pre-combusted glass-fiber filters, collected in 125 mL baked amber glass bottles, and acidified using 4.5N sulfuric acid. The 0.7-um pore size filter holding the retained suspended material will be used for the POC analysis and will be placed and wrapped in an aluminum foil sqaure of appropriate size.

Samples for dissolved copper, DOC, and POC will be placed in a cooler on wet ice and shipped overnight to the USGS NWQL in Lakewood, CO.

Receipt temperature and sample condition (broken/compromised containers, incorrect preservatives, holding time exceedance, etc.) will be recorded by receiving laboratories.

Toxicity Testing

Toxicity test samples will be delivered to the UC Davis AHP Laboratory in Davis, California, within 24 hours of sample collection. Upon arrival at AHPL, toxicity testing samples will be immediately removed from the ice-chests and the laboratory staff receiving the coolers will complete the accompanying COC. The AHPL will initiate tests within 36 hours of sample collection, although under rare circumstances, this holding time may be extended to 120 hours for precipitation-based events, when courier delivery schedules on weekends and holidays limit the availability of test organisms.

Table 9-1 provides information about storage and hold time requirements for each parameter group.

Table 9.1. Storage and hold time requirements for each parameter group.

Parameter group	**Storage**	**Hold time** (Collection to Extraction, where applicable)	**Hold time** (Extraction to analysis, where applicable)	**Storage** (Extraction to analysis, where applicable
Copper, dissolved	0 - 6°C in dark	Process immediately after collection	[USGS]	0 - 6°C in dark
DOC/POC	0 - 6°C in dark	Process immediately after collection	[USGS]	0 - 6°C in dark
Pesticides	0 - 6°C in dark	Extract within 48 hours of collection	Not to exceed 30 days	- 20°C in dark
Toxicity	0 - 6°C in dark	Initiate Test 36 h after sample collection	NA	NA
Pathogens	1˚ - 20˚ C	Elute within 96h of sample collection	7 days from completion of slide preparation	1˚ - 20˚ C

Pathogens

A courier will deliver samples to Biovir (primary lab). Eurofins will pick up one field duplicate sample per event (secondary lab). Samples must be kept on ice. The laboratories must elute the samples within 96 hours (4 days) of sample collection.

10. Analytical Methods

10.1. Field Analytical/Measurement Methods

The field collection teams will record measurements performed in the field in field sheets (electronic or paper) then enter them into a CEDEN template for subsequent entry in the Delta RMP database by SFEI-ASC. Samples collected in the field are to be placed in containers and stored under conditions appropriate for the analyses to be performed. Any unusual sample characteristics or circumstances preventing normal sample handling will also be noted in the field sheet. On return from the field, the sampling crew will prepare samples for immediate shipping to analytical laboratories or store them under appropriate conditions for subsequent shipping

To minimize discrepancy in field results and provide useful, accurate scientific data, all personnel participating in field sampling are required to follow the guidelines set out in the USGS National Field Manual for the Collection of Water-Quality Data (for pesticide element) and the MWQI Program Field Manual (for pathogen study).

Operation of any field instruments should be checked at least one day before sampling. If failure of an instrument should occur, a backup instrument should be checked and calibrated. All sampling and measurement modifications or failures that occur in the field due to instrument malfunction will be recorded on the Field Form and the Field Reference Sheet. The Field Collection Coordinators, SFEI-ASC Project Manager, and the QAO will be responsible for ensuring that staff documents all deviations from planned operations and schedule repairs and/or additional training as needed.

10.2. Laboratory Methods

For the methods selected for a particular application, the Laboratory Project Manager must be able to demonstrate and document that the methods performance meets the data quality requirements of the project. Two separate factors are involved in demonstrating method applicability: First, demonstrating that the laboratory can perform the method properly in a clean matrix with the analytical system under control, and second, demonstrating that the method selected generates “effective data” in the matrix of concern. The former addresses lab or operator training and proficiency, while the latter demonstrates that the selected method performs with the appropriate selectivity, sensitivity, bias and precision, in the actual analytical matrix, to achieve project goals.

Table 10-1 provides a summary of analytical methods and instruments used by the Delta RMP.

Table 10.1. Summary of analytical methods and instruments.

Parameter group	Methods	Instrument	Proprietary?
Copper, dissolved	Collision/reaction cell inductively coupled plasma–mass spectrometry (USGS TM-5-B1)	cICP-MS (Agilent 7500ce)	No
DOC	UV Catalyzed Persulfate Oxidation and Infrared (IR) Spectrometry (USGS Test Method O-1122-92)	Carbon Analyzer, Dohrmann DC-80, DC-180, or equivalent, with a direct concentration read-out.	No
POC	Elemental analysis (EPA 440.0)	Carbon Analyzer, Dohrmann DC-80, DC-180, or equivalent, with a direct concentration read-out.	No
Pesticides[8]	Gas Chromatography/ Mass Spectrometry (USGS TM-5-B1)	Agilent 7890 GC with a 5975 c mass spectrometer with a DB-5ms column (30 m × 0.25 mm × 0.25 µm, Agilent)	No
Pesticides	Liquid chromatography with tandem mass spectrometry (LC/MS/MS).	Agilent 1260 HPLC coupled to a 6430 tandem MS system with a Zorbax Eclipse XDB-C18 column (2.1 mm × 150 mm× 3.5 mm; Agilent).	No

[8] See Table 3.2 for a detailed list of target analytes for each method

10.2.1. Laboratory SOPs

All analytical methods SOPs can be downloaded from the SFEI-ASC Google Drive, unless the SOPs are proprietary. Copies of laboratory SOPs are also stored at SFEI-ASC but cannot be released to any external parties without prior consent of the laboratory when they are marked as proprietary.

10.2.2. Corrective Actions Procedures

Corrective actions procedures for analytical laboratories are summarized in Table 10-2.

Table 10.2. Corrective actions procedures for analytical laboratories.

Laboratory QC Sample Type	Corrective action
Matrix Spikes	Generally, no corrective action is taken for matrix spike results exceeding the control limits, as long as the surrogate recoveries are acceptable. If the surrogate recoveries are within range, then matrix interference is noted in the sample report. For analyses in which the sample has been extracted, the spike/spike duplicate may be reanalyzed and recalculated. If the laboratory process is deemed out of range, then no further samples are analyzed until the problem has been identified and corrected. In addition, samples run during the out of range episode are to be rerun once the analytical process is again in range.
Field Blanks	If target analytes are found in field blanks, sampling and handling procedures will be reevaluated and corrective actions taken. These may consist of, but are not limited to, a) obtaining sampling containers from new sources, b) training of personnel, c) discussions with the laboratory, d) invalidation of results, e) greater attention to detail during the next sampling event, or f) other procedures deemed appropriate.
Field Replicate	If criteria are exceeded, field sampling and handling procedures will be evaluated and problems corrected through greater attention to detail, additional training, revised sampling techniques, or other procedures deemed appropriate to correct the problems.

10.3. Sample Archive and Disposal

Project samples will not be disposed of until all analyses are complete and analytical and QC results have been reviewed and approved by the Project Manager and the QAO.

11. Instrument/Equipment/Supplies

Contract laboratories maintain equipment in accordance with their respective SOPs, which include those specified by the manufacturer and those specified by the method. Under the performance-based approach, the adequacy of contract laboratory testing, inspection, and maintenance procedures are determined through regular review of results for analysis of field and QC samples for all submitted data.

Prior to use in the field (typically within 24 hours prior to sampling), handheld water quality instruments are calibrated against appropriate standards and, if possible, checked against a standard from a different source. For some measurements such as dissolved oxygen, probes are often calibrated to ambient conditions (water-saturated air) rather than to known standards. In such cases, the field staff should verify appropriate qualitative instrument response (e.g. in water deoxygenated by sparging, sodium sulfite addition, or other means). All calibrations are documented on a calibration checklist on the individual instrument or its case with date, time, and operator name. If an instrument cannot be calibrated or is not reading correctly, a backup instrument will be used to measure water quality parameters.

For single or multiparameter water quality meters, the following standards are typically used to calibrate:

1. pH – commercially available standards pH 4, 7, 10. Perform a 3-point calibration covering the range of expected measurements. Use the 3rd pH standard (or standard supplied by another manufacturer) to verify calibration accuracy.
2. Specific Conductance – use standard with known specific conductance. Verify instrument response with DI water or other standard of lower or higher concentration.
3. Dissolved oxygen – use calibration procedure recommended by manufacturer, typically in water-saturated air.
4. Temperature – check against thermometer of known accuracy at least yearly (preferably quarterly). An ice water bath of approximately 0°C can be used to semi-quantitatively verify temperature probe response but may vary due to uncontrolled factors such as container size and geometry, ice/water disequilibrium, or the presence of melting point-lowering contaminants.

Laboratories maintain calibration practices as part of their method SOPs. Calibration procedures are described generally below.

Upon initiation of an analytical run, after each major equipment disruption, and whenever on-going calibration checks do not meet recommended MQOs, the system will be calibrated with a full range of analytical standards. Immediately after this procedure, the initial calibration must be verified through the analysis of a standard obtained from a different source than the standards used to calibrate the instrumentation, prepared in an independent manner, and ideally having certified concentrations of target analytes (e.g., a certified solution). The

calibration curve is acceptable if it has an r^2 of 0.995 or greater for all analytes present in the calibration mixtures. If not, the calibration standards, as well as all the samples in the batch, must be re-analyzed. All calibration standards will be traceable to an organization that is recognized for the preparation and certification of QA/QC materials (e.g., NIST, NRCC, US EPA, etc.).

Calibration curves will be established for each analyte and batch analysis from a calibration blank and a 7 point calibration, covering the range of expected sample concentrations. If the instrument response is demonstrated to be linear over the entire concentration range to be measured in the samples, the use of a calibration blank and one single standard that is higher in concentration than the samples may be appropriate. Otherwise, only data within the working calibration range (above the MDL) should be reported (i.e. extrapolation is not acceptable). Samples outside the calibration range will be diluted as appropriate, and reanalyzed.

Laboratories maintain internal SOPs for inspection and quality checking of supplies. Under a PBMS approach, these procedures are presumed to be effective unless field and QC data from analyses indicate otherwise. SFEI-ASC will then work with the laboratory to identify the causes and address deficiencies in the SOPs that resulted in those problems. If the problem is serious and cannot be corrected by the laboratory, the SFEI-ASC Project Manager and QAO will discuss and identify alternatives, including changing the sampling materials and methods, the extraction and analytical methods, the laboratory, or any combination of these.

12. Non-direct Measurements (Existing Data)

Non-direct measurements, in the form of data from previously conducted studies by SFEI-ASC and other parties in the region (e.g., Irrigated Land Regulatory Program) may be used in determining ranges of expected concentrations in field samples, characterizing average conditions (e.g., temperature, barometric pressure) for calculations, and other purposes. These data will be reviewed against the data quality objectives stated in Section 4 and used only if they meet all of the specified criteria. Data not meeting MQOs should be used only in a qualitative manner for developing conceptual models and prioritizing future data needs.

Hydrologic data (stage, flow, etc.) will be obtained from existing gauges and recorders located at or near designated monitoring locations

The Delta RMP will not conduct any additional monitoring of current use pesticide chemistry and toxicity in sediments. Instead, sediment toxicity and chemistry data collected by the Surface Water Ambient Monitoring Program (SWAMP) Stream Pollution Trends (SpoT) monitoring will be included in the initial assessment. The SpoT QAPP is available on the SPoT website.

13. Data Management

The collection agencies and laboratories provide data to SFEI-ASC in appropriate CEDEN templates (as provided by SFEI-ASC) within the timeframe stipulated in the contract, usually 90 days or less. The laboratories should use the current on-line data checker to review data for vocabulary and business rule violations prior to submitting to SFEI-ASC (contact DS@sfei.org for the current URL). SFEI-ASC will work with the labs to address vocabulary and business rule issues identified from using the data checker. SFEI-ASC will work with CEDEN to populate the lookup lists with new values as identified by the labs from using the on-line data checker.

Toxicity data that is funded by SWAMP should be submitted to SWAMP by the data provider using SWAMP templates and the SWAMP data checker. Once these data have been approved by SWAMP, the SWAMP Data Manager should provide the data in CEDEN EDD templates to SFEI/ASC for further processing.

The laboratories should report data as outlined in Section 6.2, Data Reporting Requirements. Data are maintained at SFEI as established in Section 6. SFEI-ASC tracks each data set, from submittal to final upload to the RDC database. Once all expected data have been received, expert staff on SFEI-ASC's Data Services team process the data using a series of queries designed to identify any issues remaining with the format of the data. The QA Officer or designee then reviews data for quality assurance and quality control and appropriate CEDEN QA codes are applied to the dataset. The QA officer or designee writes a report for each dataset outlining the quality of the data. This report highlights any issues that need to be addressed by the laboratory, project manager, or data management staff. In addition, specialized senior scientists further review organics datasets such as PCBs, PBDEs, and pesticides. Data are then compiled into the RDC database and distributed to the project managers. Data that are approved for public release are available through SFEI-ASC's Contaminant Data Display and Download tool (CD3), usually within one year of sample collection. Select data will also be made available through CEDEN's Advanced Query tool. The contact individual responsible for steps and tasks of data management is Amy Franz.

SFEI-ASC maintains regular backups of their enterprise databases both to disk and tape, nightly and weekly, respectively. The RDC database, specifically, is also backed up hourly. As a further protective measure, copies of the tapesets are stored both onsite and offsite. The lifetime of the backup files on tape is about 2-3 weeks. Additionally, a backup of the RDC database from the first of every month is stored on disk indefinitely, allowing for quick restore and review of archived data as the need warrants.

14. Assessment and Response Actions

Initially, a desktop or on-site performance audit will be performed by the QAO and designated staff to determine if each laboratory can meet the requirements of the QAPP and to assist the laboratory where needed. Review of current NELAP and/or state ELAP certification of a laboratory for the analyses performed for the Delta RMP may be accepted in some cases in lieu of an on-site audit. Reviews may be conducted at any time during the scope of the study.

Results will be reviewed with participating laboratory staff and corrective action recommended and implemented, where necessary. Furthermore, laboratory performance will be assessed on a continual basis through laboratory intercomparison studies (round robins) where available, such as those conducted by the National Institute of Standards and Technology (NIST).

If data quality issues are identified, a preliminary meeting will be held between SFEI-ASC's QAO and the Project Manager to discuss possible solutions. If necessary, a corrective action plan will be developed in consultation with the appropriate lab(s), the corrective actions taken, and the issue and its resolution summarized in a brief report or memorandum. A summary of these issues will be maintained in the Project files, and will be noted in any reporting that includes affected data.

15. Reports to Management

Reporting goals for the Delta RMP are being developed.

The QAO is responsible for summarizing potential QA issues with reported data and communicating those issues to the Project Manager. The QAO also reviews any SFEI-ASC analyses and reports generated from the data, to ensure that QA issues are appropriately acknowledged and addressed.

16. Data Review, Verification, and Validation

After data are submitted and included in the Delta RMP database, SFEI-ASC staff examines the data set for completeness (e.g., correct numbers of samples and analyses, appropriate QC sample data included) and accuracy (e.g., in sample IDs), and spot-check for consistency with hardcopy results reported by the laboratory. The SFEI-ASC QAO or designee will examine submitted QA data for conformance with MQOs, specified previously (Section 4). Data that are incomplete, inaccurate, or failing MQOs without appropriate explanation will be referred back to the laboratory for correction or clarification. The Project Manager and QAO will discuss data failing MQOs with laboratory staff to determine whether modifications to analytical methods can be made to improve results on reanalysis. If problems cannot be readily corrected (insufficient sample, irremovable interferences, or blank contamination based on past attempts with the lab), results outside the MQOs may be flagged to alert data users to uncertainties in quantitation. Results greatly outside the target MQO range (z-scores or p-scores >2)[9] may be censored and not reported.

In addition to contamination and other artifacts introduced by sampling and analytical methods, errors may arise at many points in the processing and transmittal of data generated

[9] z-score = |result – expected value|/acceptable deviation. See Section 4.3.1. Laboratory QC Measurements for a definition of the p-score.

for the Delta RMP. Characteristics of reported data are examined to identify possible problems in the generation and transmission of data. Data submitted to the Delta RMP are compared to values in the literature for comparable environments and from previous monitoring to evaluate if they are within the expected range of values for a given study. Simple statistics (e.g., minimum, maximum, mean, median) may be generated to quickly identify data sets or individual data points greatly outside of their expected range. Anomalous individual points will be examined for transcription errors. Unit conversions and sample quantitation calculations may be reviewed to identify larger and systematic errors.

17. Verification and Validation Methods

Data are submitted to SFEI-ASC in electronic form. The QAO or designated project staff verify that results for appropriate field and QC samples are reported by comparing the sample types and numbers provided against those specified in the detailed project plan, chain of custody forms, and/or contracts. As part of the verification process, a minimum of 5% of all submitted data reports is spot-checked visually by the Data Services Team upon receipt. SFEI-ASC's Project Manager performs a check of 10% of these reports. Reviewed data are recorded as checked by initials and dates to ensure that electronic and hardcopy reports agree. The contract laboratory's QA Officer (QAO) performs checks of all of its records and the laboratory's Director or Project Manager will recheck 10%. All checks by the laboratory may be reviewed by SFEI-ASC. Issues are noted in a narrative list and communicated to the field or laboratory teams as needed to correct any problems found (e.g. unanalyzed samples left in storage, transcription errors, etc.).

As part of the validation process, data will be evaluated as meeting or failing DQOs.

Exceedances of MQOs not already noted by the laboratory are flagged in any electronic databases and communicated to the analyzing laboratory for possible recalculation and/or reanalysis. Reconciliation and correction of errors in reported data will be addressed by consultation among SFEI-ASC's Project Manager, SFEI-ASC's QAO, and SFEI-ASC Analyst(s) with the Laboratory's QAO, Laboratory and/or Project Manager, and appropriate lab personnel. The involved parties will agree upon any corrections.

Analyses sometimes produce results that fail MQOs and may not be possible to overcome for a small number of analytes within a large group of related compounds. For example, there may be contamination that is impossible to eliminate for all analytes, when analyses are conducted at ultra-trace levels. With agreement of the SFEI-ASC Project Manager and QAO in consultation with the Laboratory, results for sample groups with data outside of MQOs may be flagged, to indicate the greater uncertainty in the quantitation of those data. Results on individual analytes that are greatly outside the target MQO range (e.g. z-scores >2) will be censored as needed rather than subjected to repeated analysis. Reports, graphs, tables, or summary statistics generated from datasets with censored date should note their exclusion or other handling.

Repeated analysis may not fix any issues but rather just mask variability, creating a false impression of the quantitative certainty of results. Contamination of method blanks can

sometimes represent a temporary source of contamination, and flagging results of batches in which contamination is found in blanks is appropriate. As a good practice, sample results in batches with detected blank contamination will be flagged (for field samples with analyte concentration >3x those found in method blanks) or censored (for results <3x those in blanks) by SFEI-ASC, but data users should be aware of the possible influence of sporadic contamination in other batches analyzed around the same time, particularly for samples with low concentrations similar to those in blanks.

Similar analogies can be made with failures of precision or accuracy QC measurements. Individual failures may fall within the range of the true variance in the measurement, e.g. NIST acceptance ranges are sometimes in excess of ±50% of the mean values, and while reporting only successful reanalysis batches may appear to produce more consistent and certain results, without fundamental changes to the analytical process, the underlying uncertainty may only have been masked/censored rather than truly reduced for the reported field samples. This is not to say that reanalyses are never warranted or desirable, but rather to underscore that improved results on QC measurements, which can sometimes be achieved simply by repeat analysis and discarding previous failed results, should not be confused with improved measurements, which are only achieved by making real substantive changes to the sampling and/or analytical methods. If reanalyses are to be attempted, it is therefore imperative that the Project Manager and QAO work in consultation with laboratory staff to identify and change the factors that may have led to MQO deviances, rather than simply repeat the analyses until the QC passes. For MQO deviations (z-score or p-score >1) for which causes are not identified and that are not fixed by corrective actions, field sample results may be qualified, or censored if grossly deviating (z-score or p-score >2). The QC data used for determination of flagging is subject to the availability of data on various QC sample types and the professional judgment of the QAO, but where possible, data for flagging recovery should be 1) in a similar matrix as samples, 2) with externally validated expected values, 3) in a quantitative range, and 4) in a similar concentration range as field samples. Thus for evaluating recovery, the order of preference is generally CRM>LRM>MS>LCS, with exceptions and changes in preference made for factors such as non-certified values, certified values with wide uncertainty bands, and concentrations greatly different from those in field samples. Similarly, for evaluation and flagging of lab precision, QC samples should be 1) in the same matrix as field samples, 2) isolate lab variation from other causes, 3) in a quantitative range, and 4) in a similar concentration range as field samples, where available. For evaluating precision then, the preferred sample types for replicates are: lab > field > MS ~ CRM > LCS, again with exceptions made depending on the available sample types, their inherent variability, concentration ranges, and other factors.

The QA/QC requirements presented in the preceding sections are intended to provide a common foundation for each laboratory's protocols; the resultant QC data will enable assessment of the comparability and uncertainty of results generated by different laboratories and analytical procedures. It should be noted that the QC requirements specified in this plan represent the minimum requirements for any given analytical method; labs are free to perform additional QC in accordance with their standard practices.

In addition to performance on required QC measures and samples (i.e. MDLs, blanks, matrix spikes, CRM, replicates), data are also examined for internal and external consistency to ensure that reported values are realistic and representative for the locations and matrices of collected samples. This review may include but is not limited to:

1. Comparison of reported values to those from previous years for the same locations and matrices, where available - large differences from previously reported values may not necessarily indicate analytical issues and may simply reflect natural spatial and temporal variability of the ecosystem.
2. Comparison of reported values to those in the published literature, where available - differences from other regions and/or species may merely indicate differences in resident species and ecosystem structure, but very large (e.g. 2-3 orders of magnitude) differences may sometimes help identify errors in analysis or reporting (e.g. unit conversions).
3. Internal checks of relative analyte abundance – variations in concentrations of one compound or isomer in a class of chemical contaminants are often tightly linked to those of related compounds, such as a compound and its degradation products or manufacturing byproducts, or various congeners in a commercial mixture. Deviations in these relative abundances can sometimes indicate matrix interferences or other analytical problems, although care should be taken to not disregard results that might reveal atypical sources and/or ecosystem processes.

At the completion of the QA review by the QAO, results are assigned a compliance code on an individual record level. See Table 17-1 for compliance codes. Data are further assigned a batch verification code on a batch level. See Table. 17-2 batch verification codes. Results from the data review will be summarized in the annual QA Report.

Table 17.1. Compliance Codes

DataCompliance Name	DataCompliance Code
Compliant	Com
Do Not Use	DNU
Estimated	Est
Historical	Hist
Not Applicable	NA
Not Recorded	NR
Pending QA review	Pend
Qualified	Qual
Qualified Historic	QualH
Rejected	Rej
Screening	Scr

Table 17.2. Batch Verification Codes

BatchVerification Name	BatchVerification Code
Alternate Level Validation	VAP
Alternate Level Validation, Incomplete QC	VAP,VI
Alternate Level Validation, Incomplete QC, Flagged by QAO	VAP,VQI

Cursory Verification, Data Rejected - EPA Flag, Flagged by QAO	VAC,VR
Cursory Verification, Minor Deviations, Flagged by QAO	VAC,VMD
Cursory Verification, Minor Deviations, Incomplete QC, Flagged by QAO	VAC,VMD,VQI
Cursory Verificaton	VAC
Cursory Verificaton, Incomplete QC, Flagged by QAO	VAC,VQI
Cursory Verificaton/Validation	VLC
Cursory Verificaton/Validation, Incomplete QC, Flagged by QAO	VLC,VQI
Cursory Verificaton/Validation, Minor Deviations, Flagged by QAO	VLC,VMD
Cursory Verificaton/Validation, Minor Deviations, Incomplete QC, Flagged by QAO	VLC,VMD,VQI
Data Rejected - EPA Flag, Flagged by QAO	VR
Full Verification	VAF
Full Verification, Incomplete QC, Flagged by QAO	VAF,VQI
Full Verification, Minor Deviations, Flagged by QAO	VAF,VMD
Full Verification/Validation	VLF
Incomplete QC, Flagged by QAO	VQI
Incomplete QC, Temporary Verificaton, Flagged by QAO	VQI,VTC
Minor Deviations, Flagged by QAO	VMD
No QC, Flagged by QAO	VQN
Not Applicable	0
Not Recorded	NR
Temporary Verification	VTC

18. Reconciliation with User Requirements

All data are reviewed by the QAO to determine if the results have met the Delta RMP MQOs of completeness, sensitivity, precision, and accuracy. Limitations of the data, including uncertainty of validated data, are reported to the data users by a QA code or qualifier. The Delta RMP has adopted the California Data Exchange Network's (CEDEN) standard list of codes to flag data at the result and analytical batch level; the Delta RMP uses a subset of the available codes to flag various QC issues as needed. The QA Report describes non-conformances with QAPP specifications. These findings should also be included in the data itself in QA codes, result qualifier codes, compliance codes, batch verification codes, and comment fields, so that all data users will be informed of the quality of the data.

The data will be stored and maintained in the Regional Data Center database structure and will follow CEDEN's business rules.

Measurement quality objectives listed previously (Section 4) establish targets to be routinely achieved by the analytical laboratory. However, it is uncertain whether obtained data, even when meeting all stated MQOs, will be sufficient to answer the Delta RMP management questions with sufficient certainty, as the relative contributions of environmental variability and analytical uncertainty to overall uncertainty (e.g. for use in modeling, comparisons to guidelines, or other functions) cannot be known *a priori* before sufficient data have been collected. However, as Delta RMP studies proceed, the ability of collected data to answer these management questions should be periodically re-evaluated for study design and budget planning in subsequent years.

19. References

California State Water Resources Control Board (SWRCB). 2008. Quality Assurance Program Plan for the State of California's Surface Water Ambient Monitoring Program (SWAMP). Prepared by the Surface Water Ambient Monitoring Program Quality Assurance Team Quality Assurance Research Group. Updated. http://www.swrcb.ca.gov/water_issues/programs/swamp/docs/mqo/15_acute_toxicity.pdf

California State Water Resources Control Board (SWRCB). Quality Control and Sample Handling Tables. Updated Quality Control and Sample Handling Tables. http://www.waterboards.ca.gov/water_issues/programs/swamp/mqo.shtml

CEDEN. 2014. CEDEN - California Environmental Data Exchange Network. Data Templates Templates, and Documentation. Retrieved from http://www.ceden.org/ceden_datatemplates.shtml

Keith, L. H. 1991. Environmental Sampling and Analysis: A Practical Guide. Lewis Publishers. Chelsea, MI.

Keith, L. H., Crummett, W., Deegan, J., Libby, R. A., Taylor, J. K. and Wentler, G. 1983. Principles of Environmental Analysis. Analytical Chemistry 55(14): 2210-2218.

Taylor, J. 1987. Quality Assurance of Chemical Measurements. Lewis Publishers. Chelsea, MI.

Stanley, T. W, and Verner, S. S. 1985. The U.S. Environmental Protection Agency's Quality Assurance Program. In: Taylor, J. K., and Stanley, T. W. (eds.) Quality Assurance of Environmental Measurements. ASTM STP 867. American Society for Testing and Materials. pp. 12-19.

USEPA. 2002a. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. Fourth Edition. EPA-821-R-02-013

USEPA. 2002b. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms. Fifth Edition. EPA-821-R-02-012

Appendix A. Management Questions

Type	Management Questions
Status and Trends	Is there a problem or are there signs of a problem? a. Is water quality currently, or trending towards, adversely affecting beneficial uses of the Delta? b. Which constituents may be impairing beneficial uses in subregions of the Delta? c. Are trends similar or different across different subregions of the Delta?
Sources, Pathways, Loadings, and Processes	Which sources and processes are most important to understand and quantify? a. Which sources, pathways, loadings, and processes (e.g., transformations, bioaccumulation) contribute most to identified problems? b. What is the magnitude of each source and/or pathway (e.g., municipal wastewater, atmospheric deposition)? c. What are the magnitudes of internal sources and/or pathways (e.g. benthic flux) and sinks in the Delta?
Forecasting Water Quality Under Different Management Scenarios	a. How do ambient water quality conditions respond to different management scenarios b. What constituent loads can the Delta assimilate without impairment of beneficial uses? c. What is the likelihood that the Delta will be water quality-impaired in the future?
Effectiveness Tracking	a. Are water quality conditions improving as a result of management actions such that beneficial uses will be met? b. Are loadings changing as a result of management actions?

Appendix B. Delta RMP Monitoring Elements

Current Use Pesticides

Water

Baseline Sites: Monthly sampling at five sites, which would also capture targeted events. Targeted events (n = 5/year): Wet Weather: (1) 1st seasonal flush (Water Year), (2) Significant winter storm; Dry weather: (1) Early Spring, (2) Late spring/early summer irrigation season, (3) Late summer irrigation season. Chemical analyses and toxicity testing on all samples. Proposed test species (endpoints): (1) *Selenastrum capricornutum* (growth) (2) *Ceriodaphnia dubia* (survival and reproduction), (3) *Hyalella azteca* (survival), and (4) *Pimephales promelas* (larval survival and growth) and/or *Oncorhynchus mykiss* (larval survival). Chemistry: pesticide scan (USGS), total suspended solids, dissolved organic carbon (DOC) and particulate organic carbon (POC), hardness, and dissolved copper analysis. Pesticide-focused Toxicity Identification Evaluations (TIEs) for a subset of samples with $\geq$ 50% of the measured endpoint; to be decided real-time by a TIE subcommittee.

Additional "targeted" sites: Three to four targeted sites for event-based sampling only. Addition of these sites is recommended for increasing the spatial coverage of current use pesticides monitoring. Ideally, these sites would also be sampled monthly. The events only based sampling at these sites represents a compromise driven by budget considerations. In principle, there is no difference between baseline sites and these additional sites targeted for event-based sampling only. However, the 5 recommended baseline sites were considered higher priority for more frequent sampling than the 3-4 additional sites.

Pathogens

Monthly sampling for a two-year special study characterizing pathogen levels (*Cryptosporidium* and *Giardia lamblia*) to address the objectives of the Pathogen Special Study required by the Central Valley Drinking Water Policy Basin Plan Amendment. The study includes monitoring at ambient locations throughout the Delta. The sampling will be added to the routine monthly sampling effort of the Department of Water Resources (DWR) Municipal Water Quality Investigations (MWQI). The Delta RMP contributes required additional laboratory analyses, data management, and reporting.

Appendix C. List of SOPs

The following SOPs, manuals, and method reference documents will be made available on CD by request or can be downloaded from the SFEI-ASC Google Drive.

Field
USGS – National Field Manual for the Collection of Water-Quality Data *(available online only)* – Collection of Pyrethroids in Water and Sediment Matrices: Development and Validation of a Standard Operating Procedure *MWQI* – MWQI Program Field Manual – Appendix A – Delta RMP Pathogen Study *Cryptosporidium* and *Giardia* Sampling
Chemical Analysis
USGS – Determination of Elements in Natural-Water, Biota, Sediment, and Soil Samples Using Collision/Reaction Cell Inductively Coupled Plasma–Mass Spectrometry (USGS TM-5-B1) – Methods of Analysis—Determination of Pyrethroid Insecticides in Water and Sediment Using Gas Chromatography/Mass Spectrometry (USGS TM-5-C2) – Analysis of the herbicide diuron, three diuron degradates, and six neonicotinoid insecticides in water—Method details and application to two Georgia streams (USGS SIR 2012-5026) – A Multi-residue Method for the Analysis of Pesticides and Pesticide Degradates in Water Using HLB Solid-phase Extraction and Gas Chromatography–Ion Trap Mass Spectrometry – WATER EXTRACTION for GCMS analysis using HLB cartridges – Suspended sediment on Filter Paper EXTRACTION for GCMS analysis – WATER EXTRACTION for LCMSMS analysis using HLB cartridges – Procedures for Processing Samples for Analysis of Dissolved Organic Carbon and Organic Particulate Carbon – Determination of Carbon and Nitrogen in Sediments and Particulates of Estuarine/Coastal Waters Using Elemental Analysis (EPA 440.0) – Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory - Determination of Dissolved Organic Carbon by uv-promoted Persulfate Oxidation and Infrared Spectrometry (USGS Test Method O-1122-92)
Toxicity Testing
UCD-AHPL – Initiation of *Selenastrum capricornutum* 96-Hour Chronic Toxicity Test (4th Edition) (SOP 1-1) – Initiation of *Ceriodaphnia dubia* Chronic Toxicity Test (4th Edition) (SOP 1-2) – Initiation of *Pimephales promelas* (Fathead Minnow) Chronic Toxicity Test (4th Edition) (SOP 1-3) – Initiation of *Hyalella azteca* Acute 96-hour Water Column Toxicity Test (SOP 1-6) – Protocol for Sample Receiving and Storage – Delta RMP Testing (SOP 12-7)
Toxicity Identification Evaluations (TIEs)
UCD-AHPL – Protocol for Making a 5 ppm Solution of PBO and Spiking it into Sample Waters (SOP 7-1) – C8 Solid Phase Extraction (SOP 7-2)

- C8 Column Elution for Phase I TIEs (SOP 7-3)
- C8 Column Elution for Phase II TIEs (SOP 7-4)
- Amendment of Water Samples with EDTA and Na_2S2O_3 (SOP 7-9)
- pH Adjustments to pH 3 and pH 11 (SOP 7-10)
- Aeration (Volatile/Surfactant Stripping) (SOP 7-11)

Toxicity Testing - Water Quality Measurements

UCD-AHPL

- Analysis for Total Water Hardness (SOP 6-1)
- Analysis for Ammonia Nitrogen (mg/L) (SOP 6-3)
- Analysis for Alkalinity (SOP 6-5)
- Use of YSI Model 33 Electrical Conductivity Meter (SOP 8-7)
- Operation of Beckman 12 pH/ISE Meter (SOP 8-8)
- Protocol for the YSI Model 58 Dissolved Oxygen Meter (SOP 8-9)

SWAMP Documentation

- SWAMP Toxicity Template Documentation
- SWAMP Toxicity Template
- SWAMP Sample Handling, Measurement Quality Objectives, and Corrective Action Tables

Pathogen Analysis

BioVir

- EPA Method 1622, 1623, 1623.1 Cryptosporidium and Giardia in Water by Filtration/IMS/FA: Sample Filtration (SOP X.C.2.a)
- EPA Method 1622, 1623 and 1623.1 Cryptosporidium and Giardia in Water by Filtration/IMS/FA: Elution and Concentration (SOP X.C.2.b)
- EPA Method 1622, 1623 and 1623.1 Cryptosporidium and Giardia in Water by Filtration/IMS/FA: Immunomagnetic Separation (IMS) (SOP X.C.2.c)
- EPA Method 1622, 1623 and 1623.1 Cryptosporidium and Giardia in Water by Filtration/IMS/FA: Slide Staining Procedure (SOP X.C.2.d)
- EPA Method 1622, 1623 and 1623.1 Cryptosporidium and Giardia in Water by Filtration/IMS/FA: Slide Examination (SOP X.C.2.e)

Eurofins

- EPA Method 1622/1623 (Micro-SOP3404)*(proprietary - by request)*

Appendix D. Example Field Sheets

Attach ASR and WatList

USGS science for a changing world

U. S. GEOLOGICAL SURVEY SURFACE-WATER QUALITY FIELD NOTES Station No. _____

NWIS Record No. _____

Station No. _____ Station Name _____ Field ID _____

Sample Date _____ Mean Sample Time _____ Time Datum _____ (eg. EST, EDT, UTC) End Date _____ End Time _____

*Sample Medium: WS WSQ OAQ *Sample Type: 9 (regular) 7 (replicate) 2 (blank) 1 (spike) _____ * see last page for additional codes

*Sample Purpose (71999): 10 (routine) 15 (NAWQA) 20 (NASQAN) 25 (NMN) 30 (Benchmark) _____

*Purpose of Site Visit (50280): 1001 (fixed-frequency SW) 1003 (extreme high flow SW) 1004 (extreme low flow SW) 1098 (NAWQA QC) _____

QC Samples Collected? Y N Blank Replicate Spike Other_____

Project No. _____ Project Name_____

Sampling Team _____ Team Lead Signature _____ Date _____

START TIME _____ GAGE HT _____ TIME _____ GHT _____ TIME _____ GHT _____ TIME _____ GHT _____ END TIME _____ GHT _____

FIELD MEASUREMENTS

Property	Parm Code	Method Code http://water.usgs.gov/usgs/owq/Forms/Fieldmeasurement_parametersmethods.doc	Result	Units	Remark Code	Value Qualifier	Null Value Qualifier	NWIS Result-Level Comments
Gage Height	00065			ft				
Discharge, instantaneous	00061			cfs				
Temperature, Air	00020	THM04 (Thermistor) THM05 (Thermometer)		˚C				
Temperature, Water	00010	THM01 (Thermistor)		˚C				
Specific Conductance	00095	SC001 (Contacting Sensor)		µS/cm				
Dissolved Oxygen	00300	LUMIN (Luminescent) MEMBR (Amperometric) SPC10 (Spectrophotometric)		mg/L				
Barometric Pressure	00025	BAROM (Barometer)		mm Hg				
pH	00400	PROBE (Electrode)		units				
Alkalinity, filtrd, incr. Alkalinity, filtrd, Gran	39086 29802	TT061 (Digital Titrator) TT062 (Buret) TT056 (Digital Titrator) TT057 (Buret)		mg/L				
Carbonate, filtrd, incr. Carbonate, filtrd, Gran	00452 63788	ASM01(Digital Titrator) ASM02(Buret) ASM03(Digital Titrator) ASM04(Buret)		mg/L				
Bicarbonate, filtrd, incr. Bicarbonate, filtrd, Gran	00453 63786	ASM01(Digital Titrator) ASM02(Buret) ASM03(Digital Titrator) ASM04(Buret)		mg/L				
Hydroxide, filtrd, incr. Hydroxide, filtrd, Gran	71834 29800	ASM01(Digital Titrator) ASM02(Buret) ASM03(Digital Titrator) ASM04(Buret)		mg/L				
Turbidity [see attachment for codes and units]								

SAMPLING INFORMATION

Parameter	Pcode	Value	Information
Sampler Type	84164	*see last page for proper codes— consider type of sampler and material*	Sampler ID:
Sampling Method	82398	10 EWI; 20 EDI; 30 single vertical; 40 multiple vertical; other _____	**BAG SAMPLER EFFICIENCY TEST**
Sampler bottle/bag material	84182	Plastic Bag (11) Teflon® Bag(12) Glass Bottle(20) Plastic Bottle (21) Teflon® Bottle (22) other (30)	Test / Duration Sampler Collected Water (seconds) / Sample Volume Collected (milliliters)
Sampler Nozzle material	72219	plastic (2) Teflon® (3) Brass (1)	1
Sampler Nozzle Diameter	72220	3/16" (3) 1/4" (4) 5/16" (5)	2
Sampler Transit Rate	50015	feet/second	3
Velocity to Calculate Isokinetic transit rate	72196	feet/second	Mean (72217) (72218)
Depth to Calculate Isokinetic transit rate	72195	feet	Bag Sampler Efficiency % *(See last page)*
Splitter Type	84171	*See last page for codes* _____	Splitter ID:
Hydrologic Condition	N/A	A Not Determined; 4 Stable, low stage; 5 Falling stage; 6 Stable, high stage; 7 Peak stage; 8 Rising stage; 9 Stable, normal stage	
Observations [Codes: 0=none; 1=mild; 2=moderate; 3=serious; 4=extreme]		Oil-grease (01300) ___ Detergent suds (01305) ___ Floating garbage (01320) ___ Floating algae mats (01325) ___ Floating debris (01345) ___ Turbidity (01350) ___ Atm. Odor (01330) ___ Fish kill (01340) ___ Gas Bubbles (01310) ___ Sewage Solids (01335) ___ Floating Vegetation (84178) ___ Ice Cover(01355) ___	

COMPILED BY: _____ **CHECKED BY:** _____ **LOGGED INTO NWIS BY:** _____

November 2013 1 SW Form version 9.0

Field Data Entry Form

Submittal/Run Name: Banks RTM Grab

Submittal ID: C0615B0161

Instructions to Field Crew:

C0615B0648 Water, Natural **Depth:** 1 **Meter** **Collection Date:** 6/3/15 **Collection Time:** ___:___

Station No.: KA000331 **Sampler:** Brown & Del Cid Normal Sample of 0

Station Name: H.O. Banks Headworks **Add'l Note:** Canal Grab

Field Measure Name		Instrument	Property No.	Probe Number
Conductance (EC) (µS/cm)	_____	EC Meter	_____	_____
Turbidity (N.T.U.)	_____	Turbidimeter	_____	_____
Field Notes ()	_____		_____	_____

Notes:

1 Glass, Amber, 40 ml Vial, H3PO4, pH <2, FiltDo Not Overfill. Vial Contains Acid.	1 Glass, Amber, 40 ml Vial, H3PO4, pH <2Do Not Overfill. Vial Contains Acid.
1 Polyethylene, 1/2 Pint, Filt	1 Polyethylene, 10 Liters

C0615B0649 Water, Purified **Depth:** 1 **Meter** **Collection Date:** 6/3/15 **Collection Time:** ___:___

Station No.: Blank; Equipment **Sampler:** Brown & Del Cid Blank; Field of 0

Station Name: Blank; Equipment **Add'l Note:** Filtered Blank

Field Measure Name		Instrument	Property No.	Probe Number
All ()	_____		_____	_____

Notes:

1 Glass, Clear, 40 ml Vial, H3PO4, pH <2, FiltDo Not Overfill. Vial Contains Acid.

1 of 1

Appendix E. Example for Chain of Custody Form

Results to:

CHAIN OF CUSTODY RECORD

Page of

San Francisco Estuary Institute
7770 Pardee Lane
Oakland, CA, 94621-1424
Phone: 510-746-7334 Fax: 510-746-7300

Bill to:

Shipped to:

Sampled by [Print Name(s)] / Affiliation

Sampler(s) Signature(s)

Preservatives (see codes)

Analyses Requested

Project Name:

Sample ID No.	Sampled Date	Sampled Time	Grab or Composite	Matrix (see codes)	Number/Size/Type of Containers	Remarks

Shipment Method

Out: / / Via:

← Total Number of Containers

Additional Comments:

Relinquished by / Affiliation	Date	Time	Accepted by / Affiliation	Date	Time

Cooler No.(s) / Temperature(s) (C)°

MATRIX CODES: F = Freshwater S = Saline SE = Sediment SW = Surface Water PW = Porewater B = Blanks T= Toxicity O = Other (specify)

PRESERVATIVE CODES: H = Hydrochloric acid + ice I = Ice only N = Nitric acid + ice S = Sulfuric acid + ice O = Other (specify)