Delta Regional Monitoring Program

Quality Assurance Project Plan

for Fiscal Year 2021–2022 Monitoring

Version 7
Updated February 14, 2022

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San Francisco Estuary Institute-Aquatic Science Center

Updated by MLJ Environmental

1. Title and Approval

For

PROJECT NAME: Delta Regional Monitoring Program, Fiscal Year 2021-2022

Date: February 14, 2022

NAME OF RESPONSIBLE ORGANIZATION: MLJ Environmental

1.1. Approval Signatures

Title:	Name/Affiliation:	Signature:	Signature Date:
Delta RMP Technical Manager	Melissa Turner/ MLJ Environmental	DocuSigned by: Melissa Turner 9796DD915C44448...	2/18/2022
Delta RMP Program QA Officer	Will Hagan/ MPSL-MLML	DocuSigned by: Will Hagan A1D771E8E50040F...	2/18/2022
CUP Data Manager	Cassandra Lamerdin/ MLJ Environmental	DocuSigned by: Cassandra Lamerdin 2801D2DF64FB454...	2/18/2022
Assistant Deputy Director SWRCB Office of Information Management and Analysis	Melissa Morris/ SWRCB		
SWAMP QA Officer	Tessa Fojut / SWRCB	DocuSigned by: Tessa Fojut 7A88852197AE41E...	2/25/2022
State Water Board QA Officer[1]	Andrew Hamilton / SWRCB	DocuSigned by: Andrew Hamilton 7CBAC1C270074C0...	2/24/2022
USGS Biogeochemistry Group Principal Investigator	Tamara Kraus/ USGS	DocuSigned by: Tamara Kraus 92CDA5CADA1F4F8...	2/21/2022
MPSL-DFW Project Manager	Wes Heim/ MPSL-DFW	DocuSigned by: BAE30CE26BA64D9...	2/21/2022
MPSL-DFW QA Officer	Autumn Bonnema/ MPSL-DFW	DocuSigned by: Autumn Bonnema 09BD18DA0DAA482...	2/21/2022

Title:	Name/Affiliation:	Signature:	Signature Date:
USGS Project Chief (pesticides)	Jim Orlando/ USGS	DocuSigned by: Jim Orlando B4DDF22E261F427...	2/22/2022
PER Project Director	Stephen Clark/ PER	DocuSigned by: Stephan Clark C4D43551B2BC478...	2/18/2022
Delta RMP Board of Directors President	Debbie Webster/ CVCWA	DocuSigned by: Debbie Webster 75932D30E03248D...	2/23/2022
Environmental Program Manager, CVRWQCB[1]	Meredith Howard/ CVRWQCB	DocuSigned by: Meredith Howard ACF8CE07B4CD4E5...	2/18/2022
QA Representative, CVRWQCB[1]	Selina Cole/ CVRWQCB	DocuSigned by: Selina Cole F3102A0E248746B...	2/24/2022

[1] The approval of this document by CVRWQCB and SWRCB staff is conditional at this time. Approval is contingent on the understanding that additional information will be finalized and included with this document according to the schedule outlined below in **Table 1.1**.

1.2. Requirements for Final Approval

Board Resolution R5-2021-0054 requires the submission of a QAPP to the CVRWQCB that adheres to the guidance and requirements from the Water Boards and U.S. EPA. The QAPP must be approved by the SWB QA Officer or the CVRWQCB QA Officer before implementation of the project.

At the time of the review of this QAPP, the United States Geological Survey Organic Chemistry Research Laboratory (USGS-OCRL) conducting pesticide analyses for the Current Use Pesticide project, was in the process of developing detailed quality assurance documentation for the analytical methods referenced in this document. Detailed quality assurance documentation, including method validation data and a Standard Operating Procedure, are needed to ensure that methods meet the needs of the Water Boards and data produced are of known quality. Since timelines for submission and review of these data quality documents would prevent the onset of the project and collection of valuable samples, CVRWQCB and SWRCB staff are providing a conditional approval of the QAPP.

The approval signatures from the CVRWQCB and SWRCB staff are conditional and contingent on the submission of deliverables to be provided to CVRWQCB and SWRCB staff by the schedule in Table 1.1. Failure to submit the deliverables by the due dates will result in the QAPP no longer being a work product approved by the Water Boards.

Table 1.1. Expected timeline for submittal and review of pesticide analysis methodology documentation.

Deliverable	Due Date
Method Validation Data	Submitted to the SWRCB QA Officer and CVRWQCB QA Representative by January 1, 2022
Draft Standard Operating Procedure	Submitted to the SWRCB QA Officer and CVRWQCB QA Representative by March 31, 2022
Revised SOP (Based on feedback from SWB QA Officer and RWB QA Representative)	Submitted to the SWRCB QA Officer and CVRWQCB QA Representative by April 30, 2022
SOP Final Version approved by SWB and RWB	May 31, 2022

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Appendices

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2.3. Acronyms and Abbreviations

Acronyms and abbreviations used in this document are listed in Table 2.1.

Table 2.1. Acronyms and abbreviations.

Abbreviation	Meaning
°C	degrees Celsius
ASTM	An international standards organization, formerly American Society for Testing and Materials
BOD	Board of Directors
BPA	Basin Plan Amendment
BrCl	bromine chloride
BSA	Bovine serum albumin or BSA Environmental Services, Inc.
C18	Octadecylsilane
CA	California

Abbreviation	Meaning
CASRN	Chemical Abstracts Service Registry Number
CBDA	California Bay Delta Authority
CEC	Constituents of Emerging Concern
CEDEN	California Environmental Data Exchange Network
CFR	Code of Federal Regulations
chl-a	chlorophyll a
COC	chain of custody
COLD	Cold Freshwater Habitat Beneficial Use
COMM	Commercial and Sport Fishing Beneficial Use
CRM	certified reference material
CUP	Current Use Pesticides
CVCWA	Central Valley Clean Water Agency
CV RDC	Central Valley Regional Data Center
CVRWQCB	Central Valley Regional Water Quality Control Board
DI	deionized water
DMT	Data Management Team
DNRP	Delta Nutrient Research Plan
DOC	dissolved organic carbon
DOI	Digital Object Identifier System
DPR	California Department of Pesticide Regulation
DQI	data quality indicator
DQO	data quality objectives
DWR	Department of Water Resources
EDD	Electronic Data Deliverable
EDTA	Ethylenediaminetetraacetic acid
ELISA	Enzyme-Linked Immunosorbent Assay
EMP	Environmental Monitoring Program
EMPC	Estimated maximum possible concentration
EPTC	A pesticide, also referred to as Eradicane, Eptam, and other names. CAS Registry Number: 759-94-4.
EST	Estuarine Habitat Beneficial Use
EVR	Effluent Valve Replacement
fDOM	fluorescent dissolved organic matter
FNU	Formazin Nephelometric Units
FY	fiscal year
g	gram
GC	gas chromatography
GLP	good laboratory practices
GPS	global positioning system
GRTS	Generalized Random Tessellation Stratified
h	hours
H2SO4	sulphuric acid

Abbreviation	Meaning
HAB	Harmful algal bloom
HCl	hydrochloric acid
Hg	mercury
ID	identification
ISUS	In situ Ultraviolet Spectrophotometer
KCl	potassium chloride
LC50	Lethal concentrations that kills 50% of test animals during an observation period
LCS	laboratory control sample
LRM	laboratory reference material
m	meter
MDL	Method detection limit
MeHg	methylmercury
mg/kg	milligram per kilogram
mg/L	milligram per liter
MIGR	Fish Migration Beneficial Use
MLJ	MLJ Environmental
mm	millimeter
MPSL-MLML	Marine Pollution Studies Laboratory at Moss Landing Marine Laboratories
MPSL-DFW	Marine Pollution Studies Laboratory – Department of Fish and Wildlife
MQO	measurement quality objective
MS	matrix spike
MS4	Municipal Separate Storm Sewer System
MSD	matrix spike duplicate
MUN	Municipal and Domestic Water Supply Beneficial Use
N	nitrogen or normal (e.g., 12N HCl)
n/a, NA	not applicable
NDT	Nondestructive Testing
ng	nanogram
NIST	National Institute of Standards and Technology
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCC	National Registry of Certified Chemists
NWIS	National Water Information System
NWQL	USGS National Water Quality Laboratory
OEHHA	California Office of Environmental Health Hazard Assessment
OFR	USGS Open-File Report
OPP	Office of Pesticide Programs
OCRL	USGS Organic Chemistry Research Laboratory
OSHA	Occupational Safety and Health Administration
PAR	photosynthetically active radiation
PBO	Piperonyl Butoxide
PCA	Pentachloroanisole

Abbreviation	Meaning
PCNB	Pentachloronitrobenzene
PER	Pacific Ecorisk
PFRG	USGS Pesticide Fate Research Group
pH	potential of hydrogen
PI	Principal Investigator
PIC	Particulate Inorganic Carbon
POC	particulate organic carbon
POD	Pelagic Organism Decline
POTW	Publicly owned treatment works
ppm/yr	parts per million per year
PSC	Percent community similarity
PTFE	Polytetrafluoroethene (Teflon)
PTI	Pesticide Toxicity Index
QA	quality assurance
QAO	Quality Assurance Officer
QAP	Quality Assurance Plan
QAPP	Quality Assurance Project Plan
QAPrP	Quality Assurance Program Plan
QC	quality control
R^2	coefficient of determination
RDC	Regional Data Center
REC1	Water Contact Recreation Beneficial Use
REC2	Non-contact Water Recreation Beneficial Use
Regional San	Sacramento Regional County Sanitation District
RL	reporting limit
RMA	Resource Management Associates, Inc.
RMP	Regional Monitoring Program
RPD	relative percent difference
RSD	relative standard deviation
S/N	signal-to-noise
S&T	Status and Trends
SOP	standard operating procedure
SPLP	sources, pathways, loadings, and processes
SPWN	Fish Spawning Beneficial Use
SRM	standard reference material
SRWTP	Sacramento Regional Wastewater Treatment Plant
ST	Status and Trends
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee or Test Acceptability Criteria
TIE	Toxicity Identification Evaluation
TM	Technical method(s)
TM	Trace metals
TMDL	Total Maximum Daily Load
TOC	total organic carbon

Abbreviation	Meaning
TPC	total particulate carbon
TPN	total particulate nitrogen
TSS	total suspended solids
TWRI	Techniques of Water-Resources Investigations, a series of USGS publications
U.S. EPA	United States (U.S.) Environmental Protection Agency
USGS	U.S. Geological Survey
v:v	volume-to-volume
VSS	volatile suspended solids
WARM	Warm Freshwater Habitat Beneficial Use
WDL	Water Data Library
WDR	Waste Discharge Requirement
WILD	Wildlife Habitat Beneficial Use
WQ	water quality
WQO	Water Quality Objective
WT	water tracing
ww	wet weight
YSI	A water quality instrument manufacturer, formerly Yellow Springs Instrument Company
µg	microgram
µm	micrometer
µM	micro-Molar
µS/cm	micro-Siemens per centimeter

3. Distribution List

The organizations and persons listed in **Table 3.1** will receive a copy of the approved Quality Assurance Project Plan (QAPP) and any subsequent revisions.

In addition, copies of the QAPP will be posted on the Delta Regional Monitoring Program (Delta RMP) website and made publicly available via the internet at https://deltarmp.org/.

Previous versions of this document, covering monitoring conducted from 2014 - 2020, can be found on the project website, https://deltarmp.org/.

Table 3.1. Distribution list.

Name	Affiliation	Title	Email Address
Steering Committee members			delta-rmp-sc@sfei.org (distribution list)
Technical Advisory Committee members			delta-rmp-tac@sfei.org (distribution list)
Melissa Turner	MLJ Environmental	Delta RMP Technical Program Manager	mturner@mljenvironmental.com
Debbie Webster	Delta RMP BOD	President	eofficer@cvcwa.org
Selina Cole	CVRWQCB	Region 5 Technical and QA Representative	Selina.Cole@waterboards.ca.gov
Meredith Howard	CVRWQCB	Environmental Program Manager	Meredith.Howard@waterboards.ca.gov
Wes Heim	MPSL-DFW	PI/Project Manager	wheim@mlml.calstate.edu
Autumn Bonnema	MPSL-DFW	QA Officer	bonnema@mlml.calstate.edu
Andrew Hamilton	SWRCB	QA Officer, OIMA	Andrew.Hamilton@waterboards.ca.gov
Jim Orlando	USGS	Project Chief	jorlando@usgs.gov
Joe Domagalski	USGS	Program Chief	joed@usgs.gov
Stephen Clark	PER	PI/Project Director	slclark@pacificecorisk.com
Stevi Vasquez	PER	Project Manager	svasquez@pacificecorisk.com
Tamara Kraus	USGS	Co-PI	tkraus@usgs.gov
Peggy Lehman	DWR	Co-PI	peggy.lehman@water.ca.gov
Angela Hansen	USGS	Co-PI	anhansen@usgs.gov
John Beaver	BSA	Co-PI	j.beaver@bsaenv.com
Cassandra Lamerdin	MLJ Environmental	Data Manager	clamerdin@mljenvironmental.com
Will Hagan	MPSL-MLML	Program QA Officer	whagan@mlml.calstate.edu

4. Project Task/Organization

This Quality Assurance Project Plan (QAPP) has been prepared for the monitoring of surface water quality in the Sacramento-San Joaquin River Delta (the Delta) by the Delta Regional Monitoring Program (Delta RMP) in fiscal year 2021/2022 (FY 21-22; July 1, 2021 to June 30, 2022). This section of the QAPP describes how the project will be managed, organized and implemented.

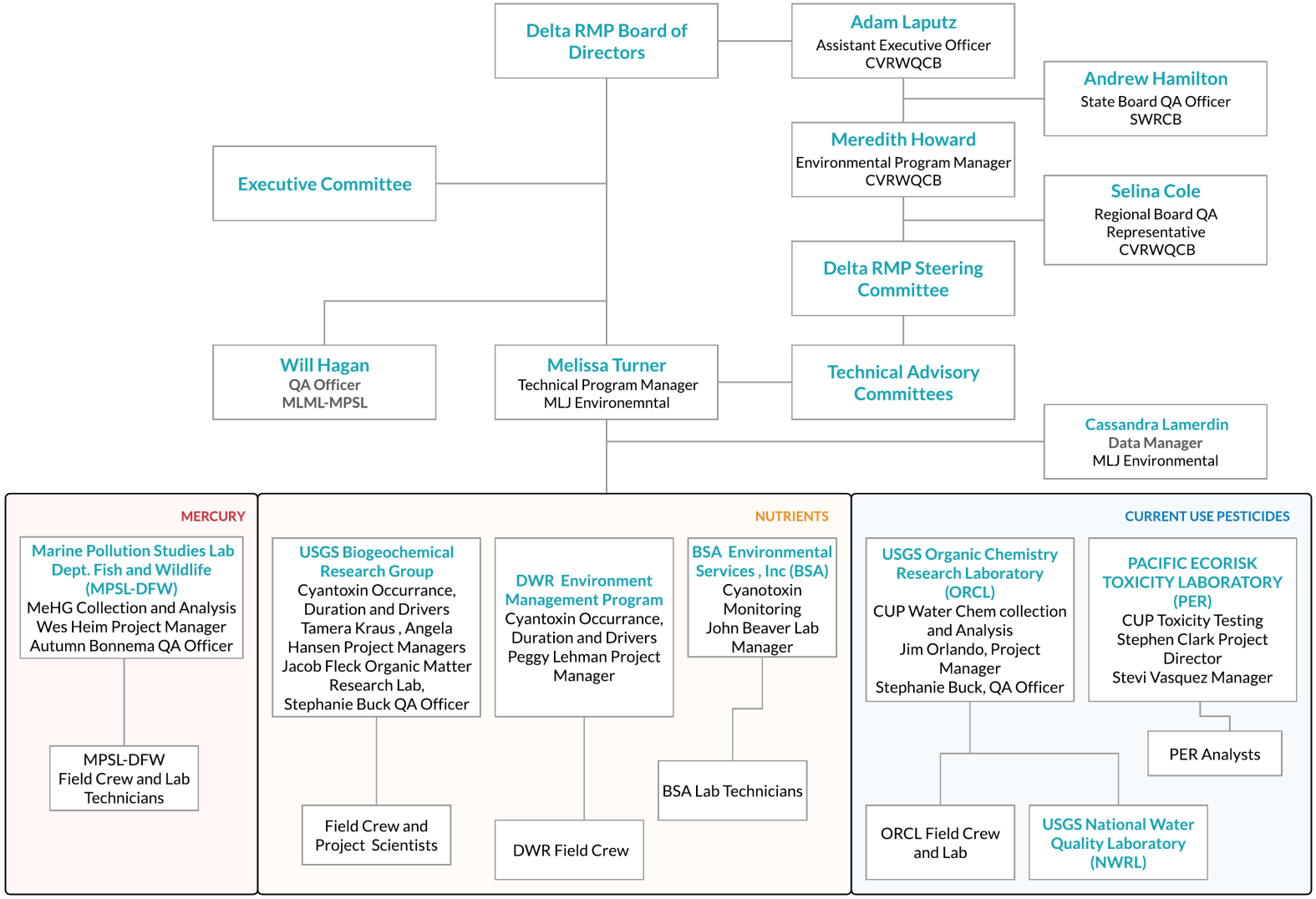
The Delta Regional Monitoring Program (RMP) was initiated by the Central Valley Regional Water Quality Control Board with the primary goal of tracking and documenting the effectiveness of beneficial use protection and restoration efforts through comprehensive monitoring of water quality constituents and their effects in the Delta. The 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. Moreover, many stressors on beneficial uses are interrelated and must be addressed more holistically. The Delta RMP can be seen as a complement to 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 basic criteria for "adequate participation" in the Delta Regional Monitoring Program (RMP) is contributing financial or in-kind services to the RMP, at the level established on a yearly basis. Permitted dischargers are entities subject to NPDES or WDR permit requirements for monitoring. The Regional Board allows, through amended permits, permitted dischargers in the Sacramento/San Joaquin watershed to demonstrate "adequate participation" in the Delta RMP *in lieu* of conducting specific receiving water monitoring that is otherwise required by their permits.

The responsible agency for this surface water monitoring program is the Delta RMP Board of Directors (BOD) who has contracted with MLJ Environmental (MLJ) to implement this project. The BOD receives guidance from the Steering Committee regarding strategic direction and procedures to implement the Delta RMP in a manner consistent with the regulatory conditions and priorities. The Steering Committee provides direction to technical committees on priorities, constraints and management questions to develop technical recommendations and products within the resource allocations determined by the BOD. The Delta RMP contracts with, and partners with, several agencies and laboratories to carry out monitoring activities. The QA Project Plan must be approved by the State Water Board Quality Assurance Officer prior to implementation and deviations to this plan must be approved in advance by the Central Valley Quality Assurance Representative or the State Water Board Quality Assurance Officer. In the

event that the deviation is not known it must be reported to the Central Valley Water Board within 7 calendar days.

Roles and responsibilities are shown in **Figure 4.1** and described in more detail in the following sections.

Figure 4.1. Delta Regional Monitoring Program organization chart, FY21-22.



4.1. Principal Data Users and Stakeholders

Principal data users include internal (program participants) and external stakeholders (other Delta managers and policymakers, local scientists and the scientific community at large, and the public). Participants include regulatory agencies, resource agencies, water supply, coordinated monitoring programs, wastewater treatment plants, stormwater municipalities, irrigated agriculture coalitions, and dredgers (**Appendix A**).

Funding for the Delta RMP is provided by the wastewater treatment plants, stormwater municipalities, irrigated agriculture coalitions, and dredgers listed in **Appendix A**. The Central Valley Regional Water Quality Control Board (CVRWQCB) and the State Water Resources Control Board provide funding via the Surface Water Ambient Monitoring Program (SWAMP) and staff time dedicated to the program.

4.2. Project Team

An organizational chart, with monitoring responsibilities noted, is provided in **Figure 4.1**. An abridged description of the Delta RMP staff and leadership is provided here. Detailed information on the governance of the Delta RMP, along with a roster of voting members, can be found in the program's Charter.

4.2.1. Program Leadership

In 2021, a new non-profit entity was formed to govern and implement the Delta RMP. Per the bylaws, the governance structure of the new nonprofit organization includes three major functional areas: (1) a Board of Directors (BOD), (2) Executive Committee, and (3) Steering Committee, and provides for other committees of the Board and advisory committees. The Executive Committee is a standing Committee of the Board and has the authority between Board meetings to make decisions and take action relative to the operation of the nonprofit organization on behalf of the Board following developed policies and procedures of the Board. The Delta RMP Steering Committee is charged with the responsibility of advising the BOD on the following:

- strategic direction and the policies and procedures to implement the Delta RMP in a manner consistent with regulatory conditions and priorities,
- direction for technical committees on priorities, constraints, and management questions to develop technical recommendations and products within the resource allocations determined by the BOD, and
- Delta RMP work products and any other plans or products.

The Steering Committee is made up of representatives from both the regulated and regulatory community, including organizations and agencies involved in agriculture, dredging, wastewater treatment, stormwater, water supply, and flood control and habitat restoration.

The Delta RMP is in the process of developing six (6) Technical Advisory Committees (TACs) which will be 6-9 members authorized to provide recommendations to the Steering Committee and BOD. The President of the Board has been delegated the authority to appoint the members of the TAC consisting of two to three (2-3) people recommended by each of the following entities: the Delta RMP contributing entities; the regulatory agencies, resource agencies, and coordinated monitoring sectors; and the Steering Committee based on their qualifications on the subject matter. These TACs follow closely with existing RMP program areas. The President will work with the Technical Program Manager to appoint a lead scientist/project lead to serve on the TAC that has the expertise in that Committee. The following program area TACs were confirmed in September 2021:

1. Methylmercury (MeHg) TAC
2. Current Use Pesticide and Toxicity (CUP) TAC
3. Constituents of Emerging Concern (CEC) TAC
4. Nutrient TAC
5. Data Management TAC
6. Toxicity Identification and Evaluation (TIE) TAC

Under the direction of the Steering Committee, the various TACs provide technical oversight of the Delta RMP. The TACs will be provided a specific responsibility and/or deliverables by the Board (e.g., the "Charge") as also informed by Steering Committee recommendations.

In addition to the new governance structure of the RMP, a new Board Resolution No. R5-2021-0054 was adopted by the Central Valley Water Board that approved the new implementing entity and governance structure and established program requirements for submission to the Central Valley Water Board, with some requiring Executive Officer Approval. The requirements in Board Resolution No. R5-2021-0054 relevant to the QAPP include:

- Developing QAPPs that meet the requirements of the Water Boards and U.S.EPA
- Include a documentation process for deviations and a corrective action process
- Approval is required by the State Water Board Quality Assurance Officer (Andrew Hamilton) prior to implementation of monitoring

- Deviations to the QAPP must be approved by the Central Valley Water Board QA Representative (Selina Cole) or the State Water Board Quality Assurance Officer (Andrew Hamilton)
    - When prior approval is not possible for QAPP deviations, they must be reported to the Central Valley Water Board Quality Assurance Representative within 7 Calendar Days of the BOD or contractors becoming aware of the deviation

4.2.2. Implementing Entities

Melissa Turner of MLJ Environmental is serving as Technical Program Manager for the Delta RMP for FY21-22. The Technical Program Manager is responsible for overseeing and coordinating individual monitoring elements and communicating issues or problems to the appropriate Delta RMP committees and proposing solutions.

The Central Valley Regional Data Center (CV RDC) Manager (Victoria Bowles) coordinates the Data Management Team, which performs data review and validation to ensure that data submitted by subcontractor laboratories are timely, complete, and properly incorporated into the Regional Data Center database. Cassandra Lamerdin will be the specific CEC Data Manager leading the DMT under the direction of the CV RDC Manager.

The Moss Landing Marine Laboratories, Marine Pollution Studies Laboratory (MPSL-MLML) Quality Assurance Officer's (QAO, Will Hagan) role is to provide quality assurance oversight and to review and approve the quality assurance and quality control (QA/QC) procedures found in this QAPP, which include field and laboratory activities. The project QAO position is independent of data generation. Deviations to the QAPP must be approved by the Central Valley Water Board Quality Assurance Representative (Selina Cole) or the State Water Board Quality Assurance Officer (Andrew Hamilton) prior to implementation. When prior approval is not possible, the deviations must be reported to the Central Valley Water Board Quality Assurance Representative (Selina Cole) within 7 calendar days. Deviations (both planned and unplanned) address short-term conditions expected or encountered during a specific monitoring event, whereas changes or updates to the QAPP, described in **Section 4.3**, affect all monitoring conducted after the change is approved. Deviations that require approval will be stated throughout this document in the sections below.

The QAPP must be reviewed and approved by the State Water Board Quality Assurance Officer or the Central Valley Water Board's Quality Assurance Officer. Project implementation cannot occur until the QAPP is approved.

4.2.3. Field Crews and Laboratories

Laboratories contracted by the Delta RMP provide analytical services and will act as a technical resource to Delta RMP staff and management. Laboratories are listed in **Table 4.1**.

Table 4.1. Analytical laboratories.

Analytical laboratory	Lab abbreviation	Matrix to be analyzed	Analytical Services	Lab QA Manual Link
Marine Pollution Studies Lab, Moss Landing Marine Labs	MPSL-DFW	Tissue, Water	Fish attributes, mercury, suspended solids, chlorophyll-a, DOC	MPSL Laboratory QM, Revision 9, September 2021
U.S. Geological Survey, Organic Chemistry Research Laboratory	USGS-OCRL	Water	Current Use Pesticides Chemistry	USGS Quality Management System Manual, Version 02, June 16, 2021
U.S. Geological Survey National Water Quality Laboratory	USGS-NWQL	Water	TSS, DOC, POC, TIC, carbon, nitrogen dissolved copper	USGS Quality Management System Manual, Version 02, June 16, 2021
Pacific EcoRisk	PER	Water	Aquatic Toxicity	PER Quality Manual, Revision 22, June 2020.pdf

Mercury

Mercury monitoring elements are managed, reviewed, and reported to CEDEN by the SWAMP Unit and reviewed by the State Board for FY21-22 but QA for the work is described in this document. Because SWAMP is funding the mercury analyses and managing these data, SWAMP IQ will upload the Delta RMP data to CEDEN and make it publicly available without the Delta RMP review and approval steps that some other Delta RMP datasets are subject to.

The Marine Pollution Studies Lab (MPSL-DFW) at Moss Landing Marine Laboratory (MPSL-DFW) will analyze fish tissue and water samples for mercury and related measurements. Note that sediment was monitored during the 2017 - 2018 fiscal year (FY17-18), but not monitored in the years before or after.

Autumn Bonnema will serve as the MPSL-DFW QA officer. She will 1) review, evaluate, and document data reports, and 2) review and approve the elements of this QAPP pertaining to MPSL-DFW activities.

Wes Heim will serve as the project manager for the MPSL-DFW component of this project. His specific duties will be to 1) review and approve the QAPP, 2) provide oversight for mercury

field work and analyses to be done for this project, 3) ensure that all MPSL-DFW activities are completed within the proper timelines.

CUP – Pesticides and Ancillary Constituents

Jim Orlando is the project manager at the USGS Organic Chemistry Research Laboratory (OCRL). His duties will be to ensure that all project elements meet the guidelines established in the QAPP and project contract. He is responsible for the final review of all project analytical results produced by the OCRL. He serves as the primary contact between the Delta RMP and the OCRL. Jim Orlando is also the primary contact between USGS OCRL and National Water Quality Laboratory (NWQL). Samples collected by USGS OCRL will be shipped to NWQL for a subset of constituents of interest to the CUP monitoring project including organic carbon and dissolved copper.

Michelle Hladik is the Chief Chemist at the USGS OCRL and supervises all laboratory activities. Her duties will be to ensure that laboratory technicians have processing instructions and that all laboratory activities are completed following established guidelines (project specific QAPP and OCRL Standard Operating Procedures [SOPs]). She is responsible for sample analyses and initial data review and provides data to the USGS project manager for review.

Corey Sanders is the chemist for the USGS OCRL. He oversees the initial processing of samples and analytical instrument setup for pesticide analyses. He is also responsible for sample storage and custody at OCRL.

Matt DeParsia is the OCRL field technical lead for the project. His duties will be to ensure that water quality sampling is conducted following documented procedures (as described in the USGS *National Field Manual*, and this project-specific QAPP). He is also responsible for the initial processing of water samples at the OCRL and for shipping samples to the USGS NWQL in Denver for additional chemical analyses not performed at the OCRL in Sacramento, and to Pacific EcoRisk for Aquatic Toxicity testing. In addition, his duties will be to ensure that all sample collection information and analytical results are entered into the OCRL internal database and that this information is subsequently formatted and transferred to the USGS National Water Information System (NWIS) database.

CUP - Aquatic Toxicity

Stephen Clark is the Project Director for Pacific EcoRisk (PER). His duties will include ensuring all toxicity data produced by the laboratory meets the guidelines established in the QAPP and project contract, as well as reviewing case narratives and project contracts. He will serve as the

primary contact between PER and the Delta RMP and will be available to attend Delta RMP meetings as needed and provide written and verbal updates on the toxicity testing results.

Stevi Vasquez will serve as the PER Project Manager. Her duties will be to ensure that aquatic toxicity testing is conducted following documented procedures outlined in this document, SWAMP Measurement Quality Objectives (MQOs), and laboratory-specific SOPs. She is also responsible for overseeing calculation and compilation of the toxicity data and providing these data to the data managers at MLJ Environmental. Additionally, she will provide reporting data (such as copies of bench sheets and reference toxicity control charts) to the Technical Program Manager to share with the CUP TAC and the CVRWQCB.

The CV RDC is responsible for data management for Delta RMP CUP data. This includes data processing, QA/QC review, and data upload to the California Environmental Data Exchange Network (CEDEN). Cassandra Lamerdin will be the specific CUP Data Manager leading the DMT under the direction of the CV RDC Manager. Once the data have been reviewed and processed, they will undergo a final review and qualification by Will Hagan, the Program QA Officer (QAO) and/or a delegate of the QAO. In the event there are changes to the data after it has been published, they will be communicated to data users in a timely manner.

4.3. Persons Responsible for QAPP Update and Maintenance

Changes and updates to this QAPP may be made by the Delta RMP Technical Program Manager and the Delta RMPs QAO, after they review the evidence for change, and with the concurrence of the associated TAC and approval by either the State Water Board QA Officer (Andrew Hamilton) or the RWQCB QA Representative (Selina Cole) prior to implementation. The Technical Program Manager in coordination with the Delta RMP QAO will be responsible for seeking approval from the CVRWQCB QA Representative or State Water Board QA Officer, making the changes, submitting drafts for review, preparing a final copy, and submitting the final QAPP to the Central Valley Water Board Quality Assurance Representative or the State Water Board Quality Assurance Officer for approval and signatures. Changes and updates to the QAPP will require approval by the Central Valley Water Board in order for the Delta RMP to continue as a Central Valley Water Board approved regional monitoring program. Minor changes not affecting operational procedures (e.g., changes in staff, addresses, phone numbers, etc.) may be made to an Interim version without re-signing and will be finalized in the next version after receiving approval signatures. The QAPP will be reviewed on an annual basis. Changes are expected year to year in the early years of any new Delta RMP monitoring plan.

5. Problem Definition and Background

The Delta RMP was initiated in 2008 by the Central Valley Regional Water Quality Control Board (CVRWQCB) 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. Recognition that data from current monitoring programs were inadequate in coverage, could not easily be combined, and did not 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 to 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 decided at its December 3, 2012, meeting that the initial Delta RMP would focus on mercury, nutrients, pathogens, and pesticides, since these constituents represent high priority issues for management that are shared concerns of represented participant groups. The TAC subsequently developed monitoring designs for these priorities to address the Delta RMP management questions (**Appendix B**) and priority assessment questions for each constituent (**Appendix C**).

Pesticides monitoring began in 2015 to characterize the spatial and temporal variability of pesticides concentrations and toxicity to aquatic organisms.

Mercury monitoring began in 2016 to address the highest priority information needs related to implementation of the Methylmercury Total Maximum Daily Load (TMDL).

Nutrients are associated with excessive growth of nuisance aquatic vegetation that interferes with navigation and recreation, and can block water supply intakes. It is also suspected to contribute to harmful algal blooms (HABs) that can produce toxins that kill fish, wildlife, and domestic animals, and are detrimental to drinking water quality and human health. Finally,

nutrients play an important role in ecosystem health, for example by affecting the primary productivity of algae which form the base of the food chain. Water managers seek to better understand these factors in order to better manage ecosystems and craft more effective plans for the conservation and recovery of threatened and endangered species in the Delta. Nutrient monitoring began in 2017 with a one-year special study to assess spatial variability of nutrients and related water quality constituents in the Delta at the landscape scale. Delta RMP nutrient monitoring is continuing in FY21-22 with two studies: 1) "Cyanotoxin Monitoring in the Delta: Leveraging existing USGS and DWR field efforts to identify cyanotoxin occurrence, duration, and drivers" led by Tamara Krause of USGS and 2) "Source Tracking of the Cyanobacteria Blooms in the Sacramento-San Joaquin Delta" led by Dr. Ellen Preece of Robertson-Bryan Inc., Dr. Tim Otten of Bend Genetics, and Dr. Janis Cooke of the Central Valley Regional Water Board. Quality assurance documentation and methods for the cyanotoxin study are provided in other documents (see **Section 6.1** for a list).

The Source Tracking of the Cyanobacteria Blooms study is funded as a Supplemental Environmental Project and per Steering Committee direction a QAPP is not required. The project has received additional funds outside of the Delta RMP and additional sample collection and analysis will occur in FY 21/22.

5.1. Core Management Questions

5.1.1. Pesticides and Aquatic Toxicity

A better understanding of the effects of contaminants in the apparent decline of Delta ecosystems is a priority for regulators and stakeholders. Pesticide use in the Delta and Central Valley is one of the potential drivers of these effects. Constantly changing pesticide use presents a challenge for environmental scientists, resource managers, and policy makers trying to understand whether these contaminants are impacting aquatic systems and if so, which pesticides are the biggest problem. Less than half of the pesticides currently applied in the Central Valley are routinely analyzed in monitoring studies and new pesticides are continually being registered for use. Therefore, baseline monitoring of ambient surface water for both aquatic toxicity and a broad list of current use pesticides is needed to understand whether current use pesticides contribute to observed toxicity in the Delta.

The monitoring is intended to provide useful information to state and federal water quality regulators. Important regulatory drivers are described below.

Water Quality Control Plan for the Sacramento River and San Joaquin River Basin **(Basin Plan, link)**

According to the State Water Board, the Basin Plan is "the Board's master water quality control planning document. It designates beneficial uses and water quality objectives for waters of the State, including surface waters and groundwater. It also includes programs of implementation to achieve water quality objectives."

The Central Valley's Basin Plan states that, "in addition to numerical water quality objectives for toxicity, the Basin Plan contains a narrative water quality objective that requires all surface waters to '...be maintained free of toxic substances in concentrations that are toxic to or that produce detrimental physiological responses to human, plant, animal, and aquatic life.' To check for compliance with this objective, the CVRWQCB initiated a biotoxicity monitoring program to assess toxic impacts from point and nonpoint sources in Fiscal Years 1986 - 1987" (CVRWQCB 2016, IV-32.08). The plan states that the Regional Board "will continue to impose toxicity testing monitoring requirements in NPDES [National Pollutant Discharge Elimination System] permits. The focus of ambient toxicity testing will continue to be the Delta and major tributaries." In other words, the Board is interested in verifying that there are "no toxics in toxic amounts" in waterways and will continue to require aquatic toxicity testing as a key means of making this determination.

Organophosphate TMDL

In 2006, the CVRWQCB identified Delta waterways as impaired under the federal Clean Water Act Section 303(d) due to elevated concentrations of the organophosphate pesticides, diazinon and chlorpyrifos, and created a plan for their allowable discharge to the Delta referred to as the Total Maximum Daily Load (TMDL). Under this plan (CVRWQCB 2006), the board put in place a number of new rules and requirements. One of these stated that new discharge permits (or WDRs) for runoff from fields and orchards draining to Delta Waterways must include monitoring to meet a number of goals, the most relevant being:

- Determine attainment of the diazinon and chlorpyrifos water quality objectives and Load Allocations (additivity target).
- Determine whether alternatives to diazinon and chlorpyrifos are causing surface water quality impacts.
- Determine whether the discharge causes or contributes to a toxicity impairment due to additive or synergistic effects of multiple pollutants

In addition, there are nearly identical requirements for agricultural dischargers to the Sacramento and San Joaquin River under those TMDLs.

Control Program for Diazinon and Chlorpyrifos

In 2014, the Central Valley Water Board published an additional amendment to the Basin Plan containing a control program for discharges of diazinon and chlorpyrifos (CVRWQCB 2014). The control plan created new pollution control requirements for waterways designated as supporting both warm and cold freshwater habitats. Under these requirements, agricultural, municipal stormwater, and wastewater dischargers in the Sacramento and San Joaquin River basins below major reservoirs are required to monitor in order to:

- Determine compliance with established water quality objectives applicable to diazinon and/or chlorpyrifos.
- Determine whether alternatives to diazinon and/or chlorpyrifos are being discharged at concentrations that have the potential to cause or contribute to exceedances of applicable water quality objectives.

In addition, agricultural dischargers are also required to monitor water quality in order to:

- Determine whether the discharge causes or contributes to a toxicity impairment due to additive or synergistic effects of multiple pollutants

Pyrethroids Basin Plan Amendment

In 2017, the Regional Board determined that more than a dozen waterways are impaired due to elevated concentrations of pyrethroid pesticides under the Clean Water Act, section 303(d). In response, the regional board adopted a Basin Plan Amendment (CVRWQCB 2017) which includes a pyrethroid pesticide control program for the Sacramento and San Joaquin River Basins. On 8 June 2017, the Central Valley Water Board adopted Resolution R5-2017-0057, which adopted the Basin Plan Amendment (BPA) for the Control of Pyrethroid Pesticide Discharges and approved the supporting Substitute Environmental Documentation and Staff Report. The BPA was approved by the State Water Resources Control Board on 10 July 2018 and was approved by the Office of Administrative Law (OAL) on 19 February 2019. With OAL approval, the BPA (apart from TMDLs) became fully approved and effective. On 22 April 2019, the United States Environmental Protection Agency (USEPA) approved the Pyrethroid TMDLs included in this BPA for nine urban creeks in Sacramento and Roseville. With USEPA approval, the BPA and TMDLs are now fully approved and effective.

The amendment contains requirements for monitoring of pyrethroids, pyrethroid alternatives, and aquatic toxicity to the invertebrate *Hyalella* in discharges and/or receiving water in order to:

- Determine if the pyrethroid concentration goals are being attained through monitoring pyrethroids either in discharges (monitoring requirements apply to wastewater

treatment plants or publicly-owned treatment works, POTWs) or in receiving waters (monitoring requirements apply to municipal separate storm sewer systems [MS4s] and agricultural dischargers).

- Determine whether pyrethroid pesticides are causing or contributing to exceedances of the narrative water quality objectives for toxicity – through toxicity testing with *Hyalella* in water column of receiving waters (POTWs, MS4s, and agricultural dischargers) or receiving waters water column and bed sediments (agricultural dischargers and MS4s)

This monitoring must be completed two years from the February 2019 effective date of the Basin Plan Amendment (BPA). After that two-year period, dischargers will also be required to monitor for alternative insecticides that could be having water quality impacts.

Assessment Questions Addressed

The study of pesticides and toxicity is designed to help answer the core Delta RMP Management and Assessment Questions,

> Is water quality currently or trending towards adversely affecting beneficial uses of the Delta?
>
> **Status & Trends (S&T) Assessment Questions**
>
> S&T 1 - To what extent do current use pesticides contribute to observed toxicity in the Delta?
>
> S&T 1.1 - If samples are toxic, do detected pesticides explain the toxicity?
>
> S&T 1.2 - What are the spatial and temporal extent of lethal and sublethal aquatic and sediment toxicity observed in the Delta?
>
> S&T 2 - What are the spatial/temporal distributions of concentrations of currently used pesticides identified as possible causes of observed toxicity?

The study objectives are to:

- Collect water samples from a variety of locations across Delta subregions and analyze them for a broad suite of current use pesticides, and for toxicity to aquatic organisms.
- Test whether pesticides in ambient water samples exceed aquatic life benchmarks.
- Test for the co-occurrence of pesticides and observed aquatic toxicity.

Example Information Applications

The examples below show ways that information from the Delta RMP study of pesticides and toxicity could be used by scientists, water managers, and regulators. Example information applications include, but are not limited to:

- The Delta RMP may use this information to determine what percentage of Delta waters exhibit toxicity to aquatic organisms or have concentrations of pesticides that exceed screening values.
- State water quality regulators may use this information to help evaluate if waterways should be classified as impaired under Section 303(d) of the Clean Water Act. Regulators will be able to evaluate particular stream segments and parameters for signs of impairment, and, after several years of monitoring, may be able to track changes in impairment over time.
- If certain compounds are found to have adverse impacts on the aquatic environment that prevent attainment of beneficial uses, regulators may require the development of a management plan to prevent or mitigate pesticide contamination of waterways or, when warranted, adopt restrictions to further protect surface water from contamination.

5.1.2. Mercury

The Delta Methylmercury TMDL is the primary regulatory driver for management decisions for methylmercury in the Delta, establishing goals for cleanup and calling for a variety of control studies and actions. The Delta Methylmercury TMDL (aka Delta Mercury Control Program) was adopted in 2010 as a Basin Plan Amendment and includes a control program to reduce methylmercury and inorganic mercury in the Delta. The Delta Mercury Control Program emphasizes studies and pilot projects to develop and evaluate management practices to control methylmercury in the Delta. Currently, responsible entities are implementing methylmercury control studies to assess methods of limiting methylmercury entering Delta waterways. The studies encompass a variety of source types, including municipal wastewater treatment plants, urban and industrial stormwater discharges, dredging operations, tidal wetlands, open water habitats, and seasonal wetlands.

With providing information to support TMDL implementation in mind, the Mercury TAC carefully considered the assessment questions articulated by the Steering Committee and TAC for mercury.

The Delta RMP management and assessment questions addressed by each of the methylmercury monitoring elements are indicated in **Table 5.1**. In addition, the combination of

water and fish monitoring addresses a critical data need for management not captured in the current set of questions for the Program: data to strengthen the linkage analysis that is a key component of the technical foundation for the TMDL.

Monitoring of subregional trends in bass is addressing questions relating to Status and Trends, Forecasting, and Effectiveness Tracking. Status and Trends Question 1A in **Table 5.1** (Are trends over time in MeHg in sport fish similar or different among Delta subareas?) is a high priority for managers that relates to the TMDL, and is a primary driver of the sampling design for subregional bass trend monitoring. Annual monitoring of mercury in sport fish (bass) is needed to 1) firmly establish a baseline for each Delta subregion and 2) to characterize the degree of interannual variation, which is essential to designing an efficient monitoring program for detection of long-term trends. In addition to addressing status and trends, this monitoring will provide an essential foundation for Forecasting Scenarios (past trends are a starting point for projecting future conditions) and Effectiveness Tracking (evaluating whether water quality is improving at the subregional scale as a result of management actions).

Monitoring of subregional trends in water is addressing all of the major categories of Delta RMP management questions (Status and Trends; Sources, Pathways, Loadings, and Processes [SPLP]; Forecasting Scenarios; and Effectiveness Tracking). Data on concentrations of methylmercury in water are valuable as an indicator of Status and Trends as they can be compared to the TMDL implementation goal of 0.06 ng/L of unfiltered aqueous methylmercury. The use of water data to update the mass budget addresses SPLP Question 1A and is a key element of the TMDL. Aqueous methylmercury concentrations are essential input and validation data for the models that DWR and USGS are developing for the Delta that will elucidate the processes affecting methylmercury patterns and allow forecasting and testing of various water management scenarios. Water concentration data will also be valuable in Effectiveness Tracking, to support assessment of status relative to the implementation goal and of changes in loading in the context of the overall mass budget for the Delta.

Monitoring of subregional trends in bass and water will also provide information on the influence of climate, hydrology, and ecology. For example, the first two years of monitoring have already spanned the end of a prolonged drought and a high flow year, providing an opportunity to examine the impact of extreme variation in flow on methylmercury concentrations in fish and water.

Restoration monitoring will address questions relating to SPLP, Forecasting Scenarios, and Effectiveness Tracking. The basic concern with restoration projects is that they may enhance net methylmercury production within the Delta ecosystem, and represent an internal source that

increases as the projects proceed (SPLP Question 1B) – restoration monitoring will track whether this occurs or not. Restoration monitoring will yield insights into which types of projects, if any, impact net methylmercury production and food web accumulation (Forecasting Scenarios Question 1) and whether internal loadings change and ambient water quality shows net improvement as a result of restoration projects (Effectiveness Tracking).

Table 5.1. Delta RMP mercury management and assessment questions addressed or informed by each mercury monitoring element. Questions in bold were identified by the Steering Committee as the highest priority for initial studies.

Type	Core Management Questions	Assessment Questions	Sub-Questions	Subregional Trends in Bass	Subregional Trends in Water	Restoration Monitoring
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?	1.What are the status and trends in ambient concentrations of total mercury and methylmercury (MeHg) in fish, water, and sediment, particularly in subareas likely to be affected by major sources or new sources (e.g., large-scale restoration projects)?	A. Are trends over time in MeHg in sport fish similar or different among Delta subareas?	●	-	-
			B. Are trends over time in MeHg in water similar or different among Delta subareas?	-	●	-
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,	1. Which sources, pathways, and processes contribute most to observed levels of MeHg in fish?	A. What are the loads from tributaries to the Delta (measured at the point where tributaries cross the boundary of the legal Delta)?	-	●	-
			B. How do internal sources and processes influence MeHg levels in fish in the Delta?	●	●	●

Type	Core Management Questions	Assessment Questions	Sub-Questions	Subregional Trends in Bass	Subregional Trends in Water	Restoration Monitoring
	atmospheric deposition)? c. What are the magnitudes of internal sources (e.g., benthic flux) and sinks in the Delta?		C. How do currently uncontrollable sources (e.g., atmospheric deposition, both as direct deposition to Delta surface waters and as a contribution to nonpoint runoff) influence MeHg levels in fish in the Delta?	-	-	-
Forecasting 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?	1. What will be the effects of in-progress and planned source controls, restoration projects, and water management changes on ambient methylmercury concentrations in fish in the Delta?		●	●	●

Type	Core Management Questions	Assessment Questions	Sub-Questions	Subregional Trends in Bass	Subregional Trends in Water	Restoration Monitoring
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?	[none]		●	●	●

5.2. Beneficial Uses and Water Quality Goals

Two water quality control plans apply to the Sacramento-San Joaquin Delta: the *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (CVRWQCB, 2011.) This is frequently referred to as the *Central Valley Basin Plan* or simply, the *Basin Plan*. The *Basin Plan* is the Central Valley Regional Water Quality Control Board's regulatory reference for meeting the state and federal requirements for water quality control established under the federal *Clean Water Act* and California's Porter-Cologne Water Quality Control Act. The *Basin Plan* establishes numeric and narrative objectives for water quality aimed at protecting beneficial uses of water in the Sacramento River and San Joaquin River Basins, including the Sacramento-San Joaquin River Delta (Chapter III: Water Quality Objectives).

The second water quality control plan that applies to the Delta is the *Bay-Delta Water Quality Control Plan* (SWRCB 2006), commonly referred to as the *Bay-Delta Plan*. The State Water Resources Control Board adopted the Bay-Delta Plan to establish water quality objectives for the Bay-Delta Estuary related to flow and water project operations.

Table 5.2 provides an overview of beneficial uses that are relevant to the prioritized assessment questions of each of the individual monitoring elements. The full list of Delta RMP assessment questions can be found in **Appendix A**.

Table 5.3 summarizes existing numeric water quality criteria and aquatic life benchmarks for target analytes of pesticide monitoring. This information is useful for determining whether the lab's analytical methods are sensitive enough to detect pesticides at relevant concentrations. We make this determination by comparing the lab's detection limits to relevant screening values. For the majority of the pesticide analytes, there are no regulatory screening values. Exceptions are chlorpyrifos and diazinon, for which water quality objectives (WQOs) were set by the CVRWQCB. Other screening values are drawn from the literature. In order to determine whether contaminants are present in waterways at concentrations that are ecologically relevant, i.e., those which may cause harm to aquatic biota, scientists compare observed concentrations with screening values for aquatic toxicity gathered from the literature. The presence of a compound above a screening value is not necessarily evidence that harm is taking place, but rather it is a first step in a process for interpreting the data and evaluating relative ecological risk

The screening values listed in **Table 5.3** include:

- Water Quality Objectives for California's Central Valley (Central Valley Water Board 1998, 2007)

- EPA Office of Water (OW) Aquatic Life Ambient Water Quality Criteria (EPA 2000, 2015a, 2015b, website link)
- EPA Office of Pesticide Programs (OPP) Aquatic Life Benchmarks (link).
- California Department of Pesticide Regulation's Aquatic Life Benchmark Alternatives (Luo et al. 2013)

Table 5.4 lists the water quality objectives for methylmercury that will be used in evaluations of Delta RMP data. In addition to these water quality objectives, the Methylmercury TMDL includes implementation goals for largemouth bass (0.24 mg/kg in 350 mm largemouth bass) and unfiltered methylmercury in water (0.06 ng/L).

Table 5.2. Beneficial uses associated with Delta RMP monitoring elements.

Beneficial Use	Pesticides	Mercury
Cold Freshwater Habitat (COLD)	•	•
Commercial and Sport Fishing (COMM)	-	•
Estuarine Habitat (EST)	•	•
Fish Migration (MIGR)	•	-
Municipal and Domestic Water Supply (MUN)	-	-
Water Contact Recreation (REC1)	-	-
Non-contact Water Recreation (REC2)	-	-
Fish Spawning (SPWN)	•	-
Warm Freshwater Habitat (WARM)	•	•
Wildlife Habitat (WILD)	•	•

Table 5.3. Water quality screening values for pesticide analytes. All concentrations are in µg/L.

See **Appendix J**.

Table 5.4. Water quality objectives for methylmercury (Central Valley Regional Water Quality Control Board 2011).

Constituent	Water Quality Objectives	
Mercury, Methyl	Central Valley Basin Plan /Sacramento-San Joaquin Delta and Yolo Bypass waterways	
	Muscle tissue of trophic level 4 fish (mg/kg, wet weight)	Muscle tissue of trophic level 3 fish (mg/kg, wet weight))
	0.24	0.08

6. Project Tasks Description

6.1. Water Quality Monitoring Overview

The Delta RMP is one of several ongoing water-quality monitoring programs in the Delta. In terms of budgets, it represents less than 10% of all Delta monitoring (Jabusch and Gilbreath, 2009). Therefore, the Program seeks to complement existing programs and address gaps in existing monitoring, rather than to comprehensively address every water quality challenge described above.

The Delta RMP collects water quality data to address high-priority management decisions identified in **Section 5.1**. The current Delta RMP monitoring design is predominantly aimed at understanding the status and trends or impacts of three classes of pollutants: (1) pesticides and aquatic toxicity, (2) mercury, and (3) nutrients (nitrogen and phosphorus).

The pesticides monitoring element includes chemical analyses and toxicity testing. The chemical analyte groups for this monitoring element include several classes of chemicals that are referred to throughout this document as pesticides, including insecticides, herbicides, fungicides, and other compounds in products that are licensed and sold to farmers and residents in California.

Mercury monitoring includes sampling of sport fish and water and addresses the highest priority information needs related to the implementation of the Methylmercury TMDL. The study design originally included prey fish; however, due to recent permit restrictions pertaining to Delta smelt habitat, the project has been unable to secure permits for collecting prey fish as originally planned and prey fish monitoring has been suspended in 2021-2022. Prey fish monitoring may occur in future monitoring.

Nutrient monitoring in FY21-22 consists of two studies: 1) “Cyanotoxin Monitoring in the Delta: Leveraging existing USGS and DWR field efforts to identify cyanotoxin occurrence, duration, and drivers” and 2) “Source Tracking of the Cyanobacteria Blooms in the Sacramento-San Joaquin Delta.” Quality assurance documentation for the cyanotoxin study is provided in other documents as follows:

Determination of Cyanotoxins SOPs

- Streptavidin Amplification Enhanced Sensitivity Enzyme-Linked Immunosorbent Assay for the Congener-Independent* Determination of Microcystins and Nodularins in Water Samples
- Enzyme-Linked Immunosorbent Assay for the Determination of Anatoxin-a* in Water Samples

- Enzyme-Linked Immunosorbent Assay for the Determination of Cylindrospermopsin in Water Samples
- Enzyme-Linked Immunosorbent Assay for the Determination of Saxitoxin (PSP) in Water and Contaminated Samples
- Method 545: Determination of Cylindrospermopsin and Anatoxin-a in Drinking Water by Liquid Chromatography Electrospray Ionization Tandem Mass Spectrometry
- (LC/ESI-MS/MS)
- Method 544: Determination of Microcystins and Nodularin in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/ESI-MS/MS)
- Standard Operating Procedure for Solid Phase Adsorption Toxin Testing (SPATT) Assemblage and Extraction of HAB Toxins

DWR SOPs

- DWR EMP Field and Laboratory Manual
- QAPP for the Phytoplankton Monitoring of the EMP

The Source Tracking of the Cyanobacteria Blooms study is funded as a Supplemental Environmental Project and per Steering Committee direction a QAPP is not required.

Table 6.1 provides a complete list of target constituents for the current implementation of the Delta RMP.

Table 6.1. Delta RMP target constituents and reporting units.

Constituent/ Measurement	Reporting Group	Matrix	Sample Type	Target Detection Limit	Unit
Field parameters – measured by field crews any time a sample is collected					
Oxygen, Dissolved	Field Measurements	Water	In situ	0 to 20 mg/L: ±0.1 mg/L or 1% of reading, whichever is greater; 20 to 50 mg/L: ±5% of reading	mg/L
Oxygen, Dissolved	Field Measurements	Water	In situ	0 to 200%: ±1% of reading or 1% saturation, whichever is greater; 200 to 500%: ±5% of reading	% saturation
pH	Field Measurements	Water	In situ	±0.1 pH units within ±10˚C of calibration temp; ±0.2 pH units for entire temp range	pH
Specific Conductivity	Field Measurements	Water	In situ	0 to 100: ±0.5% of reading or 0.001 mS/cm, whichever is greater; 100 to 200: ±1% of reading	µS/cm
Temperature	Field Measurements	Water	In situ	5 to 35°C: ±0.01°C2 35 to 50°C: ±0.05°C2	°C
Turbidity	Field Measurements	Water	In situ	0 to 999 FNU: 0.3 FNU or ±2% of reading, whichever is greater; 1000 to 4000 FNU: ±5% of reading	FNU or NTU
Aquatic Toxicity Testing – PER					
***Ceriodaphnia dubia* (Reproduction)**	Water Column Toxicity	Water	Grab	n/a	young/female
***Ceriodaphnia dubia* (Survival)**	Water Column Toxicity	Water	Grab	n/a	%
***Hyalella azteca* (Survival)**	Water Column Toxicity	Water	Grab	n/a	%
***Pimephales promelas* (Larval biomass)**	Water Column Toxicity	Water	Grab	n/a	mg/original organisms exposed
***Pimephales promelas* (Larval survival)**	Water Column Toxicity	Water	Grab	n/a	%
***Selenastrum capricornutum* (Growth)**	Water Column Toxicity	Water	Grab	n/a	cells/mL

Constituent/ Measurement	Reporting Group	Matrix	Sample Type	Target Detection Limit	Unit
***Chironomus dilutus* (Growth)**	Water Column Toxicity	Water	Grab	n/a	mg/surviving organisms
***Chironomus dilutus* (Survival)**	Water Column Toxicity	Water	Grab	n/a	%
Oxygen, Dissolved	Water Column Toxicity (WQ measurement)	Water	Grab	0.1	mg/L
pH	Water Column Toxicity (WQ measurement)	Water	Grab	0.1	pH
Specific Conductivity	Water Column Toxicity (WQ measurement)	Water	Grab	20	µS/cm
Ammonia	Water Column Toxicity (WQ measurement)	Water	Grab	1	mg/L
Alkalinity	Water Column Toxicity (WQ measurement)	Water	Grab	1	mg/L
Hardness	Water Column Toxicity (WQ measurement)	Water	Grab	1	mg/L
Temperature	Water Column Toxicity (WQ measurement)	Water	Grab	0.1	°C
Pesticides Monitoring – USGS National Water Quality Laboratory (NWQL)					
Dissolved Organic Carbon (DOC)	Conventional	Water, filtered	Grab	0.23	mg/L
Total Particulate Carbon (TPC)	Conventional	Suspended Sediment	Grab	0.05	mg/L
Total Particulate Nitrogen (TPN)	Conventional	Suspended Sediment	Grab	0.03	mg/L
Particulate Organic Carbon (POC)	Conventional	Suspended Sediment	Grab	0.05	mg/L
Particulate Inorganic Carbon (PIC)	Conventional	Suspended Sediment	Grab	0.03	mg/L
Copper (dissolved)	Trace Metals	Water, filtered	Grab	0.8	µg/L

Constituent/ Measurement	Reporting Group	Matrix	Sample Type	Target Detection Limit	Unit
Pesticides Monitoring - USGS Organic Chemistry Research Laboratory (OCRL)					
Suite of 161 Current Use Pesticides – see full list in Table 7.4.	Pesticides	Water	Grab	varies	ng/L
Suite of 161 Current Use Pesticides – see full list in Table 7.4.	Pesticides	Suspended Sediment	Grab	varies	ng/L
Total Suspended Solids (TSS)	Conventional	Water	Grab	0.1	mg/L
Mercury – Fish Sampling					
Total Length	Fish Attributes	Tissue	Individual	n/a	mm
Fork Length	Fish Attributes	Tissue	Individual	n/a	mm
Weight	Fish Attributes	Tissue	Individual	n/a	g
Sex	Fish Attributes	Tissue	Individual	n/a	male/female/ unknown
Moisture	Fish Attributes	Tissue	Individual	n/a	%
Total Mercury	Trace Metals	Tissue (fillet muscle)	Individual	0.004	µg/g ww
Mercury - Water Sampling					
Chlorophyll a	Conventional	Water	Grab	24	µg/L
Dissolved Organic Carbon (DOC)	Conventional	Water	Grab	0.23	mg/L
Total Suspended Solids (TSS)	Conventional	Water	Grab	n/a	mg/L
TSS (volatile)	Conventional	Water	Grab	n/a	mg/L
Mercury, total (filtered and unfiltered)	Trace Metals	Water	Grab	0.070	ng/L
Mercury, Methyl,(filtered and unfiltered)	Trace Metals	Water	Grab	0.015	ng/L

6.2. Constituents to be Monitored and Reported

Table 6.1 lists the water quality constituents that will be measured in mercury and pesticide monitoring by the Delta RMP in FY21-22.

Some pesticides that the Program monitored from 2015–2017 were *dropped* from the analyte list from October 2018 onward. The Organic Chemistry Research Laboratory (OCRL) decided to remove several compounds from their methods list that had not been detected in any of their monitoring in 2015-2017, and which were not present in actively registered products with EPA in the period. The following 13 compounds were removed as of October 2018 (this list includes the Chemical Abstracts Service Registry Number, or CASRN, for reference).

1. Alachlor, CASRN: 15972-60-8
2. Azinphos methyl, CASRN: 86-50-0
3. Azinphos methyl oxon, CASRN: none
4. Bromuconazole, CASRN: 116255-48-2
5. Butylate, CASRN: 2008-41-5
6. Fenarimol, CASRN: 60168-88-9
7. Fenthion, CASRN: 55-38-9
8. Flusilazole, CASRN: 85509-19-9
9. Methidathion, CASRN: 950-37-8
10. Molinate, CASRN: 2212-67-1
11. Pebulate, CASRN: 1114-71-2
12. Tetradifon, CASRN: 116-29-0
13. Thiazopyr, CASRN: 117718-60-2

We have kept these old analytes in **Table 5.3** as a reference to the data developed by the Program.

The OCRL also *added* new analytical capabilities beginning in October 2018. The lab added 20 current use pesticides that are permitted for use nationally and in California, and were regularly applied in 2015-2017, according to the California Department of Pesticide Regulation's Pesticide Use Reporting (PUR) database. The *new* analytes are (see **Table 5.3** for ecotoxicological screening values and **Table 7.4** for detection limits and methods):

1. Acetochlor, CASRN: 34256-82-1
2. Benzovindiflupyr, CASRN: 1072957-71-1
3. Carboxin, CASRN: 5234-68-4
4. Chlorfenapyr, CASRN: 122453-73-0

5. Dichlorvos, CASRN: 62-73-7
6. Etoxazole, CASRN: 153233-91-1
7. Flubendiamide, CASRN: 272451-65-7
8. Fluopyram, CASRN: 658066-35-4
9. Flupyradifurone, CASRN: 951659-40-8
10. Imidacloprid urea, CASRN: 120868-66-8
11. Indaziflam, CASRN: 950782-86-2
12. Isofetamid, CASRN: 875915-78-9
13. Oxathiapiprolin, CASRN: 1003318-67-9
14. Penthiopyrad, CASRN: 183675-82-3
15. Pyriproxyfen, CASRN: 95737-68-1
16. Sulfoxaflor, CASRN: 946578-00-3
17. Tebufenozide, CASRN: 112410-23-8
18. Thiamethoxam Degradate (CGA-355190), CASRN: 902493-06-5
19. Thiamethoxam Degradate (NOA-407475), CASRN: NONE
20. Tricyclazole, CASRN: 41814-78-2

The OCRL continues to improve its analytical capabilities and methodologies. The most recent analytical updates are captured within the following publication: Gross, M.S., Sanders, C.J., De Parsia, M.D., and Hladik, M.L., 2021, A Multiresidue Method for the Analysis of Pesticides in Water using Solid-Phase Extraction with Gas and Liquid Chromatography-Tandem Mass Spectrometry: U.S. Geological Survey data release, https://doi.org/10.5066/P9J8E544. **Table 7.4** includes the updates to methods, analytes and reporting limits. Operating procedures for the updated methods are cited in **Appendix E**.

Additional pesticide analytes were also dropped from the analysis in 2021 due to updates to the analytical method and/or not being actively registered. The analytes removed from the analysis from 2021 onward include:

1. Captan, CASRN: 133-06-2
2. Carboxin, CASRN: 5234-68-4
3. Flubendiamide, CASRN: 272451-65-7
4. Methylparathion, CASRN: 298-00-0
5. Resmethrin, CASRN: 10453-86-8
6. Tricyclazole, CASRN: 41814-78-2

Analytes added to Delta RMP pesticide analyses in the 2022 WY due to this updated methodology include:

1. Atrazine, Desethyl, CASRN: 6190-65-4
2. Atrazine, Desisopropyl, CASRN: 1007-28-9
3. Bentazon, CASRN: 25057-89-0
4. Benzobicyclon, CASRN: 156963-66-5
5. Boscalid Metabolite - M510F01 Acetyl, CASRN: 661463-87-2
6. Broflanilide, CASRN: 1207727-04-5
7. Bromuconazole, CASRN: 116255-48-2
8. Clothianidin Desmethyl, CASRN: 135018-15-4
9. Cyclaniliprole, CASRN: 1031756-98-5
10. Florpyrauxifen-Benzyl, CASRN: 1390661-72-9
11. Fluindapyr, CASRN: 1383809-87-7
12. Fomesafen, CASRN: 72178-02-0
13. Halauxifen-Methyl Ester, CASRN: 943831-98-9
14. Imidacloprid Desnitro, CASRN: 127202-53-3
15. Imidacloprid, 5-Hydroxy, CASRN: 380912-09-4
16. Mandestrobin, CASRN: 173662-97-0
17. Metalaxyl Alanine Metabolite, CASRN: 85933-49-9
18. Naled (Dibrom), CASRN: 300-76-5
19. Nitrapyrin, CASRN: 1929-82-4
20. Picarbutrazox, CASRN: 500207-04-5
21. Pydiflumetofen, CASRN: 1228284-64-7
22. Tebuconazole t-Butylhydroxy, CASRN: 212267-64-6
23. Valifenalate, CASRN: 283159-90-0

6.3. Geographical and Temporal Setting

The geographic scope of the Delta RMP encompasses the legal Delta (as defined by Section 12220 of the Water Code), as well as water bodies that directly drain into the Delta, the Yolo Bypass, and Suisun Bay (**Figure 6.1**). The Delta Primary Zone encompasses approximately 500,000 acres of waterways, levees, and farmed lands, including the Yolo Bypass. Most of Yolo Bypass is located within the Primary Zone. The Secondary Zone includes approximately 250,000 acres that are surrounding the Primary Zone and are subject to increasing urban and suburban development. Suisun Marsh on the northern side of Suisun Bay consists of approximately 110,000 acres of managed wetlands. The southern side of the Suisun Bay shoreline encompasses additional tidal wetlands as well as urban, suburban, and industrial areas.

Water dynamics in the Delta and Suisun Bay are governed by inflows from the Sacramento and San Joaquin watershed, tidal exchange with the Pacific Ocean, and water withdrawals for municipal and agricultural use. The main tributaries are the Sacramento River and the San Joaquin River. Additional tributaries include the Mokelumne River, Cosumnes River, Calaveras River, Bear Creek, Marsh Creek, Cache Creek, Putah Creek, and Ulatis Creek. Flows from the Sacramento River, San Joaquin River, and other tributaries are transported across the Delta through a complex network of rivers, channels, and flooded islands, before entering Suisun Bay or the intakes of the federal and state water projects. Flows in the Delta are highly seasonal and peak in the spring and early summer when snowmelt waters from the upper watersheds arrive.

Important human activity and land use impacts in the Delta and Suisun Bay include the presence of urban and agricultural contaminants throughout the system, habitat loss, and alterations to the amount, duration, direction, and timing of water flows. In addition, more than 200 intentionally or accidentally introduced non-native species are residing in the project area.

6.3.1. Delta Subregions for Pesticides and Toxicity Sampling

For monitoring of pesticides and aquatic toxicity, all samples will be collected from within the legal boundaries of the Delta (**Figure 6.1**).

Previous efforts by both the Delta RMP and the CVRWQCB have divided the Delta into roughly similar subregions based on hydrology and management practices. The Delta RMP has divided the Delta into 6 subregions based on the contribution of source waters, as described in the 2018 report *Modeling to Assist Identification of Temporal and Spatial Data Gaps for Nutrient Monitoring* (Jabusch, Trowbridge, Heberger, and Guerin 2018). The rotating basin monitoring design for pesticides and toxicity includes monitoring random points selected within waterways in each of the 6 subregions shown in **Figure 6.2**. Geographic data files (shapefiles) of the subregions are available upon request to the Technical Program Manager.

Figure 6.1. 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.

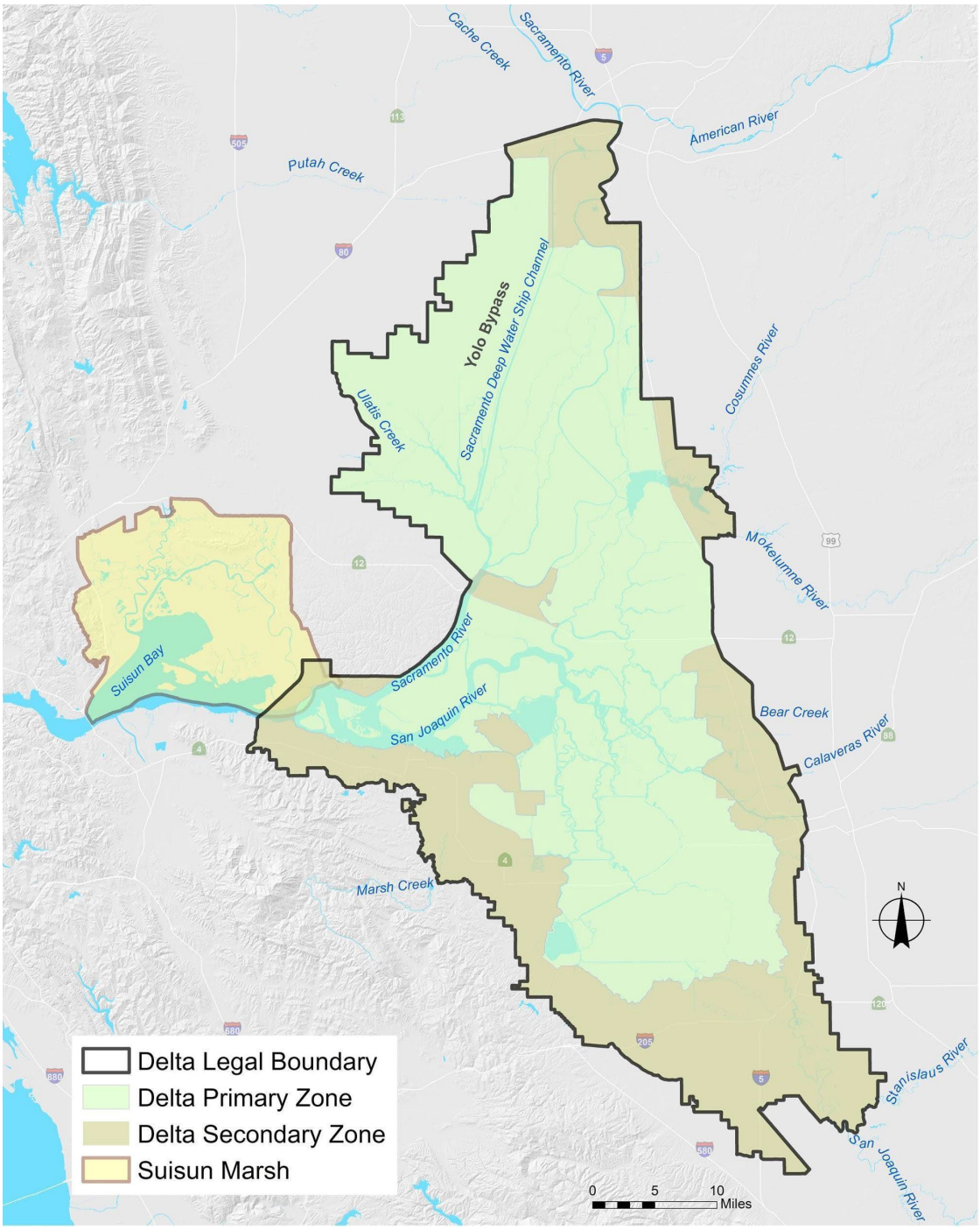
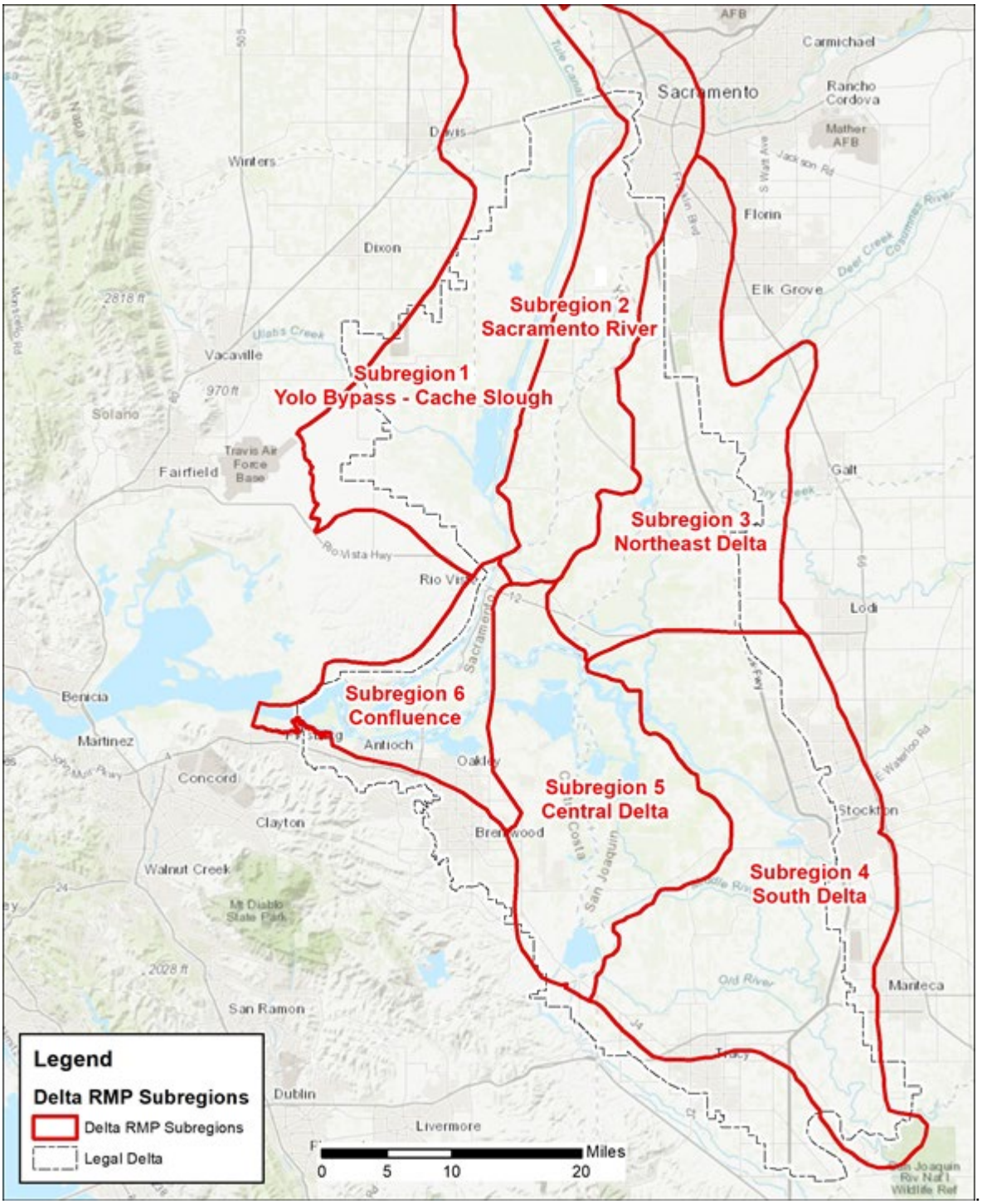


Figure 6.2. Map of Delta RMP subregions for pesticides and toxicity sampling.



6.3.2. Temporal Scope

Delta RMP Status & Trends monitoring is ongoing. Budgets are approved annually by the Steering Committee. A first phase of monitoring of mercury in sport fish and water was conducted through 2019, in order to inform a re-opening of the Methylmercury TMDL. The second phase will include continued monitoring of mercury in largemouth bass, continued monitoring of water but at a lower level of effort than the first phase, and will add monitoring of the impacts of wetland restoration projects on accumulation of mercury in largemouth bass. The original mercury monitoring design included monitoring for prey fish to evaluate impacts of wetland restoration projects, but that sampling had to be eliminated in the current monitoring year due to permitting issues associated with concerns regarding Delta smelt take. Also associated with permits are restrictions on fish sampling techniques for some locations where only hook and line sampling will be allowed.

The monitoring design for pesticides and toxicity was planned to occur over a 4-year cycle with year 1 beginning in October 2018 and ending in September 2019 (Water Year 2019). There was a gap in monitoring from March 2020 through March 2021 as directed by the SC due to changing laboratories. The current cycle of CUP and toxicity monitoring is now expected to be completed in September 2023 (Water Year 2023). Surface water samples for toxicity testing and pesticide analyses are collected in 6 sampling events during each water year. Samples are collected over the course of 2 to 3 days during each monitoring event. These events represent times of interest such as high agricultural and/or urban irrigation, periods of high flow, or following storms when pollutants are flushed from land surfaces into waterways via overland flow and drains. The specific timing for sampling events for pesticides and toxicity testing has been planned in collaboration with Delta RMP Pesticides TAC, and Delta RMP science advisors as documented in **Section 6.4.2**. Moving forward, discussions regarding the CUP monitoring will occur with the Pesticide TAC which will be formed in September 2021.

6.4. Monitoring Design

Delta RMP monitoring covered by this document includes separate programs or "projects" covering (1) mercury and (2) pesticides and toxicity. The monitoring design for each constituent group is described below.

6.4.1. Mercury

The sport fish samples for mercury analyses are collected annually from fixed stations at core and restoration sites that represent different subareas of the Delta. Surface water samples for mercury analyses are collected from fixed stations that generally align with the Delta RMP sport fish monitoring stations. The schedule for monitoring has varied from one year to the next based on budgets and priorities, as shown in **Table 6.3** and **Table 6.4**.

The Central Valley Regional Water Quality Control Board has divided the Delta into eight subregions for assessing and managing methylmercury impairment (shown in **Figure 6.3**). The sampling design was developed with consideration given to distributing stations throughout these subregions and comparing trends across the subregions.

Planned mercury sampling stations are shown in **Figure 6.3**, **Figure 6.4**, and **Figure 6.5** and listed in **Table 6.2**. The mercury monitoring element includes sport fish sampling and water sampling in open waters at core monitoring locations, and sport fish monitoring of wetland restoration projects. The chemical analyte groups for this monitoring element include mercury and methylmercury in water, total mercury in fish tissues, and ancillary parameters for water such as chlorophyll *a*, dissolved organic carbon (DOC), total suspended solids, and volatile suspended solids.

In FY21-22, sport fish monitoring is occurring at 7 core monitoring stations and 5 wetland restoration monitoring stations in late summer/early fall. A list of the target fish species and other fish collection details are included in **Section 11.1.2.2**. **Table 6.5** provides details and rationale on the stations selected for restoration monitoring.

In reviewing the design of the prey fish monitoring, TAC members questioned whether stations in the northern Liberty Island area are too close together to show differences in mercury bioaccumulation. Particle tracking models and isotope studies have found this “stair step” region to be “hydrodynamically detached” from the rest of the northwest Delta, with low mixing and long residence times (Downing et al. 2016). This raised concerns about whether the prey fish stations in this area could be considered discrete stations that could show different patterns in fish mercury concentrations (specifically, stations 4, 5, and 6 on **Figure 6.4**). Resource Management Associates (RMA) conducted a particle tracking simulation to investigate the hydraulic connectivity between the three sampling sites in question (Stephen Andrews and John DeGeorge, RMA, personal communication). Groups of “virtual particles” were released from each station at two-hour intervals over a day in the simulation, in order to average over the tidal conditions during each drop. Qualitative information about station hydraulic connectivity was assessed by creating an animation showing particle movement in

the area, and cumulative distributions of particles impacting adjacent stations were assessed (**Figure 6.6**). The simulation suggests there is relatively low connectivity between the stations. Particles originating from the Wildlands restoration impact other stations the most, with 13% of all particles released impacting the Liberty Island station within 5 days of release. If so, these stations are independent enough of one another to justify sampling at all three sites. This is further supported by a study that found differences in zooplankton community composition between nearby sites in this area (Liberty Island, Stairstep and Shag Slough sites in Kimmerer et al. [2018]). Due to permit restrictions associated with Delta smelt critical habitat, prey fish monitoring will not occur in FY21-22 but could be included in future monitoring.

Sediment was sampled in FY17/18, but there are no plans for continued sediment sampling for mercury analysis.

In FY21-22, three monthly sampling events for water are planned – fall (August - October), early spring (February - March) and late spring / early summer (April - June) at seven stations (**Table 6.2**). The timing of the early spring and late spring/ early summer events may be adjusted (in consultation with the Mercury TAC) to capture the effect of floodplain inundation in the watershed during high flow years. Scientists at MLML-DFW will choose the exact dates for water sampling within the time frames described previously. Any changes to planned sample dates shall be communicated to the Mercury TAC and Regional Board staff in a timely manner.

The overall sampling schedule is shown in **Table 6.2** through **Table 6.4.**

Table 6.2. Monitoring stations for mercury in water and fish (prey fish monitoring will not occur in FY21-22).

#	CEDEN Station Code	Station Name	Latitude	Longitude	Fall Sport Fish (Bass) Sampling	Spring Prey Fish (Silversides) sampling[2]		Water Sampling,
Core monitoring stations					(7 stations)			(7 stations)
1	510ADVLIM	Cache Slough at Liberty Island Mouth[1]	38.24213	-121.68539	●			●
2	544LILPSL	Little Potato Slough	38.09627	-121.49602	●			●
3	544MDRBH4	Middle R @ Borden Hwy (Hwy 4)	37.89083	-121.48833	●			●
4	544ADVLM6	Lower Mokelumne R 6	38.25542	-121.44006	●			●
5	510ST1317	Sacramento R @ Freeport	38.45556	-121.50189[2]	●			●
6	541SJC501	San Joaquin R @ Vernalis/Airport Way	37.67556	-121.26417	●			●
7	510ST1666	Sherman Island[1]	38.0431	-121.8044	●			
8	207SRD10A	Sacramento River at Mallard Island	38.04288	-121.92011				●
Wetland restoration monitoring stations					(5 stations)	(8 stations)		
9	544CUGRWL	Cougar Wetland	38.25644	-121.409	–	●		–
10	510DLTAMD	Delta Meadows	38.261875	-121.499355	–	●		–
11	544GZSLWC	Grizzly Slough - Westervelt - Cougar	38.25343	-121.40690	●	–		–
12	510LIBISL	Liberty Island	38.320525	-121.680263	–	●		–
13	510ST0787	Lindsey Slough	38.25843	-121.75801	●	●		–
14	511XSSLIB	Lookout Slough[1]	38.31038	-121.69304	●	–		–
15	544MCWILT	McCormack-Williamson Tract	38.22640	-121.49144	●	–		–
16	510STSTPM	Stairstep Marsh	38.32469	-121.6583	–	●		–
17	544WESTVR	Westervelt Restoration	38.246257	-121.425654	–	●		–
18	510WILDLM	Wildlands Mitigation	38.33344	-121.67098	–	●		–
19	510TDNLHT	Yolo Flyway Farms[1]	38.33842	-121.64953	●	●		–

[1]The existing permit does not allow for electrofishing at these locations; sampling crews will collect fish using hook and line sampling methods.

[2]Prey fish monitoring was originally planned for 8 wetland restoration monitoring stations; however, due to permit restrictions associated with Delta smelt critical habitat, prey fish monitoring will not occur in FY21-22.

Note: For a list of valid CEDEN station codes, see:
http://ceden.org/CEDEN_Checker/Checker/DisplayCEDENLookUp.php?List=StationLookUp

Table 6.3. Sampling schedule for mercury. Due to permit restrictions associated with Delta smelt critical habitat, prey fish monitoring did not occur in FY20/21 and will not occur in FY21/22

Year →	2016						2017																		2018												2019												2020					
Fiscal Yr →	FY 16/17 (YEAR 1)												FY17/18 (YEAR 2)												FY18/19 (YEAR 3)												FY19/20 (YEAR 4)																	
Month →	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
Monitoring element (# of sites sampled)																																																				
Bass - Core		6												6												7																							7						
Bass - Restoration																																																	5						
Prey Fish - Restoration																																																				8		
Water		5			5			5		5						6			8	8	8	8	8	8	8	8	8	8			8	8	8	8	8	8	8	8	8	8					7	7				
Sediment																6			6			6		6																													

Year →	2020						2021																		2022												2023												2024					
Fiscal Yr →	FY 20/21 (YEAR 5)												FY 21/22 (YEAR 6)												FY22/23 (YEAR 7)												FY23/24 (YEAR 8)																	
Month →	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
Monitoring element (# of sites sampled)																																																				
Bass - Core			7[1]											7[1]												7																							7						
Bass - Restoration			5[1]											5[1]												5																							5						
Prey Fish - Restoration											8												8													8																8		
Water			7[1]						7	7				7[1]							7	7				7							7	7				7									7	7				

gray shading = March-October period used for the linkage analysis in the TMDL
red shading = missed events
[1] monitoring in September 2020 was performed under an extension of the FY19-20 QAPP; monitoring in August 2021 was performed under an extension of FY20-21 QAPP.
[2] Prey fish monitoring did not occur in FY20-21 and will not occur in FY21-22 due to permit restrictions associated with Delta smelt critical habitat.

Table 6.4. Number of mercury samples by type and by fiscal year at core monitoring locations. Prey fish samples were originally planned to be collected at 8 locations starting with FY20-21; due to permit restrictions, prey fish monitoring did not occur in FY20-21 and will not occur in FY21-22.

	Sport fish (bass)				Water				Sediment				Prey fish		
	Events	Stations	# Samples		Events	Stations	# Samples*		Events	Stations	# Samples*		Events	Stations	# Samples*
FY16-17	1	6	6		4	5	20		-	-	-		-	-	-
FY17-18	1	6	6		7	6 - 8	54		4	6	24		-	-	-
FY18-19	1	7	7		10	8	80		-	-	-		-	-	-
FY19-20	1	7	7		5	7 - 8	39		-	-	-		-	-	-
FY20-21	1	7	7		3	7	21		-	-	-		-	8	-
FY21-22	1	7	7		3	7	21		-	-	-		-	-	-

*Indicates the number of environmental samples. Additional field duplicates and field blanks are collected as specified in Table 14.2.

Table 6.5. Details on sampling locations for monitoring of mercury in black bass fish tissue at and near Delta wetland restoration sites. Although prey fish monitoring will not be occurring due to permit restrictions, the restoration site information has been kept in this table for reference and context.

Station Type	Map Label	Name	Type	Restoration Timing (Breach)	Acres (Tidal Wetland or Floodplain)	Site Details	Additional Details
Prey Fish	2	Lindsey Slough	Comparison (included in current design)	2014	159	Restoration site on the natural edge of the Delta where it transitions to uplands.	Site farther up Lindsey Slough, near wetlands not associated with restoration project.
Prey Fish	3	Lookout Slough	Possible Future Site		3100	Large restoration project. Site design includes channel network and raised peninsulas.	
Prey Fish	4	Liberty Island	Comparison (included in current design)	1997		Large wetland resulting from unplanned breach	Wetlands established after unplanned breach in 1998. Treating this as comparison marsh because it was not a recent, planned restoration.

Station Type	Map Label	Name	Type	Restoration Timing (Breach)	Acres (Tidal Wetland or Floodplain)	Site Details	Additional Details
Prey Fish	5	Wildlands Mitigation	Restoration (included in current design)	2011	186	High elevation, dendritic channels created	Has dendritic channel network as part of wetland design to an extent not seen in neighboring reference wetlands. This channel structure might affect Hg levels in fish via either effects of flooding on Hg cycling or effects on fish foraging patterns.
Prey Fish	6	"Stairstep" marsh	Comparison (included in current design)	1982	800	Large wetland resulting from unplanned breach	Wetlands established after unplanned breach of Little Holland Tract in 1982. Treating this as comparison marsh because it was not a recent, planned restoration.
Prey Fish	7	Yolo Flyway Farms	Restoration (included in current design)	2018	350	One large channel excavated to connect to toe drain	New restoration. Farther up the fluvial-tidal gradient than nearby sites.
Prey Fish	8	Prospect Island	Possible Future Site	~2022	1300	Large planned restoration, used for dredged material, interior channel network, north island higher in elevation	
Prey Fish	9	Delta Meadows	Comparison (included in current design)		191	One of the few large area wetlands in the region, and a well studied site in terms of fish monitoring.	Wetland and riparian mosaic
Prey Fish	10	McCormack Williamson Tract	Possible Future Site	2021	908	Large planned restoration in the northwest Delta; Elevation gradient across site.	

Station Type	Map Label	Name	Type	Restoration Timing (Breach)	Acres (Tidal Wetland or Floodplain)	Site Details	Additional Details
Prey Fish	11	Westerveldt Restoration	Restoration (included in current design)	2011	472 (floodplain / tidal wetland)	Established floodplain restoration	Older restoration site. Site recommended by DWR as an alternative restoration project since Grizzly Slough restoration is not yet complete.
Prey Fish	12	Cougar Wetland	Restoration (included in current design)	2019	154 (floodplain)	Recent floodplain restoration	Recent restoration site. Site recommended by DWR as an alternative restoration project since Grizzly Slough restoration is not yet complete.
Prey Fish	13	Grizzly Slough	Possible Future Site	2021	400 (floodplain)	Planned floodplain restoration	
Bass	A	Lindsey Slough	New			Near Lindsey Slough wetlands.	
Bass	B	Lookout Slough	New			Near Lookout Slough, an opportunity to sample regional Hg pre-breach.	
Bass	C	Cache Slough at Liberty Island Mouth (510ADVLIM)	Existing			Part of Delta RMP core monitoring.	
Bass	D	Yolo Flyway Farms/ Lower Yolo Ranch	New			New (2020) restoration project nearby.	
Bass	E	McCormack Williamson Tract	New			Near McCormack Williamson Tract, an opportunity to sample regional Hg pre-breach.	
Bass	F	Lower Mokelumne	Existing			Part of Delta RMP core monitoring.	

Station Type	Map Label	Name	Type	Restoration Timing (Breach)	Acres (Tidal Wetland or Floodplain)	Site Details	Additional Details
		River 6 (544ADVLM6)					
Bass	G	Grizzly Slough/ Westervelt / Cougar	New			Near Westervelt, Cougar, and (future) Grizzly Slough restoration sites.	

Figure 6.3. Map of core mercury monitoring stations: sport fish and water.

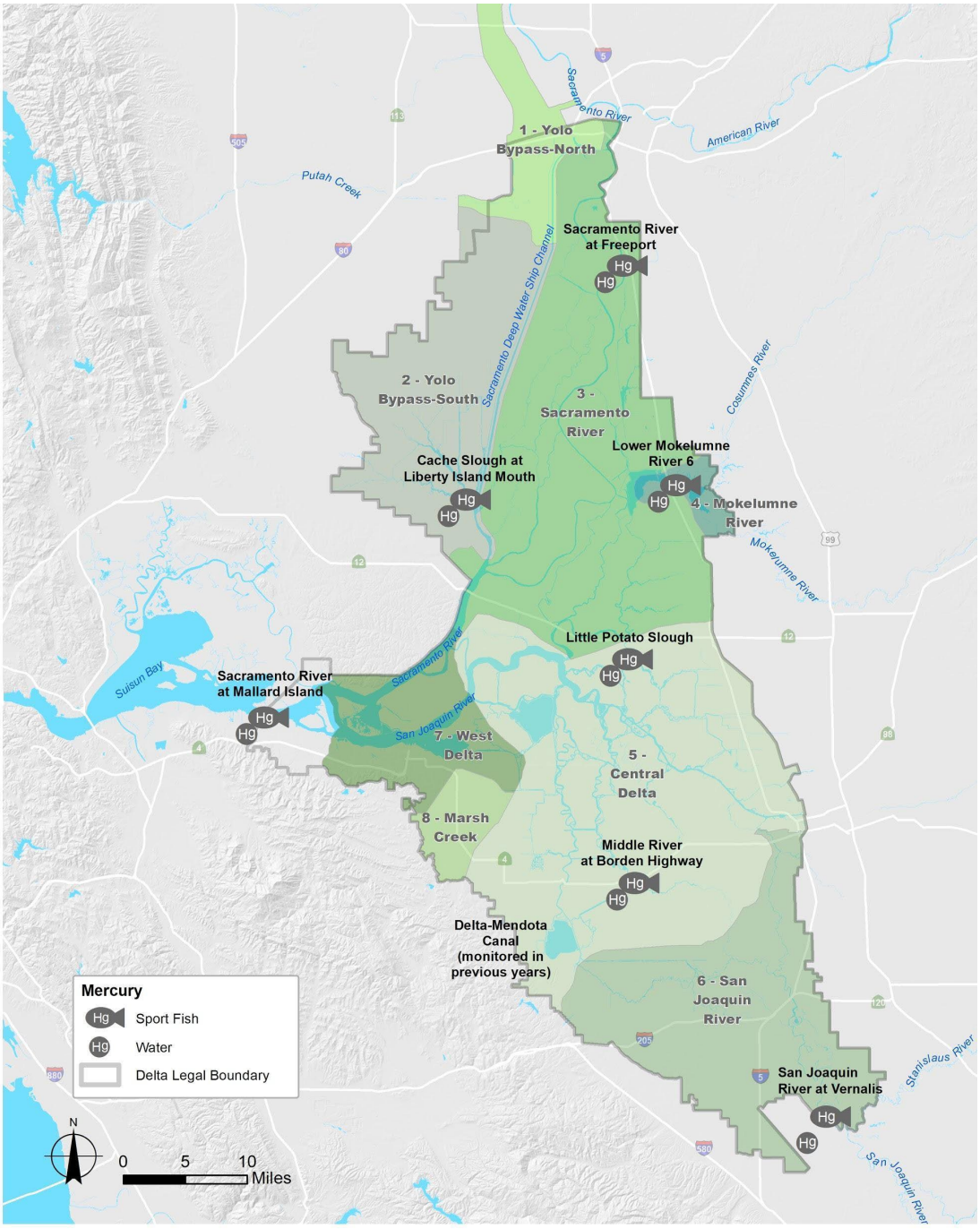


Figure 6.4. Map of mercury monitoring stations: restoration stations in the northwest Delta. Prey fish monitoring will not occur in FY21-22 due to permit restrictions associated with critical habitat.

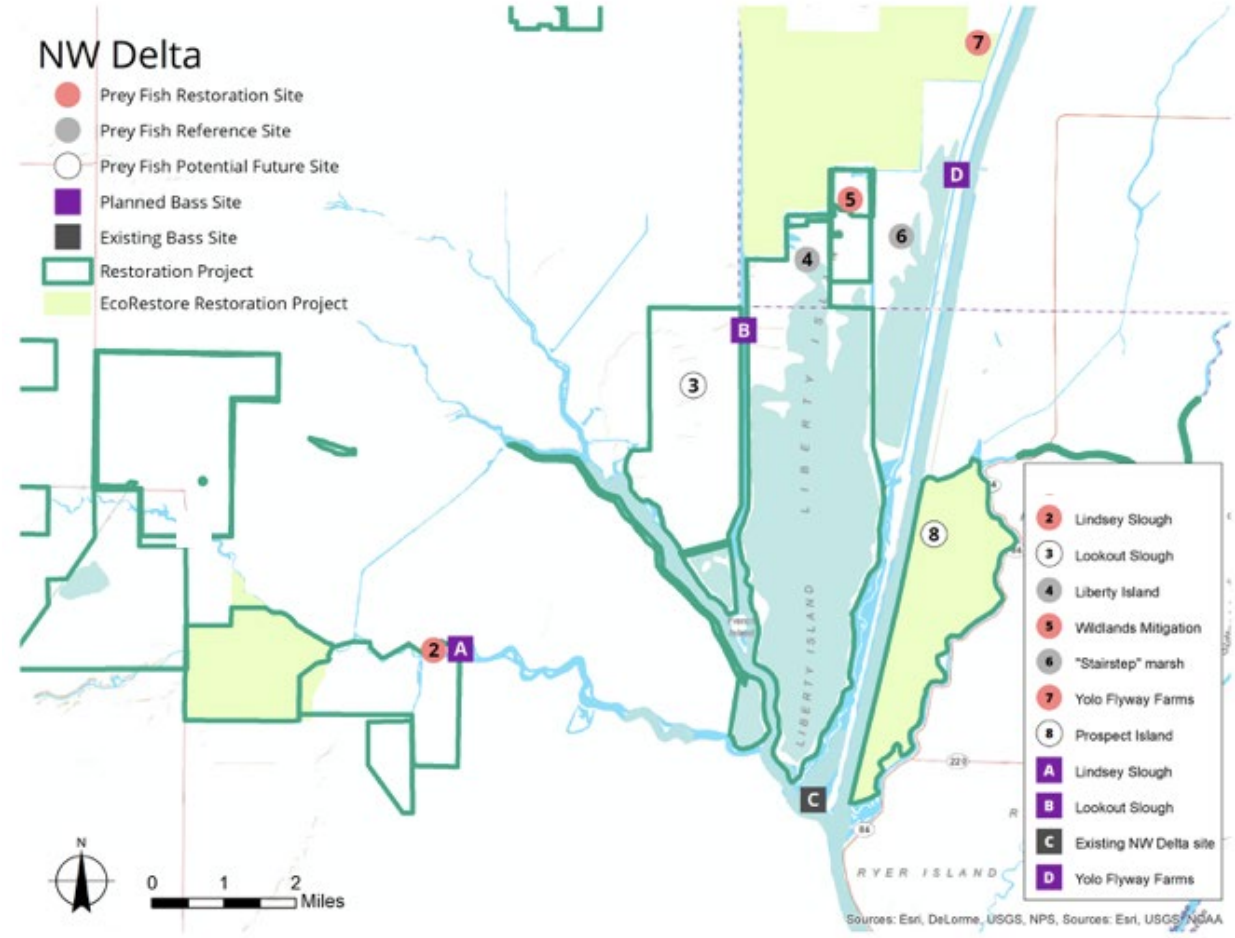


Figure 6.5. Map of mercury monitoring stations: restoration stations in the northeast Delta. Prey fish monitoring will not occur in FY 21-22 due to permit restrictions due to Delta smelt critical habitat.

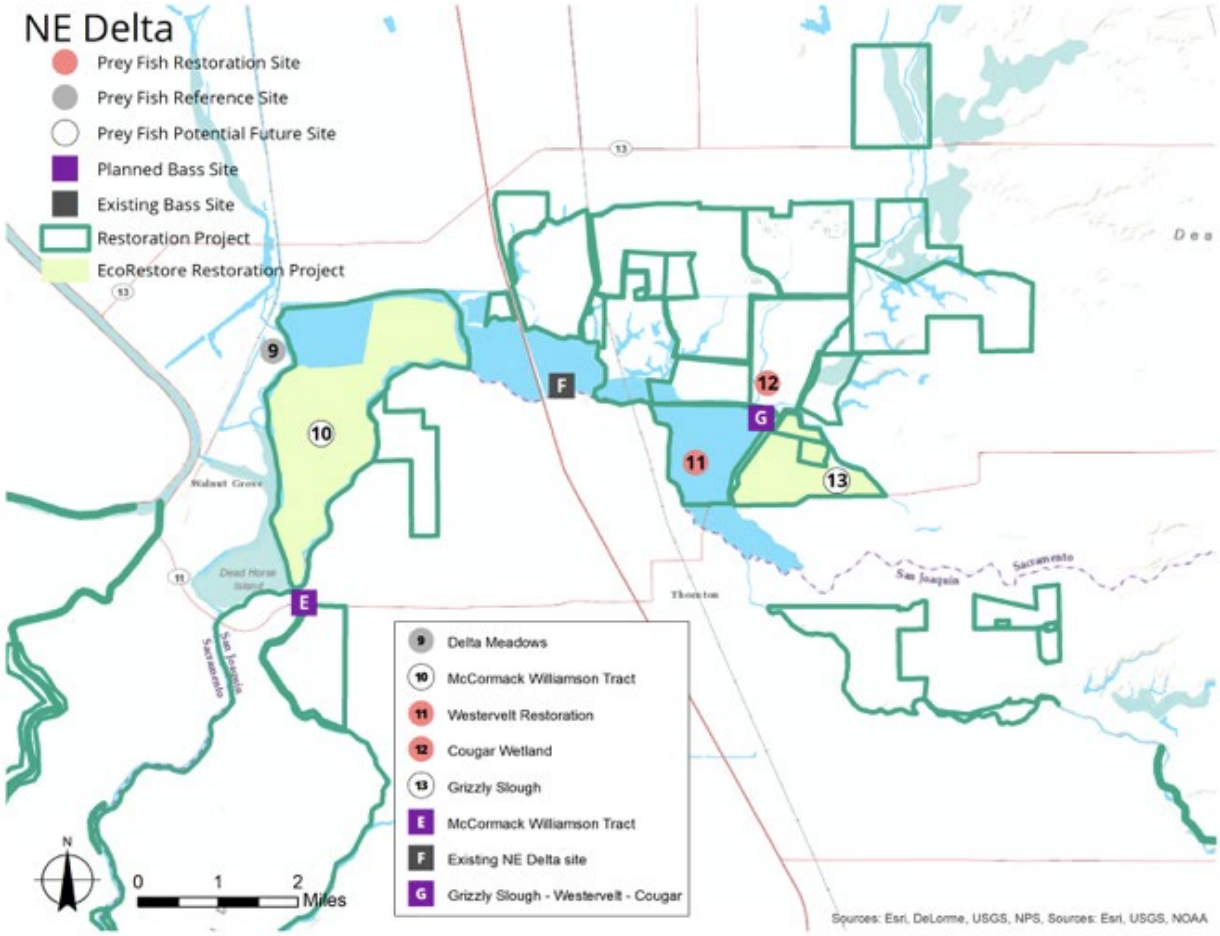
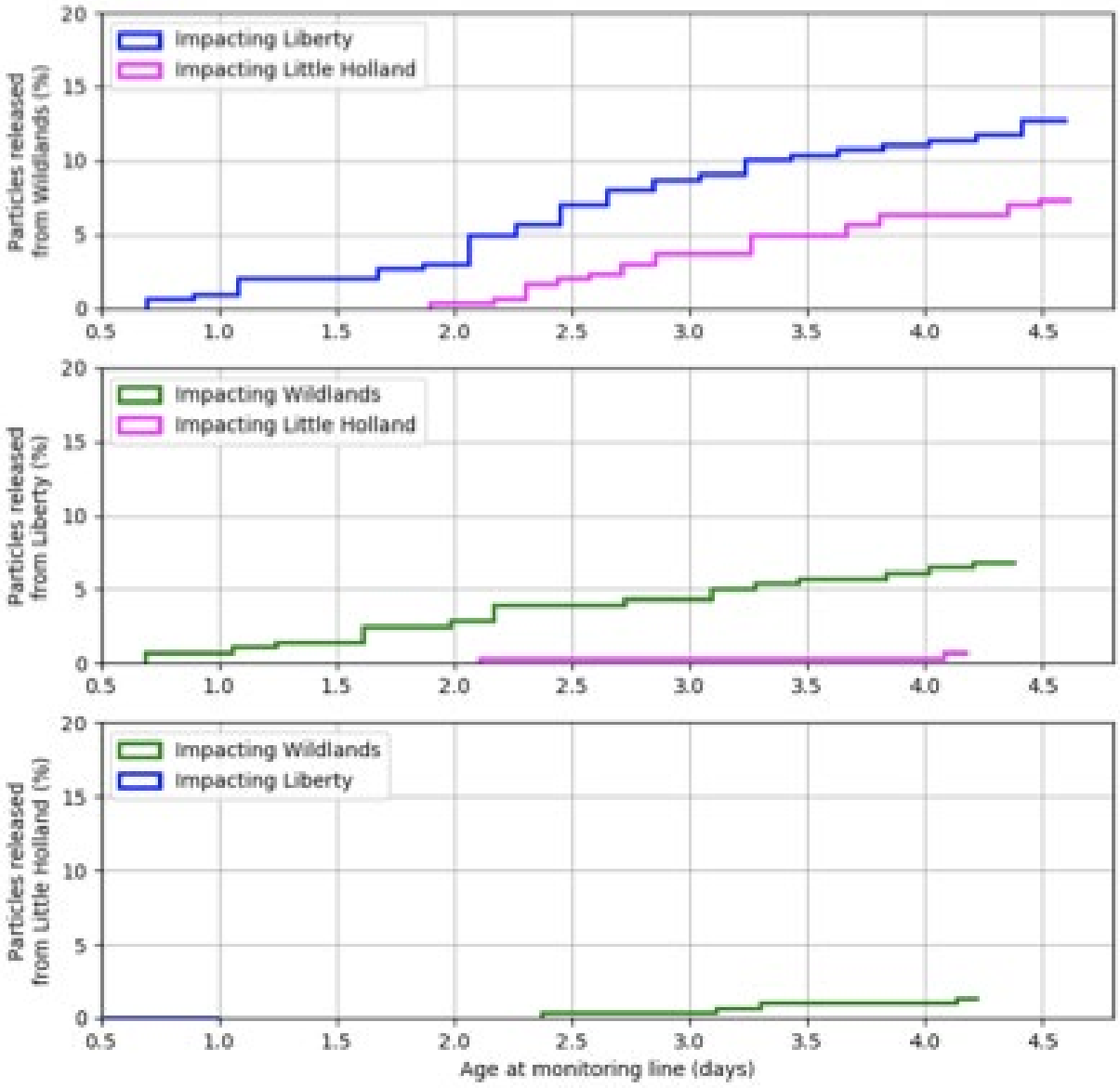


Figure 6.6. Plots of model hydrodynamic results showing the cumulative impact of particles at restoration stations other than their release location.

Impact is shown as a percent of particles released from a station reaching each of the other two stations. Particles released from the Wildlands stations are shown in the upper plot, those from the Liberty station in the middle plot, and those from the Little Holland station in the lower plot.



6.4.2. Pesticides and Aquatic Toxicity

A "rotating basin" probabilistic monitoring design was chosen for the purpose of understanding the spatial extent of toxicity and pesticide concentrations (**Table 6.6**). In this instance, the "basins" are 6 Delta subregions. Under the rotating basin monitoring design, crews will collect enough samples in each subregion to adequately characterize the mean and variance of pesticide concentrations and toxicity in each subregion. Samples will be collected by boat at randomly selected locations within each subregion. The locations and timing of sampling are described in more detail below.

Table 6.6. Sampling plan for pesticides and toxicity water samples.

Number of random sample locations per year in each subregion	**24 in first subregion 12 in second subregion**
Subregions evaluated per year	2
Number of repeated sample locations per subregion	0
Number of fixed-site sampling locations	2
Sampling events per year	6
Number of samples per year	36 samples at random locations; 12 samples at 2 fixed sites; 48 samples total each year
Time (years) to collect 24 samples in all 6 Delta subregions	One subregion fully evaluated (n = 24) in any given year. Second subregion will be sampled at half the intensity (n=12) with sampling to be continued over two subsequent years to reach the desired number of samples. It will take 4 years to obtain the desired 24 samples in each of the 6 subregions to cover the entire Delta with the desired margin of error.

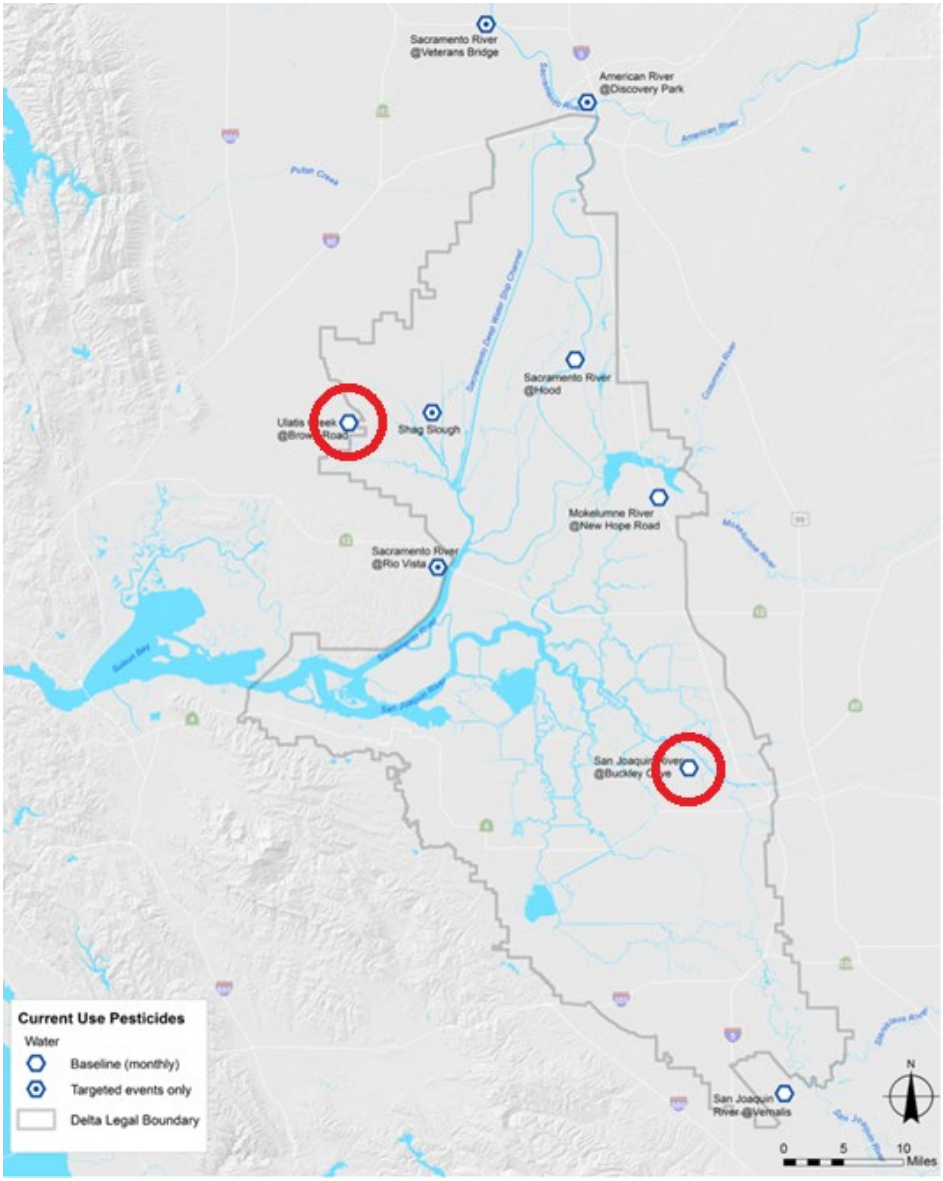
In addition, the monitoring design calls for continued monitoring 6 times per year at two fixed sites. Both sites, Ulatis Creek at Brown Road and San Joaquin River at Buckley Cove, are locations where aquatic toxicity has been observed by Delta RMP monitoring in the past (see locator map in **Figure 6.7**). For more information on the first year of Delta RMP pesticides monitoring, see recent reports by the USGS (De Parsia et al. 2018 and 2019) and SFEI-ASC

(Jabusch, Trowbridge, Heberger, Orlando, et al. 2018). Fixed site monitoring is intended to allow the Delta RMP to detect temporal trends at these two sites as well as analyzing relationships between observed pesticide concentrations and aquatic toxicity. Sampling at the same location repeatedly holds a greater number of factors constant in comparison to the rotating basin component of the monitoring design. Any relationship between pesticides and toxicity may have less variability (i.e., less noise) and be easier to identify at fixed locations than between parameters at locations that change.

Environmental water samples will be analyzed for a suite of current-use pesticides and for chronic toxicity to 5 organisms as shown in **Table 6.1**.

The monitoring design specified collecting 48 ambient surface water samples in each water year from 2019 to 2022 resulting in 24 samples being collected from each of the 6 Delta subregions after 4 years of monitoring. However, due to the COVID-19 pandemic affecting sampling in the spring and summer of 2020, and a change in the Delta RMP's toxicity testing laboratory, sampling for water year 2020 has been extended into water year 2021. Sampling will resume in spring 2021, one year from when monitoring previously stopped. Therefore, to complete the entire monitoring rotation among all 6 subregions, monitoring will occur through water year 2023. The monitoring design will allow project scientists to make inferences about water quality conditions across the Delta, as well as to detect differences among the subregions. If other rounds of monitoring based on the current design are conducted in the future, data may be used to draw inferences about trends or changes over time. However, trend detection is not an emphasis of the rotating basin component of the design associated with a single round of monitoring at each subregion.

Figure 6.7. Map of Delta RMP "integrator" sites monitored for pesticides and aquatic toxicity from 2015 to 2017, highlighting the two fixed stations selected for continued sampling beginning in Water Year 2019.



Sampling Locations

Table 6.7 contains information about the sampling locations, such as the SiteID (a unique identifier assigned to each location), subregion, and latitude and longitude coordinates. If a site is inaccessible, field crews will cross this site off the list, and sample the next "oversample" site on the list. Field crews will communicate this to the Technical Program Manager, who is responsible for notifying the CVWQCB QA Representative according to the requirements in Board Resolution Number R5-2021-0054 and the TAC members.

Table 6.7. Planned sampling locations for pesticides and toxicity monitoring. If a site cannot be accessed and must be rotated to an alternate location, this will be documented with the annual report.

SiteID	Planned Sampling Event	Subregion	Latitude	Longitude
(a) Subregion 1 Sites - Yolo Bypass - Cache Slough				
Yolo-001	WY2019 Event #1	Yolo Bypass - Cache Slough	38.27952	-121.661
Yolo-002	WY2019 Event #1	Yolo Bypass - Cache Slough	38.26919	-121.69239
Yolo-003	WY2019 Event #1	Yolo Bypass - Cache Slough	38.26105	-121.74786
Yolo-004	WY2019 Event #1	Yolo Bypass - Cache Slough	38.31957	-121.69276
Yolo-005	WY2019 Event #2	Yolo Bypass - Cache Slough	38.25905	-121.66765
Yolo-006	WY2019 Event #2	Yolo Bypass - Cache Slough	38.25214	-121.67558
Yolo-007	WY2019 Event #2	Yolo Bypass - Cache Slough	38.27122	-121.70283
Yolo-008	WY2019 Event #2	Yolo Bypass - Cache Slough	38.2743	-121.67392
Yolo-009	WY2019 Event #3	Yolo Bypass - Cache Slough	38.24957	-121.67482
Yolo-010	WY2019 Event #3	Yolo Bypass - Cache Slough	38.46178	-121.58863
Yolo-011	WY2019 Event #3	Yolo Bypass - Cache Slough	38.30568	-121.65721
Yolo-012	WY2019 Event #3	Yolo Bypass - Cache Slough	38.28241	-121.681
Yolo-013	WY2019 Event #4	Yolo Bypass - Cache Slough	38.2082	-121.66306
Yolo-014	WY2019 Event #4	Yolo Bypass - Cache Slough	38.38195	-121.62601
Yolo-015	WY2019 Event #4	Yolo Bypass - Cache Slough	38.26789	-121.66321
Yolo-016	WY2019 Event #4	Yolo Bypass - Cache Slough	38.25806	-121.7258
Yolo-017	WY2019 Event #5	Yolo Bypass - Cache Slough	38.2833	-121.68577
Yolo-018	WY2019 Event #5	Yolo Bypass - Cache Slough	38.26025	-121.67886
Yolo-019	WY2019 Event #5	Yolo Bypass - Cache Slough	38.43301	-121.60288
Yolo-020	WY2019 Event #5	Yolo Bypass - Cache Slough	38.27881	-121.6778
Yolo-021	WY2019 Event #6	Yolo Bypass - Cache Slough	38.30108	-121.72977
Yolo-022	WY2019 Event #6	Yolo Bypass - Cache Slough	38.31798	-121.65177
Yolo-023	WY2019 Event #6	Yolo Bypass - Cache Slough	38.27899	-121.68779
Yolo-024	WY2019 Event #6	Yolo Bypass - Cache Slough	38.18487	-121.66101
Yolo-025	Yolo Bypass Oversample Point #1	Yolo Bypass - Cache Slough	38.53725	-121.58398
Yolo-026	Yolo Bypass Oversample Point #2	Yolo Bypass - Cache Slough	38.26114	-121.67271
Yolo-027	Yolo Bypass Oversample Point #3	Yolo Bypass - Cache Slough	38.28616	-121.72181
Yolo-028	Yolo Bypass Oversample Point #4	Yolo Bypass - Cache Slough	38.26864	-121.67708
Yolo-029	Yolo Bypass Oversample Point #5	Yolo Bypass - Cache Slough	38.26053	-121.68851
Yolo-030	Yolo Bypass Oversample Point #6	Yolo Bypass - Cache Slough	38.411	-121.6164
Yolo-031	Yolo Bypass Oversample Point #7	Yolo Bypass - Cache Slough	38.288	-121.68209
Yolo-032	Yolo Bypass Oversample Point #8	Yolo Bypass - Cache Slough	38.2411	-121.68302
Yolo-033	Yolo Bypass Oversample Point #9	Yolo Bypass - Cache Slough	38.37009	-121.63221

SiteID	Planned Sampling Event	Subregion	Latitude	Longitude
Yolo-034	Yolo Bypass Oversample Point #10	Yolo Bypass - Cache Slough	38.23202	-121.67517
(b) Subregion 2 Sites - Sacramento River				
Sacr-001	WY2019 Event #1	Sacramento River	38.16498	-121.62099
Sacr-002	WY2019 Event #1	Sacramento River	38.26207	-121.65129
Sacr-003	WY2019 Event #2	Sacramento River	38.23917	-121.52149
Sacr-004	WY2019 Event #2	Sacramento River	38.37058	-121.55289
Sacr-005	WY2019 Event #3	Sacramento River	38.18899	-121.64127
Sacr-006	WY2019 Event #3	Sacramento River	38.24024	-121.60198
Sacr-007	WY2019 Event #4	Sacramento River	38.47372	-121.52027
Sacr-008	WY2019 Event #4	Sacramento River	38.19473	-121.61907
Sacr-009	WY2019 Event #5	Sacramento River	38.31436	-121.57723
Sacr-010	WY2019 Event #5	Sacramento River	38.45881	-121.5024
Sacr-011	WY2019 Event #6	Sacramento River	38.51454	-121.54563
Sacr-012	WY2019 Event #6	Sacramento River	38.19272	-121.56752
Sacr-013	WY2020 Event #1	Sacramento River	38.33821	-121.5653
Sacr-014	WY2020 Event #1	Sacramento River	38.3777	-121.54217
Sacr-015	WY2020 Event #2	Sacramento River	38.53481	-121.51925
Sacr-016	WY2020 Event #2	Sacramento River	38.17289	-121.64852
Sacr-017	WY2020 Event #3	Sacramento River	38.27415	-121.58859
Sacr-018	WY2020 Event #3	Sacramento River	38.23966	-121.53999
Sacr-019	WY2021 Event #4	Sacramento River	38.57538	-121.51169
Sacr-020	WY2021 Event #4	Sacramento River	38.1846	-121.64806
Sacr-021	WY2021 Event #5	Sacramento River	38.31035	-121.59847
Sacr-022	WY2021 Event #5	Sacramento River	38.41424	-121.52147
Sacr-023	WY2021 Event #6	Sacramento River	38.49416	-121.55587
Sacr-024	WY2021 Event #6	Sacramento River	38.2297	-121.60339
Sacr-025	Sac. R. Oversample Point #1	Sacramento River	38.294	-121.58244
Sacr-026	Sac. R. Oversample Point #2	Sacramento River	38.34605	-121.54344
Sacr-027	Sac. R. Oversample Point #3	Sacramento River	38.47041	-121.50671
Sacr-028	Sac. R. Oversample Point #4	Sacramento River	38.22488	-121.55672
Sacr-029	Sac. R. Oversample Point #5	Sacramento River	38.33216	-121.58293
Sacr-030	Sac. R. Oversample Point #6	Sacramento River	38.39327	-121.51421
Sacr-031	Sac. R. Oversample Point #7	Sacramento River	38.56492	-121.52079
Sacr-032	Sac. R. Oversample Point #8	Sacramento River	38.16693	-121.62877
Sacr-033	Sac. R. Oversample Point #9	Sacramento River	38.24861	-121.60203
Sacr-034	Sac. R. Oversample Point #10	Sacramento River	38.43376	-121.53173
(c) Subregion 3 Sites - Northeast Delta				
Nort-001	Water Year 2020, Event #1	Northeast Delta	38.14477	-121.4394
Nort-002	Water Year 2020, Event #1	Northeast Delta	38.16557	-121.49133
Nort-003	Water Year 2020, Event #1	Northeast Delta	38.2702	-121.46575
Nort-004	Water Year 2020, Event #1	Northeast Delta	38.11585	-121.55172
Nort-005	Water Year 2020, Event #2	Northeast Delta	38.1425	-121.49683
Nort-006	Water Year 2020, Event #2	Northeast Delta	38.25355	-121.47979
Nort-007	Water Year 2020, Event #2	Northeast Delta	38.22487	-121.53438

SiteID	Planned Sampling Event	Subregion	Latitude	Longitude
Nort-008	Water Year 2020, Event #2	Northeast Delta	38.12016	-121.58254
Nort-009	Water Year 2021, Event #3	Northeast Delta	38.12235	-121.49829
Nort-010	Water Year 2021, Event #3	Northeast Delta	38.26999	-121.47745
Nort-011	Water Year 2021, Event #3	Northeast Delta	38.14596	-121.60069
Nort-012	Water Year 2021, Event #3	Northeast Delta	38.1228	-121.52521
Nort-013	Water Year 2021, Event #4	Northeast Delta	38.20981	-121.50713
Nort-014	Water Year 2021, Event #4	Northeast Delta	38.24697	-121.49829
Nort-015	Water Year 2021, Event #4	Northeast Delta	38.12969	-121.56176
Nort-016	Water Year 2021, Event #4	Northeast Delta	38.20163	-121.54138
Nort-017	Water Year 2021, Event #5	Northeast Delta	38.14276	-121.47036
Nort-018	Water Year 2021, Event #5	Northeast Delta	38.16881	-121.47039
Nort-019	Water Year 2021, Event #5	Northeast Delta	38.28613	-121.50318
Nort-020	Water Year 2021, Event #5	Northeast Delta	38.13087	-121.57406
Nort-021	Water Year 2021, Event #6	Northeast Delta	38.15614	-121.50311
Nort-022	Water Year 2021, Event #6	Northeast Delta	38.26963	-121.49641
Nort-023	Water Year 2021, Event #6	Northeast Delta	38.10115	-121.56298
Nort-024	Water Year 2021, Event #6	Northeast Delta	38.13515	-121.5631
Nort-025	Northeast Delta Oversample Point #1	Northeast Delta	38.12899	-121.49945
Nort-026	Northeast Delta Oversample Point #2	Northeast Delta	38.22743	-121.49593
Nort-027	Northeast Delta Oversample Point #3	Northeast Delta	38.15123	-121.54201
Nort-028	Northeast Delta Oversample Point #4	Northeast Delta	38.1161	-121.54768
Nort-029	Northeast Delta Oversample Point #5	Northeast Delta	38.20663	-121.48201
Nort-030	Northeast Delta Oversample Point #6	Northeast Delta	38.23858	-121.49731
Nort-031	Northeast Delta Oversample Point #7	Northeast Delta	38.11541	-121.58356
Nort-032	Northeast Delta Oversample Point #8	Northeast Delta	38.21212	-121.53676
Nort-033	Northeast Delta Oversample Point #9	Northeast Delta	38.14361	-121.50598
Nort-034	Northeast Delta Oversample Point #10	Northeast Delta	38.20431	-121.45748
(d) Subregion 4, South Delta				
Sout-001	Water Year 2022, Event #1	South Delta	38.05283	-121.49864
Sout-002	Water Year 2022, Event #1	South Delta	37.95823	-121.37949
Sout-003	Water Year 2022, Event #1	South Delta	38.04623	-121.47557
Sout-004	Water Year 2022, Event #1	South Delta	37.80751	-121.41535
Sout-005	Water Year 2022, Event #2	South Delta	38.03876	-121.48338
Sout-006	Water Year 2022, Event #2	South Delta	38.03283	-121.37984
Sout-007	Water Year 2022, Event #2	South Delta	37.99765	-121.41004

SiteID	Planned Sampling Event	Subregion	Latitude	Longitude
Sout-008	Water Year 2022, Event #2	South Delta	38.08578	-121.55262
Sout-009	Water Year 2022, Event #3	South Delta	37.82028	-121.49248
Sout-010	Water Year 2022, Event #3	South Delta	38.00564	-121.4443
Sout-011	Water Year 2022, Event #3	South Delta	37.79368	-121.30747
Sout-012	Water Year 2022, Event #3	South Delta	38.10007	-121.48869
Sout-013	Water Year 2022, Event #4	South Delta	37.95268	-121.3415
Sout-014	Water Year 2022, Event #4	South Delta	38.04105	-121.42992
Sout-015	Water Year 2022, Event #4	South Delta	37.79666	-121.46729
Sout-016	Water Year 2022, Event #4	South Delta	38.08991	-121.4808
Sout-017	Water Year 2022, Event #5	South Delta	38.04166	-121.49771
Sout-018	Water Year 2022, Event #5	South Delta	37.88673	-121.4445
Sout-019	Water Year 2022, Event #5	South Delta	38.05089	-121.46503
Sout-020	Water Year 2022, Event #5	South Delta	38.10563	-121.48937
Sout-021	Water Year 2022, Event #6	South Delta	37.81977	-121.52646
Sout-022	Water Year 2022, Event #6	South Delta	38.05065	-121.41834
Sout-023	Water Year 2022, Event #6	South Delta	37.9959	-121.36884
Sout-024	Water Year 2022, Event #6	South Delta	38.06388	-121.49817
Sout-025	South Delta Oversample Point #1	South Delta	37.91663	-121.32144
Sout-026	South Delta Oversample Point #2	South Delta	38.00774	-121.45576
Sout-027	South Delta Oversample Point #3	South Delta	37.80179	-121.31318
Sout-028	South Delta Oversample Point #4	South Delta	38.08441	-121.5025
Sout-029	South Delta Oversample Point #5	South Delta	37.95635	-121.29327
Sout-030	South Delta Oversample Point #6	South Delta	38.01117	-121.45969
Sout-031	South Delta Oversample Point #7	South Delta	37.81982	-121.47719
Sout-032	South Delta Oversample Point #8	South Delta	38.08585	-121.4327
Sout-033	South Delta Oversample Point #9	South Delta	38.03779	-121.48623
Sout-034	South Delta Oversample Point #10	South Delta	38.01175	-121.37018
(e) Subregion 5, Central Delta				
Cent-001	Water Year 2022, Event #1	Central Delta	37.83573	-121.55504
Cent-002	Water Year 2022, Event #1	Central Delta	37.92102	-121.51735
Cent-003	Water Year 2022, Event #2	Central Delta	38.07762	-121.57553
Cent-004	Water Year 2022, Event #2	Central Delta	38.03804	-121.59668
Cent-005	Water Year 2022, Event #3	Central Delta	37.90153	-121.614
Cent-006	Water Year 2022, Event #3	Central Delta	37.99242	-121.52336
Cent-007	Water Year 2022, Event #4	Central Delta	38.10001	-121.60055
Cent-008	Water Year 2022, Event #4	Central Delta	38.04206	-121.59015
Cent-009	Water Year 2022, Event #5	Central Delta	37.99109	-121.57778
Cent-010	Water Year 2022, Event #5	Central Delta	37.97646	-121.51462
Cent-011	Water Year 2022, Event #6	Central Delta	38.03492	-121.60047
Cent-012	Water Year 2022, Event #6	Central Delta	38.0232	-121.51372
Cent-013	Water Year 2023, Event #1	Central Delta	37.94248	-121.55928
Cent-014	Water Year 2023, Event #1	Central Delta	38.06307	-121.56103
Cent-015	Water Year 2023, Event #2	Central Delta	38.05692	-121.60865
Cent-016	Water Year 2023, Event #2	Central Delta	38.1042	-121.593

SiteID	Planned Sampling Event	Subregion	Latitude	Longitude
Cent-017	Water Year 2023, Event #3	Central Delta	37.92026	-121.55569
Cent-018	Water Year 2023, Event #3	Central Delta	37.99156	-121.51535
Cent-019	Water Year 2023, Event #4	Central Delta	38.06157	-121.61927
Cent-020	Water Year 2023, Event #4	Central Delta	38.02919	-121.58338
Cent-021	Water Year 2023, Event #5	Central Delta	37.8893	-121.57467
Cent-022	Water Year 2023, Event #5	Central Delta	38.00364	-121.52884
Cent-023	Water Year 2023, Event #6	Central Delta	38.05159	-121.63419
Cent-024	Water Year 2023, Event #6	Central Delta	38.03892	-121.56968
Cent-025	Central Delta Oversample Point #1	Central Delta	38.00963	-121.54678
Cent-026	Central Delta Oversample Point #2	Central Delta	37.97532	-121.52924
Cent-027	Central Delta Oversample Point #3	Central Delta	38.02158	-121.60701
Cent-028	Central Delta Oversample Point #4	Central Delta	38.05344	-121.52894
Cent-029	Central Delta Oversample Point #5	Central Delta	37.97748	-121.57555
Cent-030	Central Delta Oversample Point #6	Central Delta	38.0854	-121.5748
Cent-031	Central Delta Oversample Point #7	Central Delta	38.05183	-121.61223
Cent-032	Central Delta Oversample Point #8	Central Delta	38.09282	-121.66764
Cent-033	Central Delta Oversample Point #9	Central Delta	37.91614	-121.57317
Cent-034	Central Delta Oversample Point #10	Central Delta	37.98716	-121.51273
(f) Subregion 6, Confluence				
Conf-001	Water Year 2023, Event #1	Confluence	38.04107	-121.82461
Conf-002	Water Year 2023, Event #1	Confluence	38.05926	-121.82224
Conf-003	Water Year 2023, Event #1	Confluence	38.02936	-121.75401
Conf-004	Water Year 20223, Event #1	Confluence	38.0217	-121.73516
Conf-005	Water Year 2023, Event #2	Confluence	38.02386	-121.81611
Conf-006	Water Year 2023, Event #2	Confluence	38.06217	-121.84303
Conf-007	Water Year 2023, Event #2	Confluence	38.07803	-121.68256
Conf-008	Water Year 2023, Event #2	Confluence	38.04345	-121.70929
Conf-009	Water Year 2023, Event #3	Confluence	38.03502	-121.83132
Conf-010	Water Year 2023, Event #3	Confluence	38.0252	-121.74828
Conf-011	Water Year 2023, Event #3	Confluence	38.10005	-121.71903
Conf-012	Water Year 2023, Event #3	Confluence	38.10961	-121.71
Conf-013	Water Year 2023, Event #4	Confluence	38.07439	-121.77288
Conf-014	Water Year 2023, Event #4	Confluence	38.04787	-121.79496
Conf-015	Water Year 2023, Event #4	Confluence	38.02104	-121.70428
Conf-016	Water Year 2023, Event #4	Confluence	38.13653	-121.68669

SiteID	Planned Sampling Event	Subregion	Latitude	Longitude
Conf-017	Water Year 2023, Event #5	Confluence	38.04499	-121.80214
Conf-018	Water Year 2023, Event #5	Confluence	38.05608	-121.80726
Conf-019	Water Year 2023, Event #5	Confluence	38.05904	-121.67786
Conf-020	Water Year 2023, Event #5	Confluence	38.0094	-121.71992
Conf-021	Water Year 2023, Event #6	Confluence	38.02724	-121.81124
Conf-022	Water Year 2023, Event #6	Confluence	38.07076	-121.83746
Conf-023	Water Year 2023, Event #6	Confluence	38.08438	-121.71004
Conf-024	Water Year 2023, Event #6	Confluence	38.03909	-121.72454
Conf-025	Confluence Oversample Point #1	Confluence	38.06592	-121.79342
Conf-026	Confluence Oversample Point #2	Confluence	38.03582	-121.77693
Conf-027	Confluence Oversample Point #3	Confluence	38.05161	-121.69158
Conf-028	Confluence Oversample Point #4	Confluence	38.1158	-121.68543
Conf-029	Confluence Oversample Point #5	Confluence	38.08838	-121.73959
Conf-030	Confluence Oversample Point #6	Confluence	38.02255	-121.79957
Conf-031	Confluence Oversample Point #7	Confluence	38.01509	-121.69463
Conf-032	Confluence Oversample Point #8	Confluence	38.14447	-121.69162
Conf-033	Confluence Oversample Point #9	Confluence	38.0364	-121.80651
Conf-034	Confluence Oversample Point #10	Confluence	38.07157	-121.85175

These sampling points were created by performing five Generalized Random Tessellation Stratified (GRTS) draws using the R software. The project team selected draw #3 with points well distributed that included sample points in waterways that our technical advisors deemed important such as Discovery Bay, Miner Slough, Steamboat Slough, and the Stairstep.

Before sampling, the field crew chief will inspect each point against aerial photos, and make sure it can be safely reached by boat. If a location is inaccessible, the field crew may reject the site and choose the next site on the "oversample" list.

If the field crew determines in the field that target coordinates are inaccessible or unsafe, a sample should be taken within 100 meters of the target coordinates, if possible, and only if there is not some obvious change in the environment, such as moving downstream of an outfall, a change in water clarity, etc. If not possible to sample within 100 m, the crew should choose the next site on the "oversample" list shown in **Table 6.7**.

The order of visiting sampling sites during each sampling event will not affect the results. Field crews should aim to collect all samples in one day, to minimize the hold times and to maximize the number of toxicity tests that can be initiated in a single batch. If samples are collected over multiple days, separate batches may be needed for toxicity testing. The field crew may sample sites in the order that is most efficient in terms of time, fuel, and other logistical factors.

The monitoring design calls for sampling in 2 subregions each year. Sampling began in regions 1 and 2 in Water Year 2019: (1) Yolo Bypass-Cache Slough, and (2) Sacramento River. In Water

Year 2019, field crews collected a total of 24 samples in the first subregion, and 12 samples in the second subregion. In other words, the second subregion is sampled at "half intensity," with sampling split across two consecutive years. After four years, crews will have collected the desired number of samples (n = 24) in each of the 6 subregions. For subregions sampled at an intensity of n = 12 each year, crews will collect 2 samples during each of the 6 sampling events described in the following section. The detailed plan for how many samples to collect in each subregion is outlined in **Table 6.8**.

Table 6.8. Sampling schedule for pesticides and toxicity sampling at random locations in the six Delta subregions.

Subregion Number	Subregion Name	Number of Random Samples Planned in Water Year					
		2019	2020	2021	2022	2023	Total
1	Yolo Bypass - Cache Slough	24					24
2	Sacramento River	12	6	8			26
3	Northeast Delta		12	16			28
4	South Delta				24		24
5	Central Delta				12	12	24
6	Confluence					24	24
	Total	36	18	24	36	36	144

*The increased total samples in subregions 2 and 3 occurred because of repeating Event 3 from WY 20 since those samples were not analyzed for toxicity due to the onset of the COVID 19 pandemic restrictions (samples from that event were successfully analyzed for pesticides).

Field crews will collect one-sixth of the total annual samples during each of the 6 monitoring events each year. For subregions being sampled at full intensity, 4 samples will be collected during each event. For subregions being sampled at half intensity, 2 samples will be collected during each event. The number of samples collected during each event is detailed in **Table 6.9**. This table shows the number of regular environmental samples to be collected.

Table 6.9. Schedule for ambient water samples to be collected in WY21-22 for pesticides and toxicity analysis.

Sampling Event	GRTS Sites in Subregion 4	GRTS Sites in Subregion 5	Fixed Site 1: San Joaquin River at Buckley Cove	Fixed Site 2: Ulatis Creek at Brown's Road	Total
Event #1	4	2	1	1	8
Event #2	4	2	1	1	8
Event #3	4	2	1	1	8
Event #4	4	2	1	1	8
Event #5	4	2	1	1	8
Event #6	4	2	1	1	8

Sampling Event	GRTS Sites in Subregion 4	GRTS Sites in Subregion 5	Fixed Site 1: San Joaquin River at Buckley Cove	Fixed Site 2: Ulatis Creek at Brown's Road	Total
Total Samples	**24**	**12**	**6**	**6**	**48**

In addition, field crews shall collect field blanks for chemical analysis and field duplicate samples for chemical analysis and toxicity testing at a rate of 1 per 20 samples, as prescribed in **Table 14.2**. As the study design calls for 48 samples per year, this translates to 3 field duplicates collected during 6 events. Field duplicate locations will be randomly selected at the beginning of the water year for events 1, 3, and 5.

Adaptive management of the monitoring design is an important component of Delta RMP monitoring. Changes to the schedule described here may be made based on budgets, evolving priorities, or lessons learned from our sampling and data analysis. Changes may be made by the Technical Program Manager, in consultation with the Pesticide TAC and with the approval of the CVRWQCB QA Representative. The CVRWQCB QA Representative, PM, and QAO decide whether the project workplan and QAPP require modification; proposed modifications are brought to the TAC and SC for review and approval and approval is required from the CVRWQCB QA Representative.

Sampling Events

Sampling for pesticides and aquatic toxicity will be conducted over 6 events during the water year, designed to capture a range of hydrologic conditions and periods of the agricultural calendar. Among the 6 planned events, 3 are for storm sampling, and 3 for dry weather / irrigation season. Samples will be taken on the ebb tide, if possible.

Planned timing of sampling events is shown in **Table 6.10**. This table shows how the six events have been designed to capture a variety of hydrologic conditions throughout the year. The timing of sampling events shall be planned by the field crews and scientists at the Organic Chemistry Research Laboratory (OCRL), in collaboration with staff of PER, to ensure that the lab is ready to accept water samples and initiate the toxicity tests. The sampling triggers for storm sampling in **Table 6.10** are guidelines and actual sampling dates may be adjusted by the USGS-OCRL field crews based on their best professional judgment and with the goal to be as consistent as possible with the sampling triggers. Scheduling of sampling events and changes to the schedule shall be determined in coordination with the Technical Program Manager and the Pesticide TAC in a timely manner.

Staff will track the planned and actual monitoring dates as they are established; previously this was done in a google sheet called the "dashboard". The Delta RMP is currently exploring alternatives to google sheets for sharing updates regarding planned sample events and actual sampling dates; the Technical Program Manager will be responsible for tracking and communicating to the CVRWQCB QA Representative, TAC and Steering Committee the status of monitoring.

Table 6.10. Planned sampling events for pesticides and toxicity monitoring, storm triggers, and criteria.

#	Event	Event Type	Criteria	Sampling Triggers	Notes
1	First Flush	Storm Sampling	First runoff event in response to Central Valley rainfall after Oct 1st that meets the trigger.	The first event shall be an "urban first flush" event. The trigger shall be 0.5" of rainfall forecast in 24 hours for the basin. There should be at least 10 consecutive dry days between sampling events. This allows pesticide applicators time to go out and spray.	Changed in 2020, as it was felt the previous trigger (for a 2x-3x increase in flows) was too high, and there were several large precipitation events that occurred but did not technically meet this trigger.
2	Second Winter Storm	Storm Sampling	Minimum of 2 weeks since last event (time for lab to complete previous tests)	Guidance plots at appropriate discharge sites or recorded discharge at upstream flow stations show an approximately 2-3X increase in flows. Timing of actual sampling must take streamflow peak travel time into consideration.	Reservoir releases for flood control may mask storm runoff signal, need to watch Valley rainfall rates and totals.
3	Third Winter Storm or Spring Snowmelt runoff prior to irrigation	Storm Sampling/ winter runoff	Minimum of 2 weeks since last event (time for lab to complete previous tests)	Guidance plots at appropriate discharge sites or recorded discharge at upstream flow stations show an approximately 2-3X increase in flows. Timing of actual sampling must take streamflow peak travel time into consideration.	If a 3rd significant storm does not materialize, sample by the end of April during snowmelt period and prior to irrigation season.

#	Event	Event Type	Criteria	Sampling Triggers	Notes
4	Spring	Irrigation/ Baseflow	Approximately May-June but at least 30 days following last major rainfall/runoff event in Valley, to give time for drying of soils and initiation of irrigation season.	None	Timing of this sampling event is variable based on winter/spring rainfall timing and initiation of irrigation.
5	Summer	Irrigation/ Baseflow	Approximately mid-July	None	
6	Fall	Irrigation/ Baseflow	Approximately mid-September	None	

*Guidance plots developed by the California Department of Water Resources show forecast river flow and stage, and are available for dozens of river reaches in the Central Valley. https://cdec.water.ca.gov/guidance_plots

6.5. Constraints

The monitoring design calls for collecting samples for both toxicity and chemistry analysis at the same place and time. This sample design is intended to determine whether there is a relationship between pesticides in Delta waterways and harm to aquatic ecosystems. PER will be able to accept samples any day of the week, therefore not constraining sampling time.

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.

An inherent limitation of discrete samples is that they represent only a moment in time and may not represent conditions during other time periods.

6.6. Evaluation of Monitoring Data

Data analysis and interpretation in the Delta RMP provide answers to the assessment questions, and ultimately, the management questions (see **Section 5.1**).

Program participants develop the interpretation collectively in a science-based and collaborative process. With oversight by the TAC, program staff and contracted independent scientists conduct the relevant analyses by evaluating the data against the specific monitoring questions and benchmarks.

6.6.1. Mercury

The mercury monitoring is designed to answer the specific monitoring questions listed in **Section 5.1.2** and **Table 5.1**. Mercury concentrations in largemouth bass will be evaluated for interannual trends in time series and compared to the TMDL implementation goal of 0.24 mg/kg in 350 mm largemouth bass. Water concentrations for unfiltered methylmercury will be compared to the TMDL implementation goal of 0.06 ng/L. Water concentrations for unfiltered and filtered methylmercury and unfiltered and filtered total mercury will be compared to past data to evaluate trends. Concentrations in water will also be related to concentrations in fish in order to update the TMDL linkage analysis. A better understanding of the linkage, or relationship, between aqueous mercury and the concentration in fish tissue is an important goal of this study.

Monitoring of sport fish will also be conducted to assess whether wetland restoration projects in the Delta are influencing spatial and temporal patterns in bioaccumulation. Concentrations in sport fish at stations near restoration projects will be compared to concentrations in sport fish at the core stations and historic data. Time series at each station will also provide insight into the influence of the restoration projects.

6.6.2. Pesticides and Aquatic Toxicity

A better understanding of the effects of contaminants in the apparent decline of Delta ecosystems is a priority for regulators and stakeholders. Pesticide use in the Delta and Central Valley is one of the potential drivers of these effects. One of the goals of toxicity testing is to determine whether Delta waterways contain toxic substances in toxic amounts that are impairing the attainment of beneficial uses such as fish and wildlife habitat.

The overall objective of the Delta Regional Monitoring Program's (Delta RMP's) Current Use Pesticide (CUP) monitoring program is to collect ambient surface water samples to answer the program's Management and Assessment Questions (**Appendix B** and **Appendix C**). The management and assessment questions are broad and the Delta is large, so addressing them will require a correspondingly large effort over the course of several years. The study design was developed to make the best use of available funding to answer the highest priority Management and Assessment Questions in an initial effort to characterize the status and trends of pesticide concentrations and toxicity in the Delta.

6.7. Products and Reporting

Table 6.11 provides a summary of key products of the Delta RMP. Data from Status and Trends monitoring efforts will be made available annually for download via:

- The California Environmental Data Exchange Network (CEDEN)
- The California Estuaries web portal (link)

Data are planned to be reported in annual data reports and constituent-specific technical reports (i.e., reports on mercury, pesticides/toxicity, or nutrients) (every 2-3 years).

Provisional and final data will be made available for review and public release in a timely manner that will allow the Regional Board to be responsive to water quality concerns. This includes providing preliminary data within 60 calendar days of sample analysis per the requirements of Central Valley Water Board Resolution Number R5-2021-0054 (**Table 6.11**).

Technical reports will provide an in-depth evaluation of monitoring and special study results. These reports will facilitate technical review of Delta RMP studies and are targeted to a

technical audience. The annual reports and 3-year interpretive technical report for mercury will likely be prepared by staff from ASC and MPSL-DFW. For FY21-22, a mercury annual report is not currently budgeted due to some uncertainties associated with the governance transition; the TAC and Steering Committee will review the options for developing a mercury annual report and will provide a recommendation to the BOD. Reports for mercury and pesticides will be submitted first to the Mercury and Pesticide TACs, respectively, for technical review.

Table 6.11. Delta RMP reporting cycle.

Deliverable	Frequency	Planned release date
Preliminary Data Submittals		
USGS Pesticide Results	Per Event	Within 60 calendar days of sample analysis date
USGS NWQL Results	Per Event	Within 60 calendar days of sample analysis date[1]
Toxicity Results - CEDEN Template	Per Event	Within 60 calendar days of sample analysis date
Mercury Results -CEDEN Template	Per Event	Within 40 calendar days of sample analysis date
Data uploads		
CEDEN	Annually	Within 6 months of the last sampling event date
Reports		
Data Reports (including QA report)	Annually[2]	April 1
Delta RMP Annual Report	Annually[3]	February 1
Technical Reports	Variable	Variable

[1] Data from the NWQL requires additional review prior to submitting to the DRMP as preliminary; due to COVID-19, there are currently staffing issues which area delaying the review of data and may take up to 6 months for the data to receive a final internal review by USGS. The CVRWQCB Executive Officer approved providing the NWQL data to the CVRWQCB up to 6 months from the date of sample analysis, since this deviates from Resolution R5-2021-0054.

[2]CUP time period of data for Data Reports is on a water year (September 1 – October 31) and will therefore be provided by April 1 on the complete dataset.

[3] Per Resolution R5-2021-0054, the Delta RMP will submit an Annual Report to the CVRWQCB for the previous fiscal year; pesticide data collected within the previous fiscal year will be reported and assessed for precision, accuracy, and completeness in the Annual Report.

6.7.1. QA Summary Report

The Project QA officer or designee shall write a report for each dataset outlining the quality of the data (for disciplines other than toxicity testing). This report will highlight any issues that were identified by the laboratory, project manager, or data management staff and describe how they were addressed. 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:
    - Deviations and corrective actions
    - Dataset completeness
    - Overall acceptability
    - MDLs sensitivity
    - Blank sample averages and ranges (lab method blanks, field created blanks)
    - Precision averages and ranges from replicate field samples
    - Accuracy (using a variety of standard reference materials or matrix spike quality assurance recoveries)
    - Confirmation that total fractions exceed dissolved fractions
    - Comparison of results to previous year's observations as an additional check on data consistency and data quality
    - Any other data quality issues (such as toxicity test result irregularities)

The QA summary report will be reviewed and approved by the QAO and Technical Program Manager and will be included in a year-end data report as an appendix. These reports are reviewed by the Central Valley Regional Board QA Representative, TACs and the Steering Committee.

Annual data reports are planned to describe chemical analyses for each of the focus areas (e.g., pesticides, toxicity, mercury, etc.). Monitoring data (and associated metadata) will be made available to the Regional Board within 60 calendar days of sample analysis date (for preliminary data) and the fully QA'd data will be made publicly accessible no more than six months after the last sample collection per the Board Resolution Number R5-2021-0054.

7. Quality Objectives and Criteria

7.1. Data Quality Objectives

Data Quality Objectives (DQOs) aim to support defensible conclusions that address the management and assessment questions in **Appendix B** and **Appendix C**.

7.1.1. Pesticides

The overall objectives of the Delta RMP's Current Use Pesticide (CUP) monitoring program are to collect ambient surface water samples to answer the Program's Management and Assessment Questions. The management and assessment questions are broad and the Delta is large, so addressing them will require a correspondingly large effort over the course of several years. The study design was developed to make the best use of available funding to answer the highest priority Management and Assessment Questions in an initial effort to characterize the status and trends of pesticide concentrations and toxicity in the Delta.

The priority questions driving the design for the CUP study are:

ST1. To what extent do current use pesticides contribute to observed toxicity in the Delta?

ST1.1 - If samples are toxic, do detected pesticides explain the toxicity?

ST1.2 - What are the spatial and temporal extent of lethal and sublethal aquatic and sediment toxicity observed in the Delta?

ST2 - What are the spatial/temporal distributions of concentrations of currently used pesticides identified as possible causes of observed toxicity?

Data quality objectives (DQOs) for the pesticides and toxicity monitoring program are shown in **Table 7.1**. The decision rules in **Table 7.1** anticipate that parametric statistical methods will be used. If data are non-normally distributed or regression residuals are non-normal, there may be a need to use nonparametric statistical analysis methods. Nonparametric methods may require larger sample sizes to answer the assessment questions listed in **Table 7.1**. The table shows tolerable limits on decision errors (referred to by statisticians as *alpha* and *beta*) based on commonly used assumptions in similar scientific studies. The planned study calls for a statistical significance level (alpha) of 0.05 for a one-tailed hypothesis test. For example, suppose you are testing whether more than 1% of river miles have a pesticide concentration exceeding a screening value. With alpha = 0.05, there is a 5% chance of a false positive with hypothesis testing (incorrectly concluding that concentrations in these river miles exceed the screening value.) The choice of beta of 0.2 is the probability of a false negative. Statistical power is 1 – beta or 0.8. This means, for example, that you have a 20% chance of incorrectly concluding that a predicted pesticide concentration does not exceed a screening value.

Water quality screening values – The simplest way of determining whether a chemical may be causing an adverse impact on a waterway is to compare observed concentrations to a water quality standard or benchmark. When such a value has the force of law, it is referred to as a standard, or in California, a water quality objective. However, state and federal regulators have

written standards for only a few current use pesticides. For example, the CVRWQCB has established water quality objectives for chlorpyrifos and diazinon that cover much of the Central Valley including the Delta.[3] For the hundreds of other current use pesticides, there are neither national water quality criteria recommended by the EPA, nor are there state water quality objectives.

Comparing ambient concentrations to other benchmarks, or screening values, is a useful first step in the process for interpreting pesticide data and evaluating relative risk. The choice of a screening value is important. If monitoring shows that concentrations exceed a conservative screening value, the implication is that there may be a problem. The choice of screening values is a complicated technical question and will be discussed within the Pesticide TAC and with the Central Valley Water Board. As required by Board Resolution Number R5-2021-0054, the Water Board staff will provide the RMP with all relevant water quality metrics by July 1 annually (based on the current FY monitoring workplan). Additionally, the RMP is required to report to the Central Valley Water Board any exceedances of those water quality metrics within 60 calendar days of sample analysis.

Options for setting screening values include aquatic life (AL) benchmarks published by the US EPA Office of Pesticide Programs (OPP). OPP benchmarks were developed by the EPA for use in the agency's risk assessments conducted as part of the decision-making process for pesticide registration. The OPP benchmark values are based on the most sensitive species tested within taxonomic groups (fish, invertebrates, and vascular and non-vascular plants). They represent the lowest toxicity values available from peer-reviewed data with transparent data quality standards and may be divided by a safety factor.

Handling of non-detects – In the first two years of pesticide monitoring by the Delta RMP, many of the pesticide chemistry results were non-detects. Statistical methods should be chosen carefully for handling "censored data" (Helsel 2010). Common methods used in the past, such as substitution of zero or one-half the detection limit for non-detects, are known to introduce bias in data analyses. The Delta RMP will continue to evaluate non-detect analysis options and discuss future use of non-detect data in interpretative reports and annual summaries. All non-detects will be coded in CEDEN as less than the MDL.

[3] See *Amendments to the 1994 Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (Central Valley Regional Water Quality Control Board, 2016), Table III-2A, Specific Pesticide Objectives, on page III-6.01. Chronic toxicity is based on the average concentration over a 4-day period.

Table 7.1. Data Quality Objectives for Pesticides and Aquatic Toxicity Monitoring: Analytic approach, decision rule, and data quality objectives.

Questions to Answer with Delta RMP Pesticide Data	Analytic Approach	Decision Rule	Data Quality Objectives	Power Analysis
(a) Spatial extent of pesticide, toxicity occurrence				
Spatial extent of pesticide, toxicity occurrence: **For what percent of the subregion was aquatic toxicity and co-occurrence of pesticides greater than risk-based thresholds observed?** **Over what percentage of the subregion does a pesticide concentration exceed a threshold?** **Secondary objective that can be evaluated qualitatively:** **Identify spatial patterns in aquatic toxicity and pesticide concentrations within the subregion to inform decisions about sensitive habitats, sources, and strata for future designs.**	Metrics for toxicity: 1. Binary variable (0/1, or True/False) indicating whether significant toxicity was observed (stratified by species, and possibly by endpoint) 2. Continuous variable - Percent effect observed for individual toxicity tests: reduction in organism survival, reproduction, or growth compared to control. Metric for pesticides: 1. Continuous variable: Observed concentration of individual pesticides, in ng/L 2. Binary variable (0/1 or True/False) Individual pesticide observations exceeding a risk threshold. 3. Frequency with which individual pesticides exceed a threshold. 4. Cumulative frequency of exceedance (for one or all pesticides) 5. Cumulative frequency of exceedance for classes of pesticides grouped by type or	Population estimates will be made using open source R software ('spsurvey'). Population estimates are not a statistical test. There is no null hypothesis. The result will be a percent of subregion water area meeting a certain condition such as: -Percent of subregion with statically significant aquatic toxicity -Percent of subregion with pesticide concentrations above risk based thresholds -Percent of subregion with significant toxicity AND pesticide concentrations above risk based thresholds	The sample size for each subregion should be large enough to be able to estimate the percent of subregion's water area with a certain condition with error bars of ±10%. Assume a Type 1 error of <0.05 and a Type 2 error of <0.2 (80% statistical power).	Under a random sampling design, a standard probability distribution known as the binomial distribution can be used to estimate of the upper and lower bounds of confidence intervals. A sample size of n = 24 gives a 90% confidence interval of around ±13%. (This is acceptably close to our objective of ±10%.) More details on the power analysis are available in the study proposal; copies available upon request.

Questions to Answer with Delta RMP Pesticide Data	Analytic Approach	Decision Rule	Data Quality Objectives	Power Analysis
	mode of action (organophosphate and pyrethroids) Pesticide Toxicity Index*Metric for determining cause of toxicity: outcome of Toxicity Identification Evaluations (TIEs)			
(b) Co-Occurrence of Pesticides and Toxicity				
Causes of toxicity Evaluate the co-occurrence of aquatic toxicity and pesticides.	Metrics for toxicity: 1. Binary variable (0/1, or True/False) indicating whether significant toxicity was observed (stratified by species, and possibly by endpoint) 2. Continuous variable - Percent effect observed for individual toxicity tests: reduction in organism survival, reproduction, or growth compared to control. Metrics for pesticides: 1. Continuous variable: Observed concentration of individual pesticides, in ng/L 2. Binary variable (0/1 or True/False) Individual pesticide observations exceeding a risk threshold. 3. Frequency with which individual pesticides exceed a threshold.	Statistical Test: -Logistic Regression -Multivariate linear regression All data from all sites will be pooled for the test if and/or sites to be analyzed individually based on a statistical analysis of their similarity using Generalized Linear Models or Principal Components Analysis. Null hypotheses: Ho: Toxicity is not related to exposure to pesticides. (There is no relationship between pesticide levels and toxicity.) Ha: There exists a relationship between	The test should be able to detect a 5% effect** of pesticide exposure with a Type 1 error of <0.1 and a Type 2 error of <0.2 (80% power).	For the site on the San Joaquin River at Buckley Cove, to detect an effect size = 0.03 would require around 60 samples. In this context, an effect size of 0.03 is equivalent to a 3% increase in toxicity to macroinvertebrates for each unit increase in the Pesticide Toxicity Index (PTI). Requires 36 new samples at each site, or 6 years (i.e., collecting 6 samples per year at this fixed location). More details on the power analysis are available in the study

Questions to Answer with Delta RMP Pesticide Data	Analytic Approach	Decision Rule	Data Quality Objectives	Power Analysis
	4. Cumulative frequency of exceedance (for one or all pesticides) 5. Cumulative frequency of exceedance for classes of pesticides grouped by type or mode of action (organophosphate and pyrethroids) 6. Pesticide Toxicity Index*	pesticide exposure and the toxicity.		proposal; copies available upon request

* The Pesticide Toxicity Index (PTI) is a screening tool to assess potential aquatic toxicity of complex pesticide mixtures by combining measures of pesticide exposure and acute toxicity in an additive toxic-unit model. For more information, see "Pesticide Toxicity Index—A tool for assessing potential toxicity of pesticide mixtures to freshwater aquatic organisms" (Nowell et al. 2014).

** An effect size of 5% means that a unit increase of the PTI would result in a 5% reduction in a toxicity endpoint such as reproduction, survival, or growth. In general, large effect sizes (e.g., 50% reduction in survival) are easier to detect with smaller sample sizes, while small effect sizes (5% reduction in survival) are more difficult to differentiate from random chance and need a much larger number of samples to detect.)

7.1.2. Aquatic Toxicity

For the Delta RMP, the primary goal of toxicity testing is to determine whether pesticides are potentially causing significant aquatic toxicity in the Delta. Toxicity testing is an integrative tool because it evaluates the combined effects from multiple constituents on biota concurrently in site media and provides an environmentally relevant understanding of the potential for beneficial use impairment. Chemical analyses are also important for understanding trends and can be compared with paired sample toxicity test data to identify which pesticides (or other parameters) might be contributing to observed effects.

Toxicity Identification Evaluations (TIEs) are an investigative tool that can be used to identify the class of contaminants causing toxicity. The primary goal of Delta RMP TIE testing is to determine if pesticides (or degradates, or any of the inert ingredients in the formulated product), are contributing to observed effects.

Appendix I describes the protocol the Delta RMP will follow for deciding whether to initiate a TIE. TIEs will target Delta RMP samples when there is a ≥ 50 percent adverse effect observed (for *either* chronic or acute tests, at *any* point during the test, and for *all* test organisms and *all* endpoints).

TIEs shall be initiated within 48 hours of the observation of the TIE trigger being met in an initial toxicity test. 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. Potential toxicity drivers may be determined (via weight of evidence) from the TIE, paired chemistry data, and/or with more advanced TIEs. A secondary goal is to identify other factors (i.e., water quality conditions or other toxicants) contributing to reduced survival, growth, or reproduction.

Table 14.3 and **Table 14.4** outline the data quality indicators and MQOs for toxicity testing and water quality measurements associated with the toxicity testing procedures**.** Test methods shall follow USEPA (2002) and SWAMP guidance (most recent version dated August 22, 2018) and updated Toxicity Template Guide (most recent version dated October 2021).[4] Test results will be rejected when test acceptability criteria are not met; however, a sample may be retested and qualified as having exceeded the recommended hold time if the Technical Program Manager, the PER project director, PER project manager, and the SWB QA Officer and RWB QA Representative agree on the need for additional testing/retesting as advised by the TAC.

[4] https://www.waterboards.ca.gov/water_issues/programs/swamp/swamp_iq/docs/chronic_freshwater_tox_mqo_082218.pdf and October 2021 updated SWAMP Toxicity Template Guide (SWAMP_Tox_Data_Template_Guide_10-2021.pdf - Google Drive)

7.1.3. Mercury

The Delta Methylmercury TMDL uses a tissue-based implementation goal of 0.24 ppm in 350 mm largemouth bass to determine impairment within Delta subregions. However, due to permit restrictions on electrofishing, four sites will require fish monitoring by hook and line methods. For these locations, the goal will be to collect fish in the size ranges consistent with past sampling with smaller sample sizes with the priority to get the 5 fish in the 305-407 mm range:

- 2 fish in the 200-249 mm range
- 2 fish in the 250-304 mm range
- 5 fish in the 305-407 mm range
- 2 fish >407 mm

Monitoring of mercury concentrations in sport fish tissue as an index of mercury impairment in the Delta and as a performance measure for the TMDL was identified by the Delta RMP as a priority data need.

The priority assessment question driving the design for the methylmercury monitoring is:

ST1. What are the status and trends in ambient concentrations of methylmercury and total mercury in sport fish and water, particularly in subareas likely to be affected by major existing or new sources (e.g., large-scale restoration projects)?

ST1.A. Do trends over time in methylmercury in sport fish vary among Delta subareas?

ST1.B. Do trends over time in methylmercury in water vary among Delta subareas?

The initial and preliminary data quality objective (DQO) for subregional bass trend monitoring is the ability to detect a change or trend in mercury in 350 mm largemouth bass of 0.040 ppm/yr. This DQO will be refined when additional data are available. MQOs are identical to those used in other mercury studies throughout the state for determinations of impairment and trend detection. These MQOs generally call for indices of accuracy and precision to be within 30% of expected values.

The Delta Methylmercury TMDL describes a statistically significant relationship between the annual average concentration of methylmercury in unfiltered water and average mercury in 350 mm largemouth bass, when data are organized by subarea. The linkage of aqueous methylmercury concentration to fish mercury concentration provides a connection between methylmercury inputs from various in-Delta pathways (e.g., municipal wastewater, municipal

stormwater, agricultural drainage, and wetlands) and impairment of beneficial uses. Because of this linkage, the Delta Methylmercury TMDL established an implementation goal of 0.06 ng/L of unfiltered aqueous methylmercury[5,6]. Monitoring of fish mercury and aqueous methylmercury is needed to: better quantify the fish-water linkage that is the foundation of the TMDL; support development of a mercury model for the Delta; support evaluation of the fish data by providing information on processes and trends; and provide mass balance data for re-evaluation of the Delta Methylmercury TMDL, when it is updated. The aqueous methylmercury data are not intended for use for a rigorous evaluation of interannual trends.

Restoration monitoring addresses questions relating to SPLP, Forecasting Scenarios, and Effectiveness Tracking. The basic concern with restoration projects is that they may enhance net methylmercury production within the Delta ecosystem and represent an internal source that increases as projects proceed (SPLP Question 1B: How do internal sources and processes influence MeHg levels in fish in the Delta?) – restoration monitoring will track whether this occurs or not. Restoration monitoring will yield insights into which types of projects, if any, impact net methylmercury production and food web accumulation (Forecasting Scenarios Question 1: What will be the effects of in-progress and planned source controls, restoration projects, and water management changes on ambient methylmercury concentrations in fish in the Delta?) and whether internal loadings change and ambient water quality shows net improvement as a result of restoration projects (Effectiveness Tracking).

For restoration monitoring with prey fish to answer sub-questions calling for comparisons among stations over time and space, based on data collected for the same target species with the same design in the North Bay Biosentinel Project, ANOVAs to detect differences in means across groups of stations will have high power (> 0.99), and pairwise comparisons will have 80% power to detect a difference of 0.023 between stations or time intervals. Although, this won't be a part of monitoring in 2021-20211, prey sampling could occur in a subsequent monitoring year.

[5] For methylmercury, aqueous samples should be analyzed using USEPA method 1630 with a method detection limit of 0.02 ng/L or less. For total recoverable mercury, aqueous samples should be analyzed with a method detection limit of 0.2 ng/l or less.

[6] The preferred method for total mercury is USEPA Method 1631 Revision E. If quality control objectives are not being met (for example, recoveries in matrix spike samples are outside of expected limits) and matrix interferences are suspected as the cause, USEPA Method 245.7 may be used, if detectable concentrations are within the range of the method's calibration and quality control criteria.

7.2. Data Quality Indicators

Data Quality Indicators (DQIs) are the quantitative measures and qualitative descriptors used to set limits of acceptable levels of data error. The principal data quality indicators for the Delta RMP are precision, accuracy/bias, comparability, completeness, and representativeness (SWRCB 2017).

- **Precision** describes how close the agreement is between multiple measurements (SWRCB 2017).
- **Accuracy (Bias)** is the assessment of the closeness of agreement between a measured or determined value and the true value. Bias is the quantitative measure of the difference between those values (NDT 2016).
- **Comparability** expresses the measure of confidence that one dataset can be compared to and combined with another for a decision(s) to be made (US EPA QA/G-5 2002).
- **Completeness** refers to the comparison between the amount of valid data originally planned to be collected, and the actual quantity collected (US EPA QA/G-5 2002).
- **Representativeness** is the degree to which measurements correctly represent the environmental condition, target organism population, and/or watershed to be studied (US EPA QA/G-5 2002).
- **Sensitivity** is the ability of a measurement to detect small quantities and differences in concentration of the measured component.

7.3. Field Quality Control Measurements for Sensors and Sample Collection

7.3.1. Field Measurements

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). The project will address the precision of field measurements by performing replicate measures at the required intervals described in **Section 14.1**, Field Measurements.

Accuracy of field measurements is established by calibration and tested by periodic measurement of known standards. The project will perform instrument calibration prior to each sampling day or event for user-calibrated instruments (e.g., daily for handheld field meters), or at the manufacturer-specified interval for instruments requiring factory servicing or otherwise incapable of field calibration. All instruments undergo blank and calibration checks as described in **Table 14.1**.

Instruments will also be visually inspected for fouling at the checkpoints and cleaned if necessary. Fouling and drift of instruments may occur due to electrical, optical, and/or communication issues, but redundant measurements can distinguish such issues from environmental variability.

Completeness of field measurement is evaluated as the percentage of usable measurements out of the total number of measurements desired. The project will ensure that at least 90% of the planned field measurements are collected and are 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.

Comparability of field measurements will be ensured by using protocols (see **Section 23**) and QA standards that are comparable within the project and to similar monitoring projects in the study area.

Representativeness of field measurements will be ensured by utilizing standardized protocols (**Section 23**) and selecting representative monitoring sites and underway paths to support the project management questions (**Section 5.1**). Conditions that may influence the measurements will be noted in the database and measurements may be retaken if necessary.

Sensitivity is most commonly defined as the lowest value an instrument or method can measure with reasonable statistical certainty (SWRCB 2017) as well as the ability of the instrument to detect small changes. Where applicable, the desired sensitivity is expressed as a target detection limit (**Section 6.2**) and resolution of a deployed sensor. For this project, sensors will be used that meet the DQOs.

7.3.2. Field Sample Collection

Precision of the field sample collection will be evaluated by collecting field duplicates/replicates (for water and sediment samples). Replicate (e.g., duplicate) samples account for variability in the field collection and laboratory analysis combined and are collected at the same time under the same conditions as the original sample. Different ways of collecting replicate field samples are possible and include different factors contributing to sample variability. For the purposes of this project, we use the following terminology:

- Field replicate - these do not have a separate code or definition in CEDEN, and just maintain the same SampleType (e.g., Grab, Integrated), incrementing in Replicate count. For this project,"field replicate" is used to indicate separate samples collected from the field for a given site and event. These capture not just the heterogeneity of subsampling or splitting the sample matrix, but also the spatial and temporal variation in collection within a given site for a collection event. Minimum frequencies and target performance requirements for field replicates are described in **Table 14.2**.

Bias. In the field, contamination of field samples can be introduced by sampling equipment or personnel during field sample collection, in addition to any contamination already present in the sampling container or blank water used, which introduces bias to the analyses. Naming conventions for blanks will differ among projects, so here we define their usage for this project based upon CEDEN descriptions. Bottle blank - in CEDEN: "An analyte-free water sample prepared in the laboratory and used to evaluate potential contamination due to sample container or laboratory cleaning methods."

- Travel blanks - in CEDEN: "Clean water transported to site, handled like sample (never opened), and returned to laboratory for analysis". 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.
- Field (ambient) blank - in CEDEN: "Clean water taken to field, transferred to container, preserved (if appropriate) and treated same as corresponding sample type during the sampling event." These add exposure to the field sampling environment, in addition to those included in travel blanks. The "treated same as" part of the description is interpreted for the purposes of the Delta RMP as applying to steps only after the blank is in the container (i.e., not exposed to or transferred by field sampling equipment). Field blanks collected using field equipment are instead listed as "(field) equipment blanks" (defined below).
- Equipment blank - in CEDEN: "Clean water pumped through new equipment, cleaned equipment after decontamination, equipment for non-surface water, new lot of filters (metals), preserved (if appl.) and analyzed." CEDEN instructs to note in the comments field the equipment type and whether these are done in the lab or field.

To collect a field blank, reagent grade water provided by the analytical lab, shall be transferred into a sample container provided by the analytical laboratory without using the usual collection equipment, but treated the same as field samples after collection. Since this does not include any field equipment, a field blank can be collected any time while at a field site.

Any field equipment blanks for equipment used a single time within an event, can be collected at any point during sample collection, but ensure the sample is collected using clean or new equipment. For equipment used for multiple sites before replacement or recleaning at a lab, equipment will be field cleaned or flushed as usual between sites, except where site-water is normally used, using blank water instead.

Field blanks (NOT including equipment) will be obtained at a frequency of at least 5% of the collected samples, unless a lab or principal investigator opts (based on experience or best professional judgement) to collect field equipment blanks instead. Minimum frequencies and target performance requirements for field (ambient) blanks, travel/bottle blanks, and field equipment blanks are described in **Table 14.2**.

Neither bottle blanks nor travel blanks are required as part of this project at the present time. The Delta RMP QAO may decide to reinstate these other types of blanks in the future, for example when an established procedure is changed or when contamination problems are identified. In some cases, field-generated equipment blanks may be substituted for field blanks, but must be approved by the Delta RMP PM and QAO.

Accuracy. Field blank or equipment blank contamination discussed previously will also affect the accuracy of measurements, usually causing a high bias in reported concentrations. Matrix interference by various environmental substances will also cause high biases (by being mistaken for target compounds) or low biases (by competition for or consumption of reagents, or attenuating measured signals). Similarly biotic and abiotic reactions in the sample due to improper preservation and/or extended storage will cause loss of some target analytes, or generation of others (e.g., metabolites or degradates). Minimum frequencies and target performance requirements for matrix spike samples are described in **Table 14.2**.

7.4. Chemistry Laboratory Quality Control Measurements

The discussion in this section reviews the measurements and procedures expected to demonstrate the quality of reported data. **Table 7.2** provides an overview of quality control (QC) sample types and their purpose. The quality assessment process that is used after the data have been collected to evaluate whether the Data Quality Objectives (DQOs) have been satisfied is described and illustrated in **Section 22**, Data Review, Verification, and Validation.

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 measurement quality objectives and method quality objectives listed in the QAPP (**Table 14.2**) as well as demonstrate ability to meet the project's required reporting levels. On-going demonstration of capability during analysis of project samples includes routine analyses (e.g., intercomparison studies) that ensure on a continual basis that MQOs and RLs listed in **Table 7.3** and **Table 7.4** are met.

Table 7.2. 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	Bias/confirm the absence of analytes introduced in the lab (laboratory chemical analysis).
Laboratory Blanks - Instrument Blanks	Bias/Assess the presence or absence of instrument contamination (laboratory chemical analysis).
CRM (Certified 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 Equipment Blanks	Bias/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 for applicable sample types.

QC Sample Type	Data Quality Indicator/Purpose
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 in by laboratory duplicates.
Instrument Replicates	Precision of instrument (laboratory chemical analysis).
Travel/bottle blanks	Bias/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).
For Aquatic Toxicity Testing Only	
Negative Control (e.g., Laboratory control)	To evaluate test performance, health, and sensitivity of the specific batch of organisms (laboratory toxicity testing).
Negative Control – Tolerance Control Water for Unmanipulated Samples (e.g., Conductivity control)	Evaluates the effects of water quality parameters near the tolerance threshold of the organism (laboratory toxicity testing).
Positive Control (Reference toxicant testing)	To evaluate the sensitivity, precision, and accuracy of toxicity tests performed in the laboratory. Also, to 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).

Table 7.3. Summary of reporting limits (RL) and method detection limits (MDL) for Delta RMP constituents for conventional analytes, field parameters, and trace metals.

CAS Registry Number	Constituent	Matrix	Reporting group	RL	MDL	Unit	Analyzing laboratory	Method used
Mercury monitoring by Moss Landing Marine Laboratory								
479-61-8	Chlorophyll a	Water	Conventional	30	24	µg/L	MPSL-DFW	EPA 445.0
7440-44-0	Dissolved Organic Carbon	Water	Conventional	0.3	0.2	mg/L	MPSL-DFW	SM 5310 C
n/a	Total Suspended Solids	Water	Conventional	6.3	2.1	mg/L	MPSL-DFW	MPSL-108
n/a	Volatile Suspended Solids	Water	Conventional	6.75	2.25	mg/L	MPSL-DFW	MPSL-108
7782-44-7	Oxygen, Dissolved	Water	Field Parameters	0.5	0.5	mg/L	MPSL-DFW	National Field Manual for the Collection for Water-Quality Data, Chapter A6, Field Measurements
n/a	pH	Water	Field Parameters	4-8	4-8	NA	MPSL-DFW	
n/a	Specific Conductivity	Water	Field Parameters	10	10	µS/cm	MPSL-DFW	
n/a	Temperature	Water	Field Parameters	NA	NA	NA	MPSL-DFW	
7439-97-6	Mercury, total	Tissue	Trace Metals	0.012	0.004*	µg/g ww	MPSL-DFW	EPA 7473
7439-97-6	Mercury, total (unfiltered)	Water	Trace Metals	0.200	0.070*	ng/L	MPSL-DFW	EPA 1631E
7439-97-6	Mercury, dissolved (filtered)	Water	Trace Metals	0.200	0.070*	ng/L	MPSL-DFW	EPA 1631E
22967-92-6	Mercury, Methyl, total (unfiltered)	Water	Trace Metals	0.036	0.015*	ng/L	MPSL-DFW	EPA 1630
22967-92-6	Mercury, Methyl, dissolved (filtered)	Water	Trace Metals	0.036	0.015*	ng/L	MPSL-DFW	EPA 1630
Metals and ancillary parameters by the USGS National Water Quality Laboratory (NWQL)								
7440-50-8	Copper, dissolved	Water	Trace Metals	0.8	0.8	µg/L	USGS	TM-5-B1
7440-44-0	Dissolved Organic Carbon (DOC)	Water	Conventional	0.46	0.23	mg/L	USGS	SM 5310B

CAS Registry Number	Constituent	Matrix	Reporting group	RL	MDL	Unit	Analyzing laboratory	Method used
7440-44-0	Particulate Organic Carbon (POC)	Suspended Sediment	Conventional	0.1	0.05	mg/L	USGS	EPA 440.0
7440-44-0	Particulate Inorganic Carbon (PIC)	Suspended Sediment	Conventional	0.06	0.03	mg/L	USGS	EPA 440.0
7440-44-0	Total Particulate Carbon (TPC)	Suspended Sediment	Conventional	0.1	0.05	mg/L	USGS	EPA 440.0
133-74-0	Total Particulate Nitrogen (TPN)	Suspended Sediment	Conventional	0.06	0.03	mg/L	USGS	EPA 440.0

*MDL is calculated according to 40 CFR Part 136, appendix B, rev 2 (2016) and are reported with data sets. Values may change more frequently than QAPP revisions.

Table 7.4. Summary of reporting limits (RL) and method detection limits (MDL) for Delta RMP constituents for current use pesticides analyzed by USGS Organic Chemistry Research Laboratory (OCRL).

All pesticides are analyzed by method USGS-Gross, 2021. All pesticides are reported in nanograms per liter (ng/L). See also **Table 5.3** for water quality thresholds for pesticide analytes. This table does not list "historic" analytes that were dropped by the lab in 2018 or in 2021.

CAS Registry Number	Analyte	RL in Suspended Sediment (ng/L)	RL in Filtered Water (ng/L)	MDL in Suspended Sediment (ng/L)	MDL in Filtered Water (ng/L)	Analytical Instrumentation, Suspended Sediment	Analytical Instrumentation, Filtered Water
135410-20-7	Acetamiprid	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
34256-82-1	Acetochlor	3	3	1	1	LC-MS/MS	LC-MS/MS
135158-54-2	Acibenzolar-S-Methyl	6	6	2	2	GC-MS/MS	GC-MS/MS
584-79-2	Allethrin	6	6	2	2	GC-MS/MS	GC-MS/MS
1912-24-9	Atrazine	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
6190-65-4	Atrazine, Desethyl	3	3	1	1	LC-MS/MS	LC-MS/MS
1007-28-9	Atrazine, Desisopropyl	3	3	1	1	LC-MS/MS	LC-MS/MS
131860-33-8	Azoxystrobin	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
1861-40-1	Benefin (Benfluralin)	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS

CAS Registry Number	Analyte	RL in Suspended Sediment (ng/L)	RL in Filtered Water (ng/L)	MDL in Suspended Sediment (ng/L)	MDL in Filtered Water (ng/L)	Analytical Instrumentation, Suspended Sediment	Analytical Instrumentation, Filtered Water
25057-89-0	Bentazon	–	3	–	1	–	LC-MS/MS
156963-66-5	Benzobicyclon	3	3	1	1	LC-MS/MS	LC-MS/MS
1072957-71-1	Benzovindiflupyr	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
82657-04-3	Bifenthrin	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
188425-85-6	Boscalid	3	3	1	1	LC-MS/MS	LC-MS/MS
661463-87-2	Boscalid Metabolite - M510F01 Acetyl	–	1.5	–	0.5	–	LC-MS/MS
1207727-04-5	Broflanilide	–	1.5	–	0.5	–	LC-MS/MS
116255-48-2	Bromuconazole	3	3	1	1	LC-MS/MS	LC-MS/MS
33629-47-9	Butralin	–	3	–	1	–	LC-MS/MS
63-25-2	Carbaryl	–	1.5	–	0.5	–	LC-MS/MS
10605-21-7	Carbendazim	–	1.5	–	0.5	–	LC-MS/MS
1563-66-2	Carbofuran	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
500008-45-7	Chlorantraniliprole	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
122453-73-0	Chlorfenapyr	6	6	2	2	GC-MS/MS	GC-MS/MS
1897-45-6	Chlorothalonil	–	15	–	5	–	GC-MS/MS
2921-88-2	Chlorpyrifos	–	3	–	1	–	LC-MS/MS
5598-15-2	Chlorpyrifos Oxon	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
81777-89-1	Clomazone	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
210880-92-5	Clothianidin	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
135018-15-4	Clothianidin Desmethyl	3	3	1	1	LC-MS/MS	LC-MS/MS
56-72-4	Coumaphos	3	3	1	1	LC-MS/MS	LC-MS/MS
736994-63-1	Cyantraniliprole	3	3	1	1	LC-MS/MS	LC-MS/MS
120116-88-3	Cyazofamid	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
1031756-98-5	Cyclaniliprole	3	3	1	1	LC-MS/MS	LC-MS/MS

CAS Registry Number	Analyte	RL in Suspended Sediment (ng/L)	RL in Filtered Water (ng/L)	MDL in Suspended Sediment (ng/L)	MDL in Filtered Water (ng/L)	Analytical Instrumentation, Suspended Sediment	Analytical Instrumentation, Filtered Water
1134-23-2	Cycloate	–	3	–	1	–	LC-MS/MS
68359-37-5	Cyfluthrin	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
122008-85-9	Cyhalofop-Butyl	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
68085-85-8	Cyhalothrin (all isomers)	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
57966-95-7	Cymoxanil	3	3	1	1	LC-MS/MS	LC-MS/MS
52315-07-8	Cypermethrin	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
94361-06-5	Cyproconazole	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
121552-61-2	Cyprodinil	–	1.5	–	0.5	–	LC-MS/MS
1861-32-1	DCPA	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
3567-62-2	DCPMU	–	3	–	1	–	LC-MS/MS
2327-02-8	DCPU	–	3	–	1	–	LC-MS/MS
52918-63-5	Deltamethrin	3	3	1	1	GC-MS/MS	GC-MS/MS
120983-64-4	Desthio-Prothioconazole	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
333-41-5	Diazinon	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
962-58-3	Diazinon Oxon	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
95-76-1	Dichloroaniline, 3,4-	3	3	1	1	LC-MS/MS	LC-MS/MS
626-43-7	Dichloroaniline, 3,5-	6	6	2	2	LC-MS/MS	LC-MS/MS
62-73-7	Dichlorvos	–	3	–	1	–	LC-MS/MS
119446-68-3	Difenoconazole	3	3	1	1	LC-MS/MS	LC-MS/MS
110488-70-5	Dimethomorph	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
165252-70-0	Dinotefuran	3	3	1	1	LC-MS/MS	LC-MS/MS
97886-45-8	Dithiopyr	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
330-54-1	Diuron	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
759-94-4	EPTC	–	6	–	2	–	LC-MS/MS
66230-04-4	Esfenvalerate	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
162650-77-3	Ethaboxam	3	3	1	1	LC-MS/MS	LC-MS/MS

CAS Registry Number	Analyte	RL in Suspended Sediment (ng/L)	RL in Filtered Water (ng/L)	MDL in Suspended Sediment (ng/L)	MDL in Filtered Water (ng/L)	Analytical Instrumentation, Suspended Sediment	Analytical Instrumentation, Filtered Water
55283-68-6	Ethalfluralin	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
80844-07-1	Etofenprox	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
153233-91-1	Etoxazole	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
131807-57-3	Famoxadone	–	30	–	10	–	LC-MS/MS
161326-34-7	Fenamidone	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
114369-43-6	Fenbuconazole	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
126833-17-8	Fenhexamid	30	30	10	10	LC-MS/MS	LC-MS/MS
39515-41-8	Fenpropathrin	3	3	1	1	GC-MS/MS	GC-MS/MS
134098-61-6	Fenpyroximate	–	1.5	–	0.5	–	LC-MS/MS
120068-37-3	Fipronil	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
205650-65-3	Fipronil Desulfinyl	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
1115248-09-3	Fipronil Desulfinyl Amide	–	3	–	1	–	LC-MS/MS
120067-83-6	Fipronil Sulfide	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
120068-36-2	Fipronil Sulfone	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
158062-67-0	Flonicamid	3	3	1	1	LC-MS/MS	LC-MS/MS
1390661-72-9	Florpyrauxifen-Benzyl	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
79622-59-6	Fluazinam	–	1.5	–	0.5	–	LC-MS/MS
131341-86-1	Fludioxonil	3	3	1	1	LC-MS/MS	LC-MS/MS
142459-58-3	Flufenacet	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
1383809-87-7	Fluindapyr	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
62924-70-3	Flumetralin	3	3	1	1	LC-MS/MS	LC-MS/MS
239110-15-7	Fluopicolide	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
658066-35-4	Fluopyram	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
193740-76-0	Fluoxastrobin	–	1.5	–	0.5	–	LC-MS/MS
951659-40-8	Flupyradifurone	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
59756-60-4	Fluridone	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
66332-96-5	Flutolanil	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
76674-21-0	Flutriafol	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS

CAS Registry Number	Analyte	RL in Suspended Sediment (ng/L)	RL in Filtered Water (ng/L)	MDL in Suspended Sediment (ng/L)	MDL in Filtered Water (ng/L)	Analytical Instrumentation, Suspended Sediment	Analytical Instrumentation, Filtered Water
907204-31-3	Fluxapyroxad	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
72178-02-0	Fomesafen	–	6	–	2	–	LC-MS/MS
943831-98-9	Halauxifen-Methyl Ester	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
51235-04-2	Hexazinone	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
35554-44-0	Imazalil	–	1.5	–	0.5	–	LC-MS/MS
138261-41-3	Imidacloprid	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
127202-53-3	Imidacloprid Desnitro	–	3	–	1	–	LC-MS/MS
120868-66-8	Imidacloprid Urea	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
380912-09-4	Imidacloprid, 5-Hydroxy	3	3	1	1	LC-MS/MS	LC-MS/MS
950782-86-2	Indaziflam	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
173584-44-6	Indoxacarb	–	3	–	1	–	LC-MS/MS
125225-28-7	Ipconazole	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
36734-19-7	Iprodione	3	3	1	1	LC-MS/MS	LC-MS/MS
875915-78-9	Isofetamid	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
143390-89-0	Kresoxim-Methyl	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
121-75-5	Malathion	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
1634-78-2	Malathion Oxon	–	1.5	–	0.5	–	LC-MS/MS
173662-97-0	Mandestrobin	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
374726-62-2	Mandipropamid	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
57837-19-1	Metalaxyl	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
85933-49-9	Metalaxyl Alanine Metabolite	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
125116-23-6	Metconazole	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
40596-69-8	Methoprene	6	6	2	2	GC-MS/MS	GC-MS/MS
161050-58-4	Methoxyfenozide	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
51218-45-2	Metolachlor	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
88671-89-0	Myclobutanil	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS

CAS Registry Number	Analyte	RL in Suspended Sediment (ng/L)	RL in Filtered Water (ng/L)	MDL in Suspended Sediment (ng/L)	MDL in Filtered Water (ng/L)	Analytical Instrumentation, Suspended Sediment	Analytical Instrumentation, Filtered Water
300-76-5	Naled (Dibrom)	–	30	–	10	–	LC-MS/MS
15299-99-7	Napropamide	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
1929-82-4	Nitrapyrin	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
116714-46-6	Novaluron	–	6	–	2	–	LC-MS/MS
19044-88-3	Oryzalin	6	6	2	2	LC-MS/MS	LC-MS/MS
19666-30-9	Oxadiazon	–	3	–	1	–	LC-MS/MS
1003318-67-9	Oxathiapiprolin	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
42874-03-3	Oxyfluorfen	3	3	1	1	LC-MS/MS	LC-MS/MS
72-54-8	p,p'-DDD	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
72-55-9	p,p'-DDE	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
50-29-3	p,p-DDT	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
76738-62-0	Paclobutrazol	3	3	1	1	LC-MS/MS	LC-MS/MS
40487-42-1	Pendimethalin	3	3	1	1	LC-MS/MS	LC-MS/MS
219714-96-2	Penoxsulam	3	3	1	1	LC-MS/MS	LC-MS/MS
1825-21-4	Pentachloroanisole (PCA)	3	3	1	1	GC-MS/MS	GC-MS/MS
82-68-8	Pentachloronitrobenzene (PCNB)	3	3	1	1	GC-MS/MS	GC-MS/MS
183675-82-3	Penthiopyrad	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
52645-53-1	Permethrin	3	3	1	1	GC-MS/MS	GC-MS/MS
26002-80-2	Phenothrin	6	6	2	2	GC-MS/MS	GC-MS/MS
732-11-6	Phosmet	–	1.5	–	0.5	–	LC-MS/MS
500207-04-5	Picarbutrazox	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
117428-22-5	Picoxystrobin	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
51-03-6	Piperonyl Butoxide	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
29091-21-2	Prodiamine	–	6	–	2	–	LC-MS/MS
1610-18-0	Prometon	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
7287-19-6	Prometryn	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
709-98-8	Propanil	3	3	1	1	LC-MS/MS	LC-MS/MS

CAS Registry Number	Analyte	RL in Suspended Sediment (ng/L)	RL in Filtered Water (ng/L)	MDL in Suspended Sediment (ng/L)	MDL in Filtered Water (ng/L)	Analytical Instrumentation, Suspended Sediment	Analytical Instrumentation, Filtered Water
2312-35-8	Propargite	–	1.5	–	0.5	–	LC-MS/MS
60207-90-1	Propiconazole	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
23950-58-5	Propyzamide	3	3	1	1	LC-MS/MS	LC-MS/MS
1228284-64-7	Pydiflumetofen	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
175013-18-0	Pyraclostrobin	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
96489-71-3	Pyridaben	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
53112-28-0	Pyrimethanil	–	1.5	–	0.5	–	LC-MS/MS
95737-68-1	Pyriproxyfen	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
124495-18-7	Quinoxyfen	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
874967-67-6	Sedaxane	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
122-34-9	Simazine	3	3	1	1	LC-MS/MS	LC-MS/MS
946578-00-3	Sulfoxaflor	–	3	–	1	–	LC-MS/MS
107534-96-3	Tebuconazole	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
212267-64-6	Tebuconazole t-Butylhydroxy	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
112410-23-8	Tebufenozide	–	1.5	–	0.5	–	LC-MS/MS
96182-53-5	Tebupirimfos	–	1.5	–	0.5	–	LC-MS/MS
1035330-36-9	Tebupirimfos Oxon	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
79538-32-2	Tefluthrin	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
112281-77-3	Tetraconazole	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
7696-12-0	Tetramethrin	3	3	1	1	GC-MS/MS	GC-MS/MS
102851-06-9	t-Fluvalinate	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
148-79-8	Thiabendazole	–	1.5	–	0.5	–	LC-MS/MS
111988-49-9	Thiacloprid	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
153719-23-4	Thiamethoxam	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
902493-06-5	Thiamethoxam Degradate (CGA-355190)	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS

CAS Registry Number	Analyte	RL in Suspended Sediment (ng/L)	RL in Filtered Water (ng/L)	MDL in Suspended Sediment (ng/L)	MDL in Filtered Water (ng/L)	Analytical Instrumentation, Suspended Sediment	Analytical Instrumentation, Filtered Water
None	Thiamethoxam Degradate (NOA-407475)	–	3	–	1	–	LC-MS/MS
28249-77-6	Thiobencarb	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
129558-76-5	Tolfenpyrad	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
43121-43-3	Triadimefon	3	3	1	1	LC-MS/MS	LC-MS/MS
55219-65-3	Triadimenol	3	3	1	1	LC-MS/MS	LC-MS/MS
2303-17-5	Triallate	–	6	–	2	–	LC-MS/MS
78-48-8	Tribufos	–	1.5	–	0.5	–	LC-MS/MS
141517-21-7	Trifloxystrobin	–	1.5	–	0.5	–	LC-MS/MS
68694-11-1	Triflumizole	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
1582-09-8	Trifluralin	1.5	1.5	0.5	0.5	GC-MS/MS	GC-MS/MS
131983-72-7	Triticonazole	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
283159-90-0	Valifenalate	1.5	1.5	0.5	0.5	LC-MS/MS	LC-MS/MS
156052-68-5	Zoxamide	3	3	1	1	LC-MS/MS	LC-MS/MS
Count of analytes	**178**	**140**	**178**	**140**	**178**		
	distinct analytes	**in susp. sed.**	**in water**	**in susp. sed.**	**in water**		

7.4.1. Laboratory QC Measurements

Accuracy (Bias) is the assessment of the closeness of agreement between a measured or determined value and the true value. Blank spikes (laboratory control samples or LCSs), matrix spikes/matrix spike duplicates (MSs/MSDs), internal standards, surrogate recoveries, initial calibration, and calibration checks will be employed to ensure accuracy of results. 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 which can bias their results and impact accuracy.

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. This project will achieve the desired sensitivity by selecting appropriate analytical methods and the laboratory will demonstrate analytical capability to meet the project DQOs and reporting limits.

Table 7.3 and **Table 7.4** summarize the reporting limits (RL) and method detection limits (MDL) for all laboratory measurements. **Table 7.3** lists the RL and MDL for conventional analytes, field parameters, and trace metals. **Table 7.4** lists the RL and MDL for current use pesticides analyzed by USGS Organic Chemistry Research Laboratory (OCRL).

Precision is the reproducibility of an analytical measure. Field samples will be utilized to perform laboratory replicates.

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.

Comparability. The Delta RMP looks for guidance from the SWAMP Quality Assurance Program Plan (QAPrP), for parameters covered by the SWAMP Quality Control and Sample Handling Tables, to facilitate coordination and data integration with other water quality monitoring efforts. Specifically, the Delta RMP adheres to SWAMP requirements for QC and holding times and to California Environmental Data Exchange Network (CEDEN) requirements for data submittal.

Laboratory methods for analyses conducted for the Delta RMP are listed in **Appendix E**.

7.4.2. Laboratory Chemistry QC Samples

Data from USGS OCRL and NWQL (pesticides and ancillary chemistry) and MPSL-DFW (mercury and related parameters) may include the following QC data; **Table 14.2** includes the specific QC that should be performed by analyte and method:

1. Surrogate recovery (for all environmental and QC samples, where applicable)
2. Method blank (or suitable substitute, e.g., a bottle blank or similar encountering all potential lab generated contamination experienced by samples, but no/minimal field contamination sources).
3. Matrix spike recovery (where applicable)
4. Laboratory replicate precision (environmental samples or CRM, matrix spike, blank matrix spike samples when applicable)
5. Certified/lab reference material (CRM/LRM) recovery (where applicable)

Method blanks shall be run at a minimum frequency of one per analytical batch of up to 20 field samples. Results for laboratory method blanks, combined with those for field equipment 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 primarily from lab procedures. If field equipment blanks have higher contamination, sample collection methods are likely the cause. Results for method blanks shall be reported.

A laboratory control sample (LCS) shall be run at a minimum frequency of one per analytical batch (for analytical batches consisting of up to 20 field samples). At discretion of the SWRCB QA Officer, substitution by other recovery type samples (e.g., CRM or/and MS) at a minimum one per batch frequency may be permitted. Results shall be reported along with the expected values and recoveries (as a percentage of the expected value), where available for target analytes in appropriate matrices.

Matrix spikes (MS) shall be run at a minimum frequency of one per 20 samples; **Table 14.2** includes the specifics regarding which analytes and methods require an MS. 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 sufficiently high to quantify recovery (at least 3× the unspiked sample concentration) but also low enough to be a relevant accuracy indicator in the concentration range of field samples (3 - 10x the unspiked sample concentration). In cases where analytes are mostly not detected in unspiked samples, a concentration range of 10× to 100× 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 and replicate results for CRMs, LRMs, MS/MSDs, or blank spikes (LCSs) may be needed to obtain quantitative precision estimates. For whole bottle extractions, positive control sample replicates can be used to determine precision. The relative percent difference (RPD) should be calculated as described in **Section 7.4.3** and reported for all samples analyzed in replicate.

7.4.3. Precision

Precision measurements will be determined on field and/or laboratory replicates. If samples other than environmental samples are used to evaluate lab precision, target concentrations should be at least high enough to be quantitative but less than 100 times those in environmental 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 duplicate per 20 samples, or no less than 5%, of environmental samples will be collected, processed, and analyzed for precision. In addition, a minimum of one environmental sample (or alternative sample type such as a MS, where sample material is insufficient or target analytes 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.[7] 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 that results are in a quantifiable range. The RPD among replicate samples should be less than the MQO listed in **Table 14.2** for each analyte of interest. RPD is calculated as:

$$RPD = \frac{|X_1 - X_2|}{\left(\frac{X_1 + X_2}{2}\right)} \times 100$$

where X_1 and X_2 are independent measurements of the replicate samples.

When more than two replicate samples are collected, the relative standard deviation (RSD) shall be used as a basis of comparison against the MQOs:

[7] For example, if there were 61 samples, 4 environmental samples would be processed and analyzed in replicate for precision. For whole bottle extractions, a MS/MSD or LCS/LCSD may be used to assess laboratory precision.

RSD = [STDEV (all replicate samples) ÷ Average (all replicate samples)] x 100

7.4.4. Accuracy

Accuracy is the closeness of a measured result to an accepted reference value. Accuracy shall be measured as a percent recovery. QC analyses used to measure accuracy include standard recoveries, laboratory control samples (LCS), spiked samples (matrix spikes and matrix spike duplicates), internal standards, surrogate recoveries, initial calibration, and calibration checks. The accuracy of lab measurements will be evaluated based on measurement quality objectives (**Table 14.2**).

For a matrix spike, a known quantity of an analyte added to a sample to test whether the response to a sample is the same as that expected from a calibration curve. These samples are useful for determining whether elements of the matrix (the remainder of the sample other than the analyte) influence the results of the measurement. The percent recovery for spiked samples is calculated using the equation:

$$\%\, recovery = \frac{\left(C_{spiked\ sample} - C_{unspiked\ sample}\right)}{C_{added}} \times 100$$

The percent recovery for LCS and surrogates is calculated using the equation

$$\%\, recovery = \frac{analyzed\ concentration\ of\ LCS\ or\ surrogate}{certified\ concentration\ of\ LCS\ or\ surrogate} \times 100$$

Table 7.5 lists recovery surrogate standards used for pesticide analyses and associated measurement quality objectives.

Table 7.5. 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	USGS-Gross, 2021	70%–130%
Di-N-propyl-d1$_{14}$ trifluralin	Water	USGS-Gross, 2021	70%–130%
Monuron	Water	USGS-Gross, 2021	70%–130%
Imidacloprid-d$_4$	Water	USGS-Gross, 2021	70%–130%
Metolachlor-13C6	Water	USGS-Gross, 2021	70%–130%
DDE-13C12(p,p')	Water	USGS-Gross, 2021	70%–130%
Permethrin-13C6, cis-	Water	USGS-Gross, 2021	70%–130%
Tebuconazole-d14	Water	USGS-Gross, 2021	70%–130%

7.4.5. Bias (Contamination)

For laboratory chemical analyses, at least one laboratory method blank will be run at a minimum rate of one for each 20 field samples. The method blank will be processed throughout the entire analytical procedure in a manner identical to the samples (i.e., using the same reagents and equipment). The result for a method blank should be that the analyte concentration is less than the method detection limit (MDL).

A method blank with a measured concentration greater than the MDL for any analyte 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 according to the procedures outlined in the Data Management SOP. 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. The analytical lab may or may not "blank correct" the reported results, depending on the guidelines in the method and/or laboratory SOP. Blank correction involves subtracting the result of the lab method blank from all results. A "LabBatch" comment shall be included in the tabulated data, indicating whether the sample results in that batch are blank corrected or not, and the individual result records will also contain flags (CEDEN QACode) indicating use of blank correction.

7.5. Toxicity Quality Control

Toxicity is being monitored in FY21-22 for the Delta RMP using MQOs previously established and used by the Surface Water Ambient Monitoring Program (SWAMP). The following QC measures are required for toxicity tests, as excerpted from the 2017 SWAMP QAPrP, https://www.waterboards.ca.gov/water_issues/programs/swamp/qapp/swamp_QAPrP_2017_Final.pdf), with MQOs last updated in January 2020.
https://www.waterboards.ca.gov/water_issues/programs/swamp/mqo.html

Reference Toxicants (Toxicity)

Definition: A reference toxicant is a known concentration of a reference material used to evaluate test organism response. Analogous to a positive control, reference toxicant tests assess precision and overall laboratory performance. Laboratories routinely expose toxicity test species to reference toxicants, such as potassium chloride or copper sulfate, in order to evaluate their health and sensitivity and how it changes over time. The results of these tests are plotted on

control charts that are used to assess test precision and overall laboratory performance. EPA (2002) toxicity test guidance provides helpful information for interpreting reference toxicity test results. Requirements: See MQOs for frequency of use and acceptance criteria.

Negative Control

Definition: A blank consisting of a sterile form of the environmental matrix sampled, such as laboratory water or control sediment. Negative controls are used to compare the potential toxicity in a sample to a control sample where chemical induced toxicity should occur. The negative control also provides information on stock organism health and the normal variability in survival or growth of those stock organisms. Negative controls may also be used to differentiate between chemical toxicity and toxicity caused by salinity or pH. Primary negative controls consist of standard laboratory water; whereas, additional negative controls match the salinity or pH in the sample. Requirements: A minimum of one negative control per toxicity test batch is required. Toxicity test species used in negative controls must meet the minimum requirements established by the method-specific test acceptability criteria (see MQOs).

Additional Negative Controls

Definition: If sample parameters (e.g., salinity or pH) are outside the ranges established in the appropriate MQO, additional negative controls (also called secondary negative controls, tolerance controls, and conductivity controls) matching these conditions are used to account for any potential effects associated with water quality. Requirements: A conductivity or salinity control must be tested when these parameters are above or below a species' tolerance (see MQOs for tolerance ranges). All other secondary negative controls are utilized on a discretionary basis. Delta RMP Pesticide TAC recommendations for setting up alternative controls are detailed in **Appendix H: Standard Operating Procedures for Surface Water Data Management**.

Toxicity Test Water Quality Measurements

In addition to toxicity test control samples noted above, required water quality parameters (specific to the test method) must be reported. These include measurements of initial and final water quality, conditions daily or on water renewal, and minimum and maximum values as required in a given test method. Water quality measurements typically reported include DO, pH, conductivity, ammonia, alkalinity, hardness, and temperature measurement, but may include other parameters with ranges specified or recommended in the test method.

8. Special Training or Certifications

Chemistry and toxicity testing laboratories 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 Technical Program Manager and the Program QAO 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 MLJ Environmental 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 will be required to demonstrate acceptable performance before analysis of samples can proceed. Laboratory operations will be evaluated on a continuous basis through technical systems audits and by participation in laboratory intercomparison 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 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 good laboratory practices (GLPs) will be implemented accordingly.

Personnel collecting samples will be trained in the field sampling methods described in the QAPP.

For mercury monitoring, the MPSL-DFW project coordinator will be responsible for training the MPSL-DFW field staff.

For pesticides monitoring and analysis, the USGS Organic Chemistry Research Laboratory (OCRL) principal investigators will be responsible for training field and laboratory staff.

For aquatic toxicity testing, the PER project director and project manager will be responsible for ensuring training of laboratory staff.

Staff shall maintain a record of field training given. Information will include trainer, trainees, and dates of training. The sign-in sheet of the training can be the documentation of the training.

8.1. 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.

8.2. 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 scheduled to sample for the Delta RMP.

9. Documentation and Records

The main information products and reports planned by the Delta RMP are described in **Section 6.7.** These include annual data reports, annual QA reports, and occasional interpretive reports. All Delta RMP documents will be provided to the Steering Committee, which includes the Central Valley Regional Water Quality Control Board.

Preliminary raw data and monitoring results shall be provided to the CVRWQCB within 60 calendar days from the date of sample analysis. Sampling and monitoring results shall be submitted to the CVRWQCB within 6 months from the date of sample analysis and the data must go through primary quality verification and corrective actions completed, if applicable.

MLJ Environmental will collect records for sample collection, field analyses, and laboratory chemical 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.

MLJ Environmental will maintain hard copy or scanned files of field notes and measurements as well as documentation and results submitted by laboratories at the MLJ Environmental main office. The MLJ Environmental Data Manager will be responsible for the storage and organization of information.

Contract laboratories will 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.

9.1. 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 and to the Technical Program Manager, Delta RMP QA Officer and DMT:

1. **Field Standard Operating Procedures** (SOPs): Containing instructions for fieldwork activities, including procedures for conducting field observations, field measurements, and environmental sample collection. Describes requirements for sample containers, volume, preservation, and storage.
2. **Laboratory Quality Management Plan:** clearly defined policies and protocols specific to a particular laboratory, including policies and objectives, organizational authority, personnel responsibilities, and internal performance measures.
3. **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) that are not necessarily part of any analytical methodology for specific analytes or analyte types.
4. **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 services provided to the Delta RMP.
5. **Instrument Performance Information**: information on instrument baseline noise, calibration standard response, analytical precision and bias data, detection limits, etc. This information shall be reported for the periods during which Delta RMP samples are analyzed.
6. **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 shall be available upon request from the Delta RMP QA Officer or Technical Project Manager. 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 Technical Program Manager and QAO or their designees. All methods and SOPs will be provided in unredacted form to the QA Officer for the State Water Resources Control Board (State Board) for review and approval, but the State Board QA Officer will not share them with anyone else.

Handwritten original field sheets, logs, and calibration records will be maintained by the field sample collection teams.

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

All participants listed in **Table 3.1** will receive the most current version of the Delta RMP QAPP. The Delta RMP Technical Program Manager will be responsible for sharing the latest version of the QAPP. The QAPP will also be posted publicly on the Delta RMP website.

9.2. Standard Operating Procedures (SOPs)

Standard Operating Procedure documents are listed in **Appendix E** in this QAPP. The DRMP QA Officer, Technical Program Manager, and the CVRWQCB QA Representative shall approve any changes in methods before implemented which will result in an update to the QAPP, to be reviewed and approved by all signatories.

10. Sampling Process Design

10.1. Study Area and Period

Sample collection points and a justification for site selection and study areas for the different elements are described in the specific designs for each of the Delta RMP monitoring elements (**Appendix D**). Short Summaries of Delta RMP Monitoring Elements). Delta RMP monitoring occurs in, upstream, and downstream of the Delta.

The monitoring stations for mercury sampling represent different subareas of the Delta (**Figure 6.3**).

The monitoring stations for pesticides and aquatic toxicity monitoring are shown in **Figure 6.7** and **Table 6.7**.

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

- **Mercury monitoring** includes annual sport fish sampling at 12 stations (7 core stations and 5 restoration area stations) in fall, water sampling at 7 stations in early spring, late spring, and fall.

- **Sampling for pesticides and aquatic toxicity** will be conducted over 6 events during the water year, designed to capture a range of hydrologic conditions and periods of the agricultural calendar at 6 randomized locations within designated subregions and at 2 fixed sites. Among the 6 planned events, 3 are for storm sampling, and 3 for dry weather / irrigation season. It is necessary to space sampling events by at least 2 weeks so the labs can process all the samples from the previous round. Planned timing of sampling events is shown in **Table 6.10**. Samples will be taken on the outgoing, or ebb, tide, if possible.

The Delta is a highly dynamic and hydrologically complex system. Seasonal and temporal variability of target analytes within the system is shaped by numerous influencing factors, including the relative contributions of source waters and their chemical composition, seasonal and temporal variability in loads, biogeochemical processes within the system, seasonally varying process rates, flow rates and flow routing, climate variability, and habitat-specific (local) factors. Therefore, study design and data evaluation should always take into consideration co-variance of and potential bias caused by influencing factors.

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. In addition to this document, monitoring designs are described in Annual Workplans on the project website: https://deltarmp.org/.

Mercury monitoring

Table 10.1 and **Table 10.2** summarize information on sampling sites and schedule for the mercury monitoring project in FY21-22. The field team lead must report any deviations or alterations to the sampling design (such as changes due to an inaccessible site) to Tessa Fojut at SWRCB, Selina Cole at CVRWQCB, and the Technical Program Manager within 7 calendar days of becoming aware of the deviation, per the reporting requirements in Board Resolution R5-2021-0054. These deviations will be communicated via email to the Mercury TAC and discussed at the next Mercury TAC meeting if necessary.

Pesticides and aquatic toxicity

For pesticides sampling, occasionally, one of the randomly selected sampling locations will not be accessible because it is unsafe, inaccessible, etc. In this case, a sample should be taken within 100 meters of the target coordinates, if possible, and only if there is not some obvious change in the environment, such as moving downstream of an outfall, a change in water clarity, etc. If not possible to sample within 100 m, the crew should choose the next site on the “oversample” list shown in **Table 6.7**.

Table 10.1. Sampling stations and schedule for FY21-22 Mercury monitoring. For the locations of wetland restoration monitoring sites, see Table 6.2.

CEDEN Station Code	Station Name	Fish	Water
		Fall	Fall, Early Spring, Late Spring / Early Summer
510ST1301	Sacramento River at Freeport	●	●
544ADVLM6	Lower Mokelumne River 6	●	●
510ADVLIM	Cache Slough at Liberty Island Mouth	●	●
544LILPSL	Little Potato Slough	●	●
544MDRBH4	Middle River at Borden Highway (Hwy 4)	●	●
541SJC501	San Joaquin R. at Airport Way near Vernalis	●	●
510ST1666	Sherman Island	●	
207SRD10A	Sacramento River at Mallard Island		●
	Total sampling locations visited	**7**	**7**
	Sampling Events	**1**	**3**
	Number of samples	**7**	**21**

Table 10.2. Sampling sites and schedule for pesticides and aquatic toxicity monitoring.

Site Name	CEDEN Site Code	Target Longitude	Target Longitude	Sampling frequency	Schedule
San Joaquin River at Buckley Cove	544LSAC13	37.9718	-121.3736	6 x per year	3 wet-weather events, and 3 dry-weather events per Water Year. See Table 6.7 for the timing of events.
Ulatis Creek at Brown Road	511ULCABR	38.307	-121.7942	6 x per year	
Probabilistic or Random sites chosen with GRTS	Varies, see Table 6.4 for monitoring locations.			Each site sampled one time only; 6 sampling events per year	

11. Sampling (Sample Collection) Methods

11.1. Field Sample Collection

The following sections describe field sampling methods for each component of Delta RMP water quality monitoring.

Table 11.1 shows the sample container type and volume used for each parameter group for collection of water; and target species, number of individuals, and size ranges for collection of fish tissue samples.

Table 11.1. Sample container type and volume used for each parameter group for collection of water samples; and target species, number of individuals, and size ranges for collection of fish tissue samples.

Matrix	Program Element	Parameter Group	Bottle type	Number of bottles/event	Sample Volume/Site
Water	Mercury	Trace metals Conventional	Clear or amber glass	7	4L
	Nutrients	Nutrients Conventional	Amber glass or Polypropylene	50	125 mL
	Nutrients	Chl-a, chl-a > 5 µm	Amber glass	90	Requirement varies; typically 200-500 mL for both
	Pesticides	Pesticide suite	Amber glass	8-12, depending on number of QC samples planned for the event	1L
	Pesticides	Copper, DOC, PIC, POC, TPC, and TPN	Teflon	8	3L
	Aquatic Toxicity	Toxicity	Amber glass	80	10 gal
Fish[1]	Mercury	Mercury	Target species = Largemouth Bass	16 fish at each site @ 7 sites = 112[1] fish per event	Electrofishing, target lengths: 3 x (200-249 mm), 3 x (250-304 mm), 7 x (305-407 mm), 3 x (>407 mm)
					Hook and line fishing, target lengths: 2 x (200-249 mm), 2 x (250-304 mm), 5 x (305-407 mm), 2 x (>407 mm)

[1]Due to permit restrictions, electrofishing cannot occur at two core locations and two restoration locations; hook and line sampling methods will be used instead and therefore the number of fish collected has been adjusted.

11.1.1. Equipment Cleaning and Decontamination Procedures

Mercury Sampling

Equipment cleaning and decontamination procedures are documented in MPSL-DFW SOPs MPSL-111 v 3, 2021, Section 13.2. (See **Appendix E** for links to download all SOPs referenced in this document.) To avoid cross-contamination, all equipment used in sample collection will be thoroughly cleaned before each sample is processed with ultrapure water (i.e., Milli-Q®). Immediately prior to sample collection, the bucket sampler is rinsed again with ambient water from that site. Waste detergent and solvent solutions must be collected and taken back to the laboratory.

11.1.2. Mercury Sampling

The following sections describe collection of samples for analysis of mercury and methylmercury in water. For trace metals such as mercury, great care must be taken and special sampling methods to avoid contamination during sample collection, transport, and analysis. According to the US EPA (1996):

> Preventing ambient water samples from becoming contaminated during the sampling and analytical process is the greatest challenge faced in trace metals determinations. In recent years, it has been shown that much of the historical trace metals data collected in ambient water are erroneously high because the concentrations reflect contamination from sampling and analysis rather than ambient levels. Therefore, it is imperative that extreme care be taken to avoid contamination when collecting and analyzing ambient water samples for trace metals.
>
> There are numerous routes by which samples may become contaminated. Potential sources of trace metals contamination during sampling include metallic or metal-containing sampling equipment, containers, labware (e.g., talc gloves that contain high levels of zinc), reagents, and deionized water (DI); improperly cleaned and stored equipment, labware, and reagents; and atmospheric inputs such as dirt and dust from automobile exhaust, cigarette smoke, nearby roads, bridges, wires, and poles. Even human contact can be a source of trace metals contamination. For example, it has been demonstrated that dental work (e.g., mercury amalgam fillings) in the mouths of laboratory personnel can contaminate samples that are directly exposed to exhalation.

Field crews and laboratory staff are experienced in ultra-trace methods. Further details about sampling methods for each matrix (water, fish tissue) are described below. To avoid contamination, all material that comes in contact with fish are prepared and cleaned as described in Method MPSL-101 v 5, 2021, *Sample Container Preparation for Organics and Trace Metals, Including Mercury and Methylmercury*. Sample handling protocols are described in more detail below.

11.1.2.1. Water Sampling

This section describes collection of water samples for analysis of mercury and methylmercury by MPSL-DFW field crews. Samples will be collected according to MPSL-DFW Field SOP v1.1 (see **Appendix E** for link) and standard trace metal clean-hands/dirty-hands collection methods (USEPA Method 1669 modified) where appropriate to avoid sample contamination. A depth-integrated sample will be collected using a bucket sampler following methods described in the MPSL-DFW Field SOP v1.1 and MPSL-111 v 3, 2021).

Briefly, a web of clean C-Flex tubing is used to hold the bottle in place while sampling. Tubing will be replaced prior to each sampling event or sooner, if thought to have come in contact with surfaces known to be possible contamination sources, such as the boat deck. Plastic-covered lead weights are fastened with plastic fasteners to the outside bottom of the bucket to allow sufficient weight to lower the sampler through the water column. A clean polypropylene line is attached to the bucket and used to lower and raise the sampler through the water column.

The sampling bucket and line will be kept clean by storing in new clean plastic bags between uses and not allowing contact with surfaces on the sampling platform that are known to be potential sources of contamination.

A depth-integrated sample will be collected by lowering and raising the 4L bottle through the water column at a sufficient rate so that the bottle is not completely filled upon retrieval. A new pre-cleaned 4L glass bottle (MPSL-101 v 5, 2021 *Sample Container Preparation for Organics and Trace Metals, including Mercury and Methylmercury*) will be used for each site.

Field sample handling and shipping procedures are described in **Section 12**. Further, **Table 12.1** provides important information on storage and hold time requirements.

11.1.2.2. Collection of Fish Tissue for Analysis of Mercury and Methylmercury

Sport fish samples for mercury monitoring are collected annually. The appropriate sample collection method may vary by site and will be determined by the MPSL-DFW field sample collection team.

Links to Standard Operating Procedures (SOP) documents for fish sample collection are provided in **Appendix E**.

Fish will be collected in accordance with the MPSL-102a v 5, 2021 (section13.4), *Sampling Marine and Freshwater Bivalves, Fish and Crabs for Trace Metal and Synthetic Organic Analysis*. Because habitats may vary greatly, there is no single method of collection that is appropriate. Field crews will evaluate each fishing site to determine the correct method to be employed. Potential sampling methods include but are not limited to: electroshocking, seining, gill netting, and hook and line. Field crew will determine the appropriate collection method based on physical site parameters such as depth, width, flow, and accessibility and scientific collection permit restrictions. Field crew will indicate the collection method on data sheets. The project data sheet is shown in **Appendix F**. In sport fish sampling using an electroshocking boat, it is frequently necessary to sample over a linear course of 0.5 – 1 mi to obtain an adequate number of fish. A sport fish sampling station in this study can therefore be thought of as a circle with a diameter of 1 mile. The transects covered by the e-boat are documented in the sampling cruise report. If the field crew need to extend beyond 0.5 mi to obtain the target numbers of fish, they will inform the principal investigator at ASC, the Delta RMP Technical Program Manager, and the CVRWQCB QA Representative before implementing sampling whenever possible. If informing these RMP representatives prior to sampling is not feasible, then the information must be communicated to them within 7 calendar days from the date of sampling.

For the mercury status and trends study, for annual sport fish monitoring, the targeted fish species is largemouth bass (*Micropterus salmoides*). The goal is to collect 16 individuals spanning a range of total length from 200 to greater than 407 mm at each site. The targeted size range is as follows:

3 × 200–249 mm

3 × 250–304 mm

7 × 305–407 mm

3 × 407+ mm

For locations that require hook and line sampling the following target size range will be used:

- 2 x 200-249 mm
- 2 x 250-304 mm
- 5 x 305-407 mm
- 2 x >407 mm

The target sizes span a wide range to support development of a length:mercury regression at each station, with a primary focus on fish in the legal range that is most commonly caught. For hook and line stations, the primary goal is to obtain the five fish in the 305-407 mm range.

Specimens of similar predator species may be collected, if the desired number of individuals of the primary target fish species in the desired size range cannot be collected at a site. Other acceptable sport fish species include, in order of preference:

1. spotted bass, *Micropterus punctulatus*
2. smallmouth bass, *Micropterus dolomieu*

Section 12.3 provides more information on field sample handling and shipping procedures. **Table 12.1** provides information about storage and hold time requirements for each parameter group.

Fish will be processed according to MPSL-102a v 5, 2021(section13.4) *Sampling Marine and Freshwater Bivalves, Fish and Crabs for Trace Metal and Synthetic Organic Analysis;* except where noted here. Collected fish may be partially dissected in the field. The fish is placed on a measuring board covered with clean aluminum foil or plastic. Fork and total length are recorded. Weight is recorded, if the fish is large enough for the scale. If the fish is too large to fit in the bag, it will then be placed on the covered cutting board, where the head, tail, and guts are removed using a clean cleaver (scrubbed with Micro™, rinsed with tap and deionized water). The fish cross-section is tagged with a unique numbered ID, wrapped in aluminum foil, and placed in a clean labeled bag. When possible, parasites and body anomalies are noted. The cleaver and cutting board are re-cleaned with Micro™, rinsed with tap and deionized water between fish species. The equipment cleaning procedures will be repeated at each sampling site.

11.1.3. Pesticides and Aquatic Toxicity Sampling

This section describes collection of water samples for pesticides and aquatic toxicity analysis by USGS OCRL field crews. Samples for pesticides and toxicity monitoring shall be collected concurrently as grab samples 0.5 meters below the water surface. All grab samples shall be collected in accordance with the following methods described in the USGS *National Field Manual* (U.S. Geological Survey, variously dated). Relevant sections of the manual include the following chapters:

A1. Preparations for Water Sampling (Version 1.0, 11/2018)

A2. Selection of Equipment for Water Sampling (Version 3.1, 4/2014)

A3. Cleaning of Equipment for Water Sampling (Version 2.0, 4/2004)

A4. Collection of Water Samples (Version 2.0, 9/2006)

The USGS field manual is a dynamic document that has been in constant development since 1991 by the scientists and technicians at the USGS National Water-Quality Laboratory and National Research Program.

The study design calls for grab samples due to the large volume of water (approximately 40 liters or 10 gallons) required for collecting toxicity and pesticide samples concurrently, even in hydrologic conditions that might otherwise dictate integrated sampling techniques.

Samples shall be collected between the high and low tide, or on the ebb tide (for tidally influenced sites) by submerging narrow-mouthed bottles at mid-channel to a depth of 0.5 m. At the two fixed monitoring sites, during low flow conditions, samples may be collected by wading into streams and submerging handheld bottles. In high flow conditions or for sites with difficult bank access, samples shall be collected from bridges using weighted-bottle samplers.

At the probabilistic (random) sites chosen by GRTS, samples will be collected by boat using the weighted bottle sampler. Water samples for pesticide and toxicity analyses will be collected by submerging 1 L baked amber glass bottles (pesticides), 3 L Teflon (copper and dissolved organic carbon or DOC), and 4 L glass (toxicity) to a depth of 0.5 m using weighted bottle samplers. Samples will be collected on an ebb tide if logistically feasible. The sampling boat will be maintained on station at the GRTS site throughout the sample collection process.

Pesticide samples shall be collected in pre-cleaned, baked 1 L glass amber bottles and transported on ice to the USGS OCRL in Sacramento, California for processing and analysis using a combination of liquid chromatography tandem mass spectrometry (LC/MS/MS) and gas chromatography tandem mass spectrometry (GC/MS/MS). Samples for analysis at the USGS NWQL shall be collected in 3-L Teflon bottles, processed at the USGS California Water Science Center, and shipped on ice to the USGS NWQL in Denver, Colorado.

NWQL will analyze the following:

- Copper (dissolved)
- dissolved organic carbon (DOC)
- particulate inorganic carbon (PIC)
- particulate organic carbon (POC)
- total particulate carbon (TPC)
- total particulate nitrogen (TPN)

Toxicity samples shall be collected in pre-cleaned 4-L glass amber bottles provided by PER. Bottles shall be triple rinsed with native water on-site before sample collection. Bottles shall be transported on ice to PER for analysis.

Basic water-quality measurements (water temperature, specific conductance, dissolved oxygen, pH, and turbidity) shall be taken at a depth of 0.5m at mid-channel during each sample collection using a YSI EXO multi-parameter meter. The meter shall be calibrated using appropriate procedures and standards prior to sample collection as described in the USGS National Field Manual (U.S. Geological Survey, variously dated).

11.1.4. Habitat Observations

The field crew collecting pesticides and toxicity water samples shall make a number of observations about the sampling location, and record these on a field sampling data sheet. These observations are referred to (by USGS, SWAMP and others) as "habitat parameters," even though this project is not specifically monitoring wildlife habitat. **Table 11.2** shows the elements to be recorded by field crews on the SWAMP field data sheet.[8]

In the past, Delta RMP pesticides monitoring visited the same 5 sites monthly, and therefore each site was well known to us, and there was not much to be gained from these observations. However, as the project will be monitoring dozens of new, randomly selected locations, it will be important to record conditions at each site, particularly anything out of the ordinary. These observations may be useful for interpreting the pesticide and toxicity results for that station.

Table 11.2. Habitat parameters recorded by field crews at each sampling location.

Parameter	Possible responses
Site odor	None, Sulfides, Sewage, Petroleum, Smoke, Other
Sky code	Clear, Partly cloudy, Overcast, Fog, Smoky, Hazy
Other presence	Vascular, Nonvascular, Oily Sheen, Foam, Trash, Other
Dominant substrate	Bedrock, Concrete, Cobble, Boulder, Gravel, Mud, Unknown, Other
Water clarity	Clear (see bottom), Cloudy (>4" visibility), Murky (<4" visibility)
Water odor	None, Sulfides, Sewage, Petroleum, Mixed, Other
Water color	Colorless, Green, Yellow, Brown
Overland runoff (last 24 hours)	None, light, moderate/heavy, unknown

[8] Download the SWAMP Water Quality Field Data Sheet: https://drive.google.com/file/d/0B40pxPC5g-D0WTBmZlkzOHE0dnM/view

Parameter	Possible responses
Observed flow	NA, Dry Waterbody bed, No Observed Flow, Isolated Pool, Trickle (<0.1 cfs), 0.1 - 1 cfs, 1-5cfs, 5-20 cfs, 20-50cfs, 50-200cfs, >200cfs
Wadeability	Yes, No, Unknown
Wind speed (Beaufort scale)	0–12
Wind direction	
Precipitation (at time of sampling)	None, Fog, Drizzle, Rain, Snow
Precipitation (last 24 hours)	Unknown, <1", >1"
Occupation Method	Walk-in, Bridge, Other
Starting bank (facing downstream)	Left bank, Right bank, Not applicable
Distance from bank (m)	
Stream width (m)	
Water depth (m)	
Location	Bank Thalweg, Mid-channel, Open Water
Hydromodification	None, Bridge, Pipes, Concrete channel, Grade control, Culvert, Aerial zipline, Other

11.2. Field Sample Collection Quality Control Samples and Measurement Quality Objectives

Required field sample collection QC samples include field blanks, field equipment blanks and field duplicates. Each of these types of field QC samples will be collected at a rate of no less than 5% of total field sample count. Field QC samples shall be planned and collected throughout the project to evaluate potential variability sources in the field; including differing environmental conditions, geographic locations, sample collection personnel, and various field sampling protocols employed. Field equipment blanks are required for water sample collection for analysis of field filtered samples collected by MPSL-DFW: DOC, chl-a, dissolved mercury, dissolved methylmercury. Field blanks (no field equipment or processing) are collected by USGS for current use pesticides, and ancillary parameters (DOC, PIC POC, TPC, TPN). Field blanks are collected by MPSL-DFW, for total suspended solids (TSS), volatile suspended solids (VSS), and unfiltered water mercury and methylmercury. Field duplicates are required for all water samples. Field sample quality controls and measurement quality objectives are included in **Table 14.1**.

12. Sample Handling and Custody

This section describes the sample handling and custody procedures from sample collection through transport and laboratory analysis.

Chain of custody (COC) procedures shall be strictly adhered to during sample collection, transportation and laboratory handling to assure the identity of the samples. Proper sample and data handling and appropriate COC procedures help ensure that program data are credible and acceptable, in addition to considerations of accuracy and precision. COC documentation will document the processing of the sample from the time of collection to the time of analysis.

Table 12.1 provides information about storage and hold time requirements for each type of water quality measurement.

Table 12.1. Storage and hold time requirements for each parameter group.

Parameter group	Storage (Collection to Extraction, where applicable)	Hold time (Collection to Extraction, where applicable)	Hold time (Extraction to analysis, where applicable)	Storage (Extraction to analysis, where applicable)
Ammonium (Water)	4 ±2°C in dark	Cool to 4 ±2°C and preserve with 2 mL of H2SO4 per L within 48 hours of collection	28 day, if acidified	4 ±2°C
Chlorophyll-a (Water)	0 to 6°C in dark	Filtration within 24 hours of collection, then frozen immediately	28 days	≤ –20°C in dark
Dissolved Organic Carbon, DOC (Water)	0 to 6°C in dark	Filtration within 24 hours of collection, acidified with H2SO4 immediately	DOC: 28 days/ POC: 100 days	0 - 6°C in dark
Mercury, total (Tissue)	0 to 6°C in dark	Cool to < 6°C, freeze within 24 hrs of collection	1 year	≤ –20°C
Mercury, total (Unfiltered Water)	0 to 6°C in dark	Preserve with 0.5% v:v pretested BrCl or 12N HCl within 48 hours of collection	90 days	Room temperature
Mercury, total (Filtered Water)	0 to 6°C in dark	Filter and preserve with 0.5% v:v pretested BrCl or 12N HCl within 48 hours of collection	90 days	Room temperature
Mercury, Methyl (Unfiltered Water)	0 to 6°C in dark	Preserve with 0.5% v:v pretested 12N HCl within 48 hours	6 months	0 to 6°C in dark
Mercury, Methyl (Filtered Water)	0 to 6°C in dark	Filter as soon as possible after collection; preserve with 0.5% v:v pretested 12N HCl within 48 hours of collection	6 months	0 to 6°C in dark
Total Suspended Solids, TSS (Water)	4 ±2°C in dark	Cool to 4 ±2°C	7 days	4 ±2°C
Volatile Suspended Solids, VSS (Water)	4 ±2°C in dark	Cool to 4 ±2°C	7 days	4 ±2°C
Copper, dissolved	0 to 6°C in dark	Filter as soon as possible after collection	180 days	0 - 6°C in dark

Parameter group	Storage (Collection to Extraction, where applicable)	Hold time (Collection to Extraction, where applicable)	Hold time (Extraction to analysis, where applicable)	Storage (Extraction to analysis, where applicable)
Pesticides—dissolved fraction	0 to 6°C in dark	Extract within 48 hours of collection	Not to exceed 90 days	≤ –20°C in dark
Pesticides—particulate fraction	0 to 6°C in dark	Extract within 48 hours of collection	Not to exceed 180 days	≤ –20°C in dark
Aquatic Toxicity Tests	0 to 6°C in dark	Initiate Test within 48 hours of sample collection	NA	NA

12.1. 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 by the USGS PFRG field crews 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 Technical Program Manager will be immediately notified. Ice chests are examined upon delivery to ensure that samples have been properly chilled (acceptable temperature range = 0 to 6 °C).

Water samples for pesticide analyses will be processed to extraction upon arrival at the OCRL. If this is not possible, the samples will be refrigerated at 0 to 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. Prior to pesticide analysis, all water samples will be filtered through pre-weighed, pre-combusted 0.7-micrometer (μm) nominal pore-size glass-fiber filters to remove suspended material. Filter papers containing suspended sediments will be dried at room temperature overnight (in the dark), then stored in a freezer at −20 °C until extraction. The filtered water (dissolved phase) and suspended sediment phase are analyzed for pesticides (as listed in **Table 7.4**).

Samples for dissolved copper analysis and DOC/POC analysis will be processed at the USGS OCRL, within 24 hours of collection. Samples for dissolved copper analysis will be filtered using 0.45-micrometer (μm) filters and acidified to a pH less than 2 with 2 mL of 7.5N nitric acid. Samples for DOC analysis will be filtered using 0.7 μm 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 μm pore size filter holding the retained suspended material will be used for the POC analysis and will be wrapped in an aluminum foil square of appropriate size.

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

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

12.2. Toxicity Testing

Toxicity test samples will be delivered to the Pacific EcoRisk (PER) Laboratory within 24 hours of sample collection. Upon arrival at PER, toxicity testing samples will be immediately removed from the ice chests and the laboratory staff receiving the coolers will complete the accompanying Chain of Custody form (COC). PER will initiate tests within 48 hours of sample collection, although under rare circumstances, this holding time may be extended to 120 hours for storm events, or when courier delivery schedules on weekends and holidays limit the availability of test organisms. This, however, is not consistent with the MQOs and will result in a holding time flag. In these instances, PER staff will notify the Delta RMP QAO, Delta RMP Technical Program Manager, and the CVRWQCB QA Representative, and associated data will be flagged appropriately for hold time violation.

12.3. Trace Metals - Mercury

12.3.1. Sample Water

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 code, site description, collection date/time, container type, sample preservation, field measurements, sampler(s) name, and requested analyses. All forms will be included with the appropriate samples during shipping. Samples will be delivered to MPSL-DFW in Moss Landing, CA. If, upon arrival at the laboratory, samples are found to be warm (ice melted), or if sample containers are broken, the Project Manager will be immediately notified. Ice chests are

examined upon receipt to ensure that samples have been properly chilled (acceptable temperature range = 0° to 6° C).

Water samples will be delivered to MPSL-DFW within requisite holding times, where laboratory personnel will filter (if not field filtered) and preserve (if not field preserved) water samples following **Table 12.1**. Receipt temperature and sample condition (broken/compromised containers, incorrect preservatives, holding time exceedance, etc.) will be recorded by receiving laboratories. 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. Samples for dissolved mercury and dissolved methylmercury analysis will be filtered using 0.45-micrometer (μm) filters and acidified to 0.5% with pre-tested bromine monochloride, BrCl, or 12N hydrochloric acid, HCl, as appropriate within 48 hours of collection.

12.3.2. Fish Tissue

Fish samples will be wrapped in aluminum foil, placed in zipper-closure bags and frozen on dry ice for transportation to the laboratory, where they will be stored at –20°C until dissection and homogenization. To avoid contamination, all material that comes in contact with fish are prepared and cleaned as described in Method MPSL-101 v 5, 2021, *Sample Container Preparation for Organics and Trace Metals, Including Mercury and Methylmercury*. Lab homogenates will be frozen until analysis is performed. Frozen tissue samples have a 12-month hold time from the date of collection. If a hold-time violation has occurred, data will be flagged appropriately in the final results. Holding times for each analyte can be found in **Table 12.1**.

13. Analytical Methods and Field Measurements

13.1. Field Measurements

The field collection teams for water sampling events will record measurements performed in the field on field sheets (electronic or paper), then enter them into a CEDEN template for subsequent entry in the Delta RMP database by MLJ Environmental. An exception to this is field measurement data from mercury sampling, which will be submitted directly to SWAMP.

Data uploading is described in **Section 19.3**, Data storage/database. Reporting limits (RLs) and method detection limits (MDLs) for field measurements are shown in **Table 7.3** where applicable.

13.2. Laboratory Analysis

The following sections list the laboratory analytical methods that will be used in Delta RMP monitoring, and policies for sample archiving and disposal.

Reporting turnaround times are generally 90 days or less from the receipt of the samples by the laboratory; preliminary data must be provided by all laboratories within 60 calendar days of sample analysis per the requirements of Central Valley Water Board Resolution Number R5-2021-0054. Samples should be extracted and analyzed within the holding times specified for the analytical methods used (**Table 12.1**).

13.2.1. Analytical Methods

Table 13.1 provides a summary of analytical methods and instruments used by the Delta RMP.

Reporting limits (RLs) and method detection limits (MDLs) are shown in **Table 7.3** for conventional analytes, field parameters, and trace metals. **Table 7.4** shows the RLs and MDLs for pesticide analytes.

Some analytical method SOPs contain proprietary information and have been submitted directly to the State Board QAO. To receive a copy of analytical SOPs contact the Technical Program Manager. **Appendix E** provides a list and links to available SOPs.

Detailed descriptions of methods for analysis of pesticides can be found in these publications:

- *Delta Regional Monitoring Program Annual Monitoring Report for Fiscal Year 2015–16: Pesticides and Toxicity* (Jabusch, Trowbridge, Heberger, Orlando, et al. 2018)
- *Pesticide Inputs to the Sacramento-San Joaquin Delta, 2015-2016: Results from the Delta Regional Monitoring Program* (De Parsia et al. 2018)

Table 13.1. Summary of analytical methods and instruments.

Parameter group	Instrument	Methods
Current Use Pesticides		
Pesticides by GC-MS/MS	Trace 1310 GC with a TSQ 9000 mass spectrometer with a DB-5ms column (30 m × 0.25 mm × 0.25 μm; Agilent)	Gas Chromatography/ Tandem Mass Spectrometry (USGS-Gross, 2021)
Pesticides by 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 μm; Agilent).	Liquid chromatography with tandem mass spectrometry (USGS-Gross, 2021).
Dissolved Organic Carbon (DOC) (USGS)	Shimadzu TOC-L total organic carbon analyzer	By high-temperature combustion (SM 5310B)
Particulate Organic Carbon (POC)	Exeter Analytical model CE440 elemental analyzer	By combustion and thermal conductivity (EPA 440.0)
Particulate Inorganic Carbon (PIC)	Exeter Analytical model CE440 elemental analyzer	By combustion and thermal conductivity (EPA 440.0)
Total Particulate Carbon (TPC)	Exeter Analytical model CE440 elemental analyzer	By combustion and thermal conductivity (EPA 440.0)
Total Particulate Nitrogen (TPN)	Exeter Analytical model CE440 elemental analyzer	By combustion and thermal conductivity (EPA 440.0)
Copper (dissolved)	PerkinElmer NexION 350D inductively coupled plasma mass spectrometer (ICP-MS)	Collision/reaction cell inductively coupled plasma–mass spectrometry (USGS TM-5-B1)
Mercury		
Dissolved Organic Carbon (MLML-DFW)	Shimadzu TOC-V WP wet oxidation TOC analyzer	Persulfate-UV or Heated-Persulfate Oxidation Method (SM 5310C)
Nitrogen, ammonia	Segmented flow analyzer	By colorimetry after reaction with salicylate-hypochlorite by measurement on an automated-segmented flow analyzer (Fishman 1993)
Nitrogen, nitrate, and nitrite (Water)	Segmented flow analyzer	Colorimetric determination following enzymatic reduction, and reaction with sulfanilamide and naphthyl ethylenediamine followed

Parameter group	Instrument	Methods
		by measurement on an automated segmented flow analyzer (Patton and Kryskalla, 2011)
Chlorophyll a (method #1)	Turner Trilogy Laboratory Fluorometer with a Chl A Optical Modlen (Chl-a Acid)	In Vitro determination by fluorescence (EPA 445.0)
Chlorophyll a (method #2)	Genesis 10S	In Vitro determination by visible spectrophotometry (EPA 446.0)
Mercury (, Tissue)	Milestone DMA80	Thermal decomposition amalgamation and atomic absorption spectrophotometry (EPA 7473)
Mercury (Water)	Tekran 2600	Oxidation, purge and trap, and cold vapor atomic fluorescence spectrometry (EPA 1631, Revision E)
Methylmercury (Water)	Tekran 2700	Distillation, aqueous ethylation, separation, purge and trap, and cold vapor atomic fluorescence spectrometry (EPA 1630)

13.2.2. Toxicity Testing Procedures

Staff of PER shall perform aquatic toxicity testing following EPA methods, SWAMP MQOs, and the lab's SOPs as listed in **Table 14.4**. Additional project-specific requirements are listed below for 3 test species.

Any use of surrogate species must be approved by the DRMP QA Officer and the RWB QA Representative or SWB QA Officer. Furthermore, it should be discussed by the Pesticides TAC and recommended by the Steering Committee to the BOD for approval. Alternative protocols can be proposed to SWAMP and EPA, but tests shall be run per the method for this project.

Ceriodaphnia dubia

Toxicity testing according to SWAMP MQOs describes the recommendation for secondary conductivity controls when an ambient sample conductivity[9] is outside of the physiological range of the test organisms. These can be either high-conductivity controls (i.e., synthetic control waters salted up to match the highest conductivity of the ambient samples collected) or low-conductivity controls (i.e., synthetic control waters diluted with de-ionized water to match the lowest conductivity of the ambient samples collected). The latter will include nutrients (i.e., biotin, sodium selenate, and vitamin B_{12}) added to match the target concentrations in culture water. Secondary controls will be tested as outlined below.

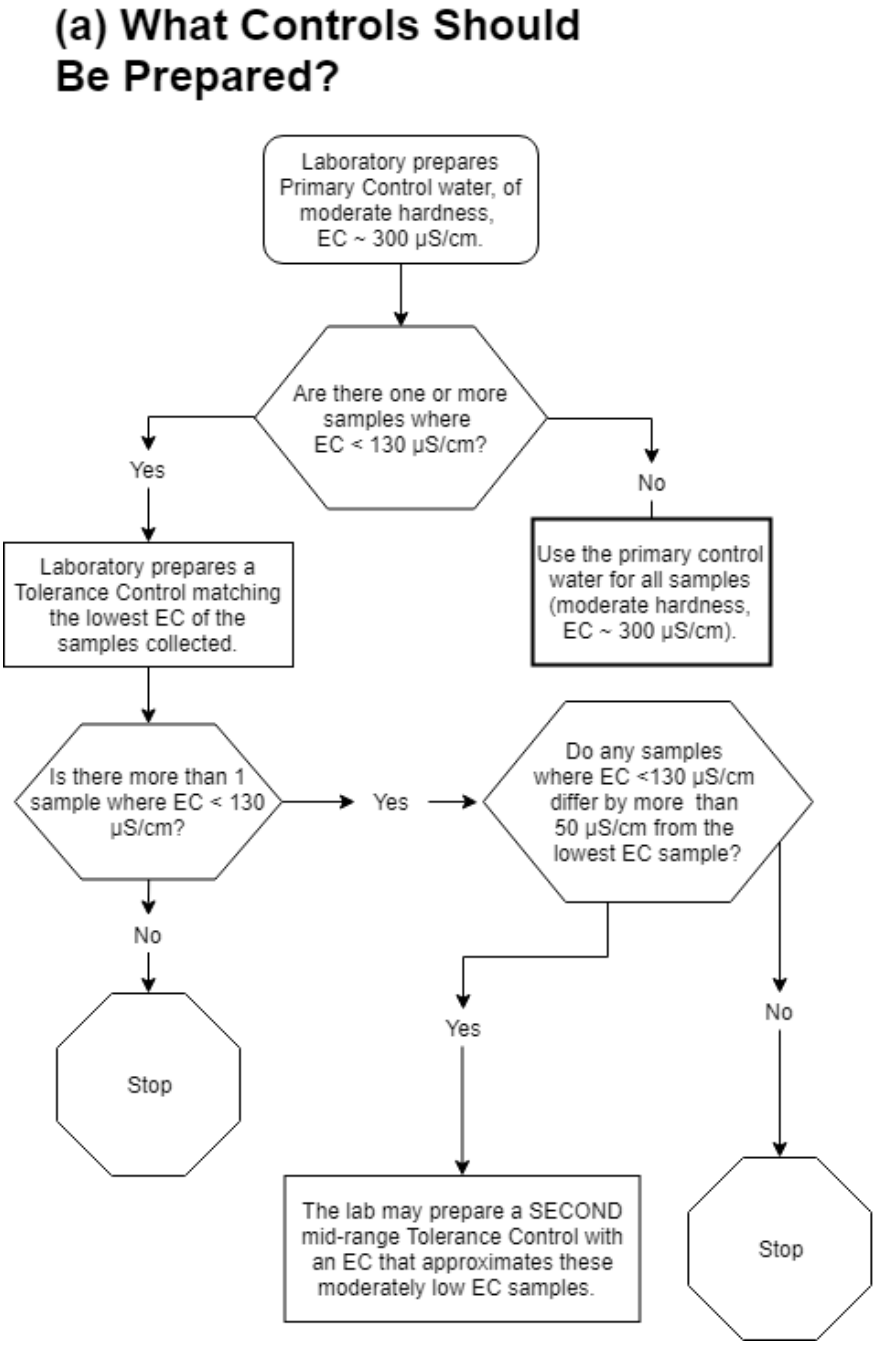
Depending on the conductivity range observed in ambient sample waters, additional negative controls may be tested to control for water quality near the organisms' tolerance screening value. **Figure 13.1** on the following page is a flowchart showing how low-conductivity controls for *C. dubia* toxicity testing should be handled. Part (a) of the figure is a flowchart depicting what controls the lab should prepare based on the range of conductivity in ambient samples. Part (b) is a flowchart showing which control each ambient sample should be compared to for performing a t-test, which will result in a binary determination of whether the ambient sample is toxic (i.e., yes/no).

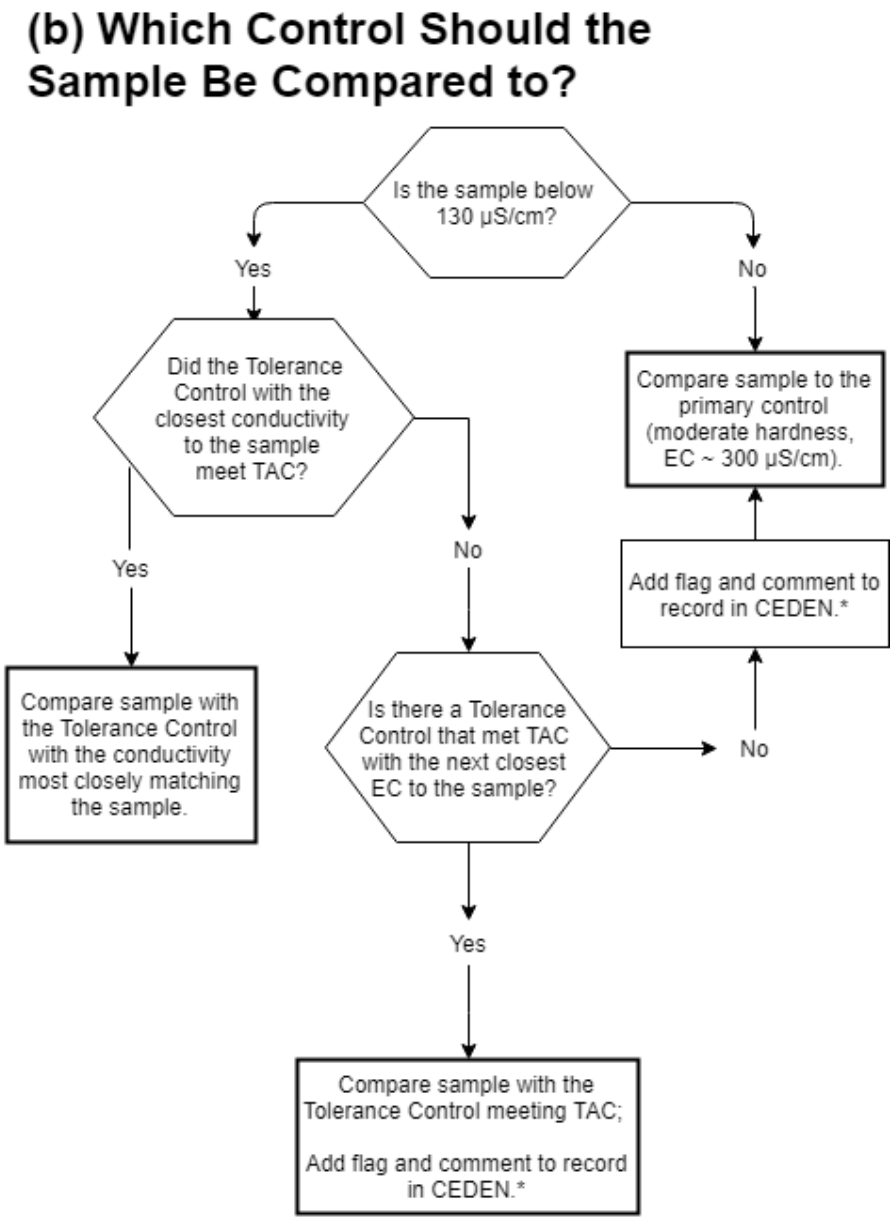
SWAMP guidance states that for *C. dubia* toxicity testing, the sample conductivity should be above 100 µS/cm; although, previous Delta RMP testing found that *C. dubia* reproduction in cultures may be affected by conductivity as high as 127 µS/cm. Therefore, the lab shall run a tolerance control matching the lowest sample conductivity when there are sample(s) with conductivity ≤ 130 µS/cm. The laboratory will also have discretion to run a second tolerance

[9] Conductivity refers to specific conductance (i.e., conductivity normalized to 25°C).

control when there are multiple samples with conductivity ≤ 130 µS/cm (i.e., if samples with conductivity ≤ 130 µS/cm have a difference of at least 50 µS/cm).

Figure 13.1. Flowchart illustrating procedure for handling low-conductivity controls for C. dubia toxicity testing.





*In cases like these for *C. dubia* toxicity testing, where sample conductivity is low, but the low-conductivity tolerance control does not meet test acceptability criteria, the sample is compared to the regular, medium-hardness control which has higher EC. In cases like these, the result of the statistical comparison may indicate that the sample is toxic, but it may not be (entirely) due to toxic contaminants, but rather due to a deficiency of ions that *C. dubia* need in order to thrive. Therefore, add a comment to the CEDEN database field ToxTestComments (limit 255 characters) as follows: “Tolerance control based on sample conductivity did not meet test acceptability criteria; percent effect based on comparison with standard control. Effects may include response to low EC in sample.” In addition, it is also appropriate to add a “TW” flag to the field ToxResultQACode. This code means, “Water quality parameters outside recommended test method ranges.”

Field crews should ensure sufficient volume is collected for all testing, and possible TIEs. (The PER project manager has indicated that the planned volume is sufficient, but staff should continue to track this and adjust if necessary, for example, if larger volumes of water are required for TIEs.)

Ceriodaphnia dubia will **not** be tested in samples with specific conductance > 2,500 µS/cm, which is outside of the maximum tolerance of this test species. SWAMP MQOs state that *Hyalella azteca* can be used as a surrogate for *C. dubia* in this case. The Delta RMP is already testing with *H. azteca*.

Nutrient addition in low-conductivity samples

This paragraph describes additional testing for research purposes, with the intent of understanding if nutrient additions to low conductivity samples will increase *C. dubia* reproduction as has shown it does in the tolerance controls (Stillway and Irvine 2018). If there is at least one sample with conductivity ≤ 130 µS/cm in a batch, the lab shall use water from one low-conductivity environmental sample to run an additional test. In this sample, the lab will treat the environmental sample by adding the standard blend of nutrients (i.e., biotin, sodium selenate, and vitamin B_{12}). The amount of nutrients added should match the amount added to the lowest conductivity tolerance control. The results of the research treatments will be compared to the secondary controls with the most closely matching conductivity, and also with the untreated sample. These data may inform the Delta RMP if background water quality and/or nutrients affect the test organism response. At this time, a minimum sample size has not been identified.

Hyalella azteca

Feeding during toxicity tests will follow the SCCWRP method where food is given two hours prior to water changes (Schiff and Greenstein 2016). This approach is consistent with SWAMP MQOs and reduces the potential for contaminants to sorb to food where they may be less bioavailable to the organism and bias the results.

Chironomus dilutus

Chronic toxicity testing is recommended by the CUP TAC to assess the potential for effects from imidacloprid and fipronil, to which the midge is sensitive. SWAMP MQOs for this 10-day chronic survival and growth test were published in August 2018, and Delta RMP sample testing with this midge commenced in late 2018.

***Selenastrum capricornutum*[10]**

Micronutrient stock solution should NOT contain ethylenediaminetetraacetic acid (EDTA), as EDTA is known to chelate metals and therefore the presence of EDTA in the algal growth test can mask metal toxicity.

13.2.3. Sample Retesting

When a test fails to meet test acceptability criteria, the Delta RMP project team may request a re-test. Therefore, retesting samples may require using samples that have exceeded the 48-hour hold time. Decisions to retest samples need to be made as quickly as possible by the testing lab in consultation with the Delta RMP Technical Program Manager, the CVRWQCB QA Representative, and TIE TAC (see **Appendix I**). The laboratory will notify the Delta RMP Technical Program Manager, the CVRWQCB QA Representative, and TIE TAC by email of the possible need to retest immediately upon identifying an invalid test or, if possible, when the control is exhibiting a poor or irregular survival or reproduction pattern that causes the laboratory staff to anticipate that Test Acceptability Criteria may not be met. In this notification, the laboratory will describe the concern and could provide a recommendation for retesting or continued monitoring of the results.

Within 24 hours of test result notification from the toxicity laboratory, the TIE TAC will review the laboratory notification, discuss (i.e., over email or a conference call), and make a consensus decision regarding whether to retest a sample. The Technical Program Manager, who will be a part of the TIE TAC communications, will inform the laboratory of the decision on retesting. The laboratory will initiate the retest of the previously collected sample within 24 hours of notification from the TIE TAC (i.e., within ~48 hours of the lab notification).

If the TIE TAC does not respond within 24 hours, or if there is not clear direction from the TIE TAC to the toxicity laboratory, then the laboratory will implement its recommendation. In the event that retesting is delayed beyond this timeline (e.g., organisms need to be ordered from a supplier or samples need to be recollected), such delays will be communicated to the TIE TAC and documented. Any issues contributing to an invalid test and its resolution will also be documented and submitted to the Delta RMP QA Officer, the Delta RMP Technical Program Manager, and the CVRWQCB QA Representative to inform adaptive management of the Delta RMP.

[10] Currently accepted scientific name for this algae species is *Raphidocelis subcapitata*. Also formerly known as *Pseudokirchneriella subcapitata*. Nevertheless, it is still widely referred to as *Selenastrum* by the aquatic toxicity testing community.

The potential need for resampling or retesting may also arise if, for example, samples are accidentally lost or destroyed in whole or in part. The bioassay laboratory will immediately notify the TIE TAC, the Technical Program Manager, the CVRWQCB QA Representative and the USGS analytical lab with a description of the problem so that a decision to resample can be made by the project team.

13.2.4. Statistical Analyses

Statistical analysis of laboratory toxicity test data will be consistent with standard single concentration statistical protocols (EPA 2002; Appendix H, page 306-308). This approach compares each sample with the appropriate control and calculates the test result according to standardized statistical methods used in aquatic toxicology. Statistics for toxicity data will be made with the software application Comprehensive Environmental Toxicity Information System™ (CETIS; Tidepool Scientific, McKinleyville, CA, USA).

If there are tests with unequal number of organisms per replicate, these tests will include a QA Code of "TOQ". If replicates are impacted by cannibalism, pupation, metamorphosis, or escape, the data will include the QA Code "TMO", and these particular organisms must be excluded from all calculations made on the Summary and Results tabs. This rule is in accordance with SWAMP guidance (Toxicity Template Guide, October 2021; https://drive.google.com/file/d/1WOV57vhPDsKJP_ulAqWBHeyYsaaFupzp/view). A comment should be added to the **LabResultComments** field regarding how many organisms were excluded and how many organisms were included in the statistical analysis (e.g., 1 organism pupated, 9 organisms used in the calculation). When a significant number of absent organisms are observed such that there are concerns regarding a bias of the statistical analyses, a retest may be requested. Decisions to request a retest due to a high occurrence of missing organisms will be made in coordination with the Technical Program Manager, the Project QA Officer, the CVRWQCB QA Representative, and the TIE TAC.

Samples will be compared with the appropriate negative control. This will be the negative control (i.e., primary or tolerance control) with water quality (i.e., specific conductance) most closely matching the sample when multiple negative controls are included as part of a toxicity test. See the SWAMP 2018 Memo: "Use of Additional Controls in SWAMP Toxicity Tests."[11]

[11] https://www.waterboards.ca.gov/water_issues/programs/swamp/swamp_iq/docs/swamp_toxicity_test_control_water_memorandum.pdf

Statistical analyses shall follow the method and SWAMP memo for additional controls. Specifically:

- Samples with conductivity > 130 µS/cm will be compared with the primary control.
    - If the primary control does not meet Test Acceptability Criteria, then results are rejected. Retesting the sample and control can be considered.
- Samples with conductivity ≤ 130 µS/cm will be compared with the tolerance control. If there is more than one tolerance control then samples with ≤ 130 µS/cm will be compared with the tolerance control with water quality (i.e., conductivity) most closely matching the sample.
    - If the tolerance control with water quality (i.e., conductivity) most closely matching the sample does not meet Test Acceptability Criteria then either:
        - 1) Compare the sample with the other tolerance control if the other tolerance control meets Test Acceptability Criteria. Add a flag and a comment to the record in CEDEN*.
        - 2) Compare the sample with the primary control if there was no other tolerance control that met Test Acceptability Criteria. Add a flag and a comment to the record in CEDEN*.

*Add to the CEDEN database field **ToxTestComments** (limit 255 characters) as follows: "Tolerance control based on sample conductivity did not meet test acceptability criteria; percent effect based on comparison with standard control. Effects may include response to low EC in sample." In addition, it is also appropriate to add a "TW" flag to the field **ToxResultQACode**. This code means, "Water quality parameters outside recommended test method ranges."

A flowchart illustrating the steps above is shown in **Figure 13.1.**

Sample comparisons with the primary control will generally determine toxicity due to contaminants in the sample when the sample is not outside or near the organisms' limit of tolerance. Likewise, comparing samples outside or near an organism's tolerance limit with the appropriate tolerance control accounts for possible background water quality effects to indicate effects due to contaminants. These comparisons will help answer the Delta RMP Assessment Question 1 (Status and Trends) "To what extent do current use pesticides contribute to observed toxicity in the Delta?" by identifying toxicity effects due to contaminants (e.g., pesticides).

When a tolerance control fails to meet Test Acceptability Criteria, it is an indication that the background water quality does not support the test organism and that the toxicity endpoint is not a reliable indicator of the effects due to contaminants in samples with similar water quality. Background water quality effects may be included in the observed effects when comparisons are made between a sample at or near an organism's tolerance limit and the primary control when the tolerance control fails to meet test acceptability criteria. This may describe the 'absolute toxicity' of a sample (i.e., difference between the sample performance and the

maximum potential performance in its normal culture water conditions), but the result may reflect effects of the background water quality.

Lab analysts shall use the software application *Comprehensive Environmental Toxicity Information System*™ (CETIS; Tidepool Scientific, McKinleyville, CA, USA) to calculate Effect Concentration and Lethal Concentration values (EC_{25} for sublethal endpoints and LC_{50} for survival endpoints) for reference toxicant tests.

Delta RMP samples will be compared with the control (either primary or secondary/tolerance control) with the most similar water quality conditions, measured by specific conductivity. This group or 'batch' will be analyzed independently of other batches. If the negative control for a batch does not meet Test Acceptability Criteria, then the test organism health is compromised in those water quality conditions. There is not a valid benchmark for comparing the toxicity endpoint in samples associated with a negative control that does not meet Test Acceptability Criteria. Samples may be retested once. Sample results will remain invalid if a batch control fails to meet Test Acceptability Criteria in a retest. The potential cause(s) of repeated control failures will then be investigated, and corrective actions identified.

13.2.5. Toxicity Identification Evaluation (TIEs)

This section provides guidance for when, and under what conditions, the toxicity testing laboratory should conduct a Toxicity Identification Evaluation (TIE). A TIE is an investigative process that uses laboratory modifications of test sample chemistry and resulting changes in toxicity to identify the constituent groups (e.g., organophosphates) that are the likely cause(s) of toxicity.

The trigger for a TIE shall be a ≥ 50% reduction in the organism response compared to the appropriate lab control. This trigger shall apply to all test organisms and all endpoints (acute and chronic). The decision on whether or not to perform a TIE will be made by the Delta RMP TIE TAC in consultation with the toxicity testing laboratory. Decisions to perform a TIE are event-specific and dependent on the degree of effects observed in baseline testing, what is known about the sample (e.g., location, previous effects and toxicants, relevant pesticide applications), test species, and the available funding to conduct the TIE. The TIE TAC and testing lab shall quickly decide whether to conduct TIEs (the TAC should be notified within 24 hours of the TIE trigger, and the TIE should begin less than 72 hours after the TIE trigger), and whether to conduct any follow-up study (e.g., additional TIE treatments, supporting analytical chemistry).

This description is intended to be a starting point to inform the discussion and interpretation of any TIEs that are conducted on Delta RMP samples. TIEs may provide additional information that lead to other approaches to identify the cause of effects that are not identified here.

Phase 1 TIEs attempt to characterize the physical and chemical properties of the possible toxicant(s) in the sample. Information is gained regarding the physical/chemical properties of the toxicant(s) when the toxicity endpoint effect is reduced in the treated sample, adding to the weight of evidence regarding the class of contaminants that may have caused the toxicity. Phase 2 TIEs attempt to identify specific constituents causing or contributing to toxicity through chemical analyses or additional TIE treatments. Multiple TIE methods are presented in EPA guidance documents (USEPA 1991, 1992, 1993a, 1993b). Other approaches may be adopted from the peer-reviewed literature (e.g., Wheelock et al., 2004) or developed to address study-specific questions.

TIEs should be initiated as soon as possible (e.g., within ~72 hours) after exceeding the TIE trigger and following approval of the TIE TAC.

All TIEs should be chronic tests, even when observed toxicity is acute unless there is no chronic endpoint (i.e., the 96-hour *H. azteca* survival test), in consultation with the TIE TAC and PER

The laboratory must also conduct a preliminary validation of the initial toxicity test results by confirming that basic water quality parameters (e.g., conductivity, dissolved oxygen) were within acceptable ranges for the affected test species and that test acceptability criteria were met, unless sufficient acute effects provide clear direction on the need for retesting. Follow-up investigations (e.g., Phase 2 or 3 TIEs) may also be considered.

Delta RMP TIE testing has the primary goal of identifying whether pesticides are causing or contributing to observed toxic effects. A secondary goal may be to identify (or exclude) other factors (i.e., water quality conditions or other toxicants) contributing to reduced survival, growth, or reproduction. A phased TIE approach will be used, to the extent possible, to achieve these goals by initially focusing on treatments that identify major classes of contaminants that could include pesticides:

- Cation exchange column (removes metals and other divalent cations) Solid-phase extraction column (e.g., C-8 or C-18; evidence of toxicity due to non-polar organics, organic-metal chelates, and some surfactants)
- Centrifugation (evidence of toxicity due to particulate-bound contaminants such as chlorpyrifos and pyrethroids; use with turbid samples or at the discretion of the TIE TAC)
- Piperonyl Butoxide (PBO) (evidence of toxicity due to a substance that is metabolized by the CYP450 enzyme system; evidence of OP insecticides if toxicity is reduced and of pyrethroid insecticides if toxicity is potentiated)
- Carboxylesterase addition (evidence of toxicity due to a contaminant with an ester bond, such as pyrethroid insecticides)
- Bovine serum albumin (BSA) addition (acts as a large organic molecule control for carboxylesterase treatment)
- Baseline (confirms if the toxicity is persistent)

If the cause of an observed effect is not clear after initial TIE testing, or if further detail describing the type or specific toxicant is desired, then the TIE TAC may choose to have the laboratory conduct additional TIE treatments. Considerations for additional TIEs could include the level of available funding, magnitude of toxicity (TIE treatment effectiveness is easier to determine when there is a strong toxicity signal), species tested, and other data (e.g., potential sources, initial TIE results, and the likelihood that pesticides will be identified). As examples, the following TIE treatments could be selected to assess factors contributing to the observed effect:

- Low temperature – evidence of toxicity due to a contaminant that is metabolized, so lower temperatures slow the organisms' metabolism; increases the toxicity of pyrethroid insecticides
- Aeration – evidence of toxicity due to volatile, sublatable, or oxidizable compounds including surfactants

- Non-polar organic solid-phase extraction (SPE) column – evidence of toxicity due to a relatively polar organic contaminant
- pH 3/11 – evidence of toxicity due to hydrolysable/pH-dependent compounds (and filtration to assess/remove/control for settleable/coagulated toxicants and particulates).
- $Na_2S_2O_3$ – evidence of toxicity due to oxidants
- EDTA – evidence of metals toxicity
- Chemical analysis of cyanotoxins (to be compared with species-specific toxicity values). This would require freezing a subsample of the freshly collected sample for potential analysis if toxicity is observed from a location with known or potential cyanobacteria bloom.

The specific TIE treatments will depend on the test species. Salinity/conductivity is an important factor affecting toxicity test results for some species in the Delta, and TIEs in some samples with species sensitive to conductivity may require appropriate low-specific conductance or high-specific conductance secondary controls in addition to laboratory culture water controls treatments as indicated in SWAMP MQOs.

13.2.6. Sample Archive and Disposal

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

14. Quality Control

14.1. Field Measurements

Prior to use in the field (typically within 24 hours prior to sampling), handheld water quality instruments will be 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 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 multi-parameter water quality meters, the following standards will be used to calibrate:

1. **pH** – commercially available standards pH 4, 7, 10. Perform a 2-point calibration covering the range of expected measurements. Use the 3rd pH standard (or standard supplied by another manufacturer) as a check standard to verify calibration accuracy.
2. **Specific Conductance** – perform a single-point calibration in the middle of the expected environmental range and use two check standards (KCl solution) bracketing the expected measurement range.
3. **Dissolved oxygen** – use calibration procedure recommended by manufacturer, typically in 100% air saturation.
4. **Temperature** – check against thermometer of known accuracy before each deployment. 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.

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 in the Field Form and the Field Reference Sheet. The Field Collection Coordinators, Technical Program Manager, and the Delta RMP QAO will be responsible for ensuring that staff document all deviations from planned operations and schedule repairs and/or additional training as needed.

Table 14.1. Measurement quality objectives for field measurements.

Method	Parameters	QC check	Matrix	Frequency	Acceptable limits (MQOs)
Mercury					
Satlantic model ISUS V3, Nitrate analyzer	Nitrate	Calibration; range 0-70 µM	Water	Monthly calibration check (blank and standard curve). Blank check within 24 h before sampling. Comparison to discrete grab samples (~1 sample collected every hour) analyzed by standard laboratory methods.	Precision: Calibration to within 10% of nominal 2.5 µM S/N Accuracy/bias: Allowable drift +10%
Seabird model 45 Thermo-salinograph WET Labs beam transmissometer (676 nm) YSI EXO 2	pH, SC, turbidity	Calibration	Water	Blank check within 24 h before sampling and at the end of the sampling event. Calibration check within 24 h before sampling. Temperature check with NIST certified thermometer every 6 months.	Precision: Allowable performance (accuracy) ±10% for Specific Conductivity, ±0.2 for pH, ±5 turbidity units or ±5% of the measured value (whichever is greater) +0.2 deg C for temperature Accuracy/bias: Drift from prior calibration ±10%
Timberline TL-2800 Analyzer	Ammonium	Calibration; range 0-70 µM	Water	Standard curve at start and end of sampling day. Blank water and standard checks intermittently (~ 1 per hour) throughout day	Precision: Calibration to within 10% of nominal 2.5 µM S/N Accuracy/bias: Allowable drift ±10%
WET Labs model WETStar cDOM fluorimeter	fDOM	Calibration in quinine sulfate	Water	Blank water check within 24 h before sampling. Intermittent functionality checks with fluorescent plastic test stick. Calibration check within 24 h before sampling.	Precision ±10% Accuracy/bias: Drift from prior calibration ±10%
YSI EXO 2 Total Algae probeWET Labs model	Chlorophyll-a, phycocyanin	Calibration in with Rhodamine WT	Water	Calibration check within 24 h before sampling. Blank water check within 24 h before sampling.	Precision ±10% Accuracy/bias: Drift from prior calibration ±10%

Method	Parameters	QC check	Matrix	Frequency	Acceptable limits (MQOs)
WETStar chlorophyll-a fluorimeter				Intermittent functionality checks with fluorescent plastic test stick	
Current Use Pesticides					
YSI EXO1	Temperature	Calibration at 6, 20, and 40 Celsius	Water	Annually	Correction factor is assigned and units with correction factor >1 are removed from service.
YSI EXO1	pH	Calibration at 4,7, 10, check at 6	Water	Daily prior to use	+/- 0.1 pH unit
		Duplicate analysis	Water	At least 10% of samples	RPD <0.6
		post-sampling pH 7 check	Water	Daily after sampling	+/- 0.1 pH unit
YSI EXO1	Specific Conductivity	1413 umhos/cm standard	Water	Once daily or per batch of 20 samples	94-106% recovery
		MB	Water	Daily prior to use	<reporting limit
		LCS bracketing working range	Water	Daily prior to use	94-106% recovery
		Duplicate analysis	Water	At least 10% of samples	RPD <1
YSI EXO1	Dissolved Oxygen	Calibration in oxygen saturated water	Water	Daily prior to use	+/- 1%
		Duplicate analysis	Water	At least 10% of samples	RPD <1.9%
YSI EXO1	Turbidity	Calibration at 0, 20, 200, 800	Water	quarterly	+/- 10%
		reporting limit check	Water	Daily prior to use	80-133% recovery
		Method blank	Water	Daily prior to use	<reporting limit
		LCS bracketing working range	Water	Daily prior to use	90-111% recovery

Method	Parameters	QC check	Matrix	Frequency	Acceptable limits (MQOs)
		LCS	Water	Every 10th analysis	90-111% recovery
		Duplicate analysis	Water	At least 10% of samples	RPD <9.5%

14.2. Laboratory Analysis

For all participating labs, the Laboratory Project Manager must 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, accuracy, bias and precision, in the actual analytical matrix, to achieve project goals.

For CUP data, the Data Manager will assign quality assurance data flags (QACodes) to results that fail to meet the measurement quality objectives (MQOs). Any decisions to reject data will be discussed with the Technical Program Manager, the Delta RMP QAO, the SWB QAO, CVRWQCB QA Representative and the laboratory in coordination with the Pesticide TAC. More information on how the CV RDC performs QA and applies flags to data can be found in the Standard Operating Procedures for Surface Water Data Management.

14.2.1. Measurement Quality Objectives

Laboratory Performance Measurements for Laboratory 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 14.2**.

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

1. **Lab method 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, to assess contamination introduced in lab processes.
2. **Field (ambient) blanks**: samples of a clean or null matrix transferred to the sampling container, then analyzed much like an ordinary field sample to assess ambient contamination introduced in the field superimposed on any existing lab method blank contamination. Field blanks (as defined for this project) do not include contributions from field sampling equipment.

3. **Field equipment blanks:** samples of a clean or null matrix transferred to the sampling container using all the normal procedure and equipment used in sample collection, then analyzed much like an ordinary field sample to assess ambient contamination introduced in the field, and originating from the sample equipment, superimposed on any existing lab method blank contamination.
4. **Laboratory duplicates**: replicate sub-samples of field samples, taken through the full analytical procedure including all lab processes combined, to measure analytical precision. Although standard reference materials, lab reference materials, matrix spike samples, or laboratory control samples can also be analyzed in replicate, references to those are usually prefaced by their sample type name, e.g., “matrix spike duplicates”.
5. **Field duplicates**: samples collected identically to the primary field samples at a site, used to assess spatial or temporal heterogeneity in the sampled matrix, superimposed on any existing laboratory analytical variation.
6. **Surrogate standards**: analytes introduced to samples prior to sample extraction to monitor sample extraction method recoveries.
7. **Internal standards**: analytes introduced after the last sample-processing step prior to analysis, to measure and correct for losses and errors introduced during analysis, with recoveries and corrections to reported values generally reported for each sample individually.
8. **Laboratory control samples:** samples of a clean or null matrix spiked with target analytes, then analyzed much like an ordinary field sample, used to assess accuracy of the analytical method.
9. **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.
10. **Certified Reference Materials:** natural matrix samples with externally validated expected "certified" concentrations of analytes of interest, usually obtained from commercial or government vendors (e.g., NIST, which calls them "SRMs" (standard reference materials)). Often analyzed across multiple analytical batches, to track drift or shifts in analytical accuracy and precision.
11. **Lab reference materials**: materials collected, bought, or created by a laboratory as internal reference samples, to track performance across batches. The term “lab reference material” is only for natural matrix samples (e.g., archived material previously analyzed, diluted natural matrix CRMs, etc.), instead using the term “lab control sample” for control samples from a clean or blank lab matrix

Table 14.2. Measurement quality objectives for laboratory measurements.

Method	QA Sample type	Matrix	Minimum Frequency	Acceptable limits (MQO)	Blank correction?
Mercury Monitoring by Moss Landing Marine Laboratory ADMINISTERED AND TO BE UPDATED BY SWAMP STAFF FY21-22					
Conventional – Chlorophyll a					
EPA 445.0	Laboratory Blank	Water	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	Yes
EPA 445.0	Laboratory Control Sample	Water	1 per 20 samples or 1 per batch, whichever is more frequent	75-125% recovery;	
EPA 445.0	Field Equipment Blank	Water	Not less than 5% of all samples	< MDL	Yes
EPA 445.0	Field Duplicates	Water	Not less than 5% of all samples	RPD < 25%; n/a if concentration of either sample < MDL	Yes
Conventional – Dissolved Organic Carbon (DOC)					
SM 5310 C	Laboratory Blank	Water	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	No
SM 5310 C	Matrix Spikes/Duplicates	Water	1 per 20 samples or 1 per batch, whichever is more frequent	70-130% recovery; RPD < 20%	No
SM 5310 C	Field Duplicates	Water	Not less than 5% of all samples	RPD < 25%; n/a if concentration of either sample < MDL	No
SM 5310 C	Field Equipment Blank	Water	Not less than 5% of all samples	< 0.15 mg/L	
Conventional – Moisture					
EPA 7473	Laboratory Blank	Tissue	not applicable		No
EPA 7473	Lab duplicate	Tissue	≥5% of all samples	<10% nominal difference	No
EPA 7473		Tissue			No
Conventional – Total Suspended Solids (TSS)					
MPSL-108	Laboratory Blank	Water	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	Yes

Method	QA Sample type	Matrix	Minimum Frequency	Acceptable limits (MQO)	Blank correction?
MPSL-108	Lab duplicate	Water	1 per 20 samples or 1 per batch, whichever is more frequent	RPD < 25%; n/a if concentration of either sample < MDL	Yes
MPSL-108	Field Blank	Water	Not less than 5% of all samples	< MDL	Yes
MPSL-108	Field Duplicates	Water	Not less than 5% of all samples	RPD < 25%; n/a if concentration of either sample < MDL	Yes
Conventional – Volatile Suspended Solids (VSS)					
MPSL-108	Laboratory Blank	Water	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	No
MPSL-108	Lab duplicate	Water	1 per 20 samples or 1 per batch, whichever is more frequent	RPD < 25%; n/a if concentration of either sample < MDL	No
MPSL-108	Field Blank	Water	Not less than 5% of all samples	< MDL	No
MPSL-108	Field Duplicates	Water	Not less than 5% of all samples	RPD < 25%; n/a if concentration of either sample < MDL	No
Trace Metals – Mercury, Total, in Tissue					
EPA 7473	Laboratory Blank	Tissue	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	No
EPA 7473	Matrix Spikes/Duplicates	Tissue	1 per 20 samples or 1 per batch, whichever is more frequent	75-125% recovery; RPD < 25%; n/a if concentration of either sample < MDL	No
EPA 7473	Lab Duplicate	Tissue	1 per 20 samples or 1 per batch, whichever is more frequent	RPD < 25%; n/a if concentration of either sample < MDL	No
EPA 7473	Certified Reference Material	Tissue	1 per 20 samples or 1 per batch, whichever is more frequent	75-125% recovery	No

Method	QA Sample type	Matrix	Minimum Frequency	Acceptable limits (MQO)	Blank correction?
Trace Metals – Mercury, Total, in Water (filtered and unfiltered)					
EPA 1631, Revision E	Laboratory Blank	Water	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	Yes
EPA 1631, Revision E	Matrix Spikes/Duplicates	Water	1 per 20 samples or 1 per batch, whichever is more frequent	75-125% recovery; RPD < 25%; n/a if concentration of either sample < MDL	Yes
EPA 1631, Revision E	Lab Duplicate	Water	1 per 20 samples or 1 per batch, whichever is more frequent	RPD < 25%; n/a if concentration of either sample < MDL	Yes
EPA 1631, Revision E	Certified Reference Material	Water	1 per 20 samples or 1 per batch, whichever is more frequent	75-125% recovery	Yes
EPA 1631, Revision E	Field Duplicates	Water	Not less than 5% of all samples	RPD < 25%; n/a if concentration of either sample < MDL	Yes
EPA 1631, Revision E	Field Blank	Water	Not less than 5% of all samples not field filtered.	< MDL	Yes
EPA 1631, Revision E	Field Equipment Blank	Water	Not less than 5% of all field filtered samples	< MDL	Yes
Trace Metals – Mercury, Methyl, in Water (filtered and unfiltered)					
EPA 1630	Laboratory Blank	Water	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	No
EPA 1630	Laboratory Control Sample	Water	1 per 20 samples or 1 per batch, whichever is more frequent	70-130% recovery; RPD < 25%	No
EPA 1630	Matrix Spikes/Duplicates	Water	1 per 20 samples or 1 per batch, whichever is more frequent	70-130% recovery RPD < 25% for duplicates; n/a if concentration of either sample < MDL	No

Method	QA Sample type	Matrix	Minimum Frequency	Acceptable limits (MQO)	Blank correction?
EPA 1630	Lab Duplicate	Water	1 per 20 samples or 1 per batch, whichever is more frequent	RPD < 25%; n/a if concentration of either sample < MDL	No
EPA 1630	Field Duplicates	Water	Not less than 5% of all samples	RPD < 25%: n/a if concentration of either sample < MDL	No
EPA 1630	Field Equipment Blank	Water	Not less than 5% of all samples	< MDL	No
Current Use Pesticides Monitoring by USGS Organic Chemistry Research Laboratory (OCRL) in Sacramento Pesticides in Water by liquid chromatography tandem mass spectrometry (LC/MS/MS)					
USGS-Gross, 2021	Calibration	Water, filtered	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	No
USGS- Gross, 2021	Calibration Check	Water, filtered	Every 6 samples.	75 -125% recovery	No
USGS- Gross, 2021	Laboratory Blanks	Water, filtered	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	No
USGS- Gross, 2021	Laboratory Control Sample	Water, filtered	1 per 20 samples or 1 per batch, whichever is more frequent	70-130% recovery	No
USGS- Gross, 2021	Matrix Spikes/Duplicates	Water, filtered	1 per 20 samples or 1 per batch, whichever is more frequent	70-130% recovery, RPD < 25%	No
USGS- Gross, 2021	Surrogate Spikes	Water, filtered	Every sample	70 -130% recovery	No
USGS- Gross, 2021	Internal Standards	Water, filtered	Every sample	70 -130% recovery	No
USGS- Gross, 2021	Field Blanks	Water, filtered	Not less than 5% of all samples	< MDL	No
Pesticides in Water by gas chromatography tandem mass spectrometry (GC/MS/MS)					

Method	QA Sample type	Matrix	Minimum Frequency	Acceptable limits (MQO)	Blank correction?
USGS- Gross, 2021	Calibration	Water, filtered	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	No
USGS- Gross, 2021	Calibration Check	Water, filtered	Every 6 samples.	75 -125% recovery	No
USGS- Gross, 2021	Laboratory Blanks	Water, filtered	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	No
USGS- Gross, 2021	Laboratory Control Sample	Water, filtered	1 per 20 samples or 1 per batch, whichever is more frequent	70-130% recovery	No
USGS- Gross, 2021	Matrix Spikes/Duplicates	Water, filtered	1 per 20 samples or 1 per batch, whichever is more frequent	70-130% recovery, RPD < 25%	No
USGS- Gross, 2021	Surrogate Spikes	Water, filtered	Every sample	70 -130% recovery	No
USGS- Gross, 2021	Internal Standards	Water, filtered	Every sample	70 -130% recovery	No
USGS- Gross, 2021	Field Blanks	Water, filtered	Not less than 5% of all samples	< MDL	No
Pesticides in Suspended Sediment by gas chromatography tandem mass spectrometry (GC/MS/MS)					
USGS- Gross, 2021	Calibration	Suspended Sediment	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	No
USGS- Gross, 2021	Calibration Check	Suspended Sediment	Every 6 samples.	75 -125% recovery	No
USGS- Gross, 2021	Laboratory Blanks	Suspended Sediment	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	No

Method	QA Sample type	Matrix	Minimum Frequency	Acceptable limits (MQO)	Blank correction?
USGS- Gross, 2021	Laboratory Control Sample	Suspended Sediment	1 per 20 samples or 1 per batch, whichever is more frequent	70-130% recovery	No
USGS- Gross, 2021	Matrix Spikes/Duplicates	Suspended Sediment	1 per 20 samples or 1 per batch, whichever is more frequent	70-130% recovery, RPD < 25%	No
USGS- Gross, 2021	Surrogate Spikes	Suspended Sediment	Every sample	70 -130% recovery	No
USGS- Gross, 2021	Internal Standards	Suspended Sediment	Every sample	70 -130% recovery	No
USGS- Gross, 2021	Field Blanks	Suspended Sediment	Not less than 5% of all samples	< MDL	No
Conventional – Total Suspended Solids (TSS)					
EPA 160.2	Laboratory Blank	Water, unfiltered	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	No
EPA 160.2	Field Blank	Water, unfiltered	Not less than 5% of all samples	< MDL	No
EPA 160.2	Field Duplicates	Water, unfiltered	Not less than 5% of all samples	RPD < 25%; n/a if concentration of either sample < MDL	No
Pesticides Monitoring - Metals and ancillary parameters by the USGS National Water Quality Laboratory (NWQL) in Denver					
Conventional – Dissolved Organic Carbon (DOC)					
Standard Methods 5310b (2016)	Laboratory Blank	Water, filtered	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	No
Standard Methods 5310b (2016)	Matrix Spikes/Duplicates	Water, filtered	1 per 20 samples or 1 per batch, whichever is more frequent	80-120% recovery; RPD < 25%	No
Standard Methods 5310b (2016)	Lab Duplicate	Water, filtered	1 per 20 samples or 1 per batch, whichever is more frequent	RPD < 25%; n/a if concentration of either sample < MDL	No

Method	QA Sample type	Matrix	Minimum Frequency	Acceptable limits (MQO)	Blank correction?
Standard Methods 5310b (2016)	Field Blanks	Water, filtered	Not less than 5% of all samples	< MDL	
Standard Methods 5310b (2016)	Field Duplicates	Water, filtered	Not less than 5% of all samples	RPD < 25%; n/a if concentration of either sample < MDL	No
Conventional – Particulate Organic Carbon (POC)					
EPA 440	Laboratory Blank	Suspended Sediment	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	No
EPA 440	Lab Duplicate	Suspended Sediment	1 per 20 samples or 1 per batch, whichever is more frequent	RPD < 10%	No
EPA 440	Instrument Blank	Suspended Sediment	12 hours	< MDL	No
EPA 440	Filter Blank	Suspended Sediment	1 per lot of filters or higher frequency	< MDL	No
Conventional – Total Nitrogen (TN)					
EPA 440	Laboratory Control Sample	Suspended Sediment	1 per 20 samples or 1 per batch, whichever is more frequent	90-110% recovery	No
EPA 440	Laboratory Blank	Suspended Sediment	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	No
EPA 440	Lab Duplicate	Suspended Sediment	1 per 20 samples or 1 per batch, whichever is more frequent	RPD < 25%	No
EPA 440	Field Blank	Suspended Sediment	Not less than 5% of all samples	< MDL	No
EPA 440	Filter Blank	Suspended Sediment	1 per lot of filters or higher frequency	< MDL	No

Method	QA Sample type	Matrix	Minimum Frequency	Acceptable limits (MQO)	Blank correction?
Conventional – Total Carbon (TC)					
EPA 440	Laboratory Control Sample	Suspended Sediment	1 per 20 samples or 1 per batch, whichever is more frequent	90-110% recovery	No
EPA 440	Laboratory Blank	Suspended Sediment	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	No
EPA 440	Lab Duplicate	Suspended Sediment	1 per 20 samples or 1 per batch, whichever is more frequent	RPD < 25%	No
EPA 440	Field Blank	Suspended Sediment	Not less than 5% of all samples	< MDL	No
EPA 440	Filter Blank	Suspended Sediment	1 per lot of filters or higher frequency	< MDL	No
Conventional – Total Inorganic Carbon (TIC)					
EPA 440	Laboratory Control Sample	Suspended Sediment	1 per 20 samples or 1 per batch, whichever is more frequent	90-110% recovery	No
EPA 440	Laboratory Blank	Suspended Sediment	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	No
EPA 440	Lab Duplicate	Suspended Sediment	1 per 20 samples or 1 per batch, whichever is more frequent	RPD < 25%	No
EPA 440	Field Duplicate	Suspended Sediment	Not less than 5% of all samples	RPD < 25%	No
EPA 440	Filter Blank	Suspended Sediment	1 per lot of filters or higher frequency	< MDL	No
Trace Metals – Copper (dissolved)					
USGS TM-5-B1	Laboratory Blank	Water, filtered	1 per 20 samples or 1 per batch, whichever is more frequent	< MDL	No

Method	QA Sample type	Matrix	Minimum Frequency	Acceptable limits (MQO)	Blank correction?
USGS TM-5-B1	CRM	Water, filtered	1 per 20 samples	70-125% recovery; RPD < 25%	No
USGS TM-5-B1	Matrix Spikes/Duplicates	Water, filtered	1 per 20 samples or 1 per batch, whichever is more frequent	75-125% recovery; RPD < 25%	No
USGS TM-5-B1	Lab Duplicate	Water, filtered	1 per 20 samples or 1 per batch, whichever is more frequent	RPD < 25%	No
USGS TM-5-B1	Field Duplicates	Water, filtered	Not less than 5% of all samples	RPD < 25%	No

MQOs for Aquatic Toxicity Testing

Lab QC samples required by SWAMP were described in **Section 7.5**. In addition, although not a standard part of SWAMP requirements, as shown in **Table 14.2**, the study design calls for a rate of field duplicates of 1 per 20 field samples for aquatic toxicity testing. The field duplicate sample should be handled the same as for all other samples, and the full suite of toxicity tests should be run using the same species as the primary sample for the site and event duplicated.

The water quality measurements specifically coupled to toxicity tests are intended to help interpret toxicity test data. Quality control practices and MQOs for toxicity testing and water quality measurements parallel those used for field meter instrumentation. Meters are calibrated at the beginning of each day and are recalibrated if measurements fall outside of the organism tolerance limits and/or outside of test requirements. Meters are recalibrated when drift exceeds the MQO for accuracy in **Table 14.3**. Quality control samples are expected to fall within the precision MQOs below and data are qualified in instances when these are exceeded.

Table 14.3. Summary of toxicity measurement quality objectives for aquatic toxicity testing.

Parameter	Accuracy	Precision	Completeness	Min	Max	Max difference	WQ Measurement Time Points
7-Day Chronic Freshwater *Pimephales promelas* Survival and Growth Toxicity Test (EPA 821/R-02-013)							
pH	± 0.2	± 0.5 pH units	90%				initial, final, renewal (daily)
Specific Conductance	± 2%	± 10%	90%				initial, final
Temperature	± 0.1	± 10%	90%	24	26	3	initial, final, renewal (daily); lab must report minimum and maximum measurement values
Dissolved Oxygen	± 0.2	± 10%	90%				initial, final, renewal (daily, 1 in old solution and 1 in new solution)
Ammonia	± 0.5%	± 10%	90%				initial, final
Hardness	Standard Reference Material (SRM) within 80 to 120% recovery	RPD < 25%	90%				initial
Alkalinity	SRM within 80 to 120% recovery	RPD < 25%	90%				initial
Toxicity Testing Field Duplicates	N/A	Statistical agreement between duplicates (RPD <25%)*	90%				N/A
6-8-Day Chronic Freshwater *Ceriodaphnia dubia* Survival and Reproduction Toxicity Test (EPA 821/R-02-013)							
pH	± 0.2	± 0.5 pH units	90%				initial, final, renewal (daily)
Specific Conductance	± 2%	± 10%	90%				initial, final
Temperature	± 0.1	± 10%	90%	24	26	3	initial, final, renewal (daily); lab must report minimum and maximum measurement values

Parameter	Accuracy	Precision	Completeness	Min	Max	Max difference	WQ Measurement Time Points
Dissolved Oxygen	± 0.2	± 10%	90%				initial, final, renewal (daily, 1 in old solution and 1 in new solution)
Ammonia	± 0.5%	± 10%	90%				initial, final
Hardness	SRM within 80 to 120% recovery	RPD < 25%	90%				initial
Alkalinity	SRM within 80 to 120% recovery	RPD < 25%	90%				initial
Toxicity Testing Field Duplicates	N/A	Statistical agreement between duplicates (RPD <25%)*	90%				N/A
96-Hour Chronic Freshwater *Selenastrum capricornutum* Growth Toxicity Test (EPA 821/R-02-013)							
pH	± 0.2	± 0.5 pH units	90%				initial, final, renewal (daily)
Specific Conductance	± 2%	± 10%	90%				initial, final
Temperature	± 0.1	± 10%	90%	24	26	3	initial, final, renewal (daily); lab must report minimum and maximum measurement values
Dissolved Oxygen	± 0.2	± 10%	90%				initial, final, renewal (daily, 1 in old solution and 1 in new solution)
Ammonia	± 0.5%	± 10%	90%				initial, final
Hardness	SRM within 80 to 120% recovery	RPD < 25%	90%				initial
Alkalinity	SRM within 80 to 120% recovery	RPD < 25%	90%				initial

Parameter	Accuracy	Precision	Completeness	Min	Max	Max difference	WQ Measurement Time Points
Toxicity Testing Field Duplicates	N/A	Statistical agreement between duplicates (RPD <25%)*	90%				N/A
96-Hour Acute Freshwater *Hyalella azteca* Survival Toxicity Test (EPA 821-R-02-012M)							
pH	± 0.2	± 0.5 pH units	90%				initial, final, renewal (daily)
Specific Conductance	± 2%	± 10%	90%				initial, final, renewal (daily)
Temperature	± 0.1	± 10%	90%	19	21	3	initial, final, renewal (daily); lab must report minimum and maximum measurement values
Dissolved Oxygen	± 0.2	± 10%	90%				initial, final, renewal (daily, 1 in old solution and 1 in new solution)
Ammonia	± 0.5%	± 10%	90%				initial, final
Hardness	SRM within 80 to 120% recovery	RPD < 25%	90%				initial
Alkalinity	SRM within 80 to 120% recovery	RPD < 25%	90%				initial
Toxicity Testing Field Duplicates	N/A	Statistical agreement between duplicates (RPD <25%)*	90%				N/A
10-Day Chronic Freshwater *Chironomus dilutus* Survival and Growth Toxicity Test (EPA 821/R-02-013M)							
pH	± 0.2	± 0.5 pH units	90%				initial, final, renewal (daily)
Specific Conductance	± 2%	± 10%	90%				initial, final, renewal (daily)

Parameter	Accuracy	Precision	Completeness	Min	Max	Max difference	WQ Measurement Time Points
Temperature	± 0.1	± 10%	90%	19	21	3	initial, final, renewal (daily); lab must report minimum and maximum measurement values
Dissolved Oxygen	± 0.2	± 10%	90%				initial, final, renewal (daily, 1 in old solution and 1 in new solution)
Ammonia	± 0.5%	± 10%	90%				initial, final
Hardness	SRM within 80 to 120% recovery	RPD < 25%	90%				initial
Alkalinity	SRM within 80 to 120% recovery	RPD < 25%	90%				initial
Toxicity Testing Field Duplicates	N/A	Statistical agreement between duplicates (RPD <25%)*	90%				N/A

*USEPA toxicity testing guidance does not specify a precision for duplicate testing and the listed RPD was determined to be a sufficient limit for the needs of the Delta RMP.

Table 14.4. Summary of toxicity methods and measurement quality objectives for aquatic toxicity testing.

Species	Test type	Duration	Endpoint(s)	CEDEN Code for Method	Method Name, Source	SWAMP MQOs
Invertebrate, *Ceriodaphnia dubia*	Chronic	6-8 days*	Survival, Reproduction	EPA 821-R-02-013	Test Method 1002.0: Daphnid, *Ceriodaphnia dubia*, survival and reproduction test (EPA 2002)	SWAMP (2018a) Table 6. 6-8-Day Chronic Freshwater *Ceriodaphnia dubia* Survival and Reproduction Toxicity Test
Invertebrate, *Chironomus dilutus*, also called *Chironomus tentans*	Chronic	10 days	Survival, Growth	EPA 821-R-02-013M	Modified Test Method 100.2: *Chironomus tentans*** 10-d Survival and Growth Test for Sediments EPA (2000)	SWAMP (2018a) Table 7. 10-Day Chronic Freshwater *Chironomus dilutus* Survival and Growth Toxicity Test

Species	Test type	Duration	Endpoint(s)	CEDEN Code for Method	Method Name, Source	SWAMP MQOs
Invertebrate, *Hyalella azteca*	Acute	4 days (96-hour)	Survival	EPA 821-R-02-012M	Modified Test Method 100.1: *Hyalella azteca* 10-d Survival and Growth Test for Sediments (EPA 2000)	SWAMP (2018b) Table 8. 96-Hour Acute Freshwater *Hyalella azteca* Survival Toxicity Test
Fish, *Pimphales promelas*	Chronic	7 days	Survival, Biomass	EPA 821-R-02-013	Test Method 1000.0: Fathead minnow, *Pimephales promelas*, larval survival and growth test (EPA 2002)	SWAMP (2018a) Table 9. 7-Day Chronic Freshwater *Pimephales promelas* Survival and Growth Toxicity Test
Algae, *Selenastrum capricornutum*, also called *Raphidocelis subcapitata*	Chronic	4 days (96-hour)	Growth	EPA 821-R-02-013	Test Method 1003.0: Green alga, *Selenastrum capricornutum*, growth test (EPA 2002)	SWAMP (2018a) Table 10. 96-Hour Chronic Freshwater *Selenastrum capricornutum* Growth Toxicity Test

*Per chronic freshwater testing manual, the chronic *C. dubia* test is not explicitly a test of 6-8 days duration, but the duration when ≥60% of lab control replicates have produced three broods. Typically occurs on days 6-8 but can occasionally (rarely) occur on day 5.

14.2.2. Corrective Actions Procedures

Field Sample Collection Corrective Actions

Table 14.5 lists typical corrective actions that may be taken by the project manager and/or QA Officer in response to issues that arise as a result of field sampling procedures. All necessary steps for corrective action will be documented on the field form and are entered into the electronic version of the Field Sampling Report that is maintained by MLJ Environmental. 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., MPSL-DFW Project Manager and USGS Principal Investigators, OCRL Project Chief), Technical Program Manager, and the QA Officer.

Table 14.5. Corrective actions procedures for field QC samples.

Issue / Field QC Sample Type	Corrective action
Evidence of contamination based on analytes detected in Field Equipment Blank, Field (Ambient) Blank, Travel/Bottle Blank (Water only)	If target analytes are found in field equipment 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.
Evidence of Poor repeatability due to significant differences detected between/among Field Replicates (for Water, Sediment, Tissue)	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.

Analytical and Toxicity Laboratory Corrective Actions

If chemical analytical laboratory results fail to meet the MQOs, the corrective actions in **Table 14.6** will be taken. Corrective actions will be documented, resolved, and followed-up on following the process for corrective actions that are outlined by SWAMP. The process is based on the SWAMP Corrective Action Form.

If toxicity laboratory results fail to meet the MQOs, or if toxicity testing requirements are not met, PER will proceed with their internal corrective action protocol. The laboratory will report and advise on how much a deviation may affect a test result. Corrective actions start with assessment of the cause of the problem (i.e., causal analysis). PER uses an "Evaluation of Non-Conforming Data" report to document and track investigations of non-conforming work and, where necessary, as documentation of implementation and monitoring of corrective actions. The PER QA Manager and their designees are responsible for initiating corrective actions on

routine data reviews where a non-conformance is found that could reoccur or where there is doubt about the compliance of the laboratory to its own policies and procedures. All deficiencies are investigated, and a corrective action plan is developed and implemented if determined to be necessary. The PER QA Manager and their designees monitor the effectiveness of corrective actions.

A description of corrective actions taken will be provided to the Delta RMP TACs, the CVRWQCB QA Representative, and other interested parties as a part of the QA Report accompanying the datasets produced in each focus area (mercury and pesticides). The Delta RMP Technical Program Manager will follow up to ensure corrective actions have been implemented.

Any significant deviations from the monitoring design described in this QAPP should be documented using the Delta RMP QAPP Deviations Form and shall be approved by the CVRWQCB QA Representative or SWB QA Officer prior to occurrence. When prior approval is not possible, the deviations must be reported to the Central Valley Water Board Quality Assurance Representative within 7 calendar days. The purpose of this form is to clearly document any requirements or intended actions (i.e., recommendations) of a Delta RMP project plan that was not met and may affect the data quality or its interpretation; this includes workplans, Sampling and Analysis Plans and/or the Quality Assurance Project Plan (QAPP). It is also meant to document corrective actions, or steps that have been taken to prevent recurrence of a problem. Another goal of this process is to provide timely notification to stakeholders of important issues, rather than waiting for a QA summary at the end of the year. The Technical Program Manager will share the completed forms with the Delta RMP TACs, the CVWQCB QA Representative, and other interested parties. Completed forms will also be included in quarterly progress reports to the Steering Committee. Finally, the forms may be included in year-end monitoring reports or QA summaries.

Table 14.6. Corrective actions procedures for analytical laboratories.

If a problem is found with this laboratory QC sample type	The following corrective action(s) shall be taken
Calibration Verification	Reanalyze the calibration verification to confirm the result. If the problem continues, halt analysis and investigate the source of the instrument drift. The analyst should determine if the instrument must be re-calibrated before the analysis can continue. All of the samples not bracketed by acceptable calibration verification must be reanalyzed.

If a problem is found with this laboratory QC sample type	The following corrective action(s) shall be taken
Matrix Spikes/ Matrix Spike Duplicates	The spiking level should be near the midrange of the calibration curve or at a level that does not require sample dilution. Reanalyze the matrix spike to confirm the result. Review the recovery obtained for the matrix spike duplicate. Review the results of the other QC samples (such as reference materials) to determine if other analytical problems are a potential source of the poor spike recovery.
Laboratory Blank	Reanalyze the blank to confirm the result. Investigate the source of contamination. If the source of contamination is isolated to the analysis procedures, reanalyze the entire batch of samples. If the source of the contamination is isolated to the sample preparation, and the blank contamination exceeds the field sample concentration (of the target in single analyte methods, or of target compounds accounting for >10% of total mass in multi-analyte methods) in 20% of detected samples, the entire batch of samples, along with the new laboratory blanks and associated QC samples, should be re-prepared and/or re-extracted and analyzed. If reanalysis or re-extraction is not possible, the associated sample results must be flagged to indicate the potential presence of contamination, and contingency plans to allow reanalysis for future samples developed and documented in a deviation form.
Laboratory Duplicate	Reanalyze the duplicate samples to confirm the results. Visually inspect the samples to determine if a high RPD between the results could be attributed to sample heterogeneity. For duplicate results due to matrix heterogeneity, or where ambient concentrations are below the reporting limit, qualify the results and document the heterogeneity.
Instrument Blank	Reanalyze the blank to confirm the result. Investigate, identify, and eliminate the source of contamination (e.g., instrument maintenance/cleaning and/or replacement of contaminated components). Analysis of samples shall be halted until contamination is eliminated.
LCS	If an LCS does not meet the acceptance criteria, there are usually problems with the laboratory method (e.g., imprecise aliquoting). Investigate, identify, and resolve the source of the bias. Samples need to be re-prepared and re-analyzed as samples with an acceptable LCS. If impossible, qualify reported data.
Field Duplicate	Visually inspect the samples to determine if a high RPD between results could be attributed to sample heterogeneity. For duplicate results due to matrix heterogeneity, or where ambient concentrations are below the reporting limit, qualify the results and document the heterogeneity. All failures should be communicated to the project coordinator, who in turn will follow the process detailed in the method.
Field Equipment Blank, Filter Blank	Investigate the source of contamination. Potential sources of contamination include sampling equipment, protocols, and handling. The laboratory should report evidence of field contamination as soon as possible, so that corrective actions can be implemented. Samples collected in the presence of field contamination should be flagged.

15. Instrument/Equipment Testing, Inspection, and Maintenance

15.1. Field Equipment

Field equipment such as boats, nets, and traps are inspected prior to each sampling event and are maintained throughout the field season and prior to storage during the off-season. Minimum equipment for the respective project elements includes:

Mercury - Fish

- Boats (electro-fishing and/or for setting nets)
- Bone saw, gill nets (various sizes), filet knives, fish picks, shackles, pliers, sharpening stone
- Rod and reels, tackle box, landing net, live bait container
- Plastic ice chests, inflatable buoy, floats, anchor chains, anchors, patch kit
- Measuring boards, tape measure, id keys, Teflon cutting boards
- Coolers

Mercury - Water

- Collection devices appropriate for site
- Field meters
- Coolers

Pesticides and Aquatic Toxicity

- Boat
- collection devices
- field meter
- bottles
- coolers and ice

15.2. Laboratory Equipment and Supplies

Contract laboratories maintain equipment in accordance with their respective SOPs, which include those specified by the manufacturer and those specified by the method.

Laboratories maintain internal SOPs for inspection and quality checking of supplies. Under a performance-based measurement system approach, these procedures are presumed to be effective unless field and QC data from analyses indicate otherwise. The Technical Program Manager, Delta RMP QAO, and CVRWQCB QA Representative 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 Technical Program Manager, Delta RMP QAO, and CVRWQCB QA Representative will discuss and identify alternatives, including changing the sampling materials and methods, the extraction and analytical methods, the laboratory, or any combination of these.

16. Instrument/Equipment Calibration and Frequency

16.1. Field Instruments/Equipment

Whenever an environmental water sample is collected, field crews shall collect basic water quality measurements using handheld measurement devices. Instruments for field data collection are described in **Section 14.1**, Field Measurements.

16.2. Laboratory Equipment

All laboratory instruments involved in analyses of Delta RMP samples shall be inspected, maintained, calibrated (as applicable) and tested prior to use. Laboratory instruments are calibrated, standardized, and maintained following procedures detailed in laboratory Quality Assurance Plans (QAPs) and Standard Operating Procedures (SOPs), adopted herein by reference, and listed in **Appendix E**.)

At a minimum, calibration procedures shall meet the requirements specified in the approved method, e.g., from USEPA or Standard Methods. Calibration procedures are described briefly 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, U.S. EPA).

Calibration curves will be established for each analyte and batch analysis from a calibration blank and a multi-point calibration (as described or required in the method), covering the range

of expected sample concentrations. 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.

Table 14.1 lists the project requirements for the frequency of calibration and type of calibration for field instruments. The required rate of calibration verification samples for laboratory instruments is listed in **Table 14.2**. A variety of sample types is used to check the accuracy and precision of lab instruments, including calibration verification samples, laboratory blanks, and lab duplicates.

If analytical instrumentation fails to meet performance requirements, the instrument(s) will be checked according to their respective SOP(s) and recalibrated. If the instrument(s) again does not meet specifications, it will be serviced and retested until performance criteria are achieved. The maintenance will be entered in the instrument log. If sample analytical information is in question due to instrument performance, the PM will be contacted regarding the proper course of action including reanalyzing the sample(s).

17. Inspection/Acceptance for Supplies and Consumables

All supplies shall be examined for damage as they are received. Laboratory personnel will review all supplies as they arrive to ensure the shipment is complete and intact. Laboratory staff shall log in all chemicals to the appropriate logbook and dated upon receipt. All supplies shall be stored appropriately following manufacturer recommendations. Chemicals and reference standards shall be discarded upon expiration date or if there is evidence that the material is degraded or damaged. **Table 17.1** indicates items that should be considered for accuracy, precision, and contamination. If these items are not found to be in compliance with the acceptance criteria, they will be discarded or returned to the manufacturer.

Table 17.1. Inspection/acceptance testing requirements for consumables and supplies.

Project-Related Supplies (source)	Inspection / Testing Specifications	Acceptance Criteria	Frequency	Responsible Individual
Certified pre-cleaned glass or plastic (IChem/Fisher Scientific or similar)	Carton custody seal is inspected	Carton custody seal intact	At receipt date of shipment	Field crew or lab personnel
Nitrile Gloves (Fisher Scientific or similar)	Carton seal is visually inspected for damage or tampering	Carton is intact and gloves within are clean and intact	At receipt date of shipment	Field crew or lab personnel

Project-Related Supplies (source)	Inspection / Testing Specifications	Acceptance Criteria	Frequency	Responsible Individual
Analytical Standards (Perkin-Elmer, VWR, Fisher Scientific or similar)	Solution bottles are inspected to verify factory seal	Manufacturer's seal intact	At receipt date of shipment	Field crew or lab personnel
Blue ice for coolers (various suppliers)	Check for leaking	no leaks	Upon receipt and at each use	Field crews
Coolers (various suppliers)	Check lid, hinges, and interior	Seals completely, no leaks, interior clean and undamaged	Upon receipt and at each use	Field crews
Zipper-closure polyethylene bags (various suppliers)	Visually inspected for damage	Carton is intact and bags within are clean and intact	At receipt date of shipment	Field crew or lab personnel

17.1. Field Supplies

All containers should meet or exceed the required trace limits established by the U.S. EPA in the document EPA/540/R-93/051, **Section 10**, *Specifications and Guidance for Contaminant-Free Sample Containers*. Chemical-resistant powder-free nitrile and polyethylene gloves shall be worn.

At a minimum, the following supplies are required for the respective project elements:

Mercury - Fish

- Waterproof labels
- Heavy-duty aluminum foil, zipper-closure polyethylene bags
- Field sheet (see **Appendix F**)
- Ice
- Chain-of-custody form (see **Appendix G**)

Mercury -Water

- Sampling containers and labels
- Polyethylene gloves
- Field sheet (see **Appendix F**)

- Ice
- Chain-of-custody form (see **Appendix G**)

Pesticides and Toxicity Sampling

- Safety gear; personal flotation devices; wet-weather gear if necessary
- GPS unit; mobile phone and/or radio
- Sampling containers and labels
- Collection devices appropriate for site
- Powder-free nitrile gloves
- Field meters
- Deionized water squirt bottle
- Field sheet (see **Appendix F**)
- Coolers and ice
- Chain-of-custody forms (see **Appendix G**)

18. Non-direct Measurements

Non-Delta RMP data (e.g., from Irrigated Lands 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 measurement quality objectives and used only if they meet all of the specified criteria (See **Section 14.2.1**, **Measurement Quality Objectives**). Data not meeting Delta RMP quality objectives 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. Only fully QA-reviewed hydrologic data will be used in analysis and reporting. Acceptable sources include the USGS National Water Information System (NWIS, https://waterdata.usgs.gov/nwis) and the DWR Water Data Library (WDL, http://wdl.water.ca.gov/waterdatalibrary/). Provisional data and modeled/forecasted data may be used for planning sampling events, for example determining whether there is sufficient rainfall and runoff forecasted to meet one of the event triggers described in **Table 6.7**.

19. Data Management

This section provides a brief overview of how project staff manage data generated by the project's sampling and analysis. For more detailed information, refer to Surface Water Data Management Standard Operating Procedures, included as **Appendix H**.

All raw and statistical analysis data are subject to review before upload, with ~10% spot-checked for accuracy by the Data Manager and Laboratory QAOs. Data are analyzed and proofread for accuracy, and then QA checked against the QAPP, and project criteria before being entered into the CV RDC database. Original hard copies of the data are stored securely until requested by the PM and/or inclusion into the Final Report. Electronic copies are stored and backed up by each analyst and respective laboratory internal project manager.

MLJ and cooperators shall update computer hardware and software as recommended by the manufacturer or as needed. Regular testing of individual components is not required, other than verifying day to day functionality. Each entity is responsible for the necessary updates or upgrades, whether provided regularly through an Information Technology department or otherwise.

19.1. Entering and formatting of sampling and QA data results

19.1.1. Laboratory reporting of results

Chemical-analytical data shall be reported by labs in SWAMP or CEDEN's Water Quality (WQ) or Tissue templates (see **Section 19.1.2** for Toxicity data procedures). Tabulated data will include the following information for each sample (when applicable):

1. **Sample identification**: Sample ID, site code, site name, collection date, collection time, analysis date, sample type (field or QC types), and matrix.
2. **Analytical method**s: 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.
4. **Batch and result comments**: Lab comments must be applied to any batch when any QA code was applied to a result in the batch that may affect data use. A brief explanation of the issue shall be included.

Required additional data include:

- 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 percent recovery relative to certified or expected value.
- Matrix (or blank) spike results: include expected value (native + spike) for each analyte, actual recovered concentrations, calculated per recovery, and RPD.
- 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). Lab replicate results and calculated RPD or RSD.

Documentation containing definitions, field length, field requirement, and associated lookup lists (if applicable) for each field is available on the CEDEN website at http://www.ceden.org/ceden_datatemplates.shtml.

Fields requiring 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 http://www.ceden.org/CEDEN_Checker/Checker/LookUpLists.php.

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

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 12.1**). Turnaround time requirements specified in subcontracts are generally 45 days or less for water and sediment, and 60 days or less for tissue matrices. Any extensions to this timeline that exceeds the Board Resolution will be discussed and approved by the Regional Board QA Representative.

19.1.2. Toxicity data

Delta RMP toxicity collection agencies and laboratories will provide toxicity data to the CV RDC in accordance with the contract requirements. The CV RDC will assume all data management responsibilities for Delta RMP toxicity data. This includes data processing, QA/QC review, and data uploading to the California Environmental Data Exchange Network (CEDEN). Data will be reviewed by the Data Manager under the supervision of the Delta RMP QA Officer, following the Standard Operating Procedures for Surface Water Data Management. The Technical Program Manager will distribute the provisional toxicity data to the Pesticide TAC for review as Electronic Data Deliverables (EDDs) are received from the toxicity lab (after verifying that all expected results for the sampling event have been provided) and will distribute the final toxicity data and QA summary to the Pesticide TAC for review upon completion of QA/QC review of the data (and prior to the data's public release). The data will be made publicly available through CEDEN's Advanced Query tool within 6 months of the last sampling event date.

19.1.3. Mercury data

The Delta RMP mercury collection laboratory will provide water and tissue data to the data managers at the State Water Resources Control Board's Information Management & Quality Assurance Center unit (SWAMP IQ) in accordance with the Water Board's contract requirements. The SWAMP IQ unit will assume all data management responsibilities for Delta RMP mercury data. This includes data processing, QA/QC review, and data uploading to the California Environmental Data Exchange Network (CEDEN). Data will be reviewed by the State Water Resources Control Board Office of Information Management and Analysis (OIMA) data managers under the supervision of the SWAMP QA Officer, following the SWAMP Chemistry Data Verification Standard Operating Procedures. The data will be made publicly available through CEDEN's Advanced Query tool.

19.1.4. Pesticides Chemistry Data

Pesticides chemistry is analyzed by the USGS Organic Chemistry Lab (OCRL) in Sacramento. The handling of these data is different from other Delta RMP datasets due to the nature of our cooperation with the USGS, which is not simply a contract lab, but a federal science agency with its own long-standing policies and procedures. According to USGS policy, results from their labs shall be included in the National Water Information System (NWIS). This is an online database where results are freely available to the public.

OCRL staff perform a quality assurance review of the results generated in their lab, and then upload provisional data to the NWIS database. Afterwards, OCRL transmits the data to CV

RDC in the CEDEN data template format. Data management staff format these data and perform a thorough and independent QA review. As with other datasets, if serious issues arise, data management staff will communicate with OCRL to resolve these issues in coordination with the Technical Program Manager. This would include, for example, missing or duplicate data, data that appear to have been reported incorrectly, results outside of the expected range, incorrect units, serious deviations from the measurement quality objectives, or any other issue identified that could indicate problems with the lab analysis.

The Technical Program Manager will distribute the provisional pesticides chemistry data to the Pesticide TAC for review. The CV RDC will upload these data to CEDEN, and they are made viewable by the public once approved by the Delta RMP BOD within 6 months of the last sampling date as described in Attachment A of the Central Valley Water Board Resolution R5-2021-0054.

Table 19.1. Schedule of data management tasks and associated days expected to complete the task relative to specific events for pesticide and toxicity results.
Mercury monitoring results are submitted directly to State Board staff per the contract with the State Water Resources Control Board.

Event	Task	Pesticide Analysis		Toxicity	
		Days to Complete Task	Accumulated Business Days from Event	Days to Complete Task	Accumulated Business Days from Event
Receipt of field sheets	Field Data Entry	5	5	5	5
	Sample Details	5	10	5	10
Receipt of samples	Notification of Sample Delivery Issues	1	1	1	1
	Receipt of Laboratory PDF	30[1]	30	30	30
	Preliminary check of report for completeness	5	35	5	35
	Receipt of Laboratory EDD	90[2]	90	45	45
	Preliminary data to Delta RMP TAC	1	46	1	46
	Preliminary data to CVRWQCB	60 days from date of sample analysis			
	Feedback to laboratory regarding any formatting, completeness or QC issues	10	100	10	55
	Laboratory data loaded into the CV RDC	10	110	10	65

Event	Task	Pesticide Analysis		Toxicity	
		Days to Complete Task	Accumulated Business Days from Event	Days to Complete Task	Accumulated Business Days from Event
	Finalized data to Delta RMP TAC	1	111	1	66
After data loading of last event	Data QA Report for TAC Review	90	within 6 months of the last sampling event date.	90	within 6 months of the last sampling event date.
	Data Published to CEDEN (pending Delta RMP approval)	30		30	

[1]USGS does not provide a pdf report; preliminary results are presented in an electronic format prior to being finalized in a CEDEN format. Preliminary data include quality control data.

19.2. Laboratory data report package information

Analytical results, including associated quality control samples (see **Section 14.2.1** Measurement Quality Objectives), will be provided to the CV RDC or OIMA by the analytical laboratories. The laboratories analyze samples according to the hold times listed in the Delta RMP QAPP. The final report may be finalized for review up to 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 Technical Program Manager, Delta RMP QAO and CVRWQCB QA Representative.

Laboratory personnel will verify, screen, validate, and prepare all data, including QA/QC results, 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 should be maintained in the laboratory's database or files for future reference.

Laboratories will provide electronic copies of the tabulated analytical data in a format agreed upon with the Technical Program Manager, Data Manager, or a designee or in accordance with the Water Board's contract requirements for mercury data.

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 QA 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 is shown in **Table 23.1**. The most

commonly used QA codes are shown in **Table 23.2**. A complete list of codes is available online at CEDEN's Controlled Vocabulary web page.

For a detailed description of the measurements and procedures that are used by the lab QA Officer, SWAMP QA Officer, and Program QA Officer to demonstrate the quality of reported, see **Section 7**, Quality Objectives and Criteria.

19.3. Data storage/database

With the exception of mercury data managed by SWRCB, data are managed by DMT staff under the supervision of the Data Manager and the Delta RMP QA Officer. Upon completion of QA/QC review and data validation, data are compiled into the CV RDC database and distributed to the project managers and TAC representatives.

Data that are approved for public release by the Delta RMP Board of Directors (BOD) are made available through CEDEN's Advanced Query Tool webpage within a timeframe that is consistent with Attachment A in the Central Valley Board Resolution R5-2021-0054. Additionally, pesticide chemistry data will be added to the National Water Information System (NWIS) online database by USGS OCRL staff.

Delta RMP mercury data are managed by OIMA staff under the supervision of the SWAMP QA Officer. Upon completion of QA/QC review and data validation, data are compiled into the SWAMP RDC database. Because SWAMP is funding the mercury analyses and managing these data, the SWAMP IQ unit will make the data publicly available through CEDEN's Advanced Query Tool webpage, without the same review and approval steps that govern the release of other Delta RMP datasets, as outlined in the Communications Plan.

20. Lab Assessment and Response Actions

Before a new monitoring project is initiated, an initial 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. Additional audits may be conducted at any time during the scope of the study. The QAO or designee will review every data file submitted as part of these audits and ensure that QC issues will be addressed as soon as they are detected. 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 (or "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 Delta RMP QAO, the Technical Program Manager, the CVRWQCB QA Representative, and the lab QAO 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 reported to the appropriate TAC, maintained in the project files, and will be noted in any reporting that includes affected data.

21. Reports to Management

The Delta RMP will produce Annual Monitoring Reports for each of the focus areas, which documents the activities of the program each year that summarizes monitoring results and synthesizes the information they provide; and technical reports that document specific studies and synthesize information from diverse sources in relation to specific topics and prioritized assessment questions. Reporting products, authors responsible for producing the reports, and schedules are described in more detail in **Section 6.7.**

The Annual Monitoring Reports and/or QA Reports for each of the focus areas will present the results of the previous July-June fiscal year of sampling. For the CUP, the monitoring is conducted on a water year and therefore the QA Reports will be completed based on the water year. The main purpose of these reports is to summarize the final data and results of the QA review. The Data Manager is responsible for summarizing potential QA issues with reported data and communicating those issues to the Technical Program Manager and the QAO; the project manager will communicate delays in data deliverables and/or QA issues to the CVWQCB QA Representative. The Delta RMP QAO also reviews any analyses and reports generated from the data by the DMT to ensure that QA issues are appropriately acknowledged in the presentation and interpretation of data. The Delta RMP QAO will prepare a QA memo for each monitoring element annually, after completion of the QA review. For mercury, the MPSL-DFW QAO and Project Coordinator will communicate any QA issues to both the State Board, Regional Board contract managers, the CVRWQCB QA Representative, and the Technical Program Manager; deviation forms will be developed and signed as needed and QA issues discussed within the Mercury TAC.

Any significant changes to the monitoring design described in this QAPP should be documented using the Delta RMP QAPP Deviations Form. The purpose of this form is to clearly document deviations from a project plan; this includes workplans, Sampling and Analysis Plans and/or the Quality Assurance Project Plan (QAPP). It is also meant to document corrective actions, or steps that have been taken to prevent recurrence of a problem. Another goal of this

process is to provide timely notification to stakeholders of important issues, rather than waiting for a QA summary at the end of the year. The Technical Program Manager will share the completed forms with the Delta RMP TACs and other interested parties. Completed forms will also be included in quarterly progress reports to the Steering Committee. Finally, the forms may be included in year-end monitoring reports or QA summaries.

22. Data Review, Verification, and Validation

Delta RMP mercury data are managed by SWAMP IQ unit staff and are reviewed following the SWAMP Chemistry Data Verification Standard Operating Procedures. All other Delta RMP data undergo review and evaluation by the DMT to ensure that the data conform to quality criteria identified in this document (particularly **Section 7**) and other project-specific criteria. In addition, data are assessed to determine usability and whether the data support their intended use. Review of the data consists of three discrete but highly interlinked processes: verification, and validation, described in the next section, and assessment, in the last section.

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.

23. Verification and Validation Methods

This section describes at a high level the CV RDC / MPSL-MLML process for verification and validation of reported environmental data. The DMT staff perform data verification following methods described in the Data Management and Quality Assurance Standard Operating Procedures. The latest version of this document is in **Appendix H**.

23.1. Data Verification

In EPA guidance (EPA QA/G-8, USEPA 2000), data verification is defined as "the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements." Data are evaluated as meeting or failing MQOs, first by the laboratory, and again by the project QA Staff. 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 for the Delta RMP.

Characteristics of reported data are examined to identify possible problems in the generation and transmission of data.

Before submitting data, the contract laboratory's QA Officer (QAO) checks all of its records and the laboratory's Director or Project Manager will recheck 10%. All checks by the laboratory may be reviewed by DMT staff. 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).

Data are submitted to DMT staff in electronic form. Labs send the results to DMT after each round of analysis, typically within 45 days after sample receipt. Data received from USGS typically takes longer (up to 3 months) due to additional internal reviews that are required within USGS. DMT staff verifies the completeness of the submittal. Data verification for chemistry results will be done after each submittal. The Delta RMP Quality Assurance Officer will prepare the QA summary for external distribution after each year's monitoring is complete.

After data are submitted to the DMT, DMT staff will verify 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, using CEDEN vocabulary), and spot-check for consistency with hardcopy results reported by the laboratory. The DMT staff will examine submitted QA data for conformance with MQOs, specified previously (**Section 14.2.1**). Data that are incomplete, inaccurate, or failing MQOs without appropriate explanation will be referred back to the laboratory for correction or clarification.

The Technical Program Manager and Delta RMP QAO will discuss data failing MQOs with laboratory staff to determine corrective actions and whether the samples need to be re-collected. If problems cannot be readily corrected (insufficient sample, irremovable interferences, or blank contamination), results outside the MQOs will be flagged using CEDEN codes appropriate for the specific deviations to alert data users to uncertainties in quantitation. **Table 23.1** shows the CEDEN controlled vocabulary for result qualifiers. **Table 23.2** shows the most frequently used CEDEN QA codes. A full list of QA codes that may be applied can be found online at CEDEN's Controlled Vocabulary web page.

Data are further assigned a batch verification code on a batch level. See **Table 23.3** for batch verification codes. When measurement quality objectives (MQOs) are not met, verification codes from the Batch Verification Look -up and/or QA Code Lookup tables may be applied by DMT staff or Delta RMP QA Officer or designee and entered into the database. Codes applied by the Delta RMP QA Officer or designee are preceded by a "V" in the "Batch Verification Code" or "QA Code" fields. Individual records for field data, and laboratory batches for

chemistry, tissue and toxicity will be coded "VAC" once verification is complete. This code is contained in the Batch Verification Code field.

If deviations from the MQOs are detected by DMT staff and applicable QACodes are not applied or incorrectly applied by the laboratory, DMT staff will adjust the QACode as per the QAPP. QACodes found to be missing will be added by the DMT staff without applying a "V" in front of the QACode. A "V" QACode is not utilized by the DMT staff since the DMT staff are working with the laboratory to ensure that the laboratory is applying the QACodes correctly as outlined in the QAPP. QACodes that are applied incorrectly by the laboratory will be removed by the DMT staff. Any QACode adjustment will be reviewed with the laboratory to ensure the appropriate coding is utilized as per the QAPP for the current data set as well as to ensure future data sets are flagged correctly by the laboratory. The "V" QACodes will be utilized by the QAO in a later review, if needed.

The DMT staff will also adjust the LabSubmissionCode to ensure it is applied correctly by the laboratory. Batches with no QACodes other than "None" will receive an "A" LabSubmissionCode. Batches with any QACode other than "None" will receive an "A, MD" or applicable LabSubmissionCode. For example, if any QC is missing, then a "QI" is applied. Overall, the DMT staff will work with the laboratory to ensure that QACodes and LabSubmissionCodes are applied correctly as per the QAPP. The BatchVerificationCode and the ComplianceCode will be applied by the QAO or designee; therefore, the DMT staff will ensure that the BatchVerificationCode is "NR" and the ComplianceCode is "Pend".

The QAO or designee will review the entire data set before the finalization of the data to ensure all QACodes are applied correctly. Any missing QACodes will be applied with a "V" by the QAO or designee. Any QACodes that are incorrectly applied will be removed by the QAO or designee and the DMT staff/laboratory will be notified. The QAO or designee will not adjust the LabSubmissionCode. BatchVerificationCodes are updated by the QAO or designee to denote the level of verification and to note incomplete data with missing QC. The QAO or designee will apply the appropriate ComplianceCode to indicate the overall assessment of the data set. Any coding added by the QAO, or designee will be reviewed and discussed with the DMT staff and relevant laboratory to ensure future data sets are marked appropriately.

When batches are determined to be missing some or all QC required information, DMT staff will initiate communication with the lab to obtain this information and will recommend corrective action so this information is included in future data deliverables. When MQOs do not exist for certain data types, the data are coded as "NA" ("Not Applicable"). Any missing or incorrect data that may affect data quality or the interpretation of results, and corrective actions, will be communicated to the appropriate TAC.

Data from the first group of samples analyzed for each matrix will be reported as completed, to establish that all sampling, analysis, and reporting processes are performing as planned; after the first sampling group, data may be reviewed at a lower frequency as warranted (e.g., if no corrective actions appear likely necessary moving forward). However, new issues identified by the field or lab teams will be reviewed and addressed by the Technical Program Manager and QAO mid-project as needed and communicated to the CVRWQCB QA Representative.

Table 23.1. CEDEN controlled vocabulary for result qualifiers.

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

Table 23.2. Primary CEDEN QA codes used by the Delta RMP.

QA Code	Description	Results to which QACode applied
Frequently used by the DMT:		
BRK	No concentration sample container broken	All analytes in broken sample
BRKA	Sample container broken but analyzed	All analytes in broken sample
BS	Insufficient sample available to follow standard QC procedures	All analytes in batches with insufficient material for LABQA
DO	Coelution	Analytes with no quantity reported, and those with combined quantities
DS	Batch Quality Assurance data from another project	Analytes where NONPJ samples used for QC (lab replicates, or MS/MSD)
EUM	LCS is outside of control limits	Failing LCS samples, and field samples in batch with failing averaged LCS
GB	Matrix spike recovery not within control limits	Failing MS/MSD, and any field samples from the same site/event combination
GBC	CRM analyte recovery not within control limits	Failing CRM samples
GN	Surrogate recovery is outside of control limits	Surrogate result, and corresponding (non-surrogate) compound in that sample
GN	Surrogate recovery is outside of control limits	Surrogate result and matching (non-surrogate) analyte
H	A holding time violation has occurred	Analyte past its analysis, extraction, or preservation time
IL	RPD exceeds laboratory control limit	Failing lab replicate sets (both parent & child results), and field samples in batch with failing averaged lab replicate precision
ILF	Field RPD (FRPD) exceeds target range	All replicates from same site & event failing FRPD (field RPD) MQO target
IP	Analyte detected in field or lab generated blank	Affected blank records, and if at least one blank fails MQO, all field samples in lab batch
IPF	Analyte detected in field blank, data validation code	Affected field blank records, and if at least one field blank fails, also field samples collected under same protocols and project
IPND	Result not distinguishable from lab blank contamination, data validation code	All field samples in lab batch below threshold distinguishable from lab blanks
IU	Percent Recovery exceeds laboratory control limit	
J	Estimated value - EPA Flag	DNQ or other non-quantitative results
M	A matrix effect is present	
UT	Sample value was blank corrected	All results reported blank corrected (even if not specified in method)
None	None - No QA Qualifier	

QA Code	Description	Results to which QACode applied
R	Data rejected - EPA Flag	
SC	Surrogate Corrected Value	
Other QA Codes available in CEDEN, less frequently used:		
BB	Sample > 4x spike concentration	
BE	Low surrogate recovery; analyzed twice	
BLM	Compound unidentified or below the RL due to over dilution	
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.	
FO	Estimated maximum possible concentration (EMPC)	
GR	Internal standard recovery is outside method recovery limit	Internal standard result and matching (associated) analyte
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	

QA Code	Description	Results to which QACode applied
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	

Table 23.3. Batch verification codes.

BatchVerification Code	BatchVerification Name
VAP	Alternate Level Validation
VAP,VI	Alternate Level Validation, Incomplete QC
VAP,VQI	Alternate Level Validation, Incomplete QC, Flagged by QAO
VAC,VR	Cursory Verification, Data Rejected - EPA Flag, Flagged by QAO
VAC,VMD	Cursory Verification, Minor Deviations, Flagged by QAO
VAC,VMD,VQI	Cursory Verification, Minor Deviations, Incomplete QC, Flagged by QAO
VAC	Cursory Verification
VAC,VQI	Cursory Verification, Incomplete QC, Flagged by QAO
VLC	Cursory Verification/Validation
VLC,VQI	Cursory Verification/Validation, Incomplete QC, Flagged by QAO
VLC,VMD	Cursory Verification/Validation, Minor Deviations, Flagged by QAO
VLC,VMD,VQI	Cursory Verification/Validation, Minor Deviations, Incomplete QC, Flagged by QAO
VR	Data Rejected - EPA Flag, Flagged by QAO
VAF	Full Verification
VAF,VQI	Full Verification, Incomplete QC, Flagged by QAO
VAF,VMD	Full Verification, Minor Deviations, Flagged by QAO
VLF	Full Verification/Validation
VQI	Incomplete QC, Flagged by QAO
VQI,VTC	Incomplete QC, Temporary Verification, Flagged by QAO
VMD	Minor Deviations, Flagged by QAO
VQN	No QC, Flagged by QAO
NA	Not Applicable
NR	Not Recorded
VTC	Temporary Verification

23.2. Data Validation

EPA (in EPA QA/G-8, USEPA 2000) defines data validation as "an analyte- and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set." Data verification evaluates the quality of reported data at a more granular level, for example, as individual batches provided by the analytical laboratory. In data validation, the results in field and lab samples are considered in aggregate across batches to assess the overall quality of the reported data.

In addition to verification of performance on required QC measures and samples (i.e., MDLs, blanks, matrix spikes, CRM, and 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 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. However, 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 are often tightly linked to those of related compounds, such as its degradation products, manufacturing byproducts, or other compounds from the same group of chemicals (e.g., congeners of the same class of chemicals within 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.

The results of performance on QC samples reviewed in the previous section on data verification is considered together with the comparability of the project's new data to that previously generated by the project, and/or in other studies, to evaluate the uncertainty in the quantities reported for field samples. At the completion of the QA review by the Delta RMP QAO or designee, results are assigned a compliance code on an individual record level. See **Table 23.4** for compliance codes. Results from the data review (both verification and validation) will be summarized in the annual QA Report.

Table 23.4. Compliance codes.

DataCompliance Name	DataCompliance Code
Compliant	Com
Do Not Use	DNU
Estimated	Est
Historical	Hist
Not Applicable	NA
Not Recorded	NR

DataCompliance Name	DataCompliance Code
Pending QA review	Pend
Qualified	Qual
Qualified Historic	QualH
Rejected	Rej
Screening	Scr

24. Data Assessment and Reconciliation with User Requirements

EPA (in EPA QA/G-9, USEPA 2000) defines data quality assessment (DQA) as "the scientific and statistical evaluation of data to determine if data obtained from environmental data operations are of the right type, quality, and quantity to support their intended use." Procedures used to evaluate the uncertainty of the reported validated data are described in **Sections 7, 14**, and **20-23**. Limitations on data use will be reported to the data users as validation and verification QA codes and comments in the CEDEN database (**Section 23**) and in Annual Monitoring Reports (**Section 21**). The monitoring reports are also central to the data quality assessment, as they report the results in the full context of the data needs of the program.

Measurement quality objectives listed previously (**Section 14.2.1**) establish targets to be routinely achieved by the analytical laboratory. Data verification checks conformance to these targets, as well as achievement of project goals by field and lab teams in completeness and conformance to project protocols of collection of samples and reporting of data. Data validation uses the provided information to report on the overall accuracy or uncertainties in the data.

In data assessment, the project team reports the results in the context of the questions and other data needs for which the project was designed. 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 cumulative 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.

Limitations on data use shall be reported to data users in the form of flags or qualifiers in the CEDEN electronic database. Program staff, working under the supervision of Delta RMP Quality Assurance Officer (QAO), write quality assurance summaries for each dataset produced by the Delta RMP. These are reviewed and approved by the Delta RMP QAO and Technical

Program Manager and will be included in year-end data reports. These reports are reviewed by the Delta RMP TACs, approved by the Delta RMP BOD per recommendation by the Steering Committee, and reviewed and approved by the CVRWQCB, prior to being published.

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Appendix A. Delta Regional Monitoring Program Participants

Participants	Participant Groups
Regulatory Agencies	Central Valley Regional Water Quality Control Board State Water Resources Control Board U.S. EPA Region 9 Water Division
Resource Agencies	NOAA Fisheries California Department of Fish and Wildlife
Coordinated Monitoring Programs	Interagency Ecological Program California Department of Fish and Wildlife California Department of Water Resources (DWR)
Wastewater Treatment Agencies	City of Brentwood City of Davis City of Rio Vista City of Sacramento City of Stockton City of Tracy City of Vacaville City of Woodland Ironhouse Wastewater Treatment Facility Lodi Water Pollution Control Facility Manteca Wastewater Quality Control Facility Mountain House Community Services District Regional San Town of Discovery Bay
Stormwater Agencies	California Department of Transportation City of Ceres City of Davis City of Hughson City of Lathrop City of Lodi City of Manteca City of Modesto City of Oakdale City of Patterson City of Rio Vista City of Ripon City of Riverbank City of Rocklin City of Stockton City of Tracy City of Turlock City of Vacaville City of West Sacramento City of Woodland

Participants	Participant Groups
	Colusa County El Dorado County Sacramento County San Joaquin County Stanislaus County Sutter County Yolo County Yuba County
Irrigated Agriculture Coalitions	East San Joaquin Water Quality Coalition Sacramento Valley Water Quality Coalition San Joaquin County and Delta Water Quality Coalition Westside San Joaquin River Watershed Coalition
Dredgers	Army Corps of Engineers Port of Stockton Port of West Sacramento Sacramento Yacht Club
Flood Control and Habitat Restoration	California Department of Water Resources

Appendix B. Management Questions

Category	Management Questions
Status and Trends	Is there a problem or are there signs of a problem? Is water quality currently, or trending towards, adversely affecting beneficial uses of the Delta? Which constituents may be impairing beneficial uses in subregions of the Delta? 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? Which sources, pathways, loadings, and processes (e.g., transformations, bioaccumulation) contribute most to identified problems? What is the magnitude of each source and/or pathway (e.g., municipal wastewater, atmospheric deposition)? 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	How do ambient water quality conditions respond to different management scenarios? What constituent loads can the Delta assimilate without impairment of beneficial uses? What is the likelihood that the Delta will be water quality-impaired in the future?
Effectiveness Tracking	Are water quality conditions improving as a result of management actions such that beneficial uses will be met? Are loadings changing as a result of management actions? Are contaminant concentrations trending towards being in compliance with relevant regulatory water quality objectives or below ecotoxicological thresholds?

Appendix C. Assessment Questions

Delta RMP assessment questions for pesticides, mercury and nutrients. Questions in bold were identified by the Steering Committee as the highest priority in FY16-17.

Type	Core Management Questions	Mercury	Pesticides and Toxicity	Nutrients
Status & Trends	Is there a problem or are there signs of a problem? Is water quality currently, or trending towards, adversely affecting beneficial uses of the Delta? Which constituents may be impairing beneficial uses in subregions of the Delta? Are trends similar or different across different subregions of the Delta?	What are the status and trends in ambient concentrations of total mercury and methylmercury (MeHg) in fish, water, and sediment, particularly in subareas likely to be affected by major sources or new sources (e.g., large-scale restoration projects)? Are trends over time in MeHg in sport fish similar or different among Delta subareas? Are trends over time in MeHg in water similar or different among Delta subareas?	To what extent do pesticides contribute to observed toxicity in the Delta? Which pesticides or degradates have the highest potential to be causing toxicity in the Delta and therefore should be the priority for monitoring and management? If samples are toxic, do detected pesticides explain the toxicity? If samples are not toxic, do detected pesticide concentrations exceed other thresholds of concern (e.g., water quality objectives or Office of Pesticide Programs aquatic toxicity benchmarks)? What are the spatial and temporal extents of lethal and sublethal aquatic and sediment toxicity observed in the Delta?	How do concentrations of nutrients (and nutrient-associated parameters) vary spatially and temporally? Are trends similar or different across subregions of the Delta? How are ambient levels and trends affected by variability in climate, hydrology, and ecology? Are there important data gaps associated with particular water bodies within the Delta subregions?

Type	Core Management Questions	Mercury	Pesticides and Toxicity	Nutrients
			Do aquatic or sediment toxicity tests at targeted sites indicate a toxic response? If answer to A is yes, which other toxicity indicator(s) should guide monitoring and management of pesticides in Years 2+? What are the spatial/temporal distributions of concentrations of currently used pesticides identified as likely causes of observed toxicity? Which pesticides have the highest risk potential (based on DPR's risk prioritization model[12]) and should be included in chemical analyses? Is the list of pesticides included in USGS pesticide scan sufficient for Delta RMP monitoring design? Are methods available to monitor pesticides with high-risk potential not	

[12] http://www.cdpr.ca.gov/docs/emon/pubs/ehapreps/analysis_memos/prioritization_report_2.pdf

Type	Core Management Questions	Mercury	Pesticides and Toxicity	Nutrients
			included in USGS pesticide scan? 2.2. How do concentrations of the pesticides with the highest risk potential vary seasonally and spatially?	
Sources, Pathways, Loadings & Processes	Which sources and processes are most important to understand and quantify? Which sources, pathways, loadings, and processes (e.g., transformations, bioaccumulation) contribute most to identified problems? What is the magnitude of each source and/or pathway (e.g., municipal wastewater, atmospheric deposition)? What are the magnitudes of internal sources and/or pathways (e.g., benthic flux) and sinks in the Delta?	Which sources, pathways and processes contribute most to observed levels of methylmercury in fish? What are the loads from tributaries to the Delta (measured at the point where tributaries cross the boundary of the legal Delta)? How do internal sources and processes influence methylmercury levels in fish in the Delta? How do currently uncontrollable sources (e.g., atmospheric deposition, both as direct deposition to Delta surface waters and as a contribution to nonpoint runoff) influence methylmercury levels in fish in the Delta?	What are the principal sources and pathways responsible for aquatic and sediment toxicity observed in the Delta? What are the fates of prioritized pesticides and degradates in the environment? Do physical/chemical properties of priority pesticides, application rates and processes, and ambient conditions influence the degree of toxicity observed? What are the spatial/temporal use patterns of priority pesticides?	Which sources, pathways, and processes contribute most to observed levels of nutrients? How have nutrient or nutrient-related source controls and water management actions changed ambient levels of nutrients and nutrient-associated parameters? What are the loads from tributaries to the Delta? What are the sources and loads of nutrients within the Delta? What role do internal sources play in influencing observed nutrient levels? What are the types and sources of nutrient sinks within the Delta? What are the types and magnitudes of nutrient exports from the Delta to Suisun Bay and water

Type	Core Management Questions	Mercury	Pesticides and Toxicity	Nutrients
				intakes for the State and Federal Water Projects? 2. How are nutrients linked to water quality concerns such as harmful algal blooms, low dissolved oxygen, invasive aquatic macrophytes, low phytoplankton productivity, and drinking water issues? A. Which factors in the Delta influence the effects of nutrients on the water quality concerns listed above?
Forecasting Scenarios	How do ambient water quality conditions respond to different management scenarios What constituent loads can the Delta assimilate without impairment of beneficial uses? What is the likelihood that the Delta will be water quality-impaired in the future?	What will be the effects of in-progress and planned source controls, restoration projects, and water management changes on ambient methylmercury concentrations in fish in the Delta?	How do pesticide concentrations respond to different management scenarios? What pesticide loads can the Delta assimilate without exceeding water quality criteria established to protect beneficial uses? How will climate change affect concentrations and/or loadings of pesticides and impacts to aquatic species?	How will nutrient loads, concentrations, and water quality concerns from Sources, Pathways, Loadings, and Processes Question #2 respond to potential or planned future source control actions, restoration projects, and water resource management changes?

Type	Core Management Questions	Mercury	Pesticides and Toxicity	Nutrients
Effectiveness Tracking	Are water quality conditions improving as a result of management actions such that beneficial uses will be met? Are loadings changing as a result of management actions?	[none]	Are pesticide-related toxicity impacts decreasing over time?	How did nutrient loads, concentrations, and water quality concerns from Sources, Pathways, Loadings & Processes Question #2 respond to source control actions, restoration projects, and water resource management changes?

Appendix D. Short Summaries of Delta RMP Monitoring Elements

Pesticides and Aquatic Toxicity

There will be six sampling events during the Water Year, with 36 samples per year at spatially distributed sites and 6 samples per year at each of 2 fixed sites, for a total of 48 environmental samples, plus field QC samples.

The timing of 3 sampling events is planned during wet weather to capture certain runoff and storm events: (1) first seasonal flush of the water year), (2) significant winter storm; (3) third winter storm. The remaining sampling events shall be during dry weather to capture the irrigation/baseflow season: (4) spring, (5) summer, and (6) fall.

Chemical analyses and toxicity testing will be performed on all samples.

Pacific EcoRisk will analyze the toxicity of water samples for a suite of test organisms based on EPA (2002, 2000) and SWAMP (2008) methods. Aquatic toxicity test species are as follows, with exposure durations and endpoints in parentheses: (1) *Selenastrum capricornutum*, a single-celled algae (96-hr growth), (2) *Ceriodaphnia dubia*, a daphnid or water flea (6–8-day survival, reproduction), (3) *Hyalella azteca*¸ an aquatic invertebrate (96-hour survival), (4) *Chironomus dilutus*, midge larvae (7-day growth, survival), (5) *Pimephales promelas* (7-day growth, survival). 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 TAC.

The following chemical analyses will be performed by the USGS: current use pesticides (178 analytes in water and 140 analytes in sediment), total suspended solids, dissolved organic carbon (DOC) and particulate organic carbon (POC), hardness, and dissolved copper.

Mercury

Sport Fish

Annual sampling at 7 fixed sites since 2016. Indicator of primary interest is methylmercury (analyzed as total mercury) in muscle fillet of 350-mm largemouth bass (or similar predator species). Sites are located to represent different subareas of the Delta and to link with water monitoring.

Water

Sampling 7 sites that align with sport fish monitoring sites 3 times per year. Indicator of primary interest is total methylmercury in water.

Important parameters include total and dissolved total Hg and MeHg. Important ancillary parameters include chlorophyll *a*, DOC, suspended sediment concentrations, and volatile suspended solids.

Nutrients

A one-year study to document the variability of nutrients and related water quality parameters at high spatial resolution in the North Delta, Central Delta, and the Western Delta out to Suisun Bay. Measurements will include nitrate, ammonium, phosphate, temperature, conductivity, dissolved oxygen, chlorophyll, blue-green algal pigments, particle size and others. Data-collection cruises will be conducted under three different environmental/flow conditions (October 2017, May 2018, and August 2018).

Sacramento River Nutrient Change Study

This study will track the effects of changes in nutrient loading resulting from a short-term wastewater hold at the Sacramento River Wastewater Treatment Plant (SRWTP). In the summer of 2019, scheduled wastewater effluent holds will occur during the Effluent Valve Replacement (EVR) project, part of the EchoWater upgrade at the SRWTP. During an EVR hold, no treated effluent will enter the Sacramento River for a period of up to 48 hours. Based on prior research (Kraus et al. 2017) this should create a parcel of effluent-free river water over six miles long in the Sacramento River. The impacts of short-term changes in nutrient loading will be tracked in parcels of water with and without effluent during movement downstream in the Sacramento River and nearby channels.

The study will occur in the lower Sacramento River and downstream connecting channels, including Georgiana Slough and the Mokelumne River. The channels in the study area are close enough to the SRWTP that water parcels with or without treated effluent can still be detected and tracked in the river water (i.e., prior to complete mixing). In the shallower lower Mokelumne River and Georgiana Slough, light penetrates a greater proportion of the water column than in the deeper lower Sacramento River. Elevated light levels increase the potential for rapid phytoplankton growth when other regulating factors are favorable, namely low turbidity, shallow water depth or stratification, sufficient nutrient concentrations, and low grazing pressure.

The project consists of one week-long river sampling campaign, field measurements laboratory analyses, numeric modeling, and reporting. The project will use multiple methods, including boat-mounted, high frequency monitoring of nutrients and fluorescence; discrete sampling for analyses of water quality, phytoplankton and zooplankton abundances, clam biomass, and phytoplankton carbon uptake (to determine growth rates). Data and hydrodynamic modeling will be used to evaluate the response of phytoplankton to a range of nutrient loads and forms,

as well as factors of light, turbidity, water residence time, and grazing by zooplankton and clams.

The project team is targeting an EVR hold in September 2019 for the field work. Regional San staff will sample at a total of 12 "grab sample" stations, three along the Sacramento River, three along Georgiana Slough, three along the North Fork Mokelumne River and three along the South Fork Mokelumne River. The USGS high frequency sampling boat will sample these river segments daily during the week of field work. At each "grab sample" station, vertical profiles of temperature, pH, electrical conductivity, dissolved oxygen and photosynthetically active radiation (PAR) will be taken. Discrete samples will be collected for turbidity, chlorophyll a, picoplankton and phytoplankton enumeration, zooplankton enumeration and growth rates, and dissolved inorganic nutrient concentrations. If visual survey of a station indicates that potentially harmful algal species such as Microcystis sp. are present, the team will collect separate water samples for BSA Environmental Services to measure microcystins. Clams will be collected using benthic trawls.

Phytoplankton enumeration will allow examination of any changes in the proportions of beneficial and potentially harmful phytoplankton. During the 1-week study, changes in phytoplankton growth rates and zooplankton growth rates are expected to be detectable and potentially also changes in phytoplankton biomass. Because changes in zooplankton abundance would be minimal during this short time period and difficult to detect, the study will examine growth of zooplankton.

River discharge, velocity, and other water-quality characteristics from three of USGS' fixed monitoring stations Freeport (0.2 km upstream of SRWTP) and Walnut Grove and Decker Island (29.2 km and 39 km downstream of SRWTP, respectively) will be used to plan sampling events and document continuous river conditions. Treated effluent flow rate data (hourly averages) will be provided by SRWTP personnel, along with effluent water quality data, including daily ammonia (NH_4^+) and weekly nitrate (NO_3^-) concentrations.

Background - Best Available Science and Conceptual Models

Water and nutrients from the Sacramento River enter Georgiana Slough, and, via the Delta Cross Channel, the North Fork Mokelumne River and South Fork Mokelumne River, providing an opportunity to test the effects of changes in water transit time, depth, light, and nutrient loading on phytoplankton and zooplankton productivity and biomass. High frequency boat mapping, performed by the USGS in support of the Delta Regional Monitoring Program, is able to detect patterns in numerous aquatic variables in these side channels, including nutrient concentrations, turbidity, and chlorophyll a. Biogeochemical model predictions (Zhang et al. 2018) suggest that EchoWater Project upgrades to the SRWTP will result in substantial changes in nutrient concentrations in these side channels. During the EVR holds the load of ammonia and nitrate from SRWTP will be zero, providing an opportunity to investigate the potential

impacts of nutrient load reductions that are lower than those mandated in SRWTP's current NPDES permit.

Under our conceptual model, the factors of transit time, light, and nutrient loading will result in different outcomes for phytoplankton productivity and biomass occurring in the side channels compared to those living in the mainstem Sacramento River. In the mainstem Sacramento River, where water depth is sufficient to make light limiting to phytoplankton growth (AMS 2017), we predict that decreased nutrient loading will have little effect on phytoplankton biomass or the higher levels of the aquatic food web. However, in the side channels, where a combination of decreased depth, increased transit time, and decreased turbidity may increase light availability (i.e., euphotic zone depth), we predict that phytoplankton productivity and biomass will be regulated by nutrient availability. Under scenarios with lower nutrient loading, we would expect to see less phytoplankton growth and biomass than under the current loading scenario. The conceptual model assume that nutrient loading from other sources upstream of Freeport are constant across situations, and that during the summer SRWTP effluent is a high proportion of the total nutrient load to the Sacramento River. We assume a time frame of days, during which increases in phytoplankton and zooplankton growth rates would be detectable, and potentially also changes in phytoplankton biomass. However, changes in zooplankton abundance and clam biomass would be minimal during this short time period and difficult to detect. We do not make an assumption about whether increased phytoplankton biomass would be in the form of beneficial or harmful algal species, but we would be able to observe any changes through the high frequency boat mapping surveys, and through phytoplankton enumerations (species counts and biomass). Changes in nutrient loading from SRWTP will be apparent in the mainstem Sacramento River, but are unlikely to manifest in changes in phytoplankton response until the water reaches the river side channels, where other key factors, namely depth, transit time, and euphotic zone depth are more favorable for phytoplankton growth.

Appendix E. Links to SOPs

The following SOPs, manuals, and method reference documents will be made available on CD by request or can be downloaded from the publicly available link.

Field Sample Collection

USGS

- National Field Manual for the Collection of Water-Quality Data (USGS Techniques and Methods, Book 9)
- Collection of Pyrethroids in Water and Sediment Matrices: Development and Validation of a Standard Operating Procedure, (USGS Scientific Investigations Report 2009–5012)
- Optical Techniques for the Determination of Nitrate in Environmental Waters: Guidelines for Instrument Selection, Operation, Deployment, Maintenance, Quality Assurance, and Data Reporting (USGS Techniques and Methods 1-D5)
- Detections of current-use pesticides at 12 surface water sites in California during a 2-year period beginning in 2015: U.S. Geological Survey Data Series 1088 (USGS-Sanders, 2018)

Mercury Monitoring - Marine Pollution Studies Laboratory (MPSL-DFW)

- Collections of Water and Bed Sediment Samples with Associated Field Measurements and Physical Habitat in California. Version 1.1 updated March 2014, MPSL Field SOP v1.1
- MPSL-101 v 5, 2021: Sample Container Preparation for Organics and Trace Metals, including Mercury and Methylmercury
- MPSL-102a v 5, 2021: Sampling Marine and Freshwater Fish and Invertebrates for Trace Metal and Synthetic Organic Analysis
- MPSL-105 v 5, 2021: Laboratory Preparation of Tissue in Marine and Freshwater Bivalves and Fish for Trace Metal and Synthetic Organic Analysis.
- EPA 1631e, and its modifications (v 4, 2021) mercury analysis
- EPA 1630, and its modifications (v 3, 2021) for methylmercury analysis
- MPSL-111v 3, 2021, Field Collection Procedures for Depth Integrated Water via Bucket Sampler

Current Use Pesticides

USGS-ORCL

- Gross, M.S., Sanders, C.J., De Parsia, M.D., and Hladik, M.L., 2021, A Multiresidue Method for the Analysis of Pesticides in Water using Solid-Phase Extraction with Gas and Liquid Chromatography-Tandem Mass Spectrometry: U.S. Geological Survey data release, https://doi.org/10.5066/P9J8E544.
- SOP: Suspended Sediment on Filter Paper Extraction for LC/MS/MS and GC/MS/MS Analysis. Version 1.0; November 3, 2021. (On file with the State Board QA Officer)
- SOP: Water Extraction for LC/MS/MS and GC/MS/MS Analysis Using HLB Cartridges. Version 1.0; November 3, 2021. (On file with the State Board QA Officer)

USGS-NWQL

- Determination of Elements in Natural Water, Biota, Sediment and Soil Samples Using Collision/Reaction Cell Inductively Coupled Plasma-Mass Spectrometry, U.S. Geological Survey Techniques and Methods (TM-5-B1)
- 5310 TOTAL ORGANIC CARBON (TOC), Standard Methods For the Examination of Water and Wastewater (Standard Methods 5310b (2016))
- Method 440.0 Determination of Carbon and Nitrogen in Sediments and Particulates of Estuarine/Coastal Waters Using Elemental Analysis (EPA 440)
- TOTAL SUSPENDED SOLIDS (TSS) EPA Method 160.2 (Gravimetric, Dried at 103-105EC) (EPA 160.2)

Toxicity Testing

PER

Pacific EcoRisk states that their SOPs are proprietary and confidential. These SOPs have been reviewed and are retained by the State Board Quality Assurance Officer, Andrew Hamilton.

- Standard Operating Procedure for *Selenastrum capricornutum* Algal Growth Bioassay – Revision #11
- Standard Operating Procedure for *Ceriodaphnia dubia* Chronic Survival and Reproduction Bioassay – Revision #9
- Standard Operating Procedure for *Pimephales promelas* Chronic Survival and Growth Bioassay – Revision #12
- Standard Operating Procedure for *Hyalella azteca* Acute Bioassay – Revision #4
- Standard Operating Procedure for 10-day *Chironomus dilutus* Survival & Growth Water Toxicity Test – Revision #4

Toxicity Identification Evaluations (TIEs)

PER

Pacific EcoRisk states that their SOPs are proprietary and confidential. These SOPs have been reviewed and are retained by the State Board Quality Assurance Officer, Andrew Hamilton.

- Standard Operating Procedure for Centrifuge Use and Preventative Maintenance – Revision #4
- Standard Operating Procedure TIE: Carboxylesterase and BSA Addition – Revision #3
- Standard Operating Procedure TIE: EDTA Addition – Revision #2
- Standard Operating Procedure TIE: PBO Addition – Revision #3
- Standard Operating Procedure for TIE: Reversed-Phase Solid Phase Extraction – Revision #3
- Standard Operating Procedure for TIE: Ion Exchange Solid Phase Extraction – Revision #1

SWAMP Documentation

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

For the Sacramento River Nutrient Change Study

Clam Measurement SOP, August 2019. By Tim Mussen, Regional San.

Applied Marine Sciences. 2017. Final Report: Spatial and Seasonal Patterns in Irradiance, Phytoplankton, and Grazers Along the Sacramento River, California. Submitted to: Tim Mussen & Lisa Thompson, Sacramento Regional County Sanitation District, 10060 Goethe Road, Sacramento, CA 95827. August 14, 2017. 65 p.

Kimmerer, Wim, Toni R. Ignoffo, Brooke Bemowski, Julien Modéran, Ann Holmes, and Brian Bergamaschi. "Zooplankton Dynamics in the Cache Slough Complex of the Upper San Francisco Estuary." *San Francisco Estuary and Watershed Science* 16, no. 3 (2018). https://escholarship.org/uc/item/63k1z819. (free download)

Kimmerer Lab Zooplankton Growth Rate Experiment Protocol. San Francisco State University, Sept. 2015. Download link.

RMA. 2017. "Regional San Project 3 Documentation: Hydraulic Modeling to Estimate Proportional Water Sources to the Lower Sacramento River." Davis, California: Resource Management Associates.

McNabb, Clarence D. "Enumeration of Freshwater Phytoplankton Concentrated on the Membrane Filter." *Limnology and Oceanography* 5, no. 1 (1960): 57–61. https://doi.org/10.4319/lo.1960.5.1.0057. (free download)

Beaver, John R., David E. Jensen, Dale A. Casamatta, Claudia E. Tausz, Kyle C. Scotese, Kristen M. Buccier, Catherine E. Teacher, Teodoro C. Rosati, Alison D. Minerovic, and Thomas R. Renicker. "Response of Phytoplankton and Zooplankton Communities in Six Reservoirs of the Middle Missouri River (USA) to Drought Conditions and a Major Flood Event." *Hydrobiologia* 705, no. 1 (March 1, 2013): 173–89. doi:10.1007/s10750-012-1397-1. [Download link]

Fichot, Cédric G., Bryan D. Downing, Brian A. Bergamaschi, Lisamarie Windham-Myers, Mark Marvin-DiPasquale, David R. Thompson, and Michelle M. Gierach. "High-Resolution Remote Sensing of Water Quality in the San Francisco Bay–Delta Estuary." *Environmental Science & Technology* 50, no. 2 (January 19, 2016): 573–83. https://doi.org/10.1021/acs.est.5b03518.

Zaffiro, Alan, Laura Rosenblum, and Steven C. Wendelken. "Method 546: Determination of Total Microcystins and Nodularins in Drinking Water and Ambient Water by Adda Enzyme-Linked Immunosorbent Assay." US Environmental Protection Agency, 2016. https://www.epa.gov/sites/production/files/2016-09/documents/method-546-determination-total-microcystins-nodularins-drinking-water-ambient-water-adda-enzyme-linked-immunosorbent-assay.pdf.

Appendix F. Example Field Data Sheets

Attach ASR and Wx List

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) _____

*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 _____

* see last page for additional codes

START TIME GAGE HT TIME CHT TIME CHT TIME CHT END TIME CHT

FIELD MEASUREMENTS

Property	Parm Code	Method Code (http://water.usgs.gov/usgs/owq/FieldManual/Chapter6/6.2_contents.html)	Result	Units	Remark Code	Value Qualifier	Null Value Qualifier	NWIS Result-Level Comments
Gage Height	00065			ft				
Discharge, instantaneous	00061			cfs				
Temperature, Air	00020	TM04 (Thermistor) TM05 (Thermometer)		°C				
Temperature, Water	00010	TI M01 (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) TI056 (Digital Titrator; TI057 (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 materia	84152	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 (milli liters)
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	NA	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; 7=extreme]		Oil-grease (01330) 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

SWAMP Tissue Sampling - Non-Trawl (Event Type = TI) **SWB_FishLk_LC_2014**		Entered in d-base (initial/date)		Pg of Pgs
***StationCode:** ___ ___ ___ ___ ___ ___ ___ ___ ___	*Station Name:		*Purpose Failure Code:	**Agency**
***FundingCode:** 1 3 S W B G 0 1	*Date (mm/dd/yyyy): / /			

Tissue Collection

Location	*Depth (m):	Distance from Bank (m):			Accuracy (ft / m)	Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, Fyke net, gill net, seine, hook & line		Start Time	Coord. 1				
SAMPLE LOCATION:	Bank, Thalweg, Midchannel, Open Water, NA			Coord. 2				
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert,		End Time	Coord. 3				
HYDROMODLOC(to sample):	US / DS / NA / WI	Other ________ Geoshape: Line Poly Point		Coord. 4				
Location	*Depth (m):	Distance from Bank (m):				Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, Fyke net, gill net, seine, hook & line		Start Time	Coord. 1				
SAMPLE LOCATION:	Bank, Thalweg, Midchannel, Open Water, NA			Coord. 2				
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert,		End Time	Coord. 3				
HYDROMODLOC(to sample):	US / DS / NA / WI	Other ________ Geoshape: Line Poly Point		Coord. 4				
Location	*Depth (m):	Distance from Bank (m):				Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, Fyke net, gill net, seine, hook & line		Start Time	Coord. 1				
SAMPLE LOCATION:	Bank, Thalweg, Midchannel, Open Water, NA			Coord. 2				
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert,		End Time	Coord. 3				
HYDROMODLOC(to sample):	US / DS / NA / WI	Other ________ Geoshape: Line Poly Point		Coord. 4				
Location	*Depth (m):	Distance from Bank (m):				Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, Fyke net, gill net, seine, hook & line		Start Time	Coord. 1				
SAMPLE LOCATION:	Bank, Thalweg, Midchannel, Open Water, NA			Coord. 2				
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert,		End Time	Coord. 3				
HYDROMODLOC(to sample):	US / DS / NA / WI	Other ________ Geoshape: Line Poly Point		Coord. 4				
Location	*Depth (m):	Distance from Bank (m):				Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, Fyke net, gill net, seine, hook & line		Start Time	Coord. 1				
SAMPLE LOCATION:	Bank, Thalweg, Midchannel, Open Water, NA			Coord. 2				
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert,		End Time	Coord. 3				
HYDROMODLOC(to sample):	US / DS / NA / WI	Other ________ Geoshape: Line Poly Point		Coord. 4				
Location	*Depth (m):	Distance from Bank (m):				Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, Fyke net, gill net, seine, hook & line		Start Time	Coord. 1				
SAMPLE LOCATION:	Bank, Thalweg, Midchannel, Open Water, NA			Coord. 2				
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert,		End Time	Coord. 3				
HYDROMODLOC(to sample):	US / DS / NA / WI	Other ________ Geoshape: Line Poly Point		Coord. 4				

Failure Codes: Dry (no water), Instrument Failure, No Access, Non-sampleable, Pre-abandoned, Other

Comments:

Modified 06/08/07

Appendix G: Chain Of Custody Form

Pacific EcoRisk
2250 Cordelia Rd., Fairfield, CA 94534
(707) 207-7760 FAX (707) 207-7916

CHAIN-OF-CUSTODY RECORD

Results To:	Delta RMP	**Invoice To:**	SFEI/ASC
Address:		**Address:**	4911 Central Avenue
			Richmond, CA 94806
Phone:		**Phone:**	
Attn:	Melissa Turner	**Attn:**	
E-mail:	mturner@mljenvironmental.com	**E-mail:**	contracts@sfei.org
Project Name:	Delta Regional Monitoring Program		
P.O.#/Ref:			

	Client Sample ID	Sample Date	Sample Time	Sample Matrix*	Grab/ Comp	Container Number	Container Type	REQUESTED ANALYSIS: Chronic *S. capricornutum* algal growth (EPA-821-R-02-013)	Chronic *C. dubia* Survival & Reproduction (EPA-821-R-02-013)	Chronic *P. promelas* Survival & Growth (EPA-821-R-02-013)	96-hr Acute *H. azteca* Survival (EPA-821-R-02-013)	10-day Chronic *C. dilutus* Survival & Growth (EPA-821-R-02-012 Mod)						
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		

Samples collected by:

Comments/Special Instruction:

RELINQUISHED BY:		**RECEIVED BY:**	
Signature:		**Signature:**	
Print:		**Print:**	
Organization:		**Organization:**	
Date:	**Time:**	**Date:**	**Time:**
RELINQUISHED BY:		**RECEIVED BY:**	
Signature:		**Signature:**	
Print:		**Print:**	
Organization:		**Organization:**	
Date:	**Time:**	**Date:**	**Time:**

***Example Matrix Codes**: (**EFF** - Effluent) (**FW** = Freshwater); (**SW** = Saltwater); (**WW** = Wastewater); (**STRMW** = Stormwater); (**SED** = Sediment); or other

Appendix H: Standard Operating Procedures for Surface Water Data Management

Appendix I: Toxicity Identification Evaluation (TIE) Communication Protocol

The TIE TAC shall be notified by the laboratory via text message and email on the day an observation is made that a sample (or samples) exceeds the TIE trigger. If the trigger occurs on a weekend, the lab should call or send a text message to TAC members, if possible.

The TIE trigger protocol should be followed for all samples where there is > 50 percent effect (for *either* chronic and acute tests, at *any* point during the test, and for *all* test organisms and *all* endpoints). Specific TIE treatments will follow those in Table 26.1 unless the laboratory recommends alternative procedures, or the TIE TAC makes alternative decisions. The TIE TAC will communicate to the laboratory decisions regarding proceeding with TIEs.

Notification from the laboratory will provide preliminary results of the associated control(s) and affected sample(s), identify the species affected, and preliminary confirmation of the test validity (e.g., Test Acceptability Criteria met, test requirements were met, and water quality parameters were within the acceptable range). The availability of laboratory resources and possible timing for conducting additional testing will also be communicated to the TIE TAC so that any potential scheduling issues can be considered in TIE decisions (e.g., delays for ordering test supplies, organisms, or days when tests can/cannot be started).

Within 24 hours of test result notification from the Toxicity Laboratory, the TAC will review the laboratory results and meet (or discuss over email) to discuss a consensus decision regarding how to proceed via email to the laboratory. Based on this communication, TIEs should be initiated within 48 hours of the observation of toxicity. Communication will be initiated by the Toxicity Laboratory and facilitated by the Technical Program Manager to ensure consensus. To aid in the communication and consensus process, a Rapid Response Team will also be identified which will be a subset of the TAC and require at least the Rapid Response Team to provide a response within 24 hours of notification. Any decisions made by the Rapid Response Team and/or the TAC will be documented to justify the intended objective and benefits of any additional use of resources.

The TIE TAC will approve TIEs based on the degree of effect, available funding, chemical data, and other available information (e.g., pesticide application reports).

It is critical to make decisions and start any testing as soon as possible to minimize the potential loss of a toxicity signal (e.g., due to sorption to sample containers, degradation, or transformations) and every attempt will be made to minimize the time between sampling and testing. However, extenuating circumstances may delay TIE initiation beyond these goals (e.g., organisms need to be ordered from a supplier). These delays will be communicated to the TIE

TAC and documented so that corrective actions/alternative planning can be considered for the next sampling event.

Decisions and their rationale will be documented to justify the intended objective and benefits of any additional use of resources. Issues and their resolution will also be documented to inform decisions for future TIE testing if the issue arises again (i.e., by providing the information indicated in Table 26.2).

The toxicity testing laboratory will proceed with the default course of action according to Table 26.2. The decision flowchart (Figure 26.1) can be used by the laboratory in the absence of clear direction from the TIE TAC (e.g., if none of the TAC members are available).

Appendix J: Table 5.3. Water quality screening values for pesticide analytes

Table 5.3. Water quality screening values for pesticide analytes. All concentrations are in µg/L.

CASRN	Compound	Type	Removed from analyte list in 2018[1]	New, i.e. added in WY 2019	WQO RS-Delta Acute	WQO RS-Delta Chronic	WQO CA Toxics Rule Acute	WQO CA Toxics Rule Chronic	OW Aquatic Life Criteria Acute	OW Aquatic Life Criteria Chronic	OPP ALB Fish Acute	OPP ALB Fish Chronic	OPP ALB Invertebrates Acute	OPP ALB Invertebrates Chronic	OPP ALB Nonvascular plants	OPP ALB Vascular plants Acute	Are values at left "OPP Benchmark Equivalents" from DPR?	Lowest treshold	Lowest Threshold is:	Acute or One Day HHBP (ppb or µg/L)	Acute HHBP Sensitive Lifestage/ Population	Chronic or Lifetime HHBPs (ppb or µg/L)	Chronic HHBP Sensitive Lifestage/Population	Carcinogenic HHBP (E-6 to E-4) (ppb or µg/L)	Lowest Human Ref Value (ppb or µg/L)	Human Health Reference Value	Human Health Reference Value Endpoint	Is lowest threshold for human health or for aquatic organisms?
135410-20-7	Acetamiprid	Insecticide									>50,000	19,200	10.5	2.1	>1,000	>1,000		2.1	OPP ALB Invertebrates Chronic	700	Children	450	General Population	-	450.	HHBP	Chronic, General Population	Humans
34256-82-1	Acetochlor	Herbicide		TRUE							190	130	4,100	22.1	1.43	3.4		1.43	OPP ALB Nonvascular plants Acute	10,000	Children	100	General Population	-				#N/A
135158-54-2	Acibenzolar-S-methyl	Fungicide									440	26	1,450	48	445	> 423		26	OPP ALB Fish Chronic	550	Children	450	Females 13-49 years	-	450.	HHBP	Chronic, Females 13-49 year	Humans
15972-60-8	Alachlor	Herbicide	TRUE								900	187	1,250	110	1.64	2.3		1.64	OPP ALB Nonvascular plants Acute						2.	US EPA Primary MCL		Aquatic organisms
584-79-2	Allethrin	Insecticide									-	-	1.05	-	-	-		1.05	OPP ALB Invertebrates Acute									#N/A
1912-24-9	Atrazine	Herbicide									2,650	-	360	60	<1	0.001		0.001	OPP ALB Vascular plants Acute						1.	CA Primary MCL		Humans
86-50-0	Azinphos methyl	Insecticide	TRUE								0.18	0.44	0.08	0.25	-	-		0.08	OPP ALB Invertebrates Acute									#N/A
NONE	Azinphos methyl oxon	Degradate	TRUE								-	-	-	-	-	-		n/a[4]										#N/A
131860-33-8	Azoxystrobin	Fungicide									235	147	130	44	49	3,400		44	OPP ALB Invertebrates Chronic	4,500	Children	1,200	General Population		1200.	HHBP	Chronic, General Population	Humans
1861-40-1	Benfluralin	Herbicide									34.85	1.9	1090	15.5	> 100	-		1.9	OPP ALB Fish Chronic	-	-	30	General Population	-				#N/A
1072957-71-1	Benzovindiflupyr	Fungicide		TRUE							1.75	0.95	42.5	5.6	240	880		0.95	OPP ALB Fish Chronic									#N/A
82657-04-3	Bifenthrin	Insecticide									0.075	0.04	0.8	0.013	-	-		0.013	OPP ALB Invertebrates Chronic	70	Children	-		-	70.	HHBP	Acute, Children	Humans
188425-85-6	Boscalid	Fungicide									1,350	116	>2,665	790	1,340	>3,900		116	OPP ALB Fish Chronic	-	-	1,400	General Population	-	1400.	HHBP	Chronic, General Population	Aquatic organisms
116255-48-2	Bromuconazole	Fungicide	TRUE								850	34	42.5	20	53	160		20	OPP ALB Invertebrates Chronic	3,000	Females 13-49	60	General Population	-				#N/A
33629-47-9	Butralin	Herbicide									-	-	-	-	-	-		n/a[4]										#N/A
2008-41-5	Butylate	Herbicide	TRUE								105	-	5,950	-	-	-		105	OPP ALB Fish Acute									#N/A
133-06-2	Captan	Fungicide									13.1	16.5	4,200	560	320	>12,700		13.1	OPP ALB Fish Acute	3,000	Females 13-49	830	General Population	-	15.	AAL		Humans
63-25-2	Carbaryl	Insecticide					2.1	2.1	2.1	2.1	110	6	0.85	0.5	660	1,500		0.5	OPP ALB Invertebrates Chronic						40.	HA	Lifetime	Aquatic organisms
10605-21-7	Carbendazim	Fungicide									190	n/a[2]	150	n/a[2]	7,700	n/a[2]	TRUE	150	DPR OPP ALB Equivalent - Invertebrates Acute									#N/A
1563-66-2	Carbofuran	Insecticide									44	5.7	1.115	0.75	-	-		0.75	OPP ALB Invertebrates Chronic									#N/A
5234-68-4	Carboxin	Fungicide		TRUE							600	0	42,200	0	370	670		0	OPP ALB Fish Chronic						700.	HA	Lifetime	Humans
500008-45-7	Chlorantraniliprole	Insecticide									>600	110	4.9	4.5	1,800	2,000		4.5	OPP ALB Invertebrates Chronic	-	-	10,100	General Population		10100.	HHBP	Chronic, General Population	Aquatic organisms
122453-73-0	Chlorfenapyr	Insecticide		TRUE							3.72	3.68	2,915	3.57	0	0		0	OPP ALB Nonvascular plants Acute	300	Children	300	General Population		300.	HHBP	Acute, Children & Chronic, G	Aquatic organisms
1897-45-6	Chlorothalonil	Fungicide									5.25	3	1.8	0.6	6.8	630		0.6	OPP ALB Invertebrates Chronic						1.5	HA	Cancer	Aquatic organisms
2921-88-2	Chlorpyrifos	Insecticide			0.025	0.015			0.083	0.041	0.9	0.57	0.05	0.04	140	-		0.015	WQO R5- Delta Chronic						2.	HA	Lifetime	Aquatic organisms
5598-15-2	Chlorpyrifos OA	Degradate									-	-	-	-	-	-		n/a[4]										#N/A
81777-89-1	Clomazone	Herbicide									1,450	350	2,700	2,200	167	30,200		167	OPP ALB Nonvascular plants Acute	30,000	Females 13-49	5,400	General Population		5400.	HHBP	Chronic, General Population	Humans
210880-92-5	Clothianidin	Insecticide									>50,750	9,700	11	11	64,000	121,000		11	OPP ALB Invertebrates Acute	1,700	Children	630	General Population	-	630.	HHBP	Chronic, General Population	Aquatic organisms
56-72-4	Coumaphos	Insecticide									140	11.7	0.037	0.0337	-	-		0.0337	OPP ALB Invertebrates Chronic	17	Children	2	General Population					#N/A
736994-63-1	Cyantraniliprole	Insecticide									>5,000	10,700	10.2	6.56	>10,000	12,100		6.56	OPP ALB Invertebrates Chronic	-	-	60	General Population	-	60.	HHBP	Chronic, General Population	Humans
120116-88-3	Cyazofamid	Fungicide									>53.5	90.1	>650	<87	-	>1,220		53.5	OPP ALB Fish Acute	30,000	Females 13-49	6,070	General Population	-	6070.	HHBP	Chronic, General Population	Aquatic organisms
1134-23-2	Cycloate	Herbicide									2,250	-	1,300	-	-	-		1300	OPP ALB Invertebrates Acute	450	Children	30	General Population	-	30.	HHBP	Chronic, General Population	Aquatic organisms
68359-37-5	Cyfluthrin, Total	Insecticide									0.034	0.01	0.0125	0.0074	>181	-		0.0074	OPP ALB Invertebrates Chronic									#N/A
122008-85-9	Cyhalofop-butyl	Herbicide									790	n/a[2]	2,700	n/a[2]	960	n/a[2]	TRUE	790	DPR OPP ALB Equivalent - Fish Acu	-	-	60	General Population	-	60.	HHBP	Chronic, General Population	Humans
91465-08-6 and 76703-62-3	Cyhalothrin, Total[3]	Insecticide									0.0145	-	0.00024	> 2,850	-	-		0.0002	OPP ALB Invertebrates Acute									#N/A
57966-95-7	Cymoxanil	Fungicide									14,500	0.98	14,000	6	202	> 793.8		0.98	OPP ALB Fish Chronic	1,000	Females 13-49	5	General Population		5.	HHBP	Chronic, General Population	Humans
52315-07-8	Cypermethrin, Total	Insecticide									0.195	0.14	0.21	0.069	-	-		0.069	OPP ALB Invertebrates Chronic									#N/A
94361-06-5	Cyproconazole	Fungicide									-	-	-	-	-	-		n/a[4]		600	Females 13-49	60	General Population	-				#N/A
121552-61-2	Cyprodinil	Fungicide									1,090	230	16	8.2	1,970	5900		8.2	OPP ALB Invertebrates Chronic	10,000	Children	170	General Population	-	170.	HHBP	Chronic, General Population	Humans
1861-32-1	Dacthal	Herbicide									15,000	-	13,500	-	>11,000	>11,000		11000	OPP ALB Nonvascular plants Acute									#N/A
72-54-8	DDD(p,p')	Degradate									-	-	-	-	-	-		n/a[4]										#N/A
72-55-9	DDE(p,p')	Degradate									-	-	-	-	-	-		n/a[4]										#N/A
50-29-3	DDT(p,p')	Insecticide					1.1	0.001	1.1	0.001	-	-	-	-	-	-		0.001	WQO CA Toxics Rule Chronic									#N/A
52918-63-5	Deltamethrin	Insecticide									0.29	0.017	0.055	0.0041	-	-		0.0041	OPP ALB Invertebrates Chronic	30	Children		General Population	-	30.	HHBP	Acute, Children	Humans
120983-64-4	Desthio-Prothioconazole	Fungicide									-	-	-	-	-	-		n/a[4]										#N/A
333-41-5	Diazinon	Insecticide			0.16	0.1			0.17	0.17	45	<0.55	0.105	0.17	3,700	-		0.1	WQO R5- Delta Chronic						1.	HA	Lifetime	Humans
962-58-3	Diazoxon	Degradate									-	-	-	-	-	-		n/a[4]										#N/A
95-76-1	Dichloroaniline, 3,4-	Degradate									-	-	-	-	-	-		n/a[4]										#N/A
626-43-7	Dichloroaniline, 3,5-	Degradate									-	-	-	-	-	-		n/a[4]										#N/A
2327-02-8	Dichlorophenyl Urea, 3,4	Degradate									-	-	-	-	-	-		n/a[4]										#N/A
3567-62-2	Dichlorophenyl-3-methyl	Degradate									-	-	-	-	-	-		n/a[4]										#N/A
62-73-7	Dichlorvos	Insecticide		TRUE							91.5	5.2	0.035	0.0058	14,000	0		0	OPP ALB Vascular plants Acute	50	Children	3	General Population					#N/A
119446-68-3	Difenoconazole	Fungicide									405	8.7	385	5.6	98	1,900		5.6	OPP ALB Invertebrates Chronic	1,700	Children	60	General Population	-	60.	HHBP	Chronic, General Population	Aquatic organisms
110488-70-5	Dimethomorph	Fungicide									3,100	107	> 5300	110	23800	22040		107	OPP ALB Invertebrates Acute	1,700	Children	600	General Population	-	600.	HHBP	Chronic, General Population	Aquatic organisms
165252-70-0	Dinotefuran	Insecticide									>49,550	>6,360	>484, 150	>95,300	>97,600	>110,000		6360	OPP ALB Fish Chronic	8,330	Children	6,000	General Population	-	6000.	HHBP	Chronic, General Population	Aquatic organisms
97886-45-8	Dithiopyr	Herbicide									235	56	> 850	81	20	-		20	OPP ALB Nonvascular plants Acute						--			#N/A
330-54-1	Diuron	Herbicide									200	26.4	80	200	2.4	15		2.4	OPP ALB Nonvascular plants Acute						2.	HA	Cancer	Aquatic organisms
759-94-4	EPTC	Herbicide									7,000	407	3,250	800	1,400	5,600		407	OPP ALB Fish Chronic									#N/A
66230-04-4	Esfenvalerate	Insecticide									0.035	0.035	0.025	0.017	-	-		0.017	OPP ALB Invertebrates Chronic	12	Children	12	General Population		12.	HHBP	Acute, Children & Chronic, G	Humans
162650-77-3	Ethaboxam	Fungicide									1090	880	185	50	> 3600	-		50	OPP ALB Invertebrates Chronic	-	-	350	General Population					#N/A
55283-68-6	Ethalfluralin	Herbicide									16	0.4	30	24	25	-		0.4	OPP ALB Fish Chronic	21,000	Females 13-49	300	General Population	0.36-36	.36	HHBP	Cancer	Humans
80844-07-1	Etofenprox	Insecticide									1.35	23	0.4	0.17	>18.8	>26		0.17	OPP ALB Invertebrates Chronic									#N/A
153233-91-1	Etoxazole	Insecticide		TRUE							185	15	3.65	0.13	51.9	56		0.13	OPP ALB Invertebrates Chronic	-	-	290	General Population	-	290.	HHBP	Chronic, General Population	Humans
131807-57-3	Famoxadone	Fungicide									11	n/a[2]	12	n/a[2]	22	n/a[2]	TRUE	11	DPR OPP ALB Equivalent - Fish Acu	-	-	9	General Population		9.	HHBP	Chronic, General Population	Aquatic organisms
161326-34-7	Fenamidone	Fungicide									370	4.7	24.5	12.5	70	>880		4.7	OPP ALB Fish Chronic	8,330	Children	181	General Population		181.	HHBP	Chronic, General Population	Humans
60168-88-9	Fenarimol	Fungicide	TRUE								450	180	3,400	113	100	-		100	OPP ALB Nonvascular plants Acute	-	-	40	General Population	-	40.	HHBP	Chronic, General Population	Aquatic organisms
114369-43-6	Fenbuconazole	Fungicide									1,500	n/a[2]	2,300	n/a[2]	330	n/a[2]	TRUE	330	DPR OPP ALB Equivalent - Nonvasc	8,000	Females 13-49	200	General Population	8.91-891	8.91	HHBP	Cancer	Humans
126833-17-8	Fenhexamid	Fungicide									670	101	>9,400	1,000	4,820	>2,300		101	OPP ALB Fish Chronic	-	-	1,100	General Population	-	1100.	HHBP	Chronic, General Population	Humans
39515-41-8	Fenpropathrin	Insecticide									1.1	0.091	0.265	0.064	-	-		0.064	OPP ALB Invertebrates Chronic	110	Children	-		-	110.	HHBP	Acute, Children	Aquatic organisms
134098-61-6	Fenpyroximate	Insecticide									0.22	0.11	0.8	0.56	1.9	>190		0.11	OPP ALB Fish Chronic	1,000	Females 13-49	300	General Population	-	300.	HHBP	Chronic, General Population	Aquatic organisms
55-38-9	Fenthion	Insecticide	TRUE								415	7.5	2.6	0.013	400	>2,800		0.013	OPP ALB Invertebrates Chronic	5	Children	0	General Population	-				#N/A
120068-37-3	Fipronil	Insecticide									41.5	2.2	0.11	0.011	140	>100		0.011	OPP ALB Invertebrates Chronic	170	Children	1	General Population	-	1.	HHBP	Chronic, General Population	Humans
205650-65-3	Fipronil Desulfinyl	Degradate									10	0.54	100	10.3	140	>100		0.59	OPP ALB Fish Chronic									#N/A
205650-69-7	Fipronil Desulfinyl Amide	Degradate									17,000	-	20,000	-	-	-	TRUE	17000	DPR OPP ALB Equivalent - Fish Acute									#N/A
120067-83-6	Fipronil Sulfide	Degradate									41.5	6.6	1.065	0.11	140	>100		0.11	OPP ALB Invertebrates Chronic									#N/A
120068-36-2	Fipronil Sulfone	Degradate									12.5	0.67	0.36	0.037	140	>100		0.037	OPP ALB Invertebrates Chronic									#N/A
158062-67-0	Flonicamid	Insecticide									100,000	n/a[2]	100,000	n/a[2]	3,300	n/a[2]	TRUE	3,300	DPR OPP ALB Equivalent - Nonvasc	-	-	300	General Population	-	300.	HHBP	Chronic, General Population	Humans

CASRN	Compound	Type	Removed from analyte list in 2018[1]	New, i.e. added in WY 2019	WQO R5-Delta Acute	WQO R5-Delta Chronic	WQO CA Toxics Rule Acute	WQO CA Toxics Rule Chronic	OW Aquatic Life Criteria Acute	OW Aquatic Life Criteria Chronic	OPP ALB Fish Acute	OPP ALB Fish Chronic	OPP ALB Invertebrates Acute	OPP ALB Invertebrates Chronic	OPP ALB Nonvascular plants	OPP ALB Vascular plants Acute	Are values at left "OPP Benchmark Equivalents" from DPR?	Lowest treshold	Lowest Threshold is:	Acute or One Day HHBP (ppb or µg/L)	Acute HHBP Sensitive Lifestage/ Population	Chronic or Lifetime HHBPs (ppb or µg/L)	Chronic HHBP Sensitive Lifestage/Population	Carcinogenic HHBP (E-6 to E-4) (ppb or µg/L)	Lowest Human Ref Value (ppb or µg/L)	Human Health Reference Value	Human Health Reference Value Endpoint	Is lowest threshold for human health or for aquatic organisms?
79622-59-6	Fluazinam	Fungicide									18	0.69	90	68	1.1	-		0.69	OPP ALB Fish Chronic	2,000	Females 13-49	70	General Population	-	70.	HHBP	Chronic, General Population	Humans
272451-65-7	Flubendiamide	Insecticide		TRUE							32.55	60.5	0.14	41.1	69.3	54.6		0.14	OPP ALB Invertebrates Acute	6,630	Children	150	General Population	-	150.	HHBP	Chronic, General Population	Aquatic organisms
131341-86-1	Fludioxonil	Fungicide									235	18	450	14	280	630		14	OPP ALB Invertebrates Chronic	30,000	Females 13-49	200	General Population	-	200.	HHBP	Chronic, General Population	Aquatic organisms
142459-58-3	Flufenacet	Herbicide									130	75	1400	6300	2.9	2.45		2.45	OPP ALB Vascular plants Acute									#N/A
62924-70-3	Flumetralin	Plant Growth Regulator									-	-	-	-	-	-		n/a[4]		10,000	Females 13-49 years	-		-					#N/A
239110-15-7	Fluopicolide	Fungicide									174.5	151	>850	190	<1.4	>3,200		1.4	OPP ALB Nonvascular plants Acute	-	-	1,000	General Population	-	1000.	HHBP	Chronic, General Population	Humans
658066-35-4	Fluopyram	Fungicide		TRUE							-	-	-	-	-	-		n/a[4]		3,000	Children	77	General Population	-	77.	HHBP	Chronic, General Population	#N/A
361377-29-9	Fluoxastrobin	Fungicide									435	n/a[2]	480	n/a[2]	350	n/a[2]	TRUE	350	DPR OPP ALB Equivalent - Nonvasc	-	-	96	General Population	-	96.	HHBP	Chronic, General Population	Humans
951659-40-8	Flupyradifurone	Insecticide		TRUE							-	-	-	-	-	-		n/a[4]		2,300	Children	500	General Population	-	500.	HHBP	Chronic, General Population	#N/A
59756-60-4	Fluridone	Herbicide									2,800	480	680	-	-	-		480	OPP ALB Fish Chronic	34,500	Females 13-49	960	General Population	-				#N/A
85509-19-9	Flusilazole	Fungicide	TRUE								-	-	-	-	-	-		n/a[4]		600	Females 13-49	10	General Population	-				#N/A
66332-96-5	Flutolanil	Fungicide									1,250	233	>3,400	530	8,010	8,010		233	OPP ALB Fish Chronic	-	-	3,000	General Population	-	3000.	HHBP	Chronic, General Population	Humans
76674-21-0	Flutriafol	Fungicide									16,500	4,800	33,550	310	460	780		310	OPP ALB Invertebrates Chronic	2,100	Females 13-49	300	General Population	-	300.	HHBP	Chronic, General Population	Aquatic organisms
907204-31-3	Fluxapyroxad	Fungicide									-	-	-	-	-	-		n/a[4]		8,330	Children	130	General Population	-	130.	HHBP	Chronic, General Population	#N/A
51235-04-2	Hexazinone	Herbicide									137,000	17,000	75,800	20,000	7	37.4		7	OPP ALB Nonvascular plants Acute						400.	HA	Lifetime	Humans
35554-44-0	Imazalil	Fungicide									1,480	n/a[2]	3,500	n/a[2]	870	n/a[2]	TRUE	870	DPR OPP ALB Equivalent - Nonvasc	470	Females 13-49	16	General Population	0.524-52.4	.524	HHBP	Cancer	Aquatic organisms
138261-41-3	Imidacloprid	Insecticide									>114,500	9,000	0.385	0.01	>10,000	-		0.01	OPP ALB Invertebrates Chronic	930	Children	360	General Population	-	360.	HHBP	Chronic, General Population	Humans
120868-66-8	Imidacloprid urea	Insecticide		TRUE							0	0	47,400	0	0	0		0	OPP ALB Fish Acute									#N/A
950782-86-2	Indaziflam	Herbicide		TRUE							1,000	n/a[2]	10,000	n/a[2]	750	n/a[2]	TRUE	750	DPR OPP ALB Equivalent - Nonvasc	500	Children	100	General Population	-	100.	HHBP	Chronic, General Population	Aquatic organisms
173584-44-6	Indoxacarb	Insecticide									145	150	300	75	>110	>84		75	OPP ALB Invertebrates Chronic	800	Children	100	General Population	-	100.	HHBP	Chronic, General Population	Humans
125225-28-7	Ipconazole	Fungicide									765	0.18	850	-	-	-		0.18	OPP ALB Fish Chronic						96.	HHBP	Chronic, General Population	Aquatic organisms
36734-19-7	Iprodione	Fungicide									-	260	120	-	>130	>12,640		120	OPP ALB Invertebrates Acute	1,000	Females 13-49	300	General Population	0.729-72.9	.729	HHBP	Cancer	Aquatic organisms
875915-78-9	Isofetamid	Fungicide		TRUE							1,135	86	2,350	390	4,100	4,900		86	OPP ALB Fish Chronic	-	-	4,900	General Population	-	4900.	HHBP	Chronic, General Population	Humans
143390-89-0	Kresoxim-methyl	Fungicide									95	87	166	55	30.3	> 301		30.3	OPP ALB Nonvascular plants Acute	-	-	2,300	General Population	11-1100	11.	HHBP	Cancer	Aquatic organisms
1634-78-2	Malaoxon	Degradate							0.065	0.013	-	-	-	-	-	-		0.013	OW Aquatic Life Criteria Chronic									#N/A
121-75-5	Malathion	Insecticide								0.1	16.5	8.6	0.295	0.035	2,400	>9,630		0.035	OPP ALB Invertebrates Chronic						160.	AAL		Humans
374726-62-2	Mandipropamid	Fungicide									-	220	3,550	-	>2,500	>7,400		220	OPP ALB Fish Chronic	-	-	300	General Population	-	300.	HHBP	Chronic, General Population	Aquatic organisms
57837-19-1	Metalaxyl	Fungicide									65,000	9,100	14,000	1,200	-	85,000		1200	OPP ALB Invertebrates Chronic							--		#N/A
125116-23-6	Metconazole	Fungicide									2,100	n/a[2]	4,200	n/a[2]	1,700	n/a[2]	TRUE	1,700	DPR OPP ALB Equivalent - Nonvasc	3,300	Females 13-49	300	General Population	-	300.	HHBP	Chronic, General Population	Aquatic organisms
950-37-8	Methidathion	Insecticide	TRUE						0.065	0.013	1.1	6.3	1.5	0.66	-	-		0.013	OW Aquatic Life Criteria Chronic	10	Children	10	General Population	-	9.6	HHBP	Chronic, General Population	Humans
40596-69-8	Methoprene	Insecticide									380	48	165	51	-	-		48	OPP ALB Fish Chronic									#N/A
161050-58-4	Methoxyfenozide	Insecticide									> 2100	530	28.5	3.1	> 3400	-		3.1	OPP ALB Invertebrates Chronic	-	-	600	General Population	-	600.	HHBP	Chronic, General Population	Humans
51218-45-2	Metolachlor	Herbicide									1,600	30	550	1	8	21		1	OPP ALB Invertebrates Chronic						700.	HA	Lifetime	Aquatic organisms
2212-67-1	Molinate	Herbicide	TRUE								105	390	170	340	220	3,300		105	OPP ALB Fish Acute									#N/A
88671-89-0	Myclobutanil	Fungicide									1,200	980	5,500	-	830	-		830	OPP ALB Nonvascular plants Acute	20,000	Females 13-49	160	General Population	-	160.	HHBP	Chronic, General Population	Humans
15299-99-7	Napropamide	Herbicide									3,200	1,100	7,150	1,100	3,400	-		1100	OPP ALB Fish Chronic	-	-	770	General Population	-	770.	HHBP	Chronic, General Population	Humans
116714-46-6	Novaluron	Herbicide									>490	6.16	0.075	0.03	3,549	>75.4		0.03	OPP ALB Invertebrates Chronic	-	-	70	General Population	-	70.	HHBP	Chronic, General Population	Humans
19044-88-3	Oryzalin	Herbicide									1,440	220	750	358	42	>15.4		15.4	OPP ALB Vascular plants Acute	6,900	Females 13-49	900	General Population	4.11-411	4.11	HHBP	Cancer	Aquatic organisms
19666-30-9	Oxadiazon	Herbicide									600	33	1,090	33	5.2	41		5.2	OPP ALB Nonvascular plants Acute							--		#N/A
1003318-67-9	Oxathiapiprolin	Insecticide		TRUE							345	460	280	750	140	790		140	OPP ALB Nonvascular plants Acute									#N/A
42874-03-3	Oxyfluorfen	Herbicide									100	1.3	750	13	1.1	0.33		0.33	OPP ALB Vascular plants Acute	-	-	200	General Population	0.437-43.7	.437	HHBP	Cancer	Humans
76738-62-0	Paclobutrazol	Fungicide									7,950	49	120	9	40,800	8		8	OPP ALB Vascular plants Acute	2,000	Children	700	General Population	-	700.	HHBP	Chronic, General Population	Aquatic organisms
298-00-0	Parathion, Methyl	Insecticide									925	<10	0.485	0.25	15,000	18,000		0.25	OPP ALB Invertebrates Chronic									#N/A
82-68-8	PCNB	Fungicide									50	13	385	18	-	-		13	OPP ALB Fish Chronic									#N/A
1114-71-2	Pebulate	Herbicide	TRUE								3,150	-	3,315	-	230	1,800		230	OPP ALB Nonvascular plants Acute	300	Children	4	Females 13-49 years	-				#N/A
40487-42-1	Pendimethalin	Herbicide									69	6.3	140	14.5	5.2	12.5		5.2	OPP ALB Nonvascular plants Acute	7,000	Children	2,000	General Population	-	2000.	HHBP	Chronic, General Population	Humans
219714-96-2	Penoxsulam	Herbicide									>51,000	10,200	>49,250	2,950	92	3		3	OPP ALB Vascular plants Acute	-	-	941	General Population	-	941.	HHBP	Chronic, General Population	Aquatic organisms
1825-21-4	Pentachloroanisole	Insecticide									28	-	150	-	-	-		28	OPP ALB Fish Acute									#N/A
183675-82-3	Penthiopyrad	Fungicide		TRUE							145	100	1,266	471	1,200	1,205		100	OPP ALB Fish Chronic	8,330	Children	1,700	General Population	-	1700.	HHBP	Chronic, General Population	Humans
52645-53-1	Permethrin, Total	Insecticide									0.395	0.0515	0.0106	0.0014	68	-		0.0014	OPP ALB Invertebrates Chronic									#N/A
26002-80-2	Phenothrin	Insecticide									7.9	1.1	2.2	0.47	-	-		1.1	OPP ALB Fish Chronic									#N/A
732-11-6	Phosmet	Insecticide									35	3.2	1	0.8	-	-		0.8	OPP ALB Invertebrates Chronic	80	Children	3	Females 13-49 years	-	3.	HHBP	Females 13-49 years	Humans
117428-22-5	Picoxystrobin	Fungicide									32.5	36	12	1	4	210		1	OPP ALB Invertebrates Chronic	1,000	Children	290	General Population	-	290.	HHBP	Chronic, General Population	Aquatic organisms
51-03-6	Piperonyl Butoxide	Synergist									950	40	255	30	-	-		30	OPP ALB Invertebrates Chronic	42,000	Children	992	General Population	-	992.	HHBP	Chronic, General Population	Aquatic organisms
29091-21-2	Prodiamine	Herbicide									>6.5	-	>6.5	1.5	-	-		1.5	OPP ALB Invertebrates Chronic							--		#N/A
1610-18-0	Prometon	Herbicide									6,000	19,700	12,850	3,450	98	-		98	OPP ALB Nonvascular plants Acute						200.	HA	Acute (1-day), Children	Aquatic organisms
7287-19-6	Prometryn	Herbicide									1,455	620	4,850	1,000	1.04	11.9		1.04	OPP ALB Nonvascular plants Acute	3,300	Females 13-49	300	General Population	-	300.	HHBP	Chronic, General Population	Aquatic organisms
23950-58-5	Pronamide	Herbicide									36,000	7,700	>2,800	600	>4,000	1,180		600	OPP ALB Invertebrates Chronic									#N/A
709-98-8	Propanil	Herbicide									1,150	9.1	600	86	16	110		9.1	OPP ALB Fish Chronic	-	-	60	General Population	-	60.	HHBP	Chronic, General Population	Humans
2312-35-8	Propargite	Insecticide									59	16	37	9	66.2	75,000		9	OPP ALB Invertebrates Chronic	2,000	Females 13-49	300	General Population	0.167-16.7	.167	HHBP	Cancer	Aquatic organisms
60207-90-1	Propiconazole	Fungicide									425	95	650	260	21	4,828		21	OPP ALB Nonvascular plants Acute	2,000	Children	600	General Population	-	600.	HHBP	Chronic, General Population	Humans
175013-18-0	Pyraclostrobin	Fungicide									3.1	2.35	7.85	4	1.5	1,720		1.5	OPP ALB Nonvascular plants Acute	1,000	Females 13-49	220	General Population	-	220.	HHBP	Chronic, General Population	Aquatic organisms
96489-71-3	Pyridaben	Insecticide									-	-	-	-	-	-		n/a[4]		2,900	Children	30	General Population	-	30.	HHBP	Chronic, General Population	#N/A
53112-28-0	Pyrimethanil	Fungicide									5,050	20	1,500	1,000	1,800	7,800		20	OPP ALB Fish Chronic	7,000	Children	1,100	General Population	-	1100.	HHBP	Chronic, General Population	Humans
95737-68-1	Pyriproxyfen	Insect growth regulator		TRUE							165	4.3	200	0.015	56	0.18		0.015	OPP ALB Invertebrates Chronic	-	-	2,200	General Population	-	2200.	HHBP	Chronic, General Population	Aquatic organisms
124495-18-7	Quinoxyfen	Fungicide									135	13	41.5	27.8	30	> 35		27.8	OPP ALB Invertebrates Chronic	-	-	1,000	General Population	-	1000.	HHBP	Chronic, General Population	Aquatic organisms
10453-86-8	Resmethrin	Insecticide									0.14	0.35	1.55	-	-	-		0.14	OPP ALB Fish Acute	-	-	220	General Population	0.5692-56.92	.5692	HHBP	Cancer	Aquatic organisms
874967-67-6	Sedaxane	Fungicide									-	-	-	-	-	-		n/a[4]		2,000	Children	700	General Population	6.90-690				#N/A
122-34-9	Simazine	Herbicide									3,200	-	500	-	2.24	140		2.24	OPP ALB Nonvascular plants Acute						4.	CA Primary MCL		Humans
946578-00-3	Sulfoxaflor	Insecticide		TRUE							181,500	660	24.5	37	81,200	99,000		24.5	OPP ALB Invertebrates Acute	2,000	Females 13-49	300	General Population	-				#N/A
107534-96-3	Tebuconazole	Fungicide									1,135	12	1,440	120	1,450	151.5		12	OPP ALB Fish Chronic	190	Children	190	General Population	-	190.	HHBP	Chronic, General Population	Humans
112410-23-8	Tebufenozide	Insecticide		TRUE							1,500	51.1	1,900	29	740	940		29	OPP ALB Invertebrates Chronic	-	-	120	General Population	-	120.	HHBP	Chronic, General Population	Aquatic organisms
96182-53-5	Tebupirimfos	Insecticide									44.5	130	0.039	0.011	630	8,800		0.011	OPP ALB Invertebrates Chronic									#N/A
NONE	Tebupirimfos oxon	Degradate									-	-	-	-	-	-		n/a[4]										#N/A
79538-32-2	Tefluthrin	Insecticide									0.03	0.004	0.035	0.008	-	-		0.004	OPP ALB Fish Chronic	11	Children	-		-				#N/A
112281-77-3	Tetraconazole	Fungicide									1,925	300	1,315	190	-	310		190	OPP ALB Invertebrates Chronic	3,000	Children	47	General Population	-	47.	HHBP	Chronic, General Population	Humans
116-29-0	Tetradifon	Insecticide	TRUE								-	-	-	-	-	-		n/a[4]										#N/A
7696-12-0	Tetramethrin	Insecticide									1.85	-	22.5	-	-	-		1.85	OPP ALB Fish Acute							--		#N/A
102851-06-9	T-Fluvalinate	Insecticide									0.175	0.064	0.47	0.1	-	-		0.1	OPP ALB Invertebrates Chronic									#N/A
148-79-8	Thiabendazole	Fungicide									280	110	155	42	3,060	2,320		42	OPP ALB Invertebrates Chronic	300	Children	210	General Population	-	210.	HHBP	Chronic, General Population	Humans

CASRN	Compound	Type	Removed from analyte list in 2018[1]	New, i.e. added in WY 2019	WQO R5-Delta Acute	WQO R5-Delta Chronic	WQO CA Toxics Rule Acute	WQO CA Toxics Rule Chronic	OW Aquatic Life Criteria Acute	OW Aquatic Life Criteria Chronic	OPP ALB Fish Acute	OPP ALB Fish Chronic	OPP ALB Invertebrates Acute	OPP ALB Invertebrates Chronic	OPP ALB Nonvascular plants	OPP ALB Vascular plants Acute	Are values at left "OPP Benchmark Equivalents"[2] from DPR?	Lowest treshold	Lowest Threshold is:	Acute or One Day HHBP (ppb or µg/L)	Acute HHBP Sensitive Lifestage/ Population	Chronic or Lifetime HHBPs (ppb or µg/L)	Chronic HHBP Sensitive Lifestage/Population	Carcinogenic HHBP (E-6 to E-4) (ppb or µg/L)	Lowest Human Ref Value (ppb or µg/L)	Human Health Reference Value	Human Health Reference Value Endpoint	Is lowest threshold for human health or for aquatic organisms?
111988-49-9	Thiacloprid	Insecticide									12,600	918	18.9	0.97	45,000	>95,400		0.97	OPP ALB Invertebrates Chronic	70	Children	30	General Population	0.788-78.8	.788	HHBP	Cancer	Aquatic organisms
153719-23-4	Thiamethoxam	Insecticide									>50,000	20,000	17.5	-	>97,000	>90,000		17.5	OPP ALB Invertebrates Acute	2,300	Children	77	General Population	-	77.	HHBP	Chronic, General Population	Humans
902493-06-5	Thiamethoxam Degradate	Insecticide		TRUE							-	-	-	-	-	-		n/a[4]										#N/A
NONE	Thiamethoxam Degradate	Insecticide		TRUE							-	-	-	-	-	-		n/a[4]										#N/A
117718-60-2	Thiazopyr	Herbicide	TRUE								3,400	-	6,100	-	40	-		40	OPP ALB Nonvascular plants Acute									#N/A
28249-77-6	Thiobencarb	Herbicide									220	21	50.6	1	17	770		1	OPP ALB Invertebrates Chronic	7,000	Children	60	General Population	-	1.	CA Secondary MCL		Humans
129558-76-5	Tolfenpyrad	Insecticide									0.0815	0.188	0.5	0.244	1	> 30		0.5	OPP ALB Invertebrates Acute									#N/A
43121-43-3	Triadimefon	Fungicide									2,050	41	800	52	17,000	-		41	OPP ALB Fish Chronic	230	Children	220	General Population	-	220.	HHBP	Chronic, General Population	Humans
55219-65-3	Triadimenol	Fungicide									21,300	-	51,000	-	9,600	-		9600	OPP ALB Nonvascular plants Acute	23	Children	22	General Population	-	22.	HHBP	Chronic, General Population	Aquatic organisms
2303-17-5	Triallate	Herbicide									600	38	45.5	14	21	2,400		14	OPP ALB Invertebrates Chronic	1,000	Females 13-49	160	General Population	0.446-44.6	.446	HHBP	Cancer	Humans
78-48-8	Tributhyl Phosphorotrithi	Herbicide									122.5	3.5	3.4	1.56	148	1,100		1.56	OPP ALB Invertebrates Chronic									#N/A
41814-78-2	Tricyclazole	Fungicide		TRUE							-	-	-	-	-	-		n/a[4]		500	Children	430	General Population	-				#N/A
141517-21-7	Trifloxystrobin	Fungicide									7.15	4.3	12.65	2.76	37.1	>1,930		2.76	OPP ALB Invertebrates Chronic	69,000	Females 13-49	240	General Population	-	240.	HHBP	Chronic, General Population	Humans
68694-11-1	Triflumizole	Fungicide									290	33	700	67	140	720		33	OPP ALB Fish Chronic	1,700	Children	75	General Population	-	74.9	HHBP	Chronic, General Population	Aquatic organisms
1582-09-8	Trifluralin	Herbicide									20.5	1.14	280	2.4	7.52	43.5		1.14	OPP ALB Fish Chronic						4.	HA	Cancer	Aquatic organisms
131983-72-7	Triticonazole	Fungicide									3,600	-	9,000	-	1,000	-		1000	OPP ALB Nonvascular plants Acute	10,000	Females 13-49	1,100	General Population	-	1100.	HHBP	Chronic, General Population	Aquatic organisms
156052-68-5	Zoxamide	Fungicide									78	3.48	>390	39	10	19		3.48	OPP ALB Fish Chronic	-	-	3,100	General Population	-	3100.	HHBP	Chronic, General Population	Aquatic organisms

[1] This table includes analytes that were dropped by the lab in 2018, as it may be a useful reference for our "historic" Delta RMP data.

[2] The California California Department of Pesticide Regulation (DPR)'s "OPP Benchmark Equivalents" are only listed for acute exposure. According to Luo et al. (2013), Appendix 3, these values represent LC50s.

[3] The USGS Organic Chemistry Research Laboratory (OCRL) reports "Total Cyhalothrins" which includes all isomers of this compound. OPP Aquatic Live Benchmarks are listed here for Gamma-cyhalothrin, CAS # 76703-62-3. There are also benchmarks for Lambda-cyhalothrin, CAS # 91465-08-6.

[4] We found no thresholds of any kind for 25 of the analytes in this table.