VOLUME II:

QUALITY ASSURANCE PROJECT PLAN

Updates and key revisions to this QAPP under existing programs are presented in the format of blue underlined or strikeout text for clarity and review. Global "un-highlighted" revisions include standardization of terms, clarification of text, and other minor editorial corrections. Other Global "un-highlighted" revisions include updates that result from the onset adoption of a new Permit (see previous CMP version for old requirements). Refer to the Monitoring Annual Report(s) for updates to the Special Studies Workplans, which are separate from this CMP. The Permittees will proceed with the monitoring program in accordance with the guidance provided herein.

RIVERSIDE COUNTY
WATERSHED PROTECTION

VOLUME II:

QUALITY ASSURANCE PROJECT PLAN

Riverside County Flood Control and
Water Conservation District
1995 Market Street
Riverside, CA 92501

Rev. 6 - November 2020
Errata January 2020
Errata January 2019
Rev. 5 - October 2018
Rev. 4 - October 2017
Errata October 2014
Rev. 3 - July 2014
Rev. 2 - November 2013
Rev. 1 - November 2012

GROUP A ELEMENTS: PROJECT MANAGEMENT

1. TITLE AND APPROVAL SHEETS

Quality Assurance Project Plan

Project Name:	Riverside County Flood Control and Water Conservation District Consolidated Monitoring Program
Date:	October 1, 2018 November 9, 2020 (Revision)
Name of Responsible Organization:	Riverside County Flood Control and Water Conservation District

PROGRAM ORGANIZATION:

Title	Name	Signature	Date
District Chief of Watershed Protection Division	Richard Boon	Richard Boon	11/12/20
District Watershed Monitoring Section Manager (Monitoring Program Manager)	Rebekah Guill		11/12/20

APPROVAL SIGNATURES - SMR

REGIONAL WATER QUALITY CONTROL BOARD:

Title	Name	Signature	Date
RWQCB – San Diego Executive Officer	David W. Gibson		
RWQCB – San Diego QA Officer			

APPROVAL SIGNATURES - SAR

REGIONAL WATER QUALITY CONTROL BOARD:

Title	Name	Signature	Date
RWQCB – Santa Ana Executive Officer	Hope A. Smythe		
RWQCB – Santa Ana QA Officer			

APPROVAL SIGNATURES - WWR

REGIONAL WATER QUALITY CONTROL BOARD:

Title	Name	Signature	Date
RWQCB – Colorado River Basin Executive Officer	Paula Rasmussen		
RWQCB – Colorado River Basin QA Officer			

Below is an example of the Consultant Approval and Responsibilities Form. Forms are required to be signed by each consultant working with the District and Co-Permittees to implement and adhere to the requirements set forth in the Consolidated Monitoring Plan (CMP). Signed and completed forms are available in Appendix O.

Consultant Approval and Responsibilities Form

Riverside County Quality Assurance Project Plan for Water Quality Monitoring

Contractor Name:

Address	
County Monitoring Project Name and Elements	
District Agreement Number and Approval Date	
Project Manager	
Signature	
Phone Number	
E-mail	
Quality Assurance Officer	
Signature	
Phone Number	
E-mail	

The Contractor's Project Manager is responsible for implementing monitoring activities and data management in accordance with the requirements of this Quality Assurance Project Plan (QAPP) and the corresponding elements of the watershed-specific Monitoring Plans. The Contractor's Quality Assurance (QA) Officer is responsible for quality assurance and quality control procedures for sampling and data management procedures in this QAPP. The Contractor's QA officer will review and assess procedures during the project against QAPP requirements. The Contractor's Project Manager will report all findings to the District's Watershed Monitoring Section Manager and/or designated District's Project Contact (may vary by watershed/assignment), including all requests for corrective action. The District may stop monitoring activities, if there are significant deviations from required practices or if there is evidence of a systematic failure.

The Contractor will be responsible for ensuring QAPP/Monitoring Plan compliance by subcontractors hired on a single or various elements of the Monitoring Project named above.

2. TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

ACRONYMS AND ABBREVIATIONS

BMI	Benthic Macroinvertebrate Index
BMP	Best Management Practice
BOD	Biological Oxygen Demand
CASQA	California Association of Stormwater Quality Agencies
CCC	Criteria Continuous Concentration
CEDEN	California Environmental Data Exchange Network
cfs	cubic feet per second
CMC	Criteria Maximum Concentration
CMP	Consolidated Monitoring Program for Water Quality Monitoring
COC	Chains of Custody
CPOM	Coarse Particulate Organic Matter
CSBP	California State Bioassessment Protocol
CTR	California Toxics Rule
District	Riverside County Flood Control and Water Conservation District
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
EDD	Electronic Data Deliverable
EPT taxa	Ephemeroptera, Plecoptera and Trichoptera taxa
FY	Fiscal Year
GIS	Geographical Information System
HSA	Hydrologic Sub-Area
HU	Hydrologic Unit
IAH	High Priority Inland Aquatic Habitat
IBI	Southern California Index of Biological Integrity
IC/ID	Illicit Connection/Illegal Discharge
ID	Identification
IDDE	Illicit Discharge Detection and Elimination
JRMP	Jurisdictional Runoff Management Plan
KiWQM	Kisters Water Quality Module
LCS	Laboratory Control Sample
LESJWA	Lake Elsinore/San Jacinto Watershed Agency
LID	Low Impact Development
MDL	Method Detection Limit
mg/L	milligram per liter
mL	milliliters
ML	State Board Minimum Level
MLS	Mass Loading Station
MQO	measurement quality objective
MRP	Monitoring and Reporting Program
MS4	Municipal Separate Storm Sewer System
NAL	Non-Stormwater Action Level
ng/L	nanograms per liter
NPDES	National Pollutant Discharge Elimination System
NWS	National Weather Service
Permittees	County of Riverside, the incorporated Cities, and Riverside County Flood Control and Water Conservation District
pH	Measurement of hydrogen ion concentration (i.e. acidity or alkalinity)
PHab	Physical habitat assessment
PoP	Probability of Precipitation

QAPP	Quality Assurance Project Plan
QAPrP	Quality Assurance Program Plan
QC	Quality Control
QPS	Quantitative Precipitation Statement
RL	Reporting Limits
RWB	Reachwide Benthos
SAL	Stormwater Action Level
San Diego Water Board	San Diego Regional Water Quality Control Board
SAR	Santa Ana Region
SAWPA	Santa Ana Watershed Protection Authority
SCCWRP	Southern California Watershed Research Project
SMC	Southern California Stormwater Monitoring Coalition
SMR	Santa Margarita Region
SMRNIG	Santa Margarita River Nutrient Initiative Group
SOP	Standard Operating Procedure
SRM	Standard Reference Materials
State Board MLs	State Board Minimum Levels or RLs
SWAMP	Surface Water Ambient Monitoring Program
SWQTF	Stormwater Quality Standards Task Force
TIE	Toxicity Identification Evaluation
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TRE	Toxicity Reduction Evaluation
Triad	Water quality assessment using chemistry, toxicity, and bioassessment evidence
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WER	Water Effects Ratio
WMA	Watershed Management Area
WQIP	Water Quality Improvement Plan
WQO	Water Quality Objective
WWR	Whitewater River Region
µg/L	microgram per liter

REVISIONS

Volume III Version	Date	Summary of Revisions
Original	October 2012	Development of a Consolidated Monitoring Plan for compliance with the MS4 Permits.
Revision 1	November 2012	The CMP (Volume II) was revised to reflect programmatic adjustments, which included: • Global revisions to formatting and standardization of terms; and • Updates of key staff assignments.
Revision 2	November 2013	As a result of lessons learned during the previous year, the CMP (Volume II) was revised to reflect programmatic adjustments. Updates included: • Global revisions to provide standardization and clarity; • Updates of key staff assignments; • Analytical methods updates; • Updates to sampling and QA/QC schedules (Tables 10-1 and 14-1); • Clarification of wet weather monitoring mobilization within the wet season; and • Improvements to sampling and QA/QC procedures.
Revision 3	July 2014	As a result of lessons learned during the previous year, the CMP (Volume II) was revised to reflect programmatic adjustments. Updates included: • Decapitalization of commonly used terms; • Clarification of key staff assignments and roles; • Reference to updated SWAMP SOPs (QAPP Attachment E); • Further analytical methods updates; • Updates to narrative relevant to bioassessment/ stream assessment programs; • Updates to sampling schedules and program tables (Tables 10-1, 10-2, 10-3, 11-1, 11-2, and 11-3) • Updated references to the WWR MS4 Permit; and.
Errata	October 2014	Revision of the QA/QC field sampling procedures for consistency with the SMR Monitoring Program (pp. 54, 67, and 68)
Errata	August 2016	Revisions to Watershed Monitoring staff (pgs. 10-14, 18, 30, 47) as well as methods for pesticides. (pgs. 22-26).
Revision 4	October 2017	Updates to program contacts and monitoring program details as needed for compliance with the most current SWAMP and MS4 Permit information.
Revision 5	October 2018	Updates to the constituent lists for inclusion of most current CWA 303(d) Listings, clarification of hydromodification monitoring program, updates to reflect current special studies, and updates of key staff assignments.
Errata	January 2019	Minor updates to include reference to a new Long-Term Receiving Water monitoring station in the Upper SMR portion of the Watershed Management Area.

Volume III Version	Date	Summary of Revisions
Errata	January 2020	Minor updates to include new program contacts, agency organization/roles, monitoring procedure clarifications, data quality objectives, and monitoring stations in the Middle SMR portion of the Watershed Management Area.
Revision	November 2020	The CMP (Volume II) has been revised for inclusion of the following updates and changes: • Updates to quality control limits for consistency with the most recent Surface Water Ambient Monitoring Program measurement quality objectives (SWAMP, 2017). • Inclusion of references to the administrative extension of monitoring requirements for each of the expired permits. • Updates to data entry procedures to address changes in technology and re-organization of the States database program (CEDEN). • Updates to Appendices B, C, F, G, H, I, K, M, N, and O to align with State's standard operating procedures and changes in data collection technology.

3. DISTRIBUTION LIST OF APPROVED QAPP

Table 3-1: Approved QAPP Distribution List

Title:	Name (Affiliation)	No. of Copies*
San Diego Regional Water Quality Control Board Executive Officer	David W. Gibson	1
Santa Ana Regional Water Quality Control Board Executive Officer	Hope A. Smythe	1
Colorado River Regional Water Quality Control Board Executive Officer	Paula Rasmussen	1
District Chief of Watershed Protection Division	Richard Boon	1
District's Watershed Monitoring Section Manager/ Monitoring Program Manager	Rebekah Guill	1
District's Water Quality Database Manager / Data QA	Abigail Suter	1
Consultant Project Managers	Project Manager	1 (each)

*Subsequent updates of the QAPP are included in the most current monitoring annual reports.

The QAPP may also be accessed online from the District's NPDES/Municipal Stormwater Management Program webpage (http://rcflood.org/NPDES/Monitoring.aspx).

4. PROJECT/TASK ORGANIZATION

4.1 Involved Parties and Roles

The Riverside County Flood Control and Water Conservation District (District) serves as the Principal Permittee for Santa Ana Regional Water Quality Control Board (Santa Ana Regional Board) Order Number R8-2010-0033 and San Diego Regional Water Quality Control Board (San Diego Regional Board) Order Number R9-2013-0001, as amended by Order Nos. R9-2015-0001 and R9-2015-0100, and serves as a Co-Principal Permittee with the County of Riverside for Colorado River Regional Water Quality Control Board (Colorado River Regional Board) Order Number R7-2013-0011. Table 4-1 provides a list of the three applicable Municipal Separate Storm Sewer System (MS4) permits issued by the respective Regional Boards and the designated Co-Permittees, including the County of Riverside, the incorporated Cities, and the Riverside County Flood Control and Water Conservation District. As Principal Permittee, the District is responsible for administering the required monitoring programs, including processing contracts and service agreements for laboratory, consulting and interagency services in accordance with the MS4 Permit requirements. Under past and current rounds of MS4 permits, the District has also been responsible for collecting samples required under the MS4 permits, ensuring that the samples are analyzed at a certified laboratory and analyzing the resulting data. Co-Permittees may also conduct monitoring activities, such as water quality sampling and field reconnaissance, either under the umbrella of the Consolidated Monitoring Program (CMP) or due to MS4 permit-specific monitoring requirements.

Table 4-1: List of NPDES MS4 Permits and Permittees

Permit	Principal Permittees	Co-Permittees
Colorado River Regional Board Order No. R7-2013-0011 NPDES Permit No. CAS617002[1]	County of Riverside Riverside County Flood Control and Water Conservation District	City of Banning City of Cathedral City City of Coachella City of Desert Hot Springs City of Indian Wells City of Indio City of La Quinta City of Palm Desert City of Palm Springs City of Rancho Mirage Coachella Valley Water District

Table 4-1 List of NPDES Permits and Permittees (continued)

Permit	Principal Permittee	Co-Permittees
Santa Ana Regional Board Order No. R8-2010-0033 NPDES Permit No. CAS618033[1]	Riverside County Flood Control and Water Conservation District	City of Beaumont City of Calimesa City of Canyon Lake City of Corona City of Eastvale City of Hemet City of Jurupa Valley City of Lake Elsinore City of Menifee[1] City of Moreno Valley City of Murrieta[2] City of Norco City of Perris City of Riverside City of San Jacinto City of Wildomar[2] County of Riverside
San Diego Regional Board Order No. R9-2013-0001, As Amended by Order Nos. R(-2015-0001 and R9-2015-0100 NPDES Permit No. CAS0109266[1]	Riverside County Flood Control and Water Conservation District	City of Menifee[2] City of Murrieta[3] City of Temecula City of Wildomar[3] County of Riverside

[1] Although the Order is expired, the Regional Board has directed the Permittees to continue implementation of the requirements therein until a new Order is adopted.
[2] The City of Menifee is solely regulated by the Santa Ana Regional Board, however, the City of Menifee is also a participating party under the implementation of the Water Quality Improvement Plan of the San Diego Regional Permit.
[3] The Cities of Murrieta and Wildomar are solely regulated by the San Diego Regional Board.

Rebekah Guill is the District's Monitoring Program Manager and has the responsibility for the following:

- Oversight of all Monitoring Program work items, coordinating participating entities and collection of data, reviewing project data, and reporting the monitoring results per MS4 permit requirements.
- Oversight of field data collection and compliance with monitoring procedures in this Quality Assurance Project Plan (QAPP).
- Compilation of all monitoring data and developing the Annual Monitoring Reports. Submitting the Annual Monitoring Reports to the Watershed Coordinators for inclusion in the comprehensive Annual Report and timely submittal to the respective Regional Boards.
- Oversight and coordination of monitoring and laboratory consultants and their respective projects.

Rebekah Guill, the District's Watershed Monitoring Section Manager, is overall responsible from programmatic Quality Assurance/ Quality Control (QA/QC) for this Monitoring Program under the CMP. As such, she is responsible for California Environmental Quality Act (CEQA) compliance and QA/QC management of data collected under the CMP.

Abigail Suter is the District's Database Manager and is responsible for maintaining an accurate and complete data set in the District's Kisters database. Abigail Suter also assists and serves as a lead for the District's data QA processes. She is responsible for event tracking, managing the water quality data collected by the Watershed Monitoring Section, and assisting with quality control and quality assurance of all incoming data as well as the generation of data deliverables in various formats as needed to support the programs including Excel Electronic Data Deliverable (EDD) format and SWAMP compatible EDD format.

The Annual Monitoring Reports will be provided to the MS4 Permit Manager responsible for Annual Report submissions to the Regional Boards. Matt Yeager, as supported by Aldo Licitra, oversee the MS4 Permit Management for the Santa Margarita Region (SMR) and are responsible for submitting the SMR Annual Report to the San Diego Regional Board. Andrea Gonzalez is the MS4 Permit Manager for the Santa Ana Region (SAR) and is responsible for submitting the SAR Annual Report to the Santa Ana Regional Board. Gracie Torres is the MS4 Permit Manager for the Whitewater River Region (WWR) and is responsible for submitting the WWR Annual Report to the Colorado River Regional Board.

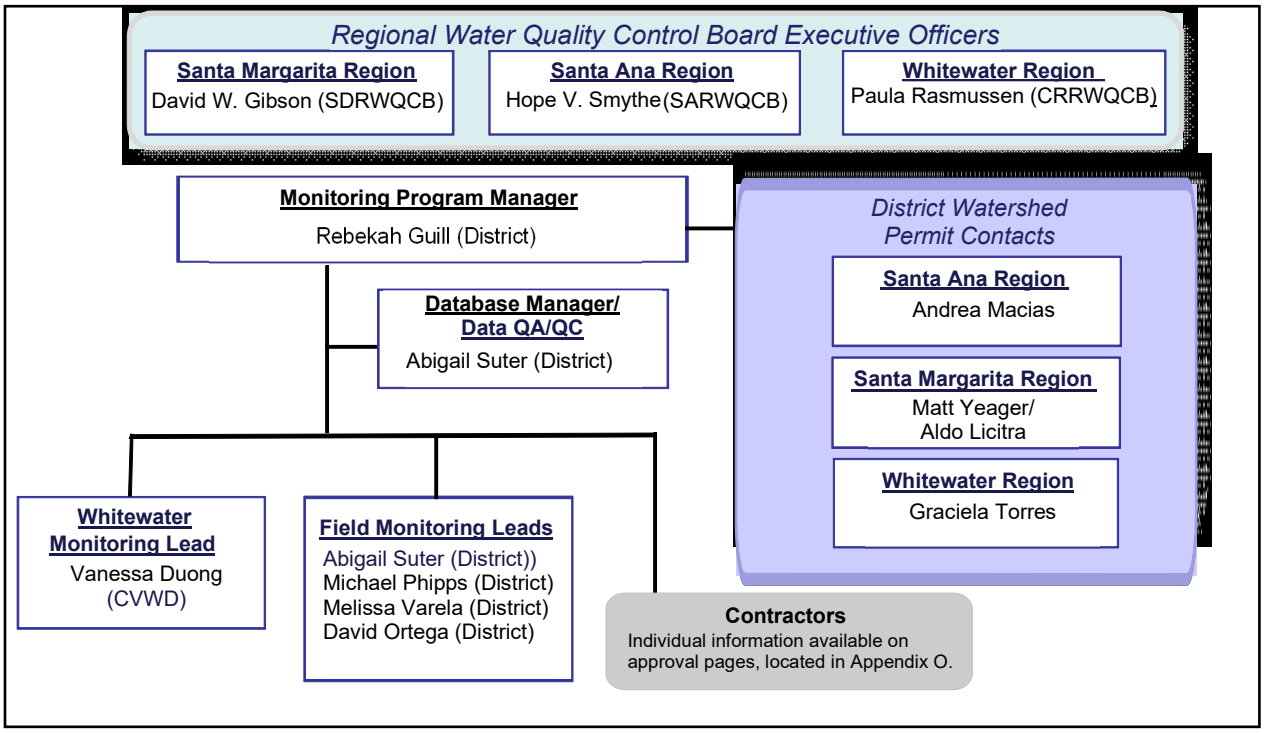
Consultant roles and responsibilities are available on the consultant approval pages in Appendix O.

Table 4-2: Program Personnel – Contact Information

Name	Agency	Title	Contact Information
David W. Gibson	San Diego Regional Board	Executive Officer	9174 Sky Park Court, Suite 100 San Diego, CA 92123-4340 Ph: 858.467.2952 (main) E-mail: dgibson@waterboards.ca.gov
Hope A. Smythe	Santa Ana Regional Board	Executive Officer	3737 Main Street, Suite 500 Riverside, CA 92501-3348 Ph: 951.782.4130 (main) 951.782.4493 (direct) E-mail: Hope.Smythe@waterboards.ca.gov
Paula Rasmussen	Colorado River Regional Board	Executive Officer	73-720 Fred Waring Drive, Suite 100 Palm Desert, CA 92260 Ph: 760.346.7491 (main) E-mail: Paula.Rasmussen@waterboards.ca.gov
Richard Boon	District	Chief of Watershed Protection Division	Ph: 951.955.1273 E-mail: rboon@rivco.org
Rebekah Guill	District	Watershed Monitoring Section Manager/ Monitoring Program Manager	Ph: 951.955.2901 E-mail: rguill@rivco.org
Abigail Suter	District	Database Manager/ Data Manager (QA/QC)/ Field Monitoring Lead	Ph. 951.955.1734 E-mail: adsuter@rivco.org
Michael Phipps	District	Mobilization Technician/ Field Monitoring Lead/ Data QA/QC Support	Ph: 951.955.01263 E-mail: mjphipps@rivco.org

Name	Agency	Title	Contact Information
Melissa Varela	District	Field Monitoring Lead/ Data QA/QC Support	Ph: 951.955.8589 E-mail: mevarela@rivco.org
David Ortega	District	IC/ID Officer/ Field Monitoring Lead	Ph. 951.955.4390 E-mail: djortega@rivco.org
Vanessa Duong	Coachella Valley Water District	Monitoring Program Manager	Ph: 760.398.2661 ext. 2782 E-mail: VDuong@cvwd.org

Figure 4-1: Project Organizational Chart



4.2 Watershed Monitoring Section Manager's Role

Rebekah Guill is the District's Watershed Monitoring Section Manager serves as the Monitoring Program Manager under the CMP. The Monitoring Program Manager's role is to establish the quality assurance and quality control procedures in this QAPP as part of the overall project, and to review and assess all procedures during the project against QAPP requirements. The Monitoring Program Manager will work closely with the District's Data Manager, as well as the consultants and laboratories to implement this project in compliance with the requirements of the QAPP. The District's Monitoring Program Manager may stop any actions, including those conducted by any laboratory or consultant if there are significant deviations from required practices or if there is evidence of a systematic failure.

4.3 Persons Responsible for QAPP Update and Maintenance

The Monitoring Program Manager is responsible for maintaining, revising, and updating this QAPP. The Monitoring Program Manager will be responsible for making the changes and making sure these updates are provided to each of the participating agencies.

5. PROBLEM DEFINITION/BACKGROUND

5.1 Problem Statement

According to the MS4 Permits for the SMR, SAR and WWR, the discharge of pollutants and/or increased flows from MS4s may threaten or impair beneficial uses or adversely affect human health. A number of receiving waterbodies within the Permittees' collective jurisdictional boundaries are listed as impaired on the Clean Water Act 40 CFR Section 303(d) list. Table 5-1 provides a summary of the corresponding Clean Water Act 303(d) listings of impaired waterbodies by watershed and receiving water. The Permittees developed a Consolidated Program for Water Quality Monitoring (CMP) within their collective jurisdictional boundaries to meet the requirements of the MS4 Permits and manage the quality of urban runoff. The CMP has been implemented by the Permittees since 1994. The CMP is designed to characterize the potential sources and nature of discharges from urban land uses in order to develop effective management measures to protect the receiving waterbodies.

Table 5-1: Clean Water Act 303(d) List

CWA 303(d) List		
Watershed	**Receiving Waterbody**	**Impairing Pollutants**
Santa Margarita Region (SMR) (by sub-area) 2014/2016 Integrated Report		
De Luz (HSA 902.21)	De Luz Creek	Iron Manganese Nitrogen Sulfates
Gavilan (HSA 902.22)	Sandia Creek	Iron Sulfates TDS Aluminum Ammonia (Unionized) Manganese Nitrogen Selenium Silver
	Santa Margarita River (Upper)	Phosphorus Toxicity Indicator Bacteria • *Enterococcus* Iron Manganese Nitrogen
Murrieta (HSA 902.32)	Long Canyon	Chlorpyrifos Iron Manganese Nitrogen Phosphorus
French (HSA 902.33)	Warm Springs Creek	Chlorpyrifos Indicator Bacteria • *E.coli* • Fecal Coliform Iron Manganese Phosphorus Nitrogen

Table 5-1 Clean Water Act 303(d) List (continued)

2010 303(d) List		
Watershed	**Receiving Waterbody**	**Impairing Pollutants**
Santa Margarita Region (SMR) (by sub-area) 2014/2016 Integrated Report		
Gertrudis (HSA 902.42)	Santa Gertrudis Creek	Chlorpyrifos Copper Iron Manganese Phosphorus Nitrogen Indicator Bacteria
Pauba (HSA 902.51)	Temecula Creek	Chlorpyrifos Copper Phosphorus TDS Toxicity Indicator Bacteria • *E.coli* • Fecal Coliform
	Redhawk Channel	Chlorpyrifos Copper Diazinon Indicator Bacteria • *E.coli* • Fecal Coliform Iron Manganese Nitrogen Phosphorus TDS
Wolf (HSA 902.52)	Murrieta Creek	Phosphorus Chlorpyrifos Copper Iron Manganese Nitrogen Toxicity Indicator Bacteria • Fecal Coliform
Lower Ysidora (HSA 902.11)	Santa Margarita River (Lower) [1]	Phosphorus Nitrogen Benthic Community Effects Chlorpyrifos Toxicity Indicator Bacteria
	Santa Margarita Lagoon[1]	Eutrophic
Gavilan (HSA 902.22)	Rainbow Creek[1]	Iron Sulfates TDS Aluminum Nitrogen Phosphorus

Santa Ana Region (SAR) 2014/2016 Integrated Report		
Middle Santa Ana River (HA Split 801.20)	Santa Ana River, Reach 3	Copper Lead Indicator Bacteria
	Santa Ana River, Reach 4	Indicator Bacteria
Perris Valley (HA 802.10)	Canyon Lake	Nutrients
Elsinore Valley (HA 802.30)	Lake Elsinore	PCBs Nutrients Organic Enrichment/Low DO Toxicity DDT
Prado Basin Management Zone (HSA 801.21)	Prado Flood Control Basin	pH
Arlington (HSA 801.26)	Goldenstar Creek	Indicator Bacteria
Whitewater Region (WWR) 2010 Integrated Report		
Coachella HA 719.40	Coachella Valley Storm Water Channel	DDT* Dieldrin* PCBs* Toxaphene* Pathogens** Nitrogen, Total Ammonia Toxicity *Only applies to the 2 mile area from Lincoln Street to the Salton Sea. **Only applies to the 17 mile area from Dillion Road to the Salton Sea.

This table will be revised to reflect updates to the 303(d) List.

1. Waterbodies outside of Riverside County but within the watershed management area and applicable to the Riverside Permittees under the new Regional Permit.

5.2 Decisions or Outcomes

The CMP is designed to assess the condition of the receiving waters, monitor pollutants in storm and non-stormwater effluent from the MS4, and conduct special studies to address Conditions of Concern. The CMP is intended to meet the following goals:

1. Assess compliance with Order Nos. R7-2013-0011, R8-2010-0033, and R9-2013-0001, as amended by Order Nos. R9-2015-0001 and R9-2015-0100;
2. Measure and improve the effectiveness of the Permittees' runoff management programs;
3. Assess the chemical, physical, and biological impacts to receiving waters resulting from MS4 discharges;
4. Characterize stormwater discharges;
5. Identify sources of specific pollutants;
6. Prioritize drainage and sub-drainage areas that need management actions;
7. Detect and eliminate IC/IDs to the MS4;
8. Assess the overall health of receiving waters; and
9. Provide information to implement required BMP improvements.

The goal of the MS4 Urban Runoff Program is to manage the quality of urban runoff to prevent impacts to receiving waters within the Permittees' collective jurisdictions. The CMP approach is driven by the following management questions:

1. Are conditions in receiving waters protective, or likely to be protective, of beneficial uses?
2. What is the extent and magnitude of the current or potential receiving water problems?
3. What is the relative MS4 discharge contribution to the receiving water problem(s)?
4. What are the sources of MS4 discharge that contribute to the receiving water problem(s)?
5. Are conditions in the receiving water getting better or worse?

This information will be provided to the Regional Boards in the Permittee's Monitoring Annual Reports. The Permittees participate in the Regional Watershed Monitoring Program which aims to address the following questions:

- What is the condition of streams in Southern California?
- What are the major stressors to aquatic life?
- Are conditions in locations of special interest getting better or worse?

The goal of this QAPP is to:

- Identify roles and responsibilities.
- Outline the monitoring programs implemented as part of the CMP in accordance with MS4 Permit requirements.
- Standardize the methods and procedures used by multiple entities implementing the CMP activities.
- Define quality assurance and control standards to generate data of consistent and known quality.
- Schedule the timeline for program implementation and deliverables to facilitate timely submittals.

5.3 Water Quality or Regulatory Criteria

Water quality or regulatory criteria will be used to initiate source investigations, further assessment of related Pollutants-of-Concern or Highest Priority Water Quality Conditions as applicable, and possible management strategies. These objectives will vary by Region, therefore, the numerical and narrative Water Quality Objectives WQOs) or other applicable criteria are provided in the individual SMR, SAR and WWR Monitoring Plans (Volumes III, IV and V, respectively).

6. PROJECT/TASK DESCRIPTION

6.1 Work Statement and Produced Products

As provided in the MS4 Permit Monitoring and Reporting Programs (MRPs), the monitoring programs include monitoring of receiving waters, MS4 discharge monitoring, and Illicit Connection/Illegal Discharge (IC/ID) monitoring, and various watershed-specific special studies. Additionally, all regions will continue to participate in regional monitoring programs such as Southern California Monitoring Coalition (SMC), the California Stormwater Quality Association (CASQA), and/or other regional groups or efforts.

Santa Margarita Region
The SMR Monitoring Programs include:

- Receiving Water Monitoring
  - Wet Weather
  - Dry Weather
  - Bioassessment
  - Hydromodification
  - Follow up Approach and Actions
  - Regional Programs
  - Sediment Quality

- MS4 Outfall Monitoring
  - Wet Weather
  - Dry Weather Field Screening
  - Non-Storm Water Persistent Flow MS4 Discharge

- Special Studies
  - WMA Special Study – SMRNIG Nutrient Initiative Study (In-kind Support Monitoring)
  - San Diego Region Special Study – SMC CLEAN
  - BIGHT 18'
  - Hydromodification
  - Regional Bioassessment Monitoring
  - Other Special Efforts (i.e., Intercalibrations, Reference Stream Study, etc.)

- IC/ID Program (Refer to local JRMPs)

Santa Ana Region
The SAR Monitoring Programs includes:

- Receiving Water Monitoring:
  - Receiving Water Monitoring
  - Water Column Toxicity
  - Bioassessments
  - Toxicity Identification Evaluation (TIE)/Toxicity Reduction Evaluation (TRE)

- MS4/Outfall Monitoring
  - Mass Emission Station Monitoring
  - Illicit Connection/Illegal Discharge (IC/ID) Monitoring

- Special Studies
  - Middle Santa Ana River Bacterial Indicator TMDL Monitoring
  - Lake Elsinore and Canyon Lake TMDL Monitoring
  - Hydromodification
  - Low Impact Development (LID) BMP Monitoring
  - Regional Bioassessment Monitoring

Whitewater Region
The WWR Monitoring Programs includes:

- Receiving Water Monitoring
- MS4 Outfall and Illicit Connection/Illegal Discharge (IC/ID) Monitoring
- Special Studies (e.g., SMC projects)

6.2 Constituents to be Monitored and Measurement Techniques

Samples will be analyzed for conventional chemistry constituents, nutrients, metals, petroleum products, pesticides, organics and volatile organic compounds. Table 6-1 provides a master list of *in-situ* field parameters and associated units inclusive of all MS4 permits and monitoring programs. A master constituent list is provided in Table 6-2 providing constituents, target Reporting Limits (RL) and analytical method requirements inclusive of all three MS4 permits and monitoring programs. The District selected the most conservative RLs to meet or exceed the requirements of all the MS4 permits and to apply to all monitoring programs covered by this CMP. The MS4 permit-specific Monitoring Plans provided in Volumes II, III, and IV contain constituent lists tailored to each permit and monitoring program requirements. Inclusion of constituents in this master list does not imply that all constituents be analyzed in any given program; the master list includes all constituents that have the potential to be analyzed.

Project RLs have been set to reflect project-specific objectives, and are based on analytical methods, method detection limit (MDLs), or expected levels of target analytes, in accordance with the Surface Water Ambient Monitoring Program (SWAMP) (SWAMP, 2017~~2008~~). Per the SWAMP QAPrP (SWAMP, 2017~~2008~~), if a project's RLs exceed those presented in Appendix C of the SWAMP QAPrP there is no need to obtain a waiver.

SWAMP was developed to document ambient water quality conditions in surface waters and was not developed to monitor effluents or discharges covered under the MS4 permits and waste discharge requirements (SWAMP, 2017~~2008~~). SWAMP RLs are most applicable to the dry weather monitoring programs conducted in receiving waterbodies within the Regions. The wet weather event data and MS4 data are expected to have a different range of target analytes than dry weather data from receiving water stations. RLs in this table represent the State Board Minimum Level (ML) RLs, which are required under the MRP for constituents listed as Priority Pollutants in the California Toxics Rule (CTR), and SWAMP recommended RLs. The analytical laboratory will attempt to improve upon these RLs, and will provide a written explanation for any failure to meet them. Standard Method RLs will be used when no required RL is available.

Table 6-1: Master List of *In-situ* Field Parameters

Hydstra©	Parameter[a]	Units	Method
1435	Conductivity	µS/cm	Field Meter/SM 4500-O
1705/ 1710	Dissolved Oxygen	mg/L	Field Meter/SM 4500 H+B Lab method
1200/ 1205	pH	pH units	Field Meter/SM2510 B Lab method
1655	Temperature	°Celsius	Field Meter/SM2550 B
1690/ 1695 ~~810~~	Turbidity	NTU	Field Meter/SM2130B Lab method
1176	Total Residual Chlorine	mg/L	Field Meter/ SM 4500 Cl G Lab method

In-situ field parameters will be measured using a hand held meter. However, in the case of instrument malfunction, field crews may request the laboratory to analyze selected constituents using the methods listed.

Table 6-2: Master List of Analytical Constituents

Hydstra© No.	Constituent	Units	Method[1]	State Board ML	SWAMP Target RL	District Target RL
	Field Parameters					
1435	Dissolved Oxygen, field	mg/l	Field Meter/SM 4500-O	None	None	0.5
1705	pH, field	pH units	Field Meter/SM 4500 H+B	None	None	0-14
1200	Specific Conductance, field	µmhos/cm	Field Meter/SM 2510 B	None	2.5	2.5
1655	Temperature, field	°Celsius	Field Meter/SM 2550 B	None	None	None
1690	Turbidity, field	NTU	Field Meter/SM 2130B	None	1.0	0.5
	Conventionals, Nutrients, and Hydrocarbons					
1051	Ammonia as Nitrogen	mg/L	EPA 350.1 / EPA 350.3 / EPA 351.2 /SM 4500 NH3	None	0.02	0.02
1425	Biological Oxygen Demand (5 day)	mg/L	EPA 405.1 / SM 5210 B	None	2.0	2.0
1430	Chemical Oxygen Demand	mg/L	EPA 410.1-.4 / SM 5220 D	None	3.0	3.0
1195	Color	Units	SM 2120 B	None	None	3.0
1490	Dissolved Phosphorus	mg/L	EPA 365.2 / SM 4500 P B E	0.1	None ~~0.01~~	0.01
1154	Dissolved Organic Carbon	mg/L	EPA 415.1 / SM 5310 B	None	1.0	0.3 ~~1.0~~
2300	Ethylene Glycol	mg/L	Colorimetric / EPA 8015 B	None	None	10
1225	Detergents - Methylene Blue Actives (MBAS)	mg/L	SM 5540 C	None	None	0.05
1340	Nitrate, as N	mg/L	EPA 300.0	None	0.01	0.01
1345	Nitrite, as N	mg/L	EPA 300.0 / SM 4500 NO2 B	None	0.01	0.01

Table 6-2: Master List of Analytical Constituents (continued)

Hydstra© No.	Constituent	Units	Method[1]	State Board ML	SWAMP Target RL	District Target RL
1360	Nitrogen, Total Kjeldahl (as N)	mg/L	EPA 351.2	None	0.5	0.1 ~~0.5~~
1355	Nitrogen, Total	mg/L	Calculation	None	None ~~0.2~~	0.05 ~~0.2~~
1365	Nitrogen, Total Inorganic	mg/L	Calculation	None	0.2	0.2
1350	Nitrogen, Total Organic	mg/L	Calculation	None	0.2	0.2
1380	Oil and Grease	mg/L	EPA 1664 A	None	1.4	1.4
1480	Ortho Phosphorus	mg/L	SM 4500 P E	None	0.01	0.01
1640	Sulfate	mg/L	EPA 300.0A / SM 54500-SO4 E	1.0	1.0	1.0
1625	Total Dissolved Solids	mg/L	SM 2540 C / EPA 160.1	None	10	10
1155	Total Organic Carbon	mg/L	SM 5310 B	None	1.0	0.3 ~~1.0~~
1265	Total Hardness (as $CaCO_3$)	mg/L	SM 2340B/ EPA 200.7	None	1	1.0
1485	Total Phosphorus	mg/L	SM 4500-P B E	None	None ~~0.2~~	0.2
1500	Total Potassium	mg/L	EPA 200.7	None	None ~~1.0~~	1.0
1630	Total Suspended Solids	mg/L	SM 2540 D / EPA 160.2	None	2.0	2.0
1272	Diesel Range Hydrocarbons[2]	mg/L	EPA 8015 M	None	None	0.1 ~~5.0~~
1273	Gasoline Range Hydrocarbons[2]	mg/L	EPA 8015 M	None	None	0.05
	Metals (Total / Dissolved)					
1040/ 1041	Aluminum	µg/L	EPA 200.7	None	0.15	0.15
1065 /1064	Antimony	µg/L	EPA 200.8	0.5	0.2	0.2
1070 /1071	Arsenic	µg/L	EPA 200.8/ EPA 1632	2.0	0.3	0.3
1090 /1088	Barium	µg/L	EPA 200.8	None	None	1.0
1120 /1119	Beryllium	µg/L	EPA 200.8	0.5	None	0.5
1135 /1136	Boron	µg/L	EPA 200.7/200.8	None	10	10
1145 /1148	Cadmium	µg/L	EPA 200.8	0.25	0.03	0.03
1185 /1184	Chromium, Hexavalent	µg/L	EPA 218.6/ EPA 200.8	None	0.9	0.9
1180 /1181	Chromium, Total	µg/L	EPA 200.8	0.5	0.3	0.3
1186 /1187	Chromium, Trivalent	µg/L	Calculation/ EPA 200.8	None	None	0.1
1210 /1209	Copper	µg/L	EPA 200.8	0.5	0.1	0.1
1285 /1284	Iron	µg/L	EPA 200.7/ EPA 300.0A/6010A	None	100	10 ~~20~~
1290 /1287	Lead	µg/L	EPA 200.8	0.5	2	0.5

Table 6-2: Master List of Analytical Constituents (continued)

Hydstra© No.	Constituent	Units	Method[1]	State Board ML	SWAMP Target RL	District Target RL
1305 /1298	Manganese	µg/L	EPA 200.8	1.0	0.05 ~~60~~	0.05 ~~10~~
1310 /1316	Mercury	µg/L	EPA 200.8	0.5	0.002	0.002
1320 /1319	Nickel	µg/L	EPA 200.8	1.0	0.6	0.6
1520 /1521	Selenium	µg/L	EPA 200.8	2.0	1.0	1.0
1535 /1534	Silver	µg/L	EPA 200.8	0.25	0.45	0.25
1665 /1666	Thallium	µg/L	EPA 200.8	1.0	1.0	1.0
1700 /1701	Zinc	µg/L	EPA 200.8	1.0	0.7	0.7
	Microbiology					
1077	*Escherichia coli*	MPN/100mL	SM 9221 E	None	None ~~2~~	2
1087	*Enterococcus*	MPN/100mL	SM 9230B /EPA 1600	None	None ~~1~~	1
1075	Fecal Coliform	MPN/100mL	SM 9221 E	None	None ~~2~~	2
1080	Fecal Streptococci	MPN/100mL	SM 9230B	None	None	2
1085	Total Coliform	MPN/100mL	SM 9221 B	None	None ~~2~~	2
	Semi-Volatile Compounds[3]					
1131	Bis(2-Ethylhexyl)Phthalate	µg/L	EPA 625C SIM	5	None ~~10~~	5
	Organics, PAHs[3]					
1097	Benzo(b)Fluoranthene	µg/L	EPA 625C SIM/ EPA 8270 SIM	None	10	10
1098	Benzo(ghi)Perylene	µg/L	EPA 625C SIM/ EPA 8270 SIM	5	10	5
2240	Chrysene	µg/L	EPA 625C SIM/ EPA 8270 SIM	10	0.005	0.005
1245	Fluoranthene	µg/L	EPA 625C SIM/ EPA 8270 SIM	1	10	1
1250	Fluorene	µg/L	EPA 625C SIM/ EPA 8270 SIM	10	10	10
2335	Indeno(1,2,3-cd)Pyrene	µg/L	EPA 625C SIM/ EPA 8270 SIM	10	0.005	0.005
1315	Naphthalene	µg/L	EPA 625C SIM/ EPA 8270 SIM	1	10	1
1455	Phenanthrene	µg/L	EPA 625C SIM/ EPA 8270 SIM	5	10	5
1505	Pyrene	µg/L	EPA 625C SIM/ EPA 8270 SIM	10	10	10

Table 6-2: Master List of Analytical Constituents (continued)

Hydstra© No.	Constituent	Units	Method[1]	State Board ML	SWAMP Target RL	District Target RL
	Pesticides[3]					
1073	Aspon	µg/L	EPA 8270M-OP	None	NA	0.05
1068	Azinphos-ethyl	µg/L	EPA 8270M-OP	None	0.08	0.08
1069	Azinphos-methyl	µg/L	EPA 8270M-OP	None	0.2	0.2
1153	Carbophenothion	µg/L	EPA 8270M-OP	None	0.1	0.1
1163	Chlorfenvinphos	µg/L	EPA 8270M-OP	None	0.05	0.05
1174	Chlorpyrifos	µg/L	EPA 8270M-OP	None	0.05	0.05
1179	Chlorpyrifos methyl	µg/L	EPA 8270M-OP	None	0.05	0.05
1214	Ciodrin (Crotoxyphos)	µg/L	EPA 8270M-OP	None	None	0.05
1213	Coumaphos	µg/L	EPA 8270M-OP	None	0.4	0.4
1219	Demeton-S	µg/L	EPA 8270M-OP	None	0.1	0.1
1227	Diazinon	µg/L	EPA 8270M-OP	None	0.05	0.05
1314	Dibrom (Naled)	µg/L	EPA 8270M-OP	None	75	0.05
1229	Dichlofenthion	µg/L	EPA 8270M-OP	None	0.05	0.05
1239	Dichlorvos	µg/L	EPA 8270M-OP	None	0.6	0.6
1226	Dicrotophos	µg/L	EPA 8270M-OP	None	10	10
1221	Dimethoate	µg/L	EPA 8270M-OP	None	0.2	0.2
1223	Dioxathion	µg/L	EPA 8270M-OP	None	NA	0.05
1224	Disulfoton	µg/L	EPA 8270M-OP	None	0.1	0.1
1242	Ethion	µg/L	EPA 8270M-OP	None	0.05	0.05
1244	Ethyl Parathion	µg/L	EPA 8270M-OP	None	0.05 ~~None~~	0.05
1246	Famphur	µg/L	EPA 8270M-OP	None	0.05	0.05
1247	Fenitrothion	µg/L	EPA 8270M-OP	None	0.05	0.05
1248	Fensulfothion	µg/L	EPA 8270M-OP	None	0.2	0.2
1249	Fenthion (Mercaptophos)	µg/L	EPA 8270M-OP	None	0.05	0.05
1256	Fonophos (Dyfonate)	µg/L	EPA 8270M-OP	None	0.05	0.05
1291	Leptophos	µg/L	EPA 8270M-OP	None	0.05	0.05
1301	Malathion	µg/L	EPA 8270M-OP	None	0.1	0.1
1302	Merphos	µg/L	EPA 8270M-OP	None	0.1 ~~0.05~~	0.05
1304	Mevinphos	µg/L	EPA 8270M-OP	None	0.05	0.05

Table 6-2: Master List of Analytical Constituents (continued)

Hydstra© No.	Constituent	Units	Method[1]	State Board ML	SWAMP Target RL	District Target RL
	Pesticides					
1303	Methyl Parathion	µg/L	EPA 8270M-OP	None	0.1 ~~None~~	0.05
1461	Phorate	µg/L	EPA 8270M-OP	None	0.1	0.1
1463	Phosmet	µg/L	EPA 8270M-OP	None	0.2	0.2
1464	Phosphamidon	µg/L	EPA 8270M-OP	None	100	0.05
1243	Prophos (Ethoprop)	µg/L	EPA 8270M-OP	None	0.1	0.1
1651	Sulfotep	µg/L	EPA 8270M-OP	None	0.05	0.05
1132	Sulprofos (Bolstar)	µg/L	EPA 8270M-OP	None	0.2	0.2
1663	Terbufos	µg/L	EPA 8270M-OP	None	0.05	0.05
1633	Tetrachlorvinphos (Stirifos)	µg/L	EPA 8270M-OP	None	0.1 ~~None~~	0.05
1672	Thionzin (Thionazin)	µg/L	EPA 8270M-OP	None	0.05	0.05
1673	Tokuthion	µg/L	EPA 8270M-OP	None	0.05	0.05
1687	Trichlorfon	µg/L	EPA 8270M-OP	None	NA	0.05
1688	Trichloronate	µg/L	EPA 8270M-OP	None	0.05	0.05
2135	4,4'-DDD	µg/L	EPA 608M	0.05	0.002	0.002
2140	4,4'-DDE	µg/L	EPA 608M	0.05	0.002	0.002
2145	4,4'-DDT	µg/L	EPA 608M	0.01	0.002	0.002
1013	Aldrin	µg/L	EPA 608M	0.005	0.002	0.002
2170	alpha-BHC (alpha-HCH)	µg/L	EPA 608M	0.01	0.002	0.002
2270	alpha-Endosulfan (Endosulfan I)	µg/L	EPA 608M	0.02	0.002	0.002
2210	beta-BHC (beta-HCH)	µg/L	EPA 608M	0.005	0.002	0.002
2265	beta-Endosulfan (Endosulfan II)	µg/L	EPA 608M	0.01	0.002	0.002
2215	Chlordane	µg/L	EPA 608M	0.1	0.002	0.002
1174	Chlorpyrifos	µg/L	EPA 8270M-OP	None	0.05	0.05
2250	delta-BHC (delta-HCH)	µg/L	EPA 608M	0.005	0.002	0.002
1715	Diazinon	µg/L	EPA 8270M-OP	None	0.05	0.05
1233	Dieldrin	µg/L	EPA 608M	0.01	0.002	0.002
2275	Endosulfan Sulfate	µg/L	EPA 608M	0.05	0.002	0.002
2285	Endrin	µg/L	EPA 608M	0.01	0.002	0.002
2280	Endrin Aldehyde	µg/L	EPA 608M	0.01	0.002	0.002
1292	gamma-BHC (lindane) (gamma-HCH)	µg/L	EPA 608M	0.02	0.002	0.002

Table 6-2: Master List of Analytical Constituents (continued)

Hydstra© No.	Constituent	Units	Method[1]	State Board ML	SWAMP Target RL	District Target RL
	Pesticides					
2310	Heptachlor	µg/L	EPA 608M	0.01	0.002	0.002
2305	Heptachlor Epoxide	µg/L	EPA 608M	0.01	0.002	0.002
1681	Toxaphene	µg/L	EPA 608M	0.5	0.75	0.5
	Polychlorinated Biphenyls (PCBs)					
2175	Aroclor-1016	µg/L	EPA 608M	0.5	0.002	0.002
2180	Aroclor -1221	µg/L	EPA 608M	0.5	0.002	0.002
2185	Aroclor -1232	µg/L	EPA 608M	0.5	0.002	0.002
2190	Aroclor -1242	µg/L	EPA 608M	0.5	0.002	0.002
2195	Aroclor -1248	µg/L	EPA 608M	0.5	0.002	0.002
2200	Aroclor -1254	µg/L	EPA 608M	0.5	0.002	0.002
2205	Aroclor -1260	µg/L	EPA 608M	0.5	0.002	0.002
	Pyrethroids					
2412	Bifenthrin	ng/L	EPA 1660M-Pyrethroids	None	0.002	0.002
2414	Cyfluthrin	ng/L	EPA 1660M-Pyrethroids	None	0.005	0.005
2428	Cyhalothrin-lambda	ng/L	EPA 1660M-Pyrethroids	None	0.0005	0.0005
2416	Cypermethrin	ng/L	EPA 1660M-Pyrethroids	None	0.005	0.005
2418	Danitol (Fenpropathrin)	ng/L	EPA 1660M-Pyrethroids	None	0.002	0.002
2420	Deltamethrin	ng/L	EPA 1660M-Pyrethroids	None	0.005	0.005
2422	Esfenvalerate	ng/L	EPA 1660M-Pyrethroids	None	0.002	0.002
2424	Fenvalerate	ng/L	EPA 1660M-Pyrethroids	None	0.002	0.002
2429	Permethrin, -cis	ng/L	EPA 1660M-Pyrethroids	None	0.005	
2431	Permethrin, -trans	ng/L	EPA 1660M-Pyrethroids	None	0.01	
2430	Permethrin, TOTAL	ng/L	EPA 1660M-Pyrethroids	None	None	0.005

Table 6-2: Master List of Analytical Constituents (continued)

Hydstra© No.	Constituent	Units	Method[1]	State Board ML	SWAMP Target RL	District Target RL
	Volatiles					
2000	1,1,1-Trichloroethane	µg/L	EPA 624	2	5	2
2005	1,1,2,2-Tetrachloroethane	µg/L	EPA 624	1	5	1
2010	1,1,2-Trichloroethane	µg/L	EPA 624	2	5	2
2015	1,1-Dichloroethane	µg/L	EPA 624	1	5	1
2040	1,2-Dichloroethane	µg/L	EPA 624	2	5	2
2045	1,2-Dichloropropane	µg/L	EPA 624	1	5	1
2030	1,2-Dichlorobenzene	µg/L	EPA 624	2	5	2
2055	1,3-Dichlorobenzene	µg/L	EPA 624	2	5	2
2060	1,4-Dichlorobenzene	µg/L	EPA 624	2	5	2
1682	1,2-Trans-Dichloroethylene	µg/L	EPA 624	1	5	1
2105	2-Chloroethylvinyl Ether	µg/L	EPA 624	1	50 ~~None~~	1
1092	Benzene	µg/L	EPA 624	2	5	2
1142	Bromoform	µg/L	EPA 624	2	5	2
1156	Carbon Tetrachloride	µg/L	EPA 624	2	5	2
2220	Chlorobenzene	µg/L	EPA 624	2	5	2
1231	Chlorodibromomethane	µg/L	EPA 624	2	5	2
2230	Chloroform	µg/L	EPA 624	2	5	2
1141	Dichlorobromomethane	µg/L	EPA 624	2	5	2
2290	Ethylbenzene	µg/L	EPA 624	2	5	2
2235	Methyl Chloride	µg/L	EPA 624	2	0.15 ~~0.1~~	0.1
1661	Tetrachloroethylene	µg/L	EPA 624	2	5	2
1671	Toluene	µg/L	EPA 624	2	5	2
1684	Trichloroethylene	µg/L	EPA 624	2	5	2

Table 6-2: Master List of Analytical Constituents (continued)

Hydstra© No.	Constituent	Units	Method[1]	State Board ML	SWAMP Target RL	District Target RL
	Other Toxic Pollutants					
1215	Cyanide, total	µg/L	SM 4500 CNE	5.0	2 ~~None~~	5.0
1460	Phenols, total	µg/L	EPA 420.4	None	10 ~~None~~	0.02
	Toxicity					
2506	*Ceriodaphnia dubia,* acute	% survival	EPA-821-R-02-012	None	None	None
2505	*Ceriodaphnia dubia,* chronic	% survival	EPA-821-R-02-013	None	None	None
2401	*Pimephales promelas*, acute	% survival	EPA-821-R-02-012	None	None	None
--	*Pimephales promelas,* chronic	% survival/ growth	EPA-821-R-02-013	None	None	None
2400	*Hyalella azteca*, acute	% survival	EPA-821-R-02-012	None	None	None
--	*Hyalella azteca,* chronic	% survival/ growth	EPA-821-R-02-013	None	None	None
2403	*Pseudokirchneriella subcapitata,* chronic	% growth	EPA-821-R-02-013	None	None	None
	Biological					
--	Riparian Condition (CRAM)	--	SWAMP	--	--	--
--	Physical Habitat (PHAB)	--	SWAMP	--	--	--
--	Benthic Macroinvertebrates Taxonomy	--	SWAMP	--	--	--
--	Periphyton (algae): Ash-free dry mass	--	SWAMP	--	--	--
--	Periphyton (algae): Chlorophyll-a	--	SWAMP	--	--	--
--	Periphyton (algae): Taxonomy (diatoms)	--	SWAMP	--	--	--
--	Periphyton (algae): Taxonomy (soft body)	--	SWAMP	--	--	--

[1] Or ELAP certified laboratory recommended equivalent method may be used.
[2] Method for Total Petroleum Hydrocarbons now analyzed and reported as Gasoline, and Diesel, range hydrocarbons.
[3] During the 2013-2014 Annual Report development, the District performed an extensive analysis to conservatively identify parameters that could be removed from monitoring based on Permit criteria (MRP Section III.E.1(b)(iv)) with additional discussions and guidance received from the Regional Board the following year. Constituents with analytical detection limits that were above corresponding CTR/Basin Plan WQOs or MSGP benchmarks (current 2008 MSGP) were not removed. The updated monitoring lists were implemented in the 2015-2016 monitoring year and included 170 constituents for the receiving water stations and from 132 to 167 constituents for the MS4 outfall stations (varying between events and event types).

6.3 Program Schedule

Table 6-3 presents a schedule for the CMP workplans, monitoring and data deliverables, and reports including completion dates and frequency of submittal. Program deliverables are described in Section 21 of this document and in further detail in the Monitoring Plans provided in Volumes II, III and IV of the CMP. When any of the Permits expire, the Co-Permittees will continue implementing the existing, relevant monitoring program requirements until permit renewal.

Table 6-3: Program Schedule Timeline

Submittal	Completion Date	Frequency
SMR Reports and Plans		
Report Of Waste Discharge	December 27, 2017	One Time
Regional Monitoring Assessment Report	December 27, 2017	One Time
Transitional Monitoring Assessment Report	January 31, 2018	One Time
Transitional Monitoring Assessment Report	January 31, 2019	One Time[1]
Water Quality Improvement Plan	January 5, 2018	One Time
Water Quality Improvement Plan Annual Reports	January 31	Annual
SAR Reports and Plans		
Report Of Waste Discharge	July 29, 2014	One Time
Annual Monitoring Report	November 30	Annual
WWR Reports and Plans		
Report Of Waste Discharge	December 23, 2017	One Time
Trash Amendment Assessment Report	December 1, 2018	One Time
Annual Monitoring Report	March 1	Annual
Monitoring and Data Deliverables		
Monitoring Deliverables include Post-storm Tech Memos and Post-event Tech Memos	Within 10 days of monitoring activity	Per event
Analytical Laboratory Reports and EDDs	Within 3 weeks of sample receipt *(BMI data within 6 weeks of sample receipt)*	Per event
Annual Data Deliverable	Submit with Annual Reports	Annual

[1] Due to timing of the permit approval process a second TMAR was developed and submitted for data collected in the given monitoring year.

6.4 Geographical Setting

The District is comprised of 2,700 square miles with three distinct watersheds, the Santa Margarita River, the Santa Ana River and the Whitewater River. Each watershed is governed by a separate Regional Water Quality Control Board (San Diego, Santa Ana, and Colorado River Basin, respectively) and MS4 permits. The District extends from the northwest portion of Riverside County east to Desert Hot Springs and Palm Springs, and south to San Diego County through the Temecula area, and has jurisdiction over the western 40% of Riverside County.

The Santa Margarita River Watershed within the Permittee's jurisdiction is located in the south to southwest portion of the District, and is referred to as the Santa Margarita Region (SMR). The Lower Santa Margarita Watershed, located in the northern portion of San Diego County, including Camp Pendleton, is governed by a separate MS4 permit and not within the Permittee's jurisdiction. The SMR is the portion of the watershed upstream of the confluence of Murrieta and Temecula Creeks and is located in the south and southwest portions of the District. The SMR encompasses 576 square miles and includes five municipalities within Riverside County. Assessor's parcel data shows that land uses are predominately non-

urban, comprising over 80% of the SMR (this does not take into account reference siting criteria for monitoring sites pursuant to the 2010 Order). As of August 1, 2016, the population of Riverside County was about 2.35 million. About 13% of the population, or 310,000 people, reside in the SMR. Roughly 22% of that population lives in unincorporated areas, with the rest residing in the cities of Menifee, Murrieta, Temecula and Wildomar.

The Santa Ana River Watershed within the Permittees' jurisdiction is located in the northwestern corner of Riverside County, and is referred to as the Santa Ana Region (SAR). The SAR is bounded on the south by the SMR, on the east by the Salton Sea Watershed, on the southwest by Orange County and on the northwest by San Bernardino County. The SAR, including the San Jacinto River subwatershed, encompasses 1,603 square miles (22 % of the 7,300 square miles within Riverside County) and includes 12 of the 24 municipalities within Riverside County. About 1,531,350 (65% of the Riverside County population) live within the SAR - approximately 1,316,900 persons residing within the 15 municipalities and an additional 214,450 persons residing in the unincorporated area.

The Whitewater River Watershed within the Co-Permittees' jurisdiction is located in the eastern portion of the District, and is referred to as the Whitewater River Region (WWR). The WWR is bound by the San Gorgonio Pass and extends southeast through the urbanized areas of Coachella Valley to the Salton Sea. The San Jacinto Mountains bound the Coachella Valley in the southwest, and the San Gorgonio Mountains, Indio Hills and Mecca Hills bound the Coachella Valley in the northeast. The generally northwest to southeast trending drainage area of the Coachella Valley is part of the Salton Basin, a large low-lying area within the Colorado Desert. The majority of the valley drains to the Whitewater River and its tributaries, which discharge into the northern portion of the Salton Sea. The WWR encompasses 350 square miles and includes 13 municipalities within Riverside County. Land uses are predominately non-urban, comprising over 60% of the watershed and do not fall under the jurisdiction of the District under the 2013 WWR Permit. Urban land uses, such as residential, commercial and industrial, encompass 3.5% of the WWR. As of 2016, the population of the urbanized areas of the WWR was approximately 480,000, with roughly 78,000 of that population residing in unincorporated areas of Riverside County.

6.5 Constraints

There are access, safety, and time constraints for site selection and implementation of sampling activities covered under the CMP:

- Special Studies: Special studies that require separate Quality Assurance Plans will be included in their individual Work Plans and/or as an addendum to this QAPP.
- Monitoring Program Updates: New monitoring programs will require field reconnaissance to identify sample locations representative of the targeted conditions. Appendix C of the QAPP will be updated to include the sample locations, GPS coordinates and site description.
- Permission to install equipment from the jurisdiction's Operations and Maintenance Department: Installation of equipment must not interfere with the functional operations of the surrounding facility or activity.
- Coordination with the Department of Fish and Wildlife: If sampling sites are located within a restricted access Department of Fish and Wildlife park or property then the field team must acquire the necessary permit(s) to remove samples from creeks and/or surrounding habitat, to access the property, and to install permanent or semi-permanent equipment.
- Compliance with black-out periods established by the California Department of Fish and Wildlife and/or established periods of sensitivity (i.e., nesting, mating, and spawning) of endangered species that have been determined to inhabit sampling areas.
- Coordination with city or private property owners: The Field Monitoring Coordinator will work with the District to contact cities and/or private property owners to make the necessary arrangements to sample.
- Unsafe or hazardous sampling conditions: Safety concerns will be addressed on a site-by-site basis to avoid sampling in unsafe conditions. Due to the hazard of flash flooding in the WWR, sampling will be conducted when there is sufficient sunlight and no sampling will occur when there is a flash flood warning or watch.
- Wet weather monitoring events will not take typically take place during recognized District and laboratory holiday closures. Please refer to Section 10.3 Staffing for a list of closure dates.

7. QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

Field and laboratory measurement quality objectives (MQOs) ~~data quality objectives~~ have been selected to specify an acceptable range of quantity and quality of data to support the program objectives. The data quality categories are described below. Table 7-1 specifies applicable sample MQOs for all laboratory testing. MQOs establish acceptable levels of uncertainty for each measurement process by addressing the major components of data quality: accuracy, precision, and completeness. The uncertainties associated with measurements generally result from (1) natural variability of a sample, (2) sample handling conditions and methods, (3) spatial and temporal variation; and (4) variations in collection or analytical procedures. MQOs were developed by the SWAMP to allow for data comparability to establish the degree to which data can be compared directly with data from other relevant programs. As such, the existing SWAMP MQOs are deemed the most applicable and relevant criteria and are incorporated into this QAPP.

MQOs were updated to be consistent with 2017 SWAMP Quality Assurance Program Plan (website[1] last updated January 30, 2020; website visited October 2020). Since the 2017 metrics were established toxicity and bioassessment MQOs have been revised and were updated accordingly. The updated toxicity MQOs for the following categories became effective July 20, 2018: Acute and Chronic Marine Sediment Toxicity Test Methods; Acute Marine Water Toxicity Test Methods; Acute Freshwater Toxicity Test Methods; Chronic Freshwater Sediment Toxicity Test Methods; Chronic Freshwater Toxicity Test Methods; and Chronic Marine Water Toxicity Test Methods. Bioassessment Algae Taxonomy (soft bodied and diatoms) became effective November 2019 and Benthic Macroinvertebrate (BMI) Taxonomy became effective January 6, 2020. MQOs for general chemistry categories follow the 2017 SWAMP Quality Assurance Program Plan.

Table 7-1: Summary of Applicable Measurement Quality Objectives

Measurement of Analysis Type	Applicable Measurement Quality Objectives		
	Accuracy	Precision	Completeness
Field Parameters	✓	✓	✓
Chemical Laboratory Analyses: • General Chemistry • Metals • Microbiology • Nutrients • Organics	✓	✓	✓
Toxicants	✓	✓	✓
Biological	✓	✓	✓

~~Data quality objectives for all laboratory testing are for accuracy, precision and completeness. Field data quality objectives~~ Field MQOs are provided in Table 7-2 and analytical MQOs ~~data quality objectives~~ are provided in Table 7-3.

Accuracy is the closeness or agreement of the test response to the true or reference value. Accuracy will be determined by measuring one or more analytes selected from performance testing samples or standard solutions from sources other than those used for calibration. The accuracy of chemical measurements will be checked by performing tests on standards prior to and/or during sample analysis at the laboratory. The concentration of the standards will be unknown to the analyst until after measurements are determined.

[1] https://www.waterboards.ca.gov/water_issues/programs/swamp/mqo.html

Recovery is the accuracy of an analytical test measured against a known analyte addition to a sample, such as with a matrix spike. Recovery measurements will be determined by laboratory spiking of a replicate sample with a known analyte concentration at two times the original sample concentration when possible. If recoveries are not within the accepted criteria, including the respective laboratory's acceptance criteria, the sample shall be reprocessed for re-analysis.

For this program, accuracy will be measured by method blanks, matrix spikes, Standard Reference Materials (SRM) and laboratory control samples. For microbiology, positive and negative controls will be used to assess accuracy.

~~Precision describes how well repeated measurements agree. Precision measurements will be determined on laboratory replicates. Precision objectives apply to replicate/split samples collected during field sampling and laboratory analysis as part of Quality Control requirements.~~ Precision describes how well repeated measurements agree, and generally refers to the degree of agreement for the entire monitoring, operational, and analysis system. Precision objectives apply to replicate/split samples collected during field sampling and laboratory analysis as part of Quality Control requirements. Precision is derived from reanalysis of individual samples (laboratory or field replicates) analyzed on equivalent instruments and expressed as the relative percent difference (RPD). For this program, precision will be measured by matrix spikes duplicates, laboratory duplicates and field duplicates. Together, accuracy and precision provide an estimate of the total error (uncertainty) of a measured value. This calculation is presented in Equation 1:

$$RPD = \frac{abs[x_1 - x_2]}{0.5 * (x_1 + x_2)} \qquad \textbf{Equation 1}$$

where:

abs is the absolute value.
x_1 is measurement 1.
x_2 is measurement 2.

Completeness is the number of analyses generating useable data for each analysis divided by the number of samples collected for that analysis. The method used under this QAPP to determine completeness is a comparison of the number of measurements anticipated to be collected against the number of measurements actually collected that meet their respective MQOs ~~data quality objectives~~. It is expected that 90 percent of all measurements will be taken as anticipated, including accounting for adverse weather conditions, safety concerns and equipment problems. Completeness will be measured as a percentage of the number of samples collected that meet the respective MQOs compared with the anticipated number of samples. This calculation is presented in Equation 2:

$$Completeness = \frac{Actual\ number\ of\ samples\ collected}{Project\ required\ total\ samples\ to\ be\ collected} * 100 \qquad \textbf{Equation 2}$$

SWAMP Target RLs, when available, are included to account for method sensitivity in addition to State Board MLs. Laboratory RLs may also be utilized when they are more stringent than those recommended by SWAMP. The analytical laboratory will attempt to improve upon these RLs, and will provide a written explanation for any failure to meet them. Standard Method RLs will be used when no required RL is available. Specific MQOs ~~data quality objectives~~, based on SWAMP targets, are presented in Tables 7-2 and 7-3. Historically Table 7-2 has included the expected range of field measurements, however as this varies by equipment type and manufacturer, it has been removed. Equipment manuals for corresponding equipment used under CMP will be referred to for expected ranges of values.

Table 7-2: Measurement Quality Objectives for Field Measurements

Group	Parameter	Unit	Accuracy	Precision	~~Range~~	Completeness[1]
Field Parameters	Conductivity	µmhos/cm ~~µS/cm~~	±2 ~~±3%~~	±2 or ±10% ~~±1%~~	~~0-9.99%~~	90%
	Dissolved Oxygen	mg/L	±0.5 ~~±0.2 or ±2% air~~	±0.5 or ±10% ~~0.1 or ±1% air~~	~~0-19.99 or 0-199% saturated air~~	90%
	pH	pH units	±0.2 ~~±0.1~~	±0.2 ~~±0.05~~	~~0-14~~	90%
	Temperature	°Celsius	±0.2 ~~±1~~	±1 or ±10% ~~±0.3~~	~~0-55~~	90%
	Turbidity	NTU	±1 ~~±5~~	±1 or ±10% ~~±3~~	~~0-800~~	90%

Note: SWAMP requirement present, recommendations only.
[1] 90% completeness MQO default applied, consistent with standard SWAMP criteria.

Table 7-3: Measurement Quality Objectives for Laboratory Analyses

Constituent	Units	Accuracy	Precision (% RPD)	Completeness[1]
Conventionals, Nutrients, and Hydrocarbons				
Ammonia as Nitrogen	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Biological Oxygen Demand (5 day)	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Chemical Oxygen Demand	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Color	Units	NA	NA	NA
Dissolved Phosphorus	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Dissolved Organic Carbon	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Ethylene Glycol	mg/L	NA	NA	NA
Detergents - Methylene Blue Actives (MBAS)	mg/L	NA	NA	NA
Nitrate, as N	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Nitrite, as N	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Nitrogen, Total Kjeldahl (as N)	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Nitrogen, Total	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Nitrogen, Total Inorganic	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%

Constituent	Units	Accuracy	Precision (% RPD)	Completeness[1]
Nitrogen, Total Organic	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Oil and Grease	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Ortho Phosphorus	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Sulfate	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Total Dissolved Solids	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Total Organic Carbon	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%

Table 7-3: Measurement Quality Objectives for Laboratory Analyses (continued)

Constituent	Units	Accuracy	Precision (% RPD)	Completeness[1]
Total Hardness (as CaCO3)	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Total Phosphorus	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Total Potassium	mg/L	NA	NA	NA
Total Suspended Solids	mg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Diesel Range Hydrocarbons2	mg/L	50-150%	RPD≤35%	90%
Gasoline Range Hydrocarbons2	mg/L	50-150%	RPD≤35%	90%
Metals (Total / Dissolved)				
Aluminum	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Antimony	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Arsenic	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Barium	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Beryllium	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Boron	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Cadmium	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%

Table 7-3: Measurement Quality Objectives for Laboratory Analyses (continued)

Constituent	Units	Accuracy	Precision (% RPD)	Completeness[1]
Chromium, Hexavalent	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Chromium, Total	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Chromium, Trivalent	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Copper	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Iron	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Lead	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Manganese	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Mercury	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Nickel	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Selenium	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Silver	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Thallium	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Zinc	µg/L	75-125% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Microbiology				
Escherichia coli	MPN/100mL	NA	NA	NA
Enterococcus	MPN/100mL	NA	NA	NA
Fecal Coliform	MPN/100mL	NA	NA	NA
Fecal Streptococci	MPN/100mL	NA	NA	NA
Total Coliform	MPN/100mL	NA	NA	NA
Semi-Volatile Compounds				
Bis(2-Ethylhexyl)Phthalate	µg/L	NA	NA	NA
Organics, PAHs				
Benzo(b)Fluoranthene	µg/L	50-150%	RPD≤35%	90%
Benzo(ghi)Perylene	µg/L	50-150%	RPD≤35%	90%
Chrysene	µg/L	50-150%	RPD≤35%	90%
Fluoranthene	µg/L	50-150%	RPD≤35%	90%
Fluorene	µg/L	50-150%	RPD≤35%	90%
Indeno(1,2,3-cd)Pyrene	µg/L	50-150%	RPD≤35%	90%
Naphthalene	µg/L	50-150%	RPD≤35%	90%
Phenanthrene	µg/L	50-150%	RPD≤35%	90%

Table 7-3: Measurement Quality Objectives for Laboratory Analyses (continued)

Constituent	Units	Accuracy	Precision (% RPD)	Completeness[1]
Pyrene	µg/L	50-150%	RPD≤35%	90%
Pesticides				
Aspon	µg/L	50-150%	RPD≤35%	90%
Azinphos-ethyl	µg/L	50-150%	RPD≤35%	90%
Azinphos-methyl	µg/L	50-150%	RPD≤35%	90%
Carbophenothion	µg/L	50-150%	RPD≤35%	90%
Chlorfenvinphos	µg/L	50-150%	RPD≤35%	90%
Chlorpyrifos	µg/L	50-150%	RPD≤35%	90%
Chlorpyrifos methyl	µg/L	50-150%	RPD≤35%	90%
Ciodrin (Crotoxyphos)	µg/L	50-150%	RPD≤35%	90%
Coumaphos	µg/L	50-150%	RPD≤35%	90%
Demeton-S	µg/L	50-150%	RPD≤35%	90%
Diazinon	µg/L	50-150%	RPD≤35%	90%
Dibrom (Naled)	µg/L	50-150%	RPD≤35%	90%
Dichlofenthion	µg/L	50-150%	RPD≤35%	90%
Dichlorvos	µg/L	50-150%	RPD≤35%	90%
Dicrotophos	µg/L	50-150%	RPD≤35%	90%
Dimethoate	µg/L	50-150%	RPD≤35%	90%
Dioxathion	µg/L	50-150%	RPD≤35%	90%
Disulfoton	µg/L	50-150%	RPD≤35%	90%
Ethion	µg/L	50-150%	RPD≤35%	90%
Ethyl Parathion	µg/L	50-150%	RPD≤35%	90%
Famphur	µg/L	50-150%	RPD≤35%	90%
Fenitrothion	µg/L	50-150%	RPD≤35%	90%
Fensulfothion	µg/L	50-150%	RPD≤35%	90%
Fenthion (Mercaptophos)	µg/L	50-150%	RPD≤35%	90%
Fonophos (Dyfonate)	µg/L	50-150%	RPD≤35%	90%
Leptophos	µg/L	50-150%	RPD≤35%	90%
Malathion	µg/L	50-150%	RPD≤35%	90%
Merphos	µg/L	50-150%	RPD≤35%	90%
Mevinphos	µg/L	50-150%	RPD≤35%	90%
Methyl Parathion	µg/L	50-150%	RPD≤35%	90%
Phorate	µg/L	50-150%	RPD≤35%	90%
Phosmet	µg/L	50-150%	RPD≤35%	90%
Phosphamidon	µg/L	50-150%	RPD≤35%	90%
Prophos (Ethoprop)	µg/L	50-150%	RPD≤35%	90%
Sulfotep	µg/L	50-150%	RPD≤35%	90%
Sulprofos (Bolstar)	µg/L	50-150%	RPD≤35%	90%
Terbufos	µg/L	50-150%	RPD≤35%	90%
Tetrachlorvinphos (Stirifos)	µg/L	50-150%	RPD≤35%	90%
Thionzin (Thionazin)	µg/L	50-150%	RPD≤35%	90%
Tokuthion	µg/L	50-150%	RPD≤35%	90%
Trichlorfon	µg/L	50-150%	RPD≤35%	90%
Trichloronate	µg/L	50-150%	RPD≤35%	90%
4,4'-DDD	µg/L	50-150%	RPD≤35%	90%
4,4'-DDE	µg/L	50-150%	RPD≤35%	90%
4,4'-DDT	µg/L	50-150%	RPD≤35%	90%
Aldrin	µg/L	50-150%	RPD≤35%	90%
alpha-BHC (alpha-HCH)	µg/L	50-150%	RPD≤35%	90%
alpha-Endosulfan (Endosulfan I)	µg/L	50-150%	RPD≤35%	90%
beta-BHC (beta-HCH)	µg/L	50-150%	RPD≤35%	90%
beta-Endosulfan (Endosulfan II)	µg/L	50-150%	RPD≤35%	90%
Chlordane	µg/L	50-150%	RPD≤35%	90%
Chlorpyrifos	µg/L	50-150%	RPD≤35%	90%
delta-BHC (delta-HCH)	µg/L	50-150%	RPD≤35%	90%

Table 7-3: Measurement Quality Objectives for Laboratory Analyses (continued)

Constituent	Units	Accuracy	Precision (% RPD)	Completeness[1]
Diazinon	µg/L	50-150%	RPD≤35%	90%
Dieldrin	µg/L	50-150%	RPD≤35%	90%
Endosulfan Sulfate	µg/L	50-150%	RPD≤35%	90%
Endrin	µg/L	50-150%	RPD≤35%	90%
Endrin Aldehyde	µg/L	50-150%	RPD≤35%	90%
gamma-BHC (lindane)(gamma-HCH)	µg/L	50-150%	RPD≤35%	90%
Pesticides				
Heptachlor	µg/L	50-150%	RPD≤35%	90%
Heptachlor Epoxide	µg/L	50-150%	RPD≤35%	90%
Toxaphene	µg/L	50-150%	RPD≤35%	90%
Polychlorinated Biphenyls (PCBs)				
Aroclor-1016	µg/L	50-150%	RPD≤35%	90%
Aroclor -1221	µg/L	50-150%	RPD≤35%	90%
Aroclor -1232	µg/L	50-150%	RPD≤35%	90%
Aroclor -1242	µg/L	50-150%	RPD≤35%	90%
Aroclor -1248	µg/L	50-150%	RPD≤35%	90%
Aroclor -1254	µg/L	50-150%	RPD≤35%	90%
Aroclor -1260	µg/L	50-150%	RPD≤35%	90%
Pyrethroids				
Bifenthrin	ng/L	50-150%	RPD≤35%	90%
Cyfluthrin	ng/L	50-150%	RPD≤35%	90%
Cyhalothrin-lambda	ng/L	50-150%	RPD≤35%	90%
Cypermethrin	ng/L	50-150%	RPD≤35%	90%
Danitol (Fenpropathrin)	ng/L	50-150%	RPD≤35%	90%
Deltamethrin	ng/L	50-150%	RPD≤35%	90%
Esfenvalerate	ng/L	50-150%	RPD≤35%	90%
Fenvalerate	ng/L	50-150%	RPD≤35%	90%
Permethrin, -cis	ng/L	50-150%	RPD≤35%	90%
Permethrin, -trans	ng/L	50-150%	RPD≤35%	90%
Permethrin, TOTAL	ng/L	50-150%	RPD≤35%	90%
Volatiles				
1,1,1-Trichloroethane	µg/L	50-150%	RPD<25%	90%
1,1,2,2-Tetrachloroethane	µg/L	50-150%	RPD<25%	90%
1,1,2-Trichloroethane	µg/L	50-150%	RPD<25%	90%
1,1-Dichloroethane	µg/L	50-150%	RPD<25%	90%
1,2-Dichloroethane	µg/L	50-150%	RPD<25%	90%
1,2-Dichloropropane	µg/L	50-150%	RPD<25%	90%
1,2-Dichlorobenzene	µg/L	50-150%	RPD<25%	90%
1,3-Dichlorobenzene	µg/L	50-150%	RPD<25%	90%
1,4-Dichlorobenzene	µg/L	50-150%	RPD<25%	90%
1,2-Trans-Dichloroethylene	µg/L	50-150%	RPD<25%	90%
2-Chloroethylvinyl Ether	µg/L	50-150%	RPD<25%	90%
Benzene	µg/L	50-150%	RPD<25%	90%
Bromoform	µg/L	50-150%	RPD<25%	90%
Carbon Tetrachloride	µg/L	50-150%	RPD<25%	90%
Chlorobenzene	µg/L	50-150%	RPD<25%	90%
Chlorodibromomethane	µg/L	50-150%	RPD<25%	90%
Chloroform	µg/L	50-150%	RPD<25%	90%
Dichlorobromomethane	µg/L	50-150%	RPD<25%	90%
Ethylbenzene	µg/L	50-150%	RPD<25%	90%
Methyl Chloride	µg/L	50-150%	RPD<25%	90%
Tetrachloroethylene	µg/L	50-150%	RPD<25%	90%
Toluene	µg/L	50-150%	RPD<25%	90%
Trichloroethylene	µg/L	50-150%	RPD<25%	90%
Other Toxic Pollutants				

Table 7-3: Measurement Quality Objectives for Laboratory Analyses (continued)

Constituent	Units	Accuracy	Precision (% RPD)	Completeness[1]
Cyanide, total	µg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Phenols, total	µg/L	80-120% recovery	RPD<25% (n/a if native concentration of either sample<RL)	90%
Toxicity				
Ceriodaphnia dubia, acute	% survival	≥90% mean survival in the controls	100% daily renewal	90%
Ceriodaphnia dubia, chronic	% survival	≥80% mean survival in controls; 60% of the surviving control females must produce 3 broods with an average of 15 or more young per female	100% daily renewal	90%
Pimephales promelas, acute	% survival	≥90% mean survival in the controls	80% renewal after 48 hours	90%
Pimephales promelas, chronic	% survival/	≥80% mean survival in the controls, and an average of ≥0.25 mg dry weight for surviving individuals	80% daily renewal	90%
Hyalella azteca, acute	% survival	≥90% mean survival in the controls	80% renewal after 48 hours	90%
Hyalella azteca, chronic	% survival/	≥80% mean survival in the controls	80% renewal on day 2, 4, and 6	90%
Pseudokirchneriella subcapitata, chronic	% growth	1x10^6 mls cell density min growth	NA	90%
Biological				
Riparian Condition (CRAM)	--	NA	NA	90% of sites targeted, 100% of samples collected.
Physical Habitat (PHAB)	--	NA	NA	90% of sites targeted, 100% of samples collected.
Benthic Macroinvertebrates Taxonomy	--	10% of samples in project	10% of samples in project	90% of sites targeted, 100% of samples collected.
Periphyton (algae): Ash-free dry mass	--	10% of samples in project	10% of samples in project	90% of sites targeted, 100% of samples collected.
Periphyton (algae): Chlorophyll-a	--	10% of samples in project	10% of samples in project	90% of sites targeted, 100% of samples collected.
Periphyton (algae): Taxonomy (diatoms)	--	10% of samples in project	10% of samples in project	90% of sites targeted, 100% of samples collected.
Periphyton (algae): Taxonomy (soft body)	--	10% of samples in project	10% of samples in project	90% of sites targeted, 100% of samples collected.

Notes:

- Due to various laboratory factors or required sample dilutions, the laboratory may not be able to meet some of the measurement quality objectives. Any data points that do not meet all MQOs will be properly qualified. The data flag will explain why the MQO was not met, and the contracted laboratory will document the QA/QC indicators that demonstrate the

analytical method are within control limits. If the results of an accepted method fail, any proposed method revisions will be reviewed by the District and any changes approved on a case by case basis.
- Methods and Target RLs are provided for each constituent in Table 6-2.
- The District will continue to evaluate measurement quality objectives used for this program, and working with the laboratories, will update as needed.
- NA = no applicable SWAMP criteria for constituent/method combination.

- 1. 90% completeness MQO default applied, consistent with standard SWAMP criteria.

Group	Constituent	Units	Accuracy	Precision (% RPD)	Recovery	Completeness
General Chemistry (Water Analysis)	All Constituents	Varied	80-120	0-25	80-120%	90%
Metals (Water Analysis)	Total and Dissolved Trace Metals	µg/L	50-155%	0-25	75-125%	90%
Microbiology (Water Analysis)	All Constituents	Varied	NA	0-25	NA	90%
Nutrients (Water Analysis)	All Constituents	mg/l	70-130%	0-25	80-120%	90%
Organics (Water Analysis)	Polynuclear Aromatic Hydrocarbons, Pesticides, and PCBs	ng/L	50-150	0-25	10-210%	90%
	Volatiles	µg/L	50-150	0-25	10-210%	90%
	Synthetic Pyrethroid Pesticides	ng/L	65-125%	0-25	10-210%	90%
Other Toxicants	All Constituents	µg/L				90%
Toxicity (Water Analysis)	Acute and Chronic	% survival	The Reference Toxicant Test result must fall within 2 standard deviations of the cumulative mean. No statistical difference for lab control water.	NA	NA	90%

Notes:
- Any changes made by the Laboratory related to the data quality objectives will be discussed on a case by case basis to determine if data validation is either acceptable by standards of analytical industry practice, or will be reported with the respective Annual Report if determined that the data quality is compromised.
- Target RLs are provided for each constituent in Table 6-2.
- The District will continue to evaluate data quality objectives used for this program, and working with the laboratories, will update as needed.

8. SPECIAL TRAINING NEEDS/CERTIFICATION

8.1 Specialized Training or Certifications

All primary and secondary monitoring field staff are required to receive training in safety and sampling protocols and procedures prior to engaging in any field activities. Several of the primary and secondary field samplers for the District are also named in the District's Storm Patrol Manual within the listing of the Storm Patrol Assignments. The District's Storm Patrol Manual is updated annually. District field crews typically include lead staff experienced in the monitoring requirements of the permits, and may also be accompanied by support staff and other volunteers as needed. At a minimum, sampling personnel will have completed the following annual training:

- Safety awareness;
- Review of field sampling hazards, safety rules and pre-sampling site visit;
- Sample handling, storage, and transport,
- Document retention,
- Field equipment use and calibration; and
- Sampling Standard Operating Procedures (SOPs) in accordance with the QAPP and Monitoring Plans.

E. S. Babcock and Sons, Inc., Environmental Laboratories (Babcock) is certified for chemical testing by the National Environmental Lab Accreditation Program (NELAP, No. 02101CA) and the California Environmental Laboratory Approval Program (CA ELAP, No. 2698). Babcock also sub-contracts certain analyses to Weck Laboratories (NELAP Certificate No. 4047 and ELAP Certification No. 1132). Additionally, Coachella Valley Water District generally conducts a portion of the WWR program analysis of *E.coli* at their in-house laboratory to facilitate compliance with the hold time constraints (ELAP Certification No. 1780). If any other subcontractors are utilized by consultants or laboratories, they too must adhere to the training and certification requirements described.

8.2 Training and Certification Documentation

The District, sampling agencies, monitoring and laboratory consultants will maintain records of training at their respective offices as presented in Table 8-1. Documentation includes the date of the training, the topic and the name of the instructor.

8.3 Training Personnel

Field crews will be properly trained in the use of monitoring equipment and proper sampling techniques in accordance with the QAPP and Monitoring Plans by the District, sampling agencies and monitoring consultants. The respective consultant Project Managers and/or Monitoring Leads are responsible for training field staff prior to field activities and conducting training sessions as needed throughout the course of the program.

Laboratory analysts shall be properly trained in analytical methods and clean analysis techniques.

Table 8-1: Specialized Personnel Training or Certification

Specialized Training Course Title or Description	Training Provider	Personnel Receiving Training/ Organizational Affiliation	Location of Records and Certificates[1]
District Sampling SOPs and Health and Safety Training[2]	District Monitoring Program Manager	District Field Sampling Staff	1995 Market Street Riverside, CA 92501
Agency Sampling SOPs and Health and Safety Training[2]	Agency Project Manager or Monitoring Lead	Agency Field Staff	(see respective Agency approval pages located in Appendix O)
Consultant Sampling SOPs and Health and Safety Training[2]	Consultant Project Manager or Monitoring Lead	Consultant Project Team Field Staff	(see respective Consultant approval pages)
Laboratory Certifications	Laboratory Project Manager	Laboratory Staff	(see respective Consultant approval pages)

[1] Training records are kept at each agency or consultant's respective offices.
[2] See Appendix J for District Health and Safety Procedures.

9. DOCUMENTS AND RECORDS

Ultimately, all electronic data generated by the CMP will be managed and stored by the District. Upon completion of each year's monitoring activities, all data and records will be managed and kept by the District. Copies of records will be maintained for a minimum of five years after project completion. Additional information on document and record retention is contained in Table 9-1 below.

Project plans will be distributed to the participating entities and the District will retain a copy of the final project plans and a record of any amendments conducted throughout the course of the project. Laboratories and the District will store laboratory results and COC forms for five years from the time the annual data deliverable is submitted. All field observations and measurements will be recorded in the field data sheet provided in Appendix B. Field data sheets include sample collection records, field measurements, field observation records, and any deviations from standard sampling protocols. Field data sheets and COCs will be scanned and stored in electronic *.pdf format by the District's Program Manager for a minimum of five years from the time the study is completed. Data records will be maintained by the consultant's Project Team and by the District for a minimum of five years from the time the annual data deliverable is submitted. Project reports will be maintained by the District.

Table 9-1: Document and Record Retention, Archival, and Disposition Information

	Identify Type Needed	Retention	Archival	Disposition
Project Plans	QAPP	District	The District will retain a copy and review after each event.	The District will retain a copy for final disposition.
	Monitoring Plans	District	The District will retain a copy and review after each event.	The District will retain a copy for final disposition.
Analytical Records	Laboratory Reports	District, Laboratory Consultant(s)	The District will retain a copy and review after each event.	The District will retain a copy for final disposition.
	EDD	District, Laboratory Consultant(s)	The District will retain a copy and review after each event.	The District will retain a copy for final disposition.
Data Records	Stream Assessment Data and Hydrology Data	District, Monitoring Consultant(s)	The District will retain a copy and review after each event.	The District will retain a copy for final disposition.
Monitoring Reports	Monitoring Annual Reports	District	The District will retain a copy and review after each event.	The District will retain a copy for final disposition.
Annual Reports	Annual Reports	District	The District will retain a copy and review after each event.	The District will retain a copy for final disposition.

GROUP B ELEMENTS: DATA GENERATION AND ACQUISITION

10. SAMPLING PROCESS DESIGN

The QAPP describes the purpose, frequency and type of sampling conducted for each monitoring program included in the CMP. Additional details of the sampling process and design are discussed in the SMR, SAR, and WWR Monitoring Plans, provided as Volumes III, IV and V respectively, of the CMP.

10.1 Summary of Monitoring Programs

10.1.1 Santa Margarita Region

On May 8, 2013, the San Diego Regional Water Board adopted a Regional Permit, National Pollutant Discharge Elimination (NPDES) Permit, Order No. R9-2013-0001. The Permit was later amended by Order Nos. R9-2015-0001 (adopted February 11, 2015 and effective April 1, 2015) and R9-2015-0100 (adopted November 18, 2015 and effective January 7, 2016). The adoption of the November 2015 amendment marked the enrollment of the Riverside County Co-Permittees under the Regional Permit.

Included in the new Permit were provisions for development of Water Quality Improvement Plans (WQIP) that Co-Permittees must implement. The WQIP's are designed for restoring water quality and protecting the beneficial uses of waterbodies within each watershed of the San Diego Region. Co-Permittees are responsible for prioritizing water quality conditions and development of strategies that improve the quality of discharges from Municipal Separate Stormwater Sewer Systems (MS4s) and receiving waters. An adaptive monitoring and assessment plan will be relied upon throughout the implementation of the WQIPs developed for each Watershed Management Area (WMA)[2]. These adaptive plans are meant to address the goals set by the Co-Permittees, as well as the water quality and the overall effort placed into the WQIP by the Co-Permittees.

The new Monitoring and Assessment Plan is a required component of the WQIP. This Plan will replace the current plan previously outlined in this volume. The Monitoring and Assessment Plan will take effect once the Regional Board has reviewed and approved the WQIP in its entirety, which is scheduled for early 2018. Until then, the SMR monitoring efforts will be implemented pursuant to the Transitional Monitoring requirements of the Regional Permit, Provision D. 1a, 2, and 3. Both the Transitional Monitoring activities and the approved WQIP Monitoring and Assessment Plan will continue to reference the general procedures and standards outlined in the most current version of the QAPP (CMP Volume II).

The following monitoring programs will be conducted in the SMR to meet the requirements of the MS4 Permit. Additional details of the sampling process and design for the SMR monitoring programs are provided in Volume III of the CMP (i.e., WQIP Monitoring and Assessment Plan). Table 10-1 presents the SMR Sampling Schedule for each monitoring program described in this section including wet and dry weather components, number of events, estimated number of sample locations, sample matrices and the years of implementation.

The SMR Monitoring Program is comprised of the following monitoring components:

[2] Within the Santa Margarita River WMA, the Upper SMR subwatershed area and Middle SMR subwatershed area are within Riverside County, whereas the Lower SMR subwatershed area is within San Diego County. Refer to the WQIP (Section 5) for details of the monitoring conducted by the County of San Diego.

- **Receiving Water Monitoring:** The Receiving Water Monitoring Program is designed to monitor the condition of the receiving waters in each Watershed Management Area (WMA) during dry weather and wet weather. Long-term receiving water monitoring will be conducted during implementation of the WQIP to assess the long-term trends in order to determine if conditions in receiving waters are improving and to evaluate attainment of numeric goals established in Section 3 of the WQIP, as applicable. The Permit requires receiving water monitoring of at least one long-term receiving water monitoring station. Monitoring is required during three wet weather events and three dry weather events per permit term. Both composite and grab sampling regimes will be used for sample collection during dry and wet weather events. Field observations and collection of field monitoring data will be conducted at two stations during all dry and wet weather events.

  The definition of wet weather season is defined as between October 1st and April 30th. In an ephemeral watershed, the first wet weather event of the year that falls under the USEPA recommended criteria may not result in runoff from surrounding lands. Mobilization criteria and guidance for wet weather event monitoring is described in this QAPP and referenced in the Monitoring and Assessment Plan.

- **Hydromodification Monitoring**: The Permit (D.1.c(6)) requires hydromodification monitoring to be conducted as described in the Copermittees' approved Hydromodification Management Plan (HMP), dated April 2016, as well as hydromodification monitoring at each receiving water monitoring station for one dry weather event per permit term.

  HMP Monitoring Program: In accordance with the 2016 HMP as developed under the SMR 2010 Permit, the Co-Permittees are committed to conducting monitoring annually at two pre-selected stations through spring of 2019. To provide a standardized assessment of the presence and condition of vegetation and habitat integrity, relevant attributes of the California Rapid Assessment Method (CRAM) module for riverine wetland (QAPP Appendix P)[3] were applied for the initial site visits the first year of HMP implementation, as applicable to the Middle SMR Subwatershed area. These included the hydrology, physical structure, and biotic structure attributes of the protocol. These attributes evaluate metrics including channel stability, riverine entrenchment ratio, structural patch richness, topographic complexity, and plant community composition and structure. CRAM is a protocol developed and calibrated to be used state-wide and is thereby applicable to the wide variety of ecological and climate regimes present in California.

  Additionally, the hydrologic and sediment supply performance standards established in the 2016 SMR HMP are based on the most recent state of the hydromodification management science[4]. It is generally acknowledged that SCCWRP's formulation of regional standards for hydromodification management may serve as a baseline for development of HMPs for specific regions in Southern California. These hydromodification tools can be viewed on SCCRWPs website[5]. Most of the methods which will be utilized during hydromodification monitoring are borrowed from standardized protocols which are also being applied in the 2015-2019 Stormwater Monitoring Coalition (SMC) Regional Monitoring Program. By using protocols consistent with the SMC Regional Program, the results from the hydromodification monitoring may be compared to other SMC stream conditions. Since the results of the CRAM are not expected to significantly

[3] California Wetland Monitoring Workgroup (CWMW). 2013. California Rapid Assessment Method (CRAM) for Wetlands Version 6.1

[4] Southern California Coastal Water Research Project. Hydromodification Assessment and Management in California. Eric D. Stein; Felicia Federico; Derek B. Booth; Brian P. Bledsoe; Chris Bowles; Zan Rubin; G. Mathias Kondolf and Ashmita Sengupta. Technical Report 667. April 2012

[5] http://www.sccwrp.org/ResearchAreas/Stormwater/AssessmentAndManagementOfHydromodification.aspx

change from year to year, the subsequent years of monitoring under the HMP program include follow-up field survey for evaluating any geomorphologic changes over time. Findings from the HMP monitoring will be reported following completion of the program in October 2019.

Dry *Weather Long-Term Receiving Water Hydromodification Monitoring Program:* In addition to the hydromodification monitoring conducted as described in the Co-Permittees' Hydromodification Management Plan[6] (HMP), the Permit requires hydromodification monitoring for each long-term receiving water station for one dry weather event per Permit term. Hydromodification monitoring is typically scheduled concurrently with dry weather monitoring efforts (refer to the monitoring scheduled in the WQIP). Hydromodification monitoring will include:

- An evaluation of channel conditions;
- Identification of locations of discharge points;
- Assessment of habitat integrity;
- Photo documentation of site conditions;
- Measurement of channel erosion dimensions; and
- Evaluation of the potential causes of erosion and habitat impact as applicable.

In general conformance with the activities conducted under the 2016 HMP and to provide a standardized assessment of the presence and condition of vegetation and habitat integrity, relevant attributes of the CRAM module for riverine wetland (QAPP Appendix P) will be applied. CRAM will be conducted in accordance with State guidelines and quality control standards described within the approved SWAMP SOP's and tools will be used as described on the State Water Boards website[7]. Following completion of the monitoring effort (refer to the WQIP Monitoring and Assessment Plan schedule), data QA/QC, and data assessment, the findings from the Dry Weather Long-Term Receiving Water Hydromodification Monitoring Program will be reported in the subsequent year's WQIP annual report.

- **Follow-up Approach and Actions:** Follow-up analysis is based on a combination of compliance and assessment approaches pursuant to the Regional Permit. Under the compliance approach, chemistry results from receiving waters monitoring stations are compared to compliance and Water Quality Standards as described in Section 2.0. Assessment will be conducted as described in the Monitoring and Assessment Plan of the WQIP. Follow-up actions may include, but are not limited to:
  - Toxicity Identification Evaluation (TIE)/Toxicity Reduction Evaluation (TRE): When there is evidence of chronic toxicity, TIEs may be utilized in the follow-up approach. The purpose of TIEs is to identify the possible cause of toxicity. If chronic toxicity is detected in receiving waters the Co-Permittees must discuss the need for conducting a TIE/TRE in the assessments required under Provision D.4.a.(2) and develop a TIE/TRE plan for incorporation into the WQIP. Once the cause of toxicity has been identified, measures must be implemented to reduce or eliminate the pollutant discharge.
  - Upstream Source Identification Investigations: If needed, a source investigation component may be conducted to facilitate the implementation of source control measures. Upstream source identification investigations will be conducted by the Co-Permittee having jurisdiction on a case-by-case basis. Refer to the actions as further defined in the Co-Permittees' respective Jurisdictional Runoff Management Plans (JRMPs).

[6] Santa Margarita Region Hydromodification Management Plan. April, 2016.
[7] https://www.waterboards.ca.gov/water_issues/programs/swamp/tools.html

- **Regional Monitoring**: Co-Permittees will participate in the regional monitoring programs to meet the requirements of Permit Provision D.1.e (1). Regional monitoring efforts under the Southern California Stormwater Monitoring Coalition (SMC) Regional Monitoring Program and Southern California Bight Regional Monitoring Program are implemented by separate project-specific workplans to meet the goals and needs of each program. Refer to the Monitoring Annual Report for the most current updates and status of the regional monitoring workplans.

- **Wet Weather MS4 Discharge Monitoring:** Five representative major outfalls will be monitored once per year during wet weather events by the Riverside County Co-Permittees within the Middle SMR subwatershed area. There are no major outfalls inventoried within the Upper SMR subwatershed area. The outfalls will continue to be monitored and as new information becomes available the Co-Permittees will consider re-evaluating the monitoring station locations and frequencies, and revising the WQIP, as needed in accordance with the Regional Permit adaptive management process. Flow measurements will be recorded in cubic feet per second. Stations that are observed to be dry or ponded will be recorded as 0 cfs, and the event will be documented as Visited Not Sampled. In the case that there is a presence of trickle flow (i.e., low flow that cannot be directly measured) the observation of flow will be entered with field data, and a visual estimated rate of <0.001 cfs will be recorded.

- **Dry Weather MS4 Field Screening:** The Regional Permit requires dry weather MS4 outfall discharge field screening monitoring with a frequency based on the number of major outfalls within a Co-Permittee's jurisdiction. Each Riverside County Co-Permittee has less than 125 major MS4 outfalls. The initial requirement for each Co-Permittee is to visually inspect at a minimum of 80 percent of the outfalls twice per year during dry weather conditions. However, the Permit also allows the Co-Permittees to adjust the field screening monitoring frequencies and locations for the MS4 outfalls in its inventory, as needed, to identify and eliminate sources of persistent flow non-stormwater discharges in accordance with the highest priority water quality conditions identified in the WQIP. This adaptive approach is permitted provided that the level of effort (e.g., number of visual inspections performed) is equivalent to the number of visual inspections initially required. The frequencies and locations for the MS4 outfalls which are inspected may be adjusted in accordance with the flexibility allowed in the Regional Permit, as needed. The dry weather field screening of major outfalls will be conducted by the Riverside County Co-Permittees within the Middle SMR subwatershed area. There are no major outfalls inventoried within the Upper SMR subwatershed area.

- **Dry Weather MS4 Discharge Monitoring:** Based on the results of the dry weather MS4 outfall discharge field screening monitoring each Co-Permittee will identify and prioritize a minimum of five of the MS4 outfalls with persistent dry weather non-stormwater flows based on their potential to contribute to the highest priority water quality conditions identified in the WQIP. Station selection will include consideration of other pertinent factors, such as safety conditions, site accessibility, flow vs. ponded observations, tributary influences, etc. Dry weather outfall discharge monitoring will be conducted by the Riverside County Co-Permittees within the Middle SMR subwatershed area. There are no major outfalls inventoried within the Upper SMR subwatershed area. The total 25 representative major outfalls (e.g., outfall stations representing Riverside County Co-Permittees' MS4 discharge) will be monitored at least twice per year until one of the following criteria pursuant to the Regional Permit (Order Section D.2.b.(2)) have been met:
    - Non-stormwater discharges have been eliminated;
    - The source of the persistent non-stormwater discharge flow has been identified as not requiring and NPDES permit;

- Constituents in the non-stormwater discharge persistent flow do not exceed NALs and the flow can be re-prioritized; or
- The source of the flow has been identified as being authorized by a separate NPDES permit.

The outfalls will continue to be monitored and as new information becomes available the Co-Permittees will consider re-evaluating the monitoring station locations and frequencies, and revising the WQIP, as needed in accordance with the Regional Permit adaptive management process. Flow measurements will be recorded in cubic feet per second. Stations that are observed to be dry or ponded will be recorded as 0 cfs, and the event will be documented as Visited Not Sampled. In the case that there is a presence of trickle flow (i.e., low flow that cannot be directly measured) the observation of flow will be entered with field data, and a visual estimated rate of <0.001 cfs will be recorded.

- **Source Identification/IDDE Monitoring:** MS4 outfall monitoring results will be compared to applicable SALs or NALs, as incorporated into the WQIP, to identify any exceedances and to support in the assessment of the effectiveness of the WQIP priorities and strategies as well as support the detection and elimination of non-stormwater discharges and illicit discharges to the MS4. Follow-up procedures may be initiated upon discovery of a SAL or NAL exceedance in a sample and are further defined in the Co-Permittees' respective Jurisdictional Runoff Management Plans (JRMPs).

- **Special Studies:** The Co-Permittees participate in several special studies for the benefit of their local and regional program efforts.

  WQIP Special Studies:
  Within the term of the 2015 Regional Permit the Co-Permittees will initiate at least two special studies:

  - The special study as relevant to Provision D.3.a.(1), specific to the Watershed Management Area, will include the Santa Margarita River Nutrient Initiative Group (SMRNIG) Nutrient Management Study. SMRNIG which includes cities and counties, utility districts, Caltrans, scientists, tribes, non-governmental organizations (NGOs), United States Geological Survey (USGS), Camp Pendleton, Farm Bureau, and RWQCB staff that periodically meet to focus on nutrient-related issues in the SMR Estuary. The SMRNIG have conducted extensive modeling efforts in support of a Total Maximum Daily Load (TMDL) Alternative for the SMR Estuary for nutrients, and their work has provided valuable insight and scientific information used in the development of the WQIP. With respect to the SMR Copermittees, this WQIP will be a key implementation mechanism for the TMDL Alternative. The Nutrient Numeric Endpoint (NNE) framework, an alternative regulatory approach advocated by SWRCB staff and United States Environmental Protection Agency (USEPA) Region 9, is currently in development. This framework can be used to develop scientifically-sound water quality goals for the estuary and river that are protective of their beneficial uses.

    The SMR NMI Stakeholder Group is piloting alternative approaches to establish biostimulatory targets based on recent science. This work includes developing targets in three phases: Phase I – SMR Estuary; Phase II – Lower SMR Mainstem (confluence of De Luz Creek to Estuary); Phase III – Upper SMR Mainstem (top of SMR gorge to confluence of De Luz Creek). In addition, Phase III includes evaluation of the impact of climate change scenarios on biological conditions in the SMR Estuary and River, an evaluation of possible restoration actions that could improve the level of biological integrity, and an

estimation of nutrient load and wasteload allocations expected to achieve the biostimulatory targets in the river. In support of the development of the NNE framework the Copermittees targeted sites for in-kind sampling to provide the study with additional nutrient data, selected in coordination with SCCRWP.

On May 9, 2019, the 2019 Investigative Order was issued by the San Diego Water Board to the Cities of Murrieta, Temecula, and Wildomar, the Counties of San Diego and Riverside, the District, and Marine Corps Base Camp Pendleton. Results from the water quality monitoring and assessment program for the Investigative Order will be used to evaluate and demonstrate water quality improvements achieved within the Estuary as a result of implementation actions taken.

- The special study as relevant to Provision D.3.a.(2-3), the San Diego Region, will be the SMC CLEAN Study. Descriptions of these special studies will be provided in the Monitoring and Assessment Plan of the WQIP (included in CMP Volume III by reference only). Details on the status and findings of these special studies will be included in the Annual WQIP Monitoring and Assessment Reports.
- The special study as relevant to Provision D.3.a.(1), specific to the Santa Margarita River WMA, will include a post-fire water quality monitoring study and report from samples collected during the 2019-2020 and 2020-2021 wet seasons. This special study was developed to assess the potential water quality impacts of the 2019 Tenaja Fire that burned approximately 1,939 acres near the Santa Rosa Plateau Ecological Preserve. The data will be used to assess the potential post-fire contaminant fluxes and pollutant load contribution from tributary runoff at stations along Murrieta Creek and the Upper Santa Margarita River located within the Middle SMR sub-watershed area of the WMA. The results will be presented in the 2019-2020 and 2020-2021 WQIP Monitoring and Assessment Reports.

Other Special Studies:
The Co-Permittees participate in additional special studies and efforts relevant to their management programs and implementation:

- The Co-Permittees support the regional laboratory intercalibration study efforts, as well as monitoring field protocols intercalibration exercise facilitated through the SMC. The SMC established a continuing goal of compiling local monitoring data to make region-wide assessments. Therefore, the SMC holds periodic laboratory intercalibration studies to ensure comparability in analytical measurements, as well as holds seasonal field survey/assessment intercalibration exercises to promote comparability of data collection methods and for assurance of data quality. One example of this was the laboratory toxicity intercalibration study completed in December 2016.
- The San Diego Regional Reference Stream Study was conceived by the San Diego, Orange County and Riverside Permittees, funded by San Diego and Orange County. The goal of this project was to collect the data necessary to derive reasonable and accurate numeric targets for bacteria, nutrients, and heavy metals by referencing natural, local conditions. The results of this study were used to support the forthcoming reopener of the regionally adopted Bacteria TMDLs and to support numeric targets in future TMDLs for bacteria, nutrients, and metals. For additional details see SCCWRP Technical Report 862[8]. This study was completed, and results were published in June 2015.

[8] SCCWRP Technical Report 862: Wet and Dry Weather Natural Background Concentrations of Fecal Indicator Bacteria in San Diego, Orange, and Ventura County, California Streams (Tiefenthaler et al., 2015) (http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/862_StreamFIBs.pdf)

Table 10-1: SMR Sampling Schedule

SMR Sampling Program[1]	Program Component	Matrix	Number of Events Per Permit Term (2015 Permit)	*Tentative* Number of Events Per Permit Term (Future Permit)	Estimated Number of Sample Locations	2016-2017[2]	2017-2018[2]	2018-2019[2,3]	2019-2020[3]	2020-2021[3]	2021-2022[3]	2022-2023[3]
Long Term Receiving Water Monitoring[4]	Dry Weather Event	Water	-[2]	3	2	-[2]	-[2]			3		
	Wet Weather Event	Water	-[2]	3	2	-[2]	-[2]		3			
	Toxicity	Water	-[2]	3	2	-[2]	-[2]		3	3		
	Bioassessment	Water, Algae, BMI, Toxicity	-[2]	1	2	-[2]	-[2]			1		
	Hydromodification	Survey	-[2]	1	2	-[2]	-[2]			1		
MS4 Outfall Monitoring	Dry Weather Field Screening	Field Observation	4 (2x Annually per station)	10 (2x Annually per station)	80% of all Inventoried major outfalls (2x annually)	2	2	2	2	2	2	2
	Dry Weather Event	Water	0[2]	~10 (2x Annually per station)	25 (min. 5 per Permittee)	-[2]	-[2]	2	2	2	2	2
	Wet Weather Event		2 (1 Annually per station)	5 (1 Annually per station)	25 (min. 5 per Permittee)	1	1	1	1	1	1	1
Regional Monitoring Programs	SMC Regional Monitoring of Southern California Coastal Watersheds	Water, Algae, BMI, Toxicity, Physical habitat	2[5] (1 Annually)	5[5] (1 Annually)	2[5]	1[5]	1[5]	1[5]	1[5]	1[5]	1[5]	1[5]
	Southern California Bight Regional Monitoring	Sediment Quality	-[5]	-[5]	-[5]	-[5]	-[5]	-[5]	-[5]	-[5]	-[5]	-[5]
Special Studies	Refer to the Annual WQIP Monitoring and Assessment Reports for the most updated information on WQIP Special Studies workplans and schedules.											

[1] Refer to the WQIP Monitoring and Assessment Plan for complete details on program requirements and schedules. The above table is included herein for reference purposes only.
[2] During the 2016-2017 and the 2017-2018 Monitoring Years the Transitional Monitoring requirements will be implemented until the approval of the WQIP.
[3] During the 2017-2018 Monitoring Year the Regional Permit Term will expire; therefore, the WQIP and the subsequent Monitoring Years may be subject to additional requirements or revisions pursuant to the next issued permit; therefore the schedule presented is subject to change. Refer to the most current approved version of the WQIP Monitoring and Assessment Plan.
[4] Two long-term receiving water stations within the Riverside County in the Watershed Management Area. Additional monitoring location(s) present in San Diego County.
[5] Refer to the Monitoring Annual Reports for the most updated information on Regional Program efforts and associated workplans.

10.1.2 SAR Monitoring Programs

The following monitoring programs are conducted in the SAR to meet the goals of the CMP and requirements of the MS4 Permit. Additional details of the sampling process and design for the SAR monitoring programs are provided in Volume IV of the CMP. Table 10-2 presents the SAR Sampling Schedule for each monitoring program described in this section including wet weather and dry weather monitoring components, number of monitoring events, estimated number of sample locations, sample matrices, and the years of implementation.

The purpose of the SAR Receiving Water Monitoring Program is to characterize the receiving water quality and determine the impacts of urban runoff. The SAR Receiving Water Monitoring Program is comprised of the following four components:

- **Receiving Water Monitoring:** At minimum, two receiving water stations will be monitored during wet weather and dry weather conditions. During two dry weather monitoring events, discrete (grab) samples will be collected at the receiving water stations. During two wet weather monitoring events, flow-weighted composite samples will be collected at receiving water stations. Additionally, samples will be tested for acute and chronic toxicity to meet the requirements of the Water Column Toxicity Monitoring Program.

- **Water Column Toxicity Monitoring:** The purpose of this program is to determine if there may be impacts of urban runoff on toxicity of the receiving waters by testing aquatic species collected from the receiving waters. During two wet weather Events, samples will be analyzed for acute and chronic toxicity. The wet weather monitoring component of the Water Column Toxicity Monitoring Program will be conducted simultaneously with the two receiving water wet weather monitoring events as previously mentioned. During two dry weather monitoring events, receiving water samples will be analyzed for acute and chronic toxicity. According to the SAR Permit, this requirement can be satisfied by participating in regional bioassessment efforts. The follow-up approach is also presented in the SAR Monitoring Plan in Volume IV of the CMP.

- **Bioassessment:** The purpose of the bioassessments is to assess the cumulative impacts of discharges to benthic invertebrates and algae in the receiving waters. Bioassessments are conducted in coordination with the SMC's Regional Bioassessment Monitoring Program. The field effort for the SMC Regional Bioassessment 5-year study (2009-2013) as defined under the 2010 MS4 Permit was completed in 2013. The Final Report is anticipated to be published in 2015. To continue to satisfy the bioassessment requirement of the Permit, the Permittees will continue to participate in and coordinate with the SMC Regional Bioassessment Monitoring effort. Refer to the CMP Volume IV for details of the Bioassessment Program and refer to the Monitoring Annual Report for the most current updates and status of the special studies workplans. Bioassessments will be conducted during the dry weather index period (approximately May-July annually).

- **Hydromodification Monitoring**: The Permit requires hydromodification monitoring at two receiving water sites selected to meet the criteria described in Provision XII.B.5.b. Each hydromodification station will be monitored for at least one event per Permit term. The hydromodification monitoring observations and measurements will be collected within an appropriate domain of analysis. To provide a standardized assessment of the presence and condition of vegetation and habitat integrity, relevant attributes of the California Rapid Assessment Method (CRAM) module for riverine wetland (QAPP Appendix P) will be applied. These included the hydrology, physical structure, and biotic structure attributes of the protocol. These attributes evaluate metrics including channel stability, riverine entrenchment ratio, structural patch richness,

topographic complexity, and plant community composition and structure. CRAM is a protocol developed and calibrated to be used state-wide and is thereby applicable to the wide variety of ecological and climate regimes present in California. When CRAM is conducted, it will be conducted in accordance with State guidelines and quality control standards described within the approved SWAMP SOP's and tools will be used as described on the State Water Boards website[9]. The methods and standards described in the Hydromodification Management Plan Evaluation Program Appendix F/G of the Watershed Action Plan (2017) are based on the hydromodification susceptibility guidance information developed by SCCWRP. It is generally acknowledged that SCCWRP's formulation of regional standards for hydromodification management may serve as a baseline for development of HMPs for specific regions in Southern California. These hydromodification tools can be viewed on SCCRWPs website[10]. In general, the majority of the methods which will be utilized during hydromodification monitoring are borrowed from standardized protocols which are also being applied in the 2015-2019 Stormwater Monitoring Coalition (SMC) Regional Monitoring Program.

- **Follow up Approach and Actions:** Follow-up analysis is based on a combination of compliance and assessment approaches. Under the compliance approach, chemistry results from receiving waters monitoring stations are compared to compliance and Water Quality Standards as described in Section 2.0. Under the assessment (also referred to as Triad) approach, the chemistry, toxicity and bioassessment lines of evidence are weighed as described in the individual Monitoring Plans provided in Volumes II, III and IV. Follow-up actions include, but are not limited to, additional data collection, Toxicity Identification Evaluations (TIEs) and upstream source identification studies.
  - TIEs: When there is evidence of toxicity, TIEs may be utilized in the follow-up approach. The purpose of TIEs is to identify the possible cause of toxicity. TIEs do not require additional samples to be collected. If there is evidence of toxicity in a sample, then a TIE is conducted on the remaining volume of that sample. Once the cause of toxicity has been identified, measures must be implemented to reduce and/or eliminate the pollutant discharge.
  - TREs: Based on TIE results, a TRE component may be conducted to facilitate the implementation of source control measures. TRE work plans will be developed on a case by case basis.

The purpose of the SAR MS4 Outfall and Mass Emissions Monitoring Program (Core Monitoring Program) is to monitor pollutants in stormwater effluent from the MS4 and to conduct special studies to address areas of concern as they may appear.

- **MS4 Outfall / Mass Emission Station Monitoring:** The MRP requires outfall monitoring at seven MS4 outfall stations, historically referred to as "Core" stations and referred to in the MRP as Mass Emissions Stations. During three wet weather monitoring events and two dry weather monitoring events at the seven MS4 outfall stations, grab samples will be collected and analyzed for the constituents presented in the SAR Monitoring Plan, provided in Volume IV of the CMP.

- **IC/ID Monitoring:** IC/ID monitoring will occur as needed as indicated by Core station outfall monitoring results. Monitoring will consist of field observations and collection of field parameter measurements. If additional follow-up is necessary, source identification will be adaptive and will vary based on the field measurement results of each specific outfall and adjacent land uses suspected to contribute to unauthorized discharges in the MS4.

[9] https://www.waterboards.ca.gov/water_issues/programs/swamp/tools.html
[10] http://www.sccwrp.org/ResearchAreas/Stormwater/AssessmentAndManagementOfHydromodification.aspx

The SAR MS4 Permit requires special studies listed in Section 6.1 of this QAPP to be conducted as part of the CMP. Special studies each contain their own separate workplans, QAPPs, and reporting requirements and frequencies. The SAR special studies are briefly described in the SAR Monitoring Plan provided in Volume IV of the CMP. Refer to the Monitoring Annual Report(s) for updates and status of the special studies.

Table 10-2: SAR Sampling Schedule

SAR Sampling Program[a]	Program Component	Matrix	Number of Events Per Year	Estimated Number of Sample Locations	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
Receiving Water Monitoring	Dry Weather Event	Water	2	2		X	X	X	X	X	X
	Wet Weather Event	Water	2	2		X	X	X	X	X	X
	Water Column Toxicity – Wet Weather Event	Water	2[b]	2		X	X	X	X	X	X
	Water Column Toxicity – Dry	Water	2[b]	2	X	X	X	X	X	X	X
	TIEs/TREs	Water	Conditional[c]	Conditional[c]	X	X	X	X	X	X	X
	Bioassessments (Dry Weather)	Water, Algae, BMI, Toxicity	1	5	X[d]	X[d]	X[d]	X[d]	X[d]	X[d]	X[d]
MS4 Outfall Monitoring	Wet Weather Event	Water	3	7	X	X	X	X	X	X	X
	Dry Weather Event		2	7	X	X	X	X	X	X	X
	IC/ID		TBD	TBD	X	X	X	X	X	X	X

[a] When any of the Permits expire, the Co-Permittees will continue implementing the existing, relevant monitoring program requirements until permit renewal.

[b] Per 2010 MS4 Permit (Appendix 3, III.E.2), to the extent that the toxicity testing is developed as part of the Regional Bioassessment Monitoring, the Permittees may satisfy this requirement by participating in the regional bioassessment effort or conducting toxicity testing consistent with the standardized protocols.

[c] Conditional – Follow up actions and TIEs/TREs are dependent on the results from the associated events and will vary.

[d] Per the 2010 MS4 Permit, bioassessments will be conducted in conjunction with the SMC Regional Bioassessment Program (see Section 10.1.2). The study design may vary by monitoring year. Refer to CMP Volume IV, Section 3.5 for additional details of the Bioassessment Program. Refer to the Monitoring Annual Report for the most current updates and status of the special studies.

10.1.3 WWR Monitoring Programs

The following monitoring programs are conducted in the WWR to meet the goals of the CMP and requirements of the WWR MS4 Permit. Additional details of the sampling process and design for the WWR monitoring programs are provided in Volume V of the CMP. Table 10-3 presents the current WWR Sampling Schedule for each monitoring program described in this section including wet weather and dry weather monitoring components, number of monitoring events, estimated number of sample locations, sample matrices and the years of implementation.

Receiving water monitoring is conducted for purposes of evaluating the health of the perennial portion of the CVSC during dry weather and wet weather conditions. During two dry weather monitoring events, discrete (grab) samples will be collected at one monitoring location. Grab samples will be collected at one monitoring location during two wet weather monitoring events.

Dry weather MS4 outfall monitoring be conducted at monitored sites for purposes of proactively seeking to identify IC/IDs; observed incidents are tracked in respective Permittee IC/ID databases, and are reported in the Monitoring Annual Report. Grab samples and field measurements will be collected at two monitoring locations during two wet weather monitoring events. During four quarterly dry weather IC/ID monitoring events, grab samples and field measurements will be collected at two monitoring locations~~,~~. Source investigations will be conducted by the responsible Permittee where there is evidence of irregular flow or water quality concerns based on the dry weather monitoring event results or observations.

Table 10-3: WWR Sampling Schedule

WWR Sampling Program[a]	Program Component[b]	Matrix	Number of Events Per Year	Estimated Number of Sample Locations[b]	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
Receiving Water Monitoring	Dry Weather	Water	2	1	-	X	X	X	X
	Wet Weather Event	Water	2	1	-	X	X	X	X
MS4 Outfall Monitoring	Wet Weather Event	Water	2	2	-	X	X	X	X
	Dry Weather/ Quarterly IC/ID		4	2	-	X	X	X	X

[a] When any of the Permits expire, the Co-Permittees will continue implementing the existing, relevant monitoring program requirements until permit renewal.

[b] Per the monitoring requirements of the 2013 Order, which take effect with the start of the 2014-2015 monitoring year.

10.1.4 Regional Monitoring Program: Applicable to SMR, SAR, and WWR.

The Permittees continually collaborate in regional efforts to tackle issues within Riverside County to those that extend beyond jurisdictional boundaries. The following groups are watershed-specific and, in addition to District staff, the Permittees are represented in the following groups:

- Santa Ana and Santa Margarita Technical Advisory Committees
- Santa Ana/Santa Margarita Management Steering Committee
- Santa Ana Watershed Project Authority (SAWPA)
- Whitewater River Region Desert Task Force
- Lake Elsinore/San Jacinto Watershed Authority (LESJWA)
- Canyon Lake/Lake Elsinore TMDL Task Force
- Stormwater Quality Standards Task Force
- Middle Santa Ana River TMDL Task Force

In general, the Permittees are represented by District staff in the following regional organizations:

- Southern California Stormwater Monitoring Coalition (SMC)
- California Stormwater Quality Association (CASQA)
- American Society of Civil Engineers - Stormwater Committee, San Bernardino/Riverside Counties Branch

10.1.5 Regional Watershed Monitoring Program

The program aims at assessing the regional health of southern California's rivers and streams and is motivated by the State's SWAMP and the Southern California SMC. Permittees of Riverside County's three MS4 Permits are represented on the SMC by the District. The SMC member agencies are:

- Los Angeles Regional Water Quality Control Board
- Santa Ana Regional Water Quality Control Board
- San Diego Regional Water Quality Control Board
- California Department Transportation (CALTRANS)
- City of Long Beach
- City of Los Angeles
- City of San Diego
- County of Orange
- County of San Diego
- San Bernardino County Flood Control District
- Los Angeles County Flood Control District
- Los Angeles County Sanitation District
- Riverside County Flood Control and Water Conservation District (District)
- Southern California Coastal Water Research Project (SCCWRP)
- State Water Resources Control Board (SWRCB)
- Ventura County Watershed Protection District

10.2 Types of Sampling Locations

This section provides a description of the type of sample locations that will be monitored in the different programs. Sample locations are described in each of the watershed-specific Monitoring Plans provided in Volumes III, IV, and V of the CMP. In general, all sites will consider safety and access conditions of each site prior to selection. A comprehensive list including station name, GPS coordinates and a brief description is provided in Appendix C.

Receiving Water Stations:
Receiving water sites are located on the main river systems within each Region. For the SMR, two long term receiving water stations will be sampled in Riverside County within the Upper and Middle SMR subwatersheds of the Watershed Management Area as defined by the Regional Permit. For SAR, the wet weather receiving water stations are located near the southern portion of the Region, but adjacent to a mixture of land uses, including urban areas. The SAR dry weather receiving water stations are located both at the southern of the Region, as well as one located at the northeast border of the Region, providing data for the water quality of the flows entering into Riverside County. For the WWR, one receiving water station is identified in the MS4 Permit.

Reference Station:
Reference Stations are sites that are within a portion of the Watershed similar to the urbanized area but are considered to have minimal influence from urban land uses. Reference Stations will be identified using protocols outlined in "A Qualitative Tool for Assessing the Integrity of Southern California Streams".

Stream Assessment/Bioassessment Stations:
Stream assessments/Bioassessments will be conducted at receiving water and reference stations as outlined in the SMR and SAR Permits. Specific information is contained in the respective Monitoring Plans of this CMP (Volumes III and IV, respectively).

MS4 Outfall Monitoring Locations:
MS4 outfall monitoring locations will be located at the end-of-pipe prior to discharge to receiving waters and as outlined in Volumes III through V. Typically, MS4 sampling locations may include the discharge at the end-of a pipe, a ditch, or a channel. Additional MS4 monitoring locations may be added to ensure that MS4 monitoring locations are representative of urban runoff. According to 40 C.F.R. §122.26(b)(5) the definition of a major outfall is:

> "…a municipal separate storm sewer outfall that discharges from a single pipe with an inside diameter of 36 inches or more or its equivalent (discharge from a single conveyance other than circular pipe which is associated with a drainage area of more than 50 acres); or for municipal separate storm sewers that receive storm water from lands zoned for industrial activity (based on comprehensive zoning plans or the equivalent), an outfall that discharges from a single pipe with an inside diameter of 12 inches or more or from its equivalent (discharge from other than a circular pipe associated with a drainage area of 2 acres or more)."

Outfall stations by program region are described below:

- SMR has 20 hydrologic subareas, seven of which contain MS4 facilities under the jurisdiction of the Riverside County SMR WMA Co-Permittees. During dry weather conditions, each Co-Permittee will field screen at least80% of their major outfalls twice per year, or equivalent due to flexibility in the permit, to determine persistent flowing outfalls. ~~Twice a year 80% of outfalls will be field screened for persistent flow determination in accordance with the Regional Permit.~~ Based

on the dry weather MS4 outfall discharge field screening monitoring records available as of the submittal of the WQIP, each Co-Permittee will identify and prioritize the five MS4 outfalls with persistent flows based on their potential to contribute to the highest priority water quality conditions identified in the WQIP ~~and on the basis of~~. Other criteria for prioritization will be based on site safety and accessibility for conducting non-stormwater persistent flow MS4 outfall discharge monitoring. Modifications to sampling locations and frequencies will be in accordance with the WQIP.

- SAR has seven MS4 outfall stations historically referred to as mass emissions or Core stations, monitoring locations identified in the 2010 MS4 Permit.

- WWR has two outfalls identified in the 2013 MS4 Permit.

10.3 Preparation and Logistics

The following preparation and logistics procedures and guidelines will be incorporated into the implementation of the monitoring programs described above and outlined in Tables 10.1 through 10.3.

Weather Tracking

Weather will be tracked throughout the wet season, typically from October through April, or until all required wet weather monitoring events have been captured. Weather will be continuously monitored by utilizing the resources of the National Weather Service (NWS) as well as local ALERT systems and any other internet resources that could prove beneficial.

Sampling Event Selection Criteria

Sampling for wet weather and dry weather monitoring events will be initiated once criteria specific to each monitoring program has been met, as available in the individual Monitoring Plans located in Volumes III-V, and in accordance with the wet weather mobilization criteria below.

Wet Weather Mobilization Criteria

The definition of Wet Season may differ by Region but, in general, falls between October 1st and May 31st; specific MS4 Permit requirements are discussed in the each respective monitoring plan.

Due to the ephemeral nature of the SMR, SAR, and WWR, the first storm event that falls under the USEPA-recommended criteria may not result in runoff discharges from the MS4s. Based on the District's monitoring experience storm event forecasts of less than 0.5" in 24 hours do not typically result in measureable runoff and often result in false starts.

The representative storm event was derived using average rainfall depths and durations from the USEPA NPDES Storm Water Sampling Guidance Document, Exhibit 2-8, "Rain Zones of the United States"[11]. The derivation is presented in Table 10-4 and summarized below.

- Pursuant to USEPA 833-B-92-001, a representative storm event for the Pacific Southwest is between:
  - 0.27" to 0.81" in depth and
  - within 6 to 18 hours in duration.
- Pursuant to District analysis of local rain gauge data conducted in accordance with USEPA 833-B-92-001, a representative storm event is between:
  - 0.38" to 1.14" in depth and
  - within 6 to 18 hours in duration.

[11] Exhibit 2-8 "Rain Zones of the United States", Pacific Southwest Region. *NPDES Storm Water Sampling Guidance Document*. U.S. EPA Document No. 833-B-92-001.

Table 10-4: Derivation of District Representative Storm

Event Type	Duration (hours)[(a)]	Volume (inches)
Pacific Southwest Average Event	11.6	0.54
50% Average Event	5.8	0.27
150% Average Event	17.4	0.81

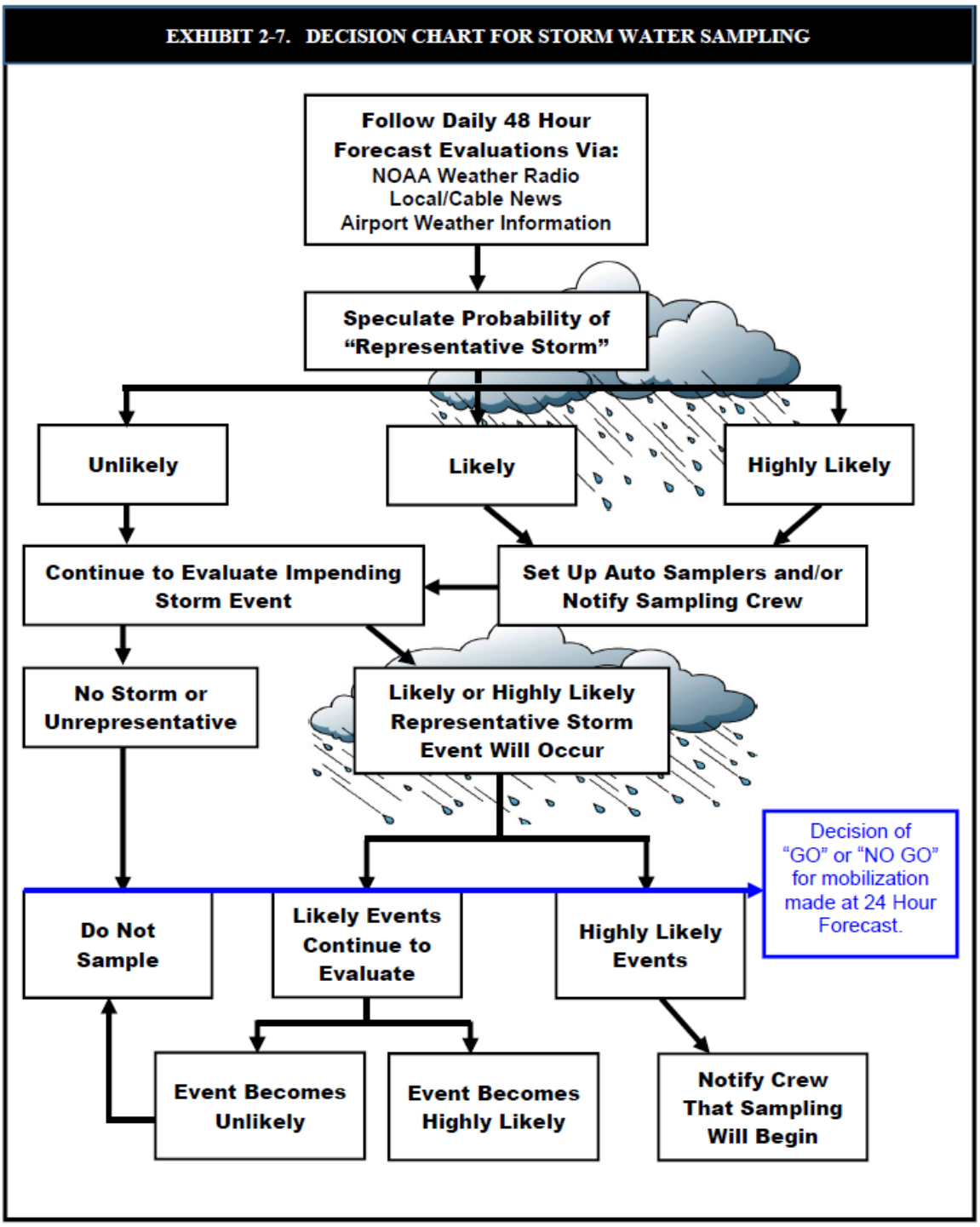
[(a)] In order to simplify the durations above to align with the 6-hour durations issued by the NWS's Qualitative Precipitation Statements, the representative storm for the District's jurisdictional area is 0.27" in 6 hours to 0.81" in 18 hours.

Storm event monitoring will be conducted according to the mobilization criteria below (40 CFR §122.21(g)(7)(ii)):

If a storm event is forecasted by the NWS QPS to be greater than 0.1" within the next 48 hours and there is at least 72 hours between the forecasted event and a previous measurable (>0.1") rainfall event:

- Then District will follow the procedure outlined in Exhibit 2-7 of USEPA NPDES Storm Water Guidance Document (EPA 833-B-92-001), included below as Figure 10-1. This decision chart references the speculation of Representative Storm size.
- Pursuant to NWS standard practice, the term "Likely" in Exhibit 2.7, represents a Probability of Precipitation (PoP) of at least 60%.
- Mobilization will occur when the NWS QPS forecast shows likely rainfall of 0.3" in 6 hours AND/OR 0.5" in 24 hours. This gives the District the greatest chance to sample a representative storm event.
- For mobilization to occur, criteria must be met 24 hours in advance of sampling for coordination with property owners, consultants, and sampling personnel.

Figure 10-1: USEPA Decision Chart for Storm Event Sampling



Staffing

A staffing plan will be prepared prior to each sampling event that designates sampling teams, monitoring locations for each team, field coordinators, and sample coordinators. Monitoring will be performed by teams of at least two field personnel. When necessary, a runner will be utilized to deliver grab samples to the laboratory to ensure that short holding times for constituents are met. Field crews will not be mobilized during or near certain holidays if the mobilization or laboratory analysis should continue through that holiday. This includes the following holidays:

- Presidents Day
- Memorial Day
- Independence Day
- Labor Day
- Thanksgiving and the day after Thanksgiving
- Christmas Eve and Christmas Day
- New Year's Eve and New Year's Day

As microbiology samples require four days of reading, any sampling scheduled within three days prior to a holiday may also cause difficulty and will try to be avoided.

Station Preparation

When mobilization criterion has been met and sampling is to occur, field personnel will perform the following pre-sampling duties to ensure stations are operational:

- Flow monitoring equipment onsite and running (if utilized)
- Automated samplers onsite and running (if utilized)
- Flow or time pacing set (if automated samplers are utilized)
- Sampler trigger set (if automated samplers are utilized)
- Iced bottles/coolers with ice onsite
- Bottle sets assembled
- Field meter calibrated (if *in-situ* field measurements are required)

11. SAMPLING METHODS

This section describes the types of field collection methods and procedures to implement the various monitoring programs described in Tables 10.1 through 10.3. Additional details of the sampling methodology used for each monitoring program are discussed in the SMR, SAR, and WWR Monitoring Plans, provided as Volumes III, IV and V of the CMP, respectively.

Field Observations and Documentation:

Field observations and measurements will be recorded electronically via the Survey 123 application or on a paper field data sheet. Appendix B to this QAPP contains an example of the paper form as well as a guide sheet for using the application. Field observations will be recorded during each monitoring activity in order to put chemical results into context with site conditions at the time of sampling. Field data sheets will be used to record general observations such as weather, debris/trash observed, color and clarity of the water, odor and any other conditions of interest. Whenever possible, any data being recorded will be verified, such as stage, flow meter status and sampler status. Field data sheets will also be used to document any equipment failure that may occur during sampling activities.

The following general information should be entered during each site visit:

- Station ID
- Date and Time
- Monitoring Project Name
- Field Team
- Conveyance Type
- Weather Conditions
- Runoff characteristics
- Flow estimations
- Field measurements
- Equipment condition/calibration (if applicable)
- Equipment failures (if applicable)
- Miscellaneous comments

During wet weather monitoring, additional data will be recorded on the field data sheet at the end of a wet weather monitored event. Data will be logged by a flow meter (if utilized) and will be downloaded after the storm; however, if downloaded data is lost for any reason, the data recorded on the field datasheet acts as a back-up. The following data will be collected at all stations when automatic sampling technologies are utilized:

Total Flow Volume (liters) – Total volume of water that passed the station during the storm
Composite Sample Aliquot Count – Total aliquots attempted, the number of aliquots missed, and the total number of successful aliquots
Total Rain (inches) – Total accumulated rainfall in centimeters since the start of the storm, measured each time the rain bucket tips
Sample Volume (liters) – Total volume of sample collected during the storm

During dry weather monitoring events, monitoring locations may be dry and, therefore, no samples will be collected. If this occurs, a field data sheet will be completed noting the site conditions and characteristics and that no samples were collected and categorized as Visited, Not Sampled. Photographs will also be taken to document the dry conditions. During wet weather, similar documentation procedures will be followed categorizing the effort as a 'false start' if a monitoring location is observed to be dry or the precipitation forecasted did not produce flow sufficient to collect required sample volumes.

***In-situ* Field Measurements:**

In-situ field measurements will vary by program and Region but may include the following list of constituents:

- Conductivity (Specific Conductance, Electronic Conductivity)
- Turbidity
- Dissolved Oxygen (DO)
- Water Temperature
- pH
- Salinity (optional; may be useful for certain types of wastes)
- Oxidation-Reduction Potential (optional; useful if sewage is suspected)
- Chlorine

Field measurements for the constituents listed above are the preferred method under the CMP. *In-situ* field measurements will be collected during composite sample collection (i.e., collected between the first and last composite sample aliquot) or during grab sampling activities, if composite samples are not required. Field measurement values and collection times will be recorded on the field data sheet.

In-situ water quality measurements will be made in the field by placing the probe(s) directly in the water column. A secondary container may be used if the water depth does not allow the probe to be completely

submerged. Probes should be exposed to flow in a representative portion of the stream or discharge. If there is no flow (i.e., ponded) or a secondary container is required to make measurements, the probe should be gently agitated, stir bar feature turned on (if present), particularly when making DO measurements using polarographic (Clark Cell) probes.

If meters fail in the field, the field team will utilize a back-up meter if available or field crews will instruct the laboratory to analyze for the required constituents that were not collected in the field. Modifications will be recorded on the field data sheet and COC accordingly. Additional volume for laboratory analyses of field measurements are accounted for in bottle lists, available in Volumes III through V, requiring no additional sample collection by field crews in the case of a meter failure. All trouble shooting and corrective actions will be recorded in the calibration log and/or field datasheet.

Composite Sampling:

Flow-weighted composite - A composite sample is a series of aliquots collected over the course of a wet weather monitoring event that is weighted by the flow rate. To collect a flow-weighted composite sample an automated sampler is utilized in conjunction with a flow meter to obtain a representative sample. Sample aliquots will be collected according to a sample pacing and programmed during pre-storm preparation. The sample pacing is determined by estimating the volume of runoff from the predicted amount of rainfall, the drainage area and the runoff coefficient. The sample pacing is determined by dividing the total runoff volume by the number of samples needed to satisfy the water volume requirement for analysis. The following equation is used to determine sample pacing:

$$\text{Sample Pacing} = \frac{P \times A \times C}{\text{Number of Aliquots}}$$

Where:
P = inches of rainfall anticipated
A = drainage area
C = runoff coefficient for drainage area

Each field team should be aware of the current status of each of its stations to determine which one will fill a bottle first so they can be onsite before the bottle fills. If the station has been programmed for the accurate amount of rainfall, changing the composite bottle should not be necessary. Pacing settings should take into account the volume of sample required to meet all analytical needs. If pacing changes are required, the bottle must be changed at the time of changing the pacing. The pacing value associated with each bottle must be reported to the analytical laboratory to allow proper sample compositing.

Time-weighted composite - During dry weather sampling, time-weighted composite samples may be collected using automated samplers. To collect a time-weighted composite sample, the sampler will be programmed to collect aliquots at discrete intervals over a specified time period, which varies by dry weather program. If a time-weighted composite is collected over a 24-hour period, aliquots will be collected at the program-specific time interval for the 24-hour monitoring period monitored using automated sampling equipment. When a time-weighted composite is collected over a 1-hour period, a minimum of four aliquots will be collected manually at 15-minute intervals. If the flow conditions of the discharge or stream allow for increased intervals, then the total number of aliquots and time intervals will be recorded on the field datasheet.

Field duplicates will typically not be collected on 24-hour composite samples as this would require a complete and separate second sampling system; however, to facilitate the random selection of stations for QA/QC sampling it may be collected as a full composite duplicate or a composite split for the SMR Monitoring Program in a given monitoring year. Field duplicates may be collected on one-hour composite samples depending on the volume and expected duration of the discharge.

In the event that the automatic samplers fail in the field the following procedures will be implemented to address sampling concerns during a dry weather composite sampling event:

- When scheduled concurrently with stream assessment/bioassessment activities, when possible a grab sample will be collected within the 24-hour window (i.e. prior to the collection of the last aliquot) to ensure that an adequate sample volume is available for required analysis. The collected composite sample will first be analyzed for priority chemistry constituents. The remaining composite sample along with the additional grab sample will be applied as the volume available for other required analysis (e.g. toxicity).
- When the monitoring activities are not scheduled concurrently with stream assessment/ bioassessment activities, the Lead Sampler will determine if the event will be rescheduled, or if the equipment will be promptly reset/replaced in preparation of a second attempt of the 24-hour composite sampling event.

In the event that flows intermittently stop during a dry weather composite sampling event, where flows were assumed to be constant, the Lead Sampler will determine if insufficient volume has been collected for the event based on observations of the site conditions. One of the following procedures will be implemented to address sampling concerns:

- The equipment will be promptly reset or replaced in preparation of a second attempt of the 24-hour composite sampling event (location subject to change). *If applicable to the event, stream assessment/bioassessment activities should be called-off and rescheduled accordingly.*

OR

- When possible, a grab sample will be collected within the 24-hour window (i.e. prior to the collection of the last aliquot) to ensure that an adequate sample volume is available for required analysis. The collected composite sample will first be analyzed for priority chemistry constituents. The remaining composite sample along with the additional grab sample will be applied as the volume available for other required analysis (e.g. toxicity). *If applicable to the event, stream assessment/bioassessment activities will remain on schedule.*

Grab Sampling:

Storm drains will be inspected prior to grab sample collection, and debris will be removed as safe conditions allow. Grab water samples will be collected by inserting the sample container under or down current of the discharge, with the container opening facing upstream. Less accessible sampling points may require the use of grab poles and buckets to collect grab samples. If samples cannot be safely collected directly or with a grab pole samples may be collected with a peristaltic pump using Teflon® and silicone tubing. Grab water samples will be collected as close as possible from the horizontal and vertical center of the channel as safe conditions allow. The following sample handling protocols will be followed when collecting samples to minimize the possibility of contamination:

- Previously unused (new) sample bottles will be employed. Sample bottles and bottle caps will be protected from contact with solvents, dust or other contaminants during storage and bottle handing. Sample bottles will not be reused until the laboratory has cleaned and blanked the containers.
- Field personnel will make an effort, within reason, to prevent large gravel and uncharacteristic floating debris from entering the sample containers. Personnel will also make an effort to not disturb sediments that may be at the bottom of the channel.

- The inside of the sampling container will not be touched to the maximum extent practicable during preparation and sampling activities.
- Vehicle engines will be turned off during sampling activities to minimize exposure of samples to exhaust fumes.
- All samples will be collected in accordance with the "clean sampling" techniques outlined in Appendix D.
- Manual water grab samples will be collected by inserting the transfer container under or down current of the direction of flow, with the container opening facing upstream. For microbiology water grab samples, containers will contain sodium thiosulfate ($Na_2S_2O_3$) to neutralize the impact of chlorine that may be in the stormwater at the immediate time of collection.
- Sample containers with liquid preservatives such as nitric acid will not be overfilled to avoid flushing out the required preservative.
- Once sample containers are filled, they will be promptly placed on bagged ice, in a clean cooler (target temperature 6 degrees Celsius), in the dark and transported to the laboratory for processing to meet holding times.

Benthic Macroinvertebrate Collection:

Benthic Macroinvertebrate (BMI) samples will be collected according to the SWAMP Bioassessment SOP for the Reachwide Benthos Procedure provided in Appendix F/G. The first step in implementing a stream assessment is to delineate the monitoring reach and the 11 main transects through the following steps; a summary of this process is provided below:

SWAMP's standard BMI (and algae) sampling layout consists of a 150-meter reach or a 250-meter reach, depending upon the average wetted width of the channel. If the average wetted width is less than or equal to 10 meters, use 150 meters for the monitoring reach length. If the average wetted width is greater than 10 meters, use a 250 meter long reach. Features that should not be present within a monitoring reach are: tributaries, "end-of-pipe" outfalls, bridge crossings, changes between natural and man-made channel bottoms, waterfalls, and impoundments (dams and weirs). Try to stay out of the channel as much as possible to avoid disturbing the stream bottom, which could compromise the samples and data that will be collected. Always work starting from the downstream end of the reach, moving upstream.

The monitoring reach will be divided into 11 equidistant main transects that will be arranged perpendicularly to the direction of flow. Main transects are designated "A" through "K". There will also be 10 additional transects (designated "inter-transects"), one between each pair of adjacent main transects, to give a total of 21 transects per monitoring reach. Inter-transects are designated by their nearest upstream and downstream main transects ("AB", "BC", etc.).

The Reachwide Benthos Procedure method can be used to sample any wadeable stream reach. The sampling approach used may vary by individual channel characteristics. For the Reachwide Benthos Procedure method, the BMI sub-sampling positions alternate between left, center, and right portions of the transects, as field personnel proceed upstream from one transect to the next. In high-gradient systems, sampling locations are defined as the points at 25% ("left"), 50% ("center") and 75% ("right") of the wetted width of the stream. Low-gradient streams, characterized as having a slope of 1% or less, comprise the majority of the District's streams monitored under the CMP. In low gradient streams, the Reachwide Benthos Procedure "margin-center-margin" method is utilized where channel substrates are nearly uniform, resulting in low diversity within the majority of the channel.

Algae Sample Collection:

Algae samples, when collected in conjunction with SWAMP bioassessments, must be collected prior to Physical Habitat Assessment data collection to avoid disturbance of the algae. Algae samples will be collected at the 11 main transects utilized in the Physical Habitat Assessment. After collection, the 11 sub-samples will be composited into a single sample per site (sampling reach). Algae sample collection may be used for the following types of data collection, each with specific sub-sampling procedures: collection of samples for taxonomic identification of diatoms and soft-bodied algae; collection of samples for determination of biomass based on chlorophyll *a* and ash-free dry mass; and estimation of percent algal cover. Detailed sampling methods are provided in the SWAMP Algae Field SOP located in Appendix F/G.

Physical Habitat Assessment:

Physical Habitat Assessment is designed to assess the physical habitat conditions of the stream reach to aid interpretation of the chemical, BMI and algae data and will be implemented according to the full suite Physical Habitat Assessment as described in the SWAMP Bioassessment SOP (Appendix F/G). Once all BMI and algae samples have been collected at a given transect, Physical Habitat Assessment data collection may begin according to the full Physical Habitat Assessment protocol described in Appendix F/G.

The Physical Habitat Assessment data to be collected includes the following:

- Wetted width
- Bankfull width
- Bankfull height
- Pebble count: Transect substrates
- Depth
- Particle size class
- Coarse particulate organic Matter
- Algal cover
- Macrophytes
- Dry substrates
- Bank stability
- Human influence
- Densitometer readings (canopy cover)

Sediment Sampling:

Sediment toxicity samples will be collected as a composite along a cross-section of the creek. A surface sample will be collected using a pre-cleaned stainless steel spoon from the top two inches of sediment at locations approximately 25%, 50%, and 75% across the channel. Sediment samples will be collected after the collection of water samples. Samplers should avoid disturbing and cross contamination of surface sediments.

Rainfall:

During wet weather monitoring at stations requiring flow-weighted composites and extended flow monitoring, a tipping bucket rain gauge may be used in conjunction with automated sampling and flow monitoring equipment. A tipping bucket rain gauge is configured with a small "bucket" that holds a known amount of rainfall. When the bucket fills, it tips the water out, momentarily closes a switch, then resets itself and starts the process again. The data logger/controller counts each switch closure to calculate rainfall totals. The rain gauges used for this program tip after every 0.01 inch of rain.

Flow Measurements:

Flow measurements will be recorded in cubic feet per second. Stations that are observed to be dry or ponded will be recorded as 0 cfs, and the event will be documented as Visited Not Sampled. In the case that there is a presence of trickle flow (i.e., low flow that cannot be directly measured) the observation of flow will be entered with field data, and a visual estimated rate of <0.001 cfs will be will be recorded.

Extended flow monitoring: Stations that require extended flow monitoring will require a temporary installation of flow monitoring equipment and paired automated sampling equipment. Flow rates will be monitored using a flow meter with an ultrasonic sensor. A submerged bubbler may also be installed as a measuring device. The sensor will continuously measure stage (stream height) and relay that information to the flow meter. The flow meter will continuously calculate flow rates by inserting the stage information into the preprogrammed discharge equation or by utilizing velocity measured by the ultrasonic sensor. Using this system, the flow meter will be able to actuate the automated sampler to achieve a flow-weighted composite sample. Sampling and flow equipment will be monitored manually.

The flow meters will measure and log flow levels, rainfall and sample history. One-minute average flow and rainfall data will be recorded in the flow meters. The flow meters convert instantaneous flow into total runoff volume. Data containing storm and hydrological information is electronically stored in the flow meter, with each monitoring event stored separately. The recorded information includes:

- Flow rates
- Time of peak flow rate
- Cumulative rainfall
- Rainfall intensity
- Discharge volume totals
- Time of each sample
- Success or failure of each sample

Instantaneous flow measurements: Programs that do not require extended flow measurements will take instantaneous flow measurements at the time of sampling. Flow will be estimated using one of the following methods:

Area-Velocity Method

This method is useful when low flows are present. This method requires the physical measurement of the depth (D), and width (W) of flowing water. Estimate the velocity (V) and calculate discharge based on the following equation:

Equation 1: Discharge (ft^3/sec) = Velocity (ft/sec) x Depth (ft) x Width (ft)

Partially-Filled Pipe Method

This method is useful when substantial flow is coming through a pipe or out of an outfall. Measure the water depth and inside pipe diameter and apply the following formula using the partially filled pipe formula chart in Table 10-4.

D = water depth.
d = *inside* pipe diameter.
Calculate D/d.
Find the tabulated (Ta) value on the partially filled pipe formula chart below using the D/d value (i.e., if D/d = 0.263 then Ta =0.1623).
Find the area using the formula: $a = Ta*d^2$.
Multiply area (a) by the water velocity.
Convert to desired value.

Table 10-5: Partially Filled Pipe Tabulated Value (Ta) Chart

Tabulated Value (Ta) as Determined by the Tenths and Hundredths of the Quotient of D/d										
D = Depth of water d = diameter of the pipe Ta = Tabulated Value (i.e. if D/d = 0.263 then Ta = 0.1623)										
D/d	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0013	0.0037	0.0069	0.0105	0.0147	0.0192	0.0242	0.0294	0.0350
0.1	0.0409	0.0470	0.0534	0.0600	0.0668	0.0739	0.0817	0.0885	0.0951	0.1039
0.2	0.1118	0.1199	0.1281	0.1365	0.1440	0.1535	0.1623	0.1711	0.1800	0.1890
0.3	0.1982	0.2074	0.2187	0.2280	0.2355	0.2450	0.2540	0.2642	0.2780	0.2836
0.4	0.2934	0.3032	0.3130	0.3220	0.3328	0.3428	0.3527	0.3627	0.3727	0.3827
0.5	0.3980	0.4030	0.4130	0.4230	0.4330	0.4430	0.4520	0.4620	0.4720	0.4820
0.6	0.4920	0.5020	0.5120	0.5210	0.5310	0.5400	0.5500	0.5590	0.5690	0.5780
0.7	0.5870	0.5960	0.6050	0.6140	0.6230	0.6320	0.6400	0.6490	0.6570	0.6660
0.8	0.6740	0.6810	0.6890	0.6970	0.7040	0.7120	0.7190	0.7250	0.7320	0.7360
0.9	0.7450	0.7500	0.7560	0.7610	0.7660	0.7710	0.7750	0.7790	0.7820	0.7840

Timed Object Method

Drop a floatable object such as a leaf or twig in the water, time (T) how long it takes to move a measured distance (D). Estimate or measure the channel cross-sectional area, then calculate the volumetric flow rate using the following equation:

$$Q = \frac{A*D}{T}$$

United States Geological Survey (USGS) Flow Gauge – Flow may be determined by using an available USGS flow gauge within close proximity of the sample location.

Field Corrective Actions:

Any failures (e.g., instrument failures) that occur during data collection will be the responsibility of the field crew conducting the work. Crews will carry basic spare parts and consumables with them to the field, and will have access to spare parts to be stored at their respective agency. In the case of field instruments, problems will be addressed through instrument cleaning, repair or replacement of parts or the entire instrument, as warranted. If meters fail in the field, field crews will instruct the laboratory to analyze for required constituents that were not collected in the field and will record this modification on the field data sheet, and notify the Program Manager immediately. All trouble shooting and corrective actions will be recorded in the calibration log and/or field datasheet. Records of all repairs or replacements of field instruments will be maintained at the offices of field sampling personnel.

Field QA/QC Sampling:

In addition to the sampling activities summarized in tables 11-1, 11-2, and 11-3, QA/QC samples will be collected on a program-wide basis during each monitoring year in accordance with the SWAMP required frequencies. Refer to Section 14.1 for detailed description of QA/QC sampling.

Table 11-1: SMR Sampling Programs and Sampling Methods

A detailed description of sampling locations and program requirements will be provided in the WQIP Monitoring and Assessment Plan.

Sampling Program (Monitoring Locations)	Program Component	Matrix	Analytical Categories	# of Samples	Type of Sampling
Receiving Water Station(s)[a] (2)	Dry Weather	Water	Field Parameters, Chemistry, Microbiology, Toxicity	3	Time-weighted[b] or Flow-weighted[b] Composite and Grab
	Bioassessment[,b]	Water, Algae, BMI	Field Parameters, Chemistry, Microbiology, Toxicity	1	Time-weighted[b] or Flow-weighted[b] Composite and Grab
	Wet Weather Event	Water	Field Parameters, Chemistry, Microbiology, Toxicity	3	Time-weighted[b] or Flow-weighted[b] Composite and Grab
	Hydromodification	N/A	Channel dimensions, Hydrologic and geomorphic conditions, Presence and condition of vegetation and habitat	1	N/A
	Follow up Approach and Actions	Water	No additional analyses are required. Field Parameters, Chemistry and Toxicity, may be collected as part of source investigation.	Conditional[c]	Grabs
MS4 Outfall Stations	Dry Weather Field Screening	N/A	Flow condition	80%[a],[d]	N/A
	Dry Weather Event	Water	Field Parameters, Chemistry, Microbiology	25[e]	Grabs (or Time-weighted[b] / Flow-weighted[b] Composite)
	Wet Weather Event	Water	Field Parameters, Chemistry, Microbiology	5[f]	Time-weighted or Flow-weighted[b] Composite and Grab

N/A – Not Applicable
(a) Refer to WQIP Monitoring and Assessment Plan for program details and frequencies.
(b) Composite technique selected as appropriate for site and event conditions.
(c) Follow up actions and source investigations are dependent on the results from the associated events and will vary each year.
(d) In general, at least 80% of the major outfall inventory is visually screened twice per year, or an equivalent effort in accordance with the WQIP.
(e) Minimum of five dry weather outfall stations per jurisdiction. Selected from initial screening and prioritization of persistent outfalls pursuant to the Regional Permit.
(f) Minimum of one wet weather outfall station per jurisdiction. Selected per representative land use criteria pursuant to the Regional Permit.

Table 11-2: SAR Sampling Programs and Sampling Methods

A description of sampling locations is provided in the Monitoring Plan, Volume IV.

Sampling Program (Monitoring Stations)	Program Component	Matrix	Analytical Categories	# of Samples	Type of Sampling
Receiving Water (2)	Dry Weather	Water	Field Parameters, Chemistry, Microbiology, Toxicity[a]	4	Grab
	Bioassessment[b]	Water, Algae, BMI	Field Parameters, Chemistry, Microbiology, Toxicity[a]	4	Grab
	Wet Weather Event	Water	Field Parameters, Chemistry, Microbiology, Toxicity[a]	4	Flow-weighted Composite and Grab
	Water Column Toxicity – Wet Weather Event	Water	Acute and Chronic Toxicity	4[a]	Grab
	Water Column Toxicity – Dry Weather	Water	Acute and Chronic Toxicity	4[a]	Grab
	Follow up Approach and Actions	Water	No additional analyses are required. Field Parameters, Chemistry and Toxicity, may be collected as part of source investigation.	Conditional[c]	Grabs, if necessary
MS4 Outfall Monitoring (7)	Non-stormwater Dry Weather	Water	Field Parameters, Chemistry, Microbiology	14	Grab
	Source ID Monitoring		Conditional[c]	Conditional[c]	Grab
	Wet Weather Event		Field Parameters, Chemistry, Microbiology	21	Grab
	Source ID Monitoring		Conditional[c]	Conditional[c]	Grab

(a) Per 2010 MS4 Permit (Appendix 3, III.E.2), the Permittees may satisfy this requirement by participating in the SMC's Regional Monitoring effort or conducting toxicity testing consistent with standardized protocols.
(b) The Regional Bioassessment Monitoring Program, as coordinated with SMC, typically includes four sample locations unlike the rest of the Receiving Waters Monitoring Program, which has two dry weather sample locations. Refer to Section 10.1.2 herein for a summary of the bioassessment monitoring effort. Refer to CMP Volume IV, Section 3.5 for program details.
(c) Conditional – Follow-up actions and source investigations are dependent on the results from the associated events and will vary each year.

Table 11-3: WWR Sampling Programs and Sampling Methods

A description of sampling locations is provided in the Monitoring Plan, Volume IV.

Sampling Program (Monitoring Stations)[a]	**Program Component**	**Matrix**	**Analytical Categories**	**# of Samples**	**Type of Sampling**
Receiving Water (1)	Dry Weather	Non-Stormwater	Field Parameters, Chemistry, Microbiology	2	Grab[b] or composite
	Wet Weather Event	Stormwater	Field Parameters, Chemistry, Microbiology	1	Grab[b] or composite
MS4 Monitoring (2)	Wet Weather Event	Stormwater	Field Parameters, Chemistry, Microbiology	4	Grab[b] or composite
	Quarterly Dry Weather IC/ID Monitoring	Non-Stormwater	Field Parameters, Chemistry, Microbiology Conditional[b]	8, Conditional[a]	Grab[b] or composite

(a) Conditional – Additional constituent analysis, follow up actions, and source investigations are dependent on the results from the associated monitoring events and may vary each event.

(b) Note that currently and historically the samples have been collected via grab under this program.

12. SAMPLE HANDLING AND CUSTODY

This section describes the general samples handling and custody procedures used by all field and laboratory personnel.

12.1 Sample Handling Protocols

The laboratory will provide appropriate sample containers for the samples. At the time of sample collection, the sample labels will be completed in the field with the date and time. The Sample IDs will also be entered directly onto the Field Data Sheets (FDS), or into the Survey 123 field data electronic application, and the COC Forms. The COCs will be pre-printed along with the bottle labels when feasible. The COCs will be completed in the field with dates, times and sample team names, and will be cross-checked with the bottles to make sure proper samples have been collected. The COC form for this project is attached in Appendix A.

All samples bottles will be labeled with the following information:

Required	Recommended (in addition)
Sample ID (unique)	Project name
Site ID	Monitoring program
Sample date	Bottle size and type
Sample time	Bottle __ of __
Sampler's initials	Preservative
Grab or Composite	Field tests/remarks/analysis*
Client	

* Analysis may be listed on the bottle or "see attached list" may be referenced on the bottle when a separate list is provided to the laboratory prior to the monitoring event.

The following sample handling protocols will be followed when collecting samples to minimize the possibility of contamination:

- Composite sampling requires multiple automated aliquots to be transferred into a composite bottle. After the aliquots are collected, the bottle will be tightly capped.

- Once sample containers are filled, they will be promptly placed on bagged ice, (target temperature = 6ºC) and transported to the laboratory for processing to meet holding times. All necessary pre-processing for analysis, such as filtration and acidification, will take place in the laboratory by certified personnel.

- After the field crew collects and delivers the samples to the laboratory, the laboratory will conduct the analysis within the holding times. These field and laboratory activities will be coordinated to make sure all samples are handled within the proper holding times and analyses are completed within holding times. With composite samples, the start of holding times is considered to be the time that the last aliquot was collected.

- After the laboratory receives the water samples, the certified laboratory technicians will dispense the sample contents into containers that contain the required volume, as specified in individual monitoring programs, available in Volumes III through V. The laboratory will preserve the water

samples using the appropriate preservatives and the laboratory will conduct the analysis within the maximum holding time limits. When applicable, the sample handling and custody procedures described are in compliance with SWAMP SOP, as defined in Appendix E "Collection of Water and Bed Sediment Samples with Associated Field Measurements and Physical Habitat in California", as well as the U.S. Geological Survey's recommendations for clean sampling techniques described in Appendix D.

12.2 Sample ID Format

Sample IDs for the monitoring programs under this CMP will follow the same general format to reduce field and laboratory errors and improve data management. The sample IDs will have the same general format that includes the sampling year, event code, last three or four digits of the station ID number, and a two digit sample code. Below are details of the segments of the sample IDs followed by some examples of proper Sample ID labeling:

General Sample ID Format:
[Sample Year] – [Event Code] – [Station Code] – [Sample Code]

Format Detail:

- **Sample Year** – The sample year is the fiscal year in which sampling is taking place. For example, if a sample is collected in October of 2010, that falls within the fiscal year of 2010-2011, therefore the Sample Year for that Sample ID is '1011'.
- **Event Code** – The event code designates if the sample is a wet weather or dry weather monitoring event sample by a 'W' or 'D', respectively. The sequential event number for that season follows the letter. For example, W1 would be the first wet weather event for a given sample year and D2 would be the second dry weather monitoring event for a given sample year.
- **Station Code** – The last three digits of the Station ID as assigned by the District. For example, Temecula Creek Station ID 902LTC777 is contained in the Sample ID as '777' and Warm Springs Channel Station ID 902WMS397 is contained in the Sample ID as '397'.
- **Sample Code** – The sample code designates if the sample is a primary sample, a field duplicate sample, or a field blank sample. The codes are as follows:
  - 01 – Primary Sample
  - 02 – Field Duplicate
  - 03 – Field Blank
  - 04 – Travel (Trip) Blank

General Sample ID Examples:

Ex. 1 SMR Dry Weather Receiving Water
Sample ID: 1718-D1-828-01
(2017-2018 year, 1st Dry Weather monitoring event, Middle Santa Margarita Site 902USM828, Primary Sample)

Ex. 2 SAR Wet Weather QA/QC
Sample ID: 1011-W1-040-03
(2010-2011 year, 1st Wet Weather monitoring event, Corona Storm Drain Site 801CRN040, Field Blank)

Ex. 3 SMR Wet Weather Outfall

Sample ID: 1718-W1-4034-01
(2017-2018 year, 1st Wet Weather monitoring event, Outlet to Warm Springs Creek d/s of Murrieta Hot Springs Rd Site 902MS44034. Primary Sample)

Investigation Sample ID Format:

- **Investigation Station Code** – If samples are collected in response to an IC/ID or as part of a Source Identification Study the following Sample ID convention will be used:

  [Sample Year] – [Event Type = I][Location Identifier = XXX]a-e – [Region Code] – [Sample Code]

  - **Sample Year** – The sample year is the fiscal year in which sampling is taking place, as noted under the general format details above.
  - **Event Type** – The event type designates if the sample is an Investigation (I), either associated with IC/ID response or a Source Investigation effort in support of other compliance activities.
  - **Location Identifier** (random) – The field investigator shall randomly assign a 3-digit alpha-numeric identifier for the location associated with the special investigation (see example below). Furthermore, when samples are collected in response to an IC/ID or as part of a Source Identification Study, samples will be collected on an as-needed basis moving upstream from the original monitoring location. Given that the number of samples for a source identification study is unknown, alpha-numeric sampling code will be followed by an ascending digit to indicate the sample number moving upstream from the original monitoring point. The ascending digits will be denoted by **a, b, c**, etc. within the Sample ID format as shown above. The field investigator must document the corresponding latitude and longitude for each sequential investigation location (i.e., a, b, c, etc.) as appropriate.
  - **Region Code** – The Region Code represents the watershed in which the investigation is being conducted, where '809' is for SAR, '823' is for WWR, '825' is for SMR.
  - **Sample Code** – The sample code designates if the sample is a primary sample, a field duplicate sample, or a field blank sample as defined under the general format details above.

Investigation Sample ID Examples:

Ex. 1 IC/ID Response to Spill
Sample ID: 1718-IDYCa-809-01
(2017-2018 year, Investigation event, Day Creek Channel at 'a' point, SAR, Primary Sample)
Sample ID: 1718-IDYCb-809-01
(2017-2018 year, Investigation event, u/s Day Creek Channel at 'b' point, SAR, Primary Sample)

12.3 Chain-of-Custody Procedures

COCs will be pre-printed along with the bottle labels when feasible. The COCs will contain the same data as the labels, including the name of the laboratory the samples are being submitted to, and, in some cases as needed, even greater detail. The COCs will be completed in the field with dates, times and sample team names, and will be cross-checked with the bottles to make sure proper samples have been collected. The COC form being used for projects under this CMP is attached in Appendix A.

The COC forms for the samples will be transported with the samples to the analytical laboratory. Sampled water will be kept properly chilled and transferred to an analytical laboratory within holding times. When

custody of the samples is transferred to the laboratory courier, the COC will be signed and dated, and a Xerox or *.pdf copy will be sent from the laboratory to the District and/or other monitoring personnel. The COCs will be reviewed by personnel at the receiving laboratories to ensure that no samples have been lost in transport. The laboratories will also verify that each sample has been received and analyzed within holding times.

13. ANALYTICAL METHODS

The majority of constituents for this project will be analyzed using USEPA-required, State Board-required, and/or SWAMP-required methods and RLs. If laboratory-suggested reporting limits are more stringent than those recommended by SWAMP, laboratory-suggested reporting limits ~~will be applied~~ may be applied with approval from the District. Due to various factors or required sample dilutions, the laboratory may not be able to meet some measurement quality objectives. Data points that do not meet MQOs will be properly qualified in final analytical reports. The data flag will explain why the MQO was not met, and the contracted laboratory will document the QA/QC indicators that demonstrate the analytical method are within control limits. If the results of an accepted method fail, proposed method revisions will be brought to the attention of the District, reviewed by the District, and approved on a case-by-case basis. Table 6-2 summarizes required information regarding analytical methods. For details regarding the QA measure or performance criteria for each analytical method, refer to Sections 7 and 14. The MS4 Permit-specific monitoring plans provided in Volumes III, IV and V contain constituent lists, holding time criteria, and WQOs tailored to each MS4 Permit and monitoring program requirements.

13.1 Laboratory Analysis

The appropriate preservation and preparation methods will be conducted for each parameter. All samples will be analyzed for the listed constituents within their respective hold times. Analyses methods are consistent with those described in the Standard Methods for the Examination of Water and Wastewater (APHA *et al*, 2005) and USEPA Standard Methods. The list of constituents, measurement techniques and RLs are presented in Table 6-2.

13.2 Sample Disposal Procedures

After analysis, including QA/QC procedures, any excess sample will be disposed of by the analytical laboratories.

13.3 Corrective Action Procedures

Corrective action is taken when an analysis is deemed suspect for some reason. The reasons include exceedances of the Relative Percent Difference ranges, recoveries and blanks. The corrective action varies somewhat from analysis to analysis, but the procedure typically involves the following:

- A check of procedures;
- A review of documents and calculations to identify possible errors;
- Correction of errors;
- A re-analysis of the sample extract, if sufficient volume is available, to determine if results can be improved; and
- A complete reprocessing and re-analysis of additional sample material, if sufficient volume is available, and if the holding time has not been exceeded.

Any failures (e.g., instrument failures) that occur during laboratory analyses will be the responsibility of the laboratory conducting the work. The QA Officer at each laboratory has procedures in place to follow when failures occur, and will identify individuals responsible for corrective action and develop appropriate documentation. Any corrective actions taken will be documented in the laboratory's hard copy deliverable or in a Corrective Action Plan. For more information on laboratory QA procedures please refer to their QA Manual available upon request. Laboratory contact information is available in Appendix O.

14. QUALITY CONTROL

This section addresses QA/QC activities associated with both field sampling and laboratory analyses. The field QA/QC samples are used to evaluate potential contamination and sampling error introduced prior to submittal of samples to the analytical laboratory. QA/QC samples will be collected on a program-wide basis during each monitoring year in accordance with the SWAMP required frequencies (Refer to Table 14-1). Laboratory QA/QC activities provide information needed to assess laboratory contamination, analytical precision and analytical accuracy. If any QA/QC standards are not met, the appropriate corrective actions will be taken in accordance with Section 8.3 of this document and the laboratory QA manual, available in Appendix A. Laboratory contact information is available in Appendix O.

14.1 Field Sampling Quality Control

Sampling quality control uses the following field quality control samples used to evaluate sampling error, potential contamination and precision of sampling methodology. The results of the field quality control data will be included with the environmental sample data in lab reports and EDDs (i.e., simple text format and SWAMP compatible format) with the exception of equipment blank results which will be provided separately prior to any sampling activities. Table 14.1 describes the frequency and acceptance limits for each type of field quality control samples.

1. **Field Blanks** – Field blanks verify that field conditions, field sampling activities and air deposition are non-contaminating. A sample bottle is filled with reagent-grade, analyte-free de-ionized water in the field during a sampling event. Field blanks will not be conducted on flow-weighted or 24-hour time-weighted composite samples. Field blanks will be analyzed for the full suite of constituents being analyzed from grab samples for that particular sampling event and/or project (with the exception of toxicity bioassays as DI water is not suitable for organism's survival).
2. **Field Duplicates** – Field duplicates evaluate sampling error introduced by both field sampling and laboratory analyses. Field duplicates are submitted blind to the laboratory. Procedures for collecting field duplicates should be the same as those used for collecting field samples. Duplicates of manual grab samples will be collected by filling two grab sample containers at the same time. Field duplicates will typically not be conducted on flow-weighted or time-weighted composite samples (exception, under the SMR Monitoring Program they may be collected as a full composite duplicate or a composite split from automated samplers and submitted blindly to the lab). Field duplicates will be analyzed for the same suite of analyses as the primary grab samples.
3. **Equipment Blanks** – Equipment blanks verify that the re-usable sampling containers and tubing are contaminant free prior to sampling. If sampling containers or tubing are re-used then equipment/bottles will be cleaned and blanked. When containers are not pre-certified or provided from a laboratory then one container per batch ordered will be blanked prior to use in sample collection. Field blanks will be analyzed for a representative set of constituents.
4. **Travel Blanks** – Travel or trip blanks verify that volatile organic analysis samples are handled and transported from the field to the laboratory without contamination. One volatile organic analysis vial with reagent water free of volatile contaminants is transported to the site in the same cooler as the empty sample containers. The travel blank is handled like a sample but never opened and then returned to the laboratory. Travel blanks will be analyzed for VOCs and/or SVOCs only.

Table 14-1: Program-Wide Field Sampling Quality Control

Field QC Type	Description	Frequency	Acceptance Limits[a]
Equipment or Container Blanks[b]	Used to verify that re-usable containers and equipment are not contaminated.	Once per batch of equipment	Concentrations should be below the RL.
Field Blank[c]	Used to verify field conditions	Amount equal to 5% of all program samples	Concentrations should be below the RL.
Field Duplicate[c]	Used to evaluate sampling error	Amount equal to 5% of all program samples	Relative Percent Difference range of 0-25%.
Travel (Trip) Blank[d]	Used to verify that VOCs are properly handled/transported	For VOCs/SVOCs only Amount equal to 5% of all program samples	Concentrations should be below the RL.

(a) Acceptance limits are not applicable if the concentration of either the primary or duplicate sample is less than the RL.
(b) If contamination is detected in field equipment blanks, equipment will be decontaminated a second time and analysis will be redone as necessary to resolve the issue.
(c) Field Blanks are not required for flow-weighted composites or time-weighted composites or toxicity bioassays. Field Duplicates are typically not used for composites; however, under the SMR Monitoring Program they may be collected as a full composite duplicate or a composite split from the automated samplers.
(d) Travel (Trip) Blanks only apply to samples being analyzed for VOCs or SVOC's (e.g. SAR Monitoring Program).

14.2 Laboratory Quality Control Analyses

Laboratory quality control analyses will include the use of laboratory replicates, method blanks, MS/MSDs, laboratory control samples and Standard Reference Materials (SRM) as described below. Laboratory quality control results will be provided in a laboratory report and EDDs (i.e., simple text format and SWAMP compatible format) with a batch identification number to correlate with the corresponding environmental sample data set. Table 14.2 describes the frequency and types of quality control samples for each constituent category.

1. **Laboratory Replicate/Split** – A sample is split by the laboratory into two portions and each portion is analyzed. Once analyzed, the results are evaluated by calculating the Relative Percent Difference between the two sets of results. This serves as a measure of the reproducibility, or precision, of the sample analysis. Typically, replicate results should fall within an accepted Relative Percent Difference range, depending upon the analysis. These are comparable to the Precision metrics (RPDs) in Table 7-3.
2. **Method Blanks** – A method blank is an analysis of a known clean sample matrix that has been subjected to the same complete analytical procedure as the field sample to determine if potential contamination has been introduced during processing. Blank analysis results are evaluated by checking against RLs for that analyte. Results obtained should be less than the RL for each analyte. For toxicity, laboratory control water will be tested based on the manipulations performed on one or more of the ambient samples and will be consistent with the USEPA method guidance. RL's listed in Table 6-2 should be verified for use.
3. **Matrix Spike and Matrix Spike Duplicates (MS/MSDs)** – The purpose of matrix spikes and matrix spike duplicates are to determine how the matrix of the sample affects both the precision and bias associated with the results. Matrix spikes and matrix spike duplicates involve adding a known amount of the chemical(s) of interest to one of the actual samples being analyzed. One sample is split into three separate portions. One portion is analyzed to determine the concentration

of the analyte in question in an un-spiked state. The other two portions are spiked with a known concentration of the analytes of interest. The recovery of the spike, after accounting for the concentration of the analyte in the original sample, is a measure of the accuracy of the analysis. An additional precision measure is made by calculating the Relative Percent Difference of the duplicate spike recoveries. Both the Relative Percent Difference values and spike recoveries are compared against accepted and known method dependent acceptance limits. Results outside these limits are subject to corrective action. The Matrix Spike should be compared to the Accuracy metrics in Table 7-3. The Matrix Spike Duplicates should be compared to the Precision metrics (RPDs) in Table 7-3.

4. **Standard Reference Material** – A SRM is a sample containing a known and certified amount of the analyte of interest and is typically analyzed with the analyst not knowing the analyte concentration. SRMs are typically purchased from independent suppliers who prepare them and certify the analyte concentrations. Results are evaluated by comparing results obtained against the known quantity and the acceptable range of results supplied by the manufacturer. For toxicity, accuracy will be measured with the use of a reference toxicant test that must be conducted per batch for species from commercial supplier settings or monthly for species raised within a laboratory.
5. **Laboratory Control Sample** – The laboratory control sample procedure involves spiking known amounts of the analyte of interest into a known, clean, sample matrix to assess the possible matrix effects on spike recoveries. High or low recoveries of the analytes in the matrix spikes may be caused by interferences in the sample. Laboratory control samples assess these possible matrix effects since the laboratory control sample is known to be free from interferences. Laboratory control samples should be compared to the Accuracy metrics in Table 7-3.
6. **Surrogate compounds** – Surrogate compounds accompany organic measurements in order to estimate losses of the target analyte during sample extraction and analysis. If there is any loss of the surrogate compound during preparation and analysis then it is presumed that the target analyte experienced a similar loss. Surrogate results will be reported with the corresponding organic results for each sample analyzed.
7. **Dilution Samples** – For dilutions carried out to facilitate analysis, all reported results must be corrected for the dilution and flagged to identify that a sample was diluted. Corresponding batch QA samples must be analyzed at the same dilution factor as the analytical batch.
8. **Benthic Macroinvertebrates** – Accuracy will be determined annually by having 20 percent of the samples re-analyzed and validated to SAFIT STE Level 2 (genus/species identifications with chironomid midges identified to genus/species group) by a professional taxonomist.

Table 14-2: Analytical Quality Control

Analyte	Laboratory Replicate	Method Blank	MS/MSD	SRM	LCS[a]
General Chemistry[b]	✓	✓	✓	✓	✓
Total and Dissolved Trace Metals	✓	✓	✓	–	–
Microbiology	✓	–	–	✓(c)	–
Organics					
Polynuclear Aromatic Hydrocarbons (PAHs)	–	✓	✓	✓	–
Pesticides	–	✓	✓	✓	–
Aroclor PCBs	–	✓	–	–	–
Synthetic Pyrethroid Pesticides by NCI-GCMS	–	✓	✓	✓	–
Volatiles	–	✓	✓	✓	–
Toxicity	–	✓(e)	–	✓(d)	–
Other Toxicants	–	✓	–	✓	–

Frequency: Laboratory quality control samples will be analyzed once per analytical batch. An analytical batch is defined as 20 samples or less and may include samples from multiple projects.

(a) According the SWAMP requirements, the laboratory's control sample is an alternate method of assessing accuracy when a Standard Reference Material (SRM) is not available.

(b) Most general chemistry constituents are addressed by SWAMP requirements, however, some are not and quality control analyses will be conducted based on the USEPA Standard Methods.

(c) For microbiology, the SRM is the analysis of positive and negative controls.

(d) For toxicity, the SRM is a reference toxicant test that must be conducted per batch for a given species. ~~from commercial supplier settings or monthly for species raised within a laboratory.~~

(e) For toxicity, the method blank is the control water used in all of the dilutions for test samples.

15. INSTRUMENT/EQUIPMENT TESTING, INSPECTION AND MAINTENANCE

All field equipment will be tested, inspected and maintained according to manufacturer specifications. Sample equipment testing, inspection and maintenance shall be performed on a general schedule of semi-annually or on an event basis as-needed, no more than seven days before a monitoring event (Table 15-1). Replacement parts will be installed as necessary and may be stored onsite in the monitoring shed or brought to the site with field crews. General descriptions of field equipment to be used for the monitoring programs covered under this QAPP are as follows:

Data Logging Flow Meter

Data logging flow meters measure, calculate and log flow data based on a set of continuous measurements and programmed information. Water stage is measured using a bubbler level meter or a pressure transducer. A bubbler level meter translates the proportional relationship of the hydrostatic pressure associated with releasing air bubbles from the bubbler orifice into the height of water above the bubbler orifice. Pressure transducers work in a similar manner except the pressure of the water acts directly on the pressure transducer installed in the water column. The flow meters may incorporate a velocity sensor to measure water velocity using Doppler technology, which rates the velocity of particles in the water. The flow meter allows for programming of the geometry of the conveyance and based on input from the water level sensor and velocity, if applicable, the flow meter calculates instantaneous flow rates. The flow meters also have inputs for a rain gauge, sampler communication and telemetry devices.

Automated Sampler

Automated samplers are programmable to collect time-weighted or flow-weighted composite samples. Samples are collected using Teflon® or Teflon®-lined intake tubing and silicone peristaltic pump tubing. When collecting time-weighted composites, the sampler can be programmed to collect sample aliquots based on desired time intervals. When collecting flow-weighted composites the sampler is programmed to collect samples based on data received from the flow meter. Samplers can be volume calibrated to collect aliquots of a desired volume. Samplers can be equipped with a distributor arm to deliver samples to multiple bottles, if desired. Other settings can be made to the samplers, including start/stop triggers such as high or low water level, which is transmitted via a flow meter. The samplers can also be set to deliver a notification to the data logging flow meter every time an aliquot is collected along with the sample status of "success" or "failure" to provide a record of sample history.

Tipping Bucket Rain Gauge

A tipping bucket rain gauge has a bucket inside that is calibrated to tip once a set volume of water associated with 0.01 inch of rainfall has accumulated. Each time the bucket tips a switch is momentarily closed, sending a signal to the data logging flow meter and it is recorded as 0.01 inch of rainfall with a date/time stamp.

Data Telemetry Unit

Data telemetry units (if available) can be used in areas where cellular data service is available to communicate remotely with the data logging flow meter. This allows for remote control of flow meter setting, sample pacings, data downloading and program initiation or completion.

Field Water Quality Probes

Field water quality probes are used to collect *in-situ* water quality measurements in the field by placing directly in the water column or in a secondary container if the water depth does not allow the probe to be completely submerged. Probes should be exposed to flow in a representative portion of the stream or discharge. If there is no flow (i.e., ponded) or a secondary container is required to make measurements, the probe should be gently agitated, or stir bar turned on (if applicable), particularly when making DO measurements using polarographic (Clark Cell) probes. Probes can either be individual or part of a multi-

parameter meter (sonde). Probes should be calibrated per manufacturer specification prior to use in the field.

Power

The automated sampling equipment and flow meters will be powered by 12-VDC power sources. The power sources will be either 12-VDC deep-cycle marine batteries or 12-VDC gel cell batteries. At each monitoring station, one battery will be used to power the automated samplers and another will power the flow meters and modems. A 30-watt solar panel may be installed at long-term stations, if desired, to keep the batteries charged. If a solar panel is installed a solar panel voltage regulator will be installed to regulate the voltage from the panel to the battery to allow for safe charging.

Equipment Security Housing

Fiberglass or metal equipment enclosures may be used at monitoring stations where access allows. The enclosures will house all monitoring equipment. The enclosures will be bolted to the concrete monitoring pads and locked to secure the monitoring equipment.

Permanent Station Installation

Monitoring stations installed as "permanent" stations are intended to remain in the same location for multiple years or indefinite periods of time. This type of installation typically includes installing a security housing to contain a flow meter, automated sampler, battery, solar panel and regulator, and rain gauge. Sample tubing, bubbler tubing and/or AVB sensors are routed to the discharge through conduit and mounted to stationary features or buried to provide long-term protection. If desired, the station electronics may be removed during the summer months to avoid potential overheating and damage. Sample tubing should be replaced with clean tubing at the beginning of each monitoring season as dictated by each monitoring program.

Temporary Station Installation

Monitoring stations installed as "temporary" stations are intended to remain onsite for short periods of time such as a single monitoring event or a single season with a few events. This type of installation typically involves mounting sampling tubing, bubbler tubing and/or AVB probes in the discharge using expansion rings or similar light-duty methods of installation. The tubing and probe cables are not typically shrouded in conduit and can either be removed between sampling events or coiled and stored onsite, depending on site characteristics and channel access. Monitoring electronics are placed onsite during pre-monitoring activities and may be locked together or to stationary features if available. Monitoring electronics are removed at the completion of sampling activities.

Handheld Flow Meter

Handheld flow meters are used to measure instantaneous water velocity. These meters can be used to take a single measurement or to conduct stream gauging in accordance with United States Geological Survey (USGS) stream gauging protocols (Rantz, 1982). Some handheld flow meters have the capability to store data points during stream gauging and output a final discharge value.

Handheld Global Positioning System (GPS) Unit

Handheld GPS units are used to locate the position of sites based on latitude and longitude. Units should be equipped with differential capabilities to provide higher accuracy. Users should allow time for the unit to communicate with satellites prior to use to obtain accurate position data.

Table 15-1: Testing, Inspection, and Maintenance of Field Equipment and Monitoring Instruments

Equipment	Maintenance/ Testing/Inspection Activity	Responsible Person	Frequency	SOP Reference
Data Logging Flow Meter	Maintenance and Inspection	Deploying agency or Consultant	Semi-annually or as needed	Manufacturer O&M Manual
Automated Sampler	Maintenance and Inspection	Deploying agency or Consultant	Semi-annually or as needed	Manufacturer O&M Manual
Tipping Bucket Rain Gauge	Maintenance and Inspection	Deploying agency or Consultant	Semi-annually or as needed	NA
Data Telemetry Unit	Maintenance and Inspection	Deploying agency or Consultant	Semi-annually or as needed	Manufacturer O&M Manual
Field Water Quality Meter(s)	Maintenance and Inspection	Deploying agency or Consultant	Semi-annually or as needed	Manufacturer(s) O&M Manual(s)

All laboratory equipment is tested, inspected and maintained based on manufacturer recommendations and accepted laboratory protocols. The laboratories maintain testing, inspection and maintenance practices as part of their method SOPs maintained in their laboratories by their Laboratory Director/QA Officer and can be provided upon request.

All field instrument testing, inspection, and maintenance frequencies are consistent with the SWAMP QAPrP. Monitoring consultants will maintain instrument testing, inspection and maintenance practices as part of the method SOPs and recorded in calibration logs at their respective offices. The District's Section Manager has reviewed these practices and finds them in conformity with SWAMP requirements.

16. INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Calibration of field meters will be performed no more than seven days prior to a sampling event, or as-needed. A calibration log will be maintained for all meters used in the field. All meters will be calibrated according to the manufacturer's operations manual. Any parameters that do not require frequent calibration per manufacturer recommendation will be checked in a known standard for verification and documentation purposes. Calibration logs will be kept on file at the District. For District-owned equipment, instructions for calibration and measurements are provided in Appendix H.

All laboratory equipment is calibrated based on manufacturer recommendations and accepted laboratory protocols. The laboratories maintain calibration practices as part of their method SOPs maintained in their laboratories by their Laboratory Director/QA officer and can be provided upon request.

Calibration for all flow meters and automated samplers will be conducted prior to installation and, thereafter, no more than seven days before a monitoring event. The data logging flow meter and automated sampler will be calibrated per the manufacturer's operation manual. For flow meter calibration, the recorded water level will be checked by comparing the level to actual levels while the water level sensor is submerged in water of a known level. Computational calibrations cannot be performed but deviations from known

values are documented and the equipment will be replaced or repaired as necessary. For automated sampler calibration, the aliquot volume will be calibrated using a graduated flask or beaker.

All field instrument calibration frequencies are consistent with the SWAMP QAPrP. Laboratory consultants maintain calibration practices as part of their method SOPs. The District's Section Manager has reviewed these practices and finds them in conformity with SWAMP requirements.

17. INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

All glassware, sample bottles and collection equipment, including tubing, will be inspected prior to use. All ordered supplies will be examined for damage as they are received. Bottles and caps will be inspected for damage prior to sampling, and only sound bottles with intact threads will be used. The container caps will be tested for tightness prior to transport of samples.

The monitoring agency's/consultant's Project Manager will ensure sufficient field supplies are on hand prior to the start of sampling for each period. Field supplies will be stored at each respective monitoring agency's/consultant's offices or onsite in a monitoring shed. Laboratory supplies will be stored at the laboratories conducting the work.

Table 17-1: Inspection/Acceptance Testing Requirements for Consumables and Supplies

Project-Related Supplies/Consumables	Inspection/Testing Specifications	Acceptance Criteria	Frequency	Responsible Individual
Pre-Cleaned Sample Containers	Open container	Lids screwed on bottles	100%	Sampling agency or Consultant
Laboratory Glassware	Dirty	Clean	100%	Laboratory Consultant
Lab Solvents and Acids	Leaks	No cracks or chips	Prior to use	Laboratory Consultant
19-Liter Glass or 1-Liter Glass	If not certified pre-cleaned then laboratory blanked	Pass blanking analysis	New bottles each monitoring year or if not blanked, then new bottles each event	Laboratory Consultant, Sampling agency or Consultant
Silicone Tubing	Laboratory cleaned and blanked	Pass blanking analysis	New tubing at start of fiscal year or if not blanked, then new tubing each event	Laboratory Consultant, Sampling agency or Consultant
Teflon Tubing	Laboratory cleaned and blanked	Pass blanking analysis	New tubing at start of fiscal year or if not blanked, then new tubing each event	Laboratory Consultant, Sampling agency or Consultant

18. NON-DIRECT MEASUREMENTS (EXISTING DATA)

Historical monitoring data and fire data collected by an outside agency will be used in the Monitoring Annual Report to identify trends and conduct comparisons.

19. DATA MANAGEMENT

After completion of data quality reviews and addressing analytical field or laboratory report revisions, the District will compile the MS4 monitoring and analytical data. The District will provide the data set(s) to the San Diego, Santa Ana, and Colorado River Regional Boards as incorporated into the respective Annual Monitoring Report deliverables. Any intentional deviations from SWAMP protocols or requirements not specified in this QAPP or the Monitoring Plans will be referenced and explained in the respective Annual Monitoring Report.

Monitoring program data will be submitted directly to the California Environmental Data Exchange Network (CEDEN) annually pursuant to the Santa Ana Region MS4 Permit and the San Diego Regional MS4 Permit. SMC regional data will be submitted directly to SCCWRP through the SMC Data Portal in a standardized SWAMP-compatible format consistent with the standard used by SCCWRP. SCCWRP staff will then ensure the SMC data is uploaded to CEDEN in order to standardize the data provided by multiple entities, document data quality, to allow for comparison of regional data sets, and to facilitate timely submittals. The District will retain CEDEN upload receipts for a reasonable time, as consistent with permit-specific document retention requirements. Data uploaded into CEDEN will also be stored in the District's KiWQM database as described in Sections 19.2, 19.3, and Appendix M.

~~Data will be submitted in a standardized SWAMP-compatible format consistent with the standard used by the Regional Data Center at SCCWRP in order to standardize the data provided by multiple entities, document data quality to ease the comparison of data sets and to facilitate timely submittals. The District will compile the monitoring and analytical data, and provide the data set(s) to San Diego, Santa Ana, and Colorado River Regional Boards in the respective Annual Monitoring Reports and deliverables. Data is submitted to the California Environmental Data Exchange Network (CEDEN) Regional Data Center at SCCWRP annually. Any intentional deviations from SWAMP protocols or requirements not specified in this QAPP (Volume II) or the Monitoring Plans (Volumes III, IV, or V) will be provided in the respective Monitoring Annual Report.~~

19.1 Hydrologic Data

The respective monitoring agency's or consultant's Project Manager is responsible for hydrologic data management of their respective monitoring project and will track the data logger results, which include rainfall, sampling history and discharge (velocity, stage and instantaneous flow) data, when applicable. The original electronic data logger files will be saved electronically as Insight files on the project file. Sampling teams will manually check the data logger results while at the site. The visual discharge and precipitation observed by field crews during the storm and the precipitation posted for nearby sites on the NWS website will be compared to the logged data. If a large discrepancy exists, all equipment will be checked for malfunction. Any other site problems, such as debris clogging the conduits, will be checked and eradicated during the monitoring event. After each storm event, the logged data will be screened for the following major items:

- A check of the meter and sampler settings associated with each data logger file, including Station ID and units, to verify that correct information matches the flow data set. Incorrect settings will be re-programmed for future events.
- A data gap check to identify time periods with no recorded data during the monitoring event. Any data gaps will be identified, logged, and investigated.
- A check of the discharge start time and precipitation start time.
- A check of rainfall intensity and discharge values throughout the monitoring event to verify that the discharge increased and decreased when the rainfall intensity increased and decreased.

- A check of the number of samples and discharge to verify that the frequency of sampling increased when discharge increased.

19.2 Field Observations and *In-situ* Measurements

The District's Monitoring Data Manager ~~Program Manager~~ will review all Field Data for completeness, and maintain electronic files ~~the original hard copies and scan electronic copies (*.pdf)~~ for storage in the project file. Photographs of the monitoring sites taken by field personnel will be uploaded into the project file within three business days of field visits. Field team members will name the photographs using the photograph naming convention developed specifically for a particular monitoring project. Calibration logs for handheld meters will be tracked and reviewed by Watershed Monitoring staff under direction of the Project Manager and saved in the project file. If monitoring is conducted by consultants or other agencies then copies ~~Copies~~ of field data sheets, photographs and calibration logs will be delivered to the District within fourteen (14) calendar days of each monitoring event in the form of a simple post-event technical memorandum (i.e., event summary). Refer to Section 19.5 for a description of the Event Summary deliverables. Further details regarding field data and the database can be found in Appendix M.

19.3 Analytical Data

The laboratories will provide data in both *.pdf copies of lab reports and in ~~a SWAMP compatible~~ electronic data deliverable format. Formatting of the EDD into a CEDEN~~A SWAMP~~-compatible template will ensure that the data files can be uploaded to the ~~SWAMP regional~~ CEDEN database if required by the permits. SWAMP Compatible Data Guidance Manuals are provided in Appendix I. The Laboratory Project Manager will review all lab reports and EDDs for accuracy, completeness and compatibility with SWAMP. Chemistry analytical results will be submitted to the District in *.pdf format and as EDDs (i.e., ~~simple text format and SWAMP compatible~~ excel format) within three (3) weeks (i.e., 21 calendar days) of receipt of samples.

Within ~~seven (7) days from receipt~~ a reasonable amount of time based on prioritization of program requirements, the District's Data Manager will screen preliminary data deliverables for the following major items:

- A 100% check between electronic data provided by the laboratory and the hard copy (or pdf) reports
- Conformity check between the Chain-of-Custody Forms and laboratory reports
- A check for laboratory data report completeness
- A check for typographical errors on the laboratory reports
- A check for use of appropriate analytical methods and reporting limits
- A check for suspect values, flagged data and review of laboratory QA data

The District's Data Manager will upload the data into a database to check that the data meets the quality requirements of the CMP and QAPP. ~~After the District's Data Manager has made the necessary corrections or revisions and verified the data meets the quality requirements of the CMP and QAPP, the data will be uploaded into a database.~~ The District maintains its rainfall in a proprietary integrated data management system known as Hydstra©[12]. The Hydstra© software system was installed early in FY 1999-2000. In 2017 the District upgraded their water quality database to Kisters Water Quality Module (KiWQM). It uses stringent quality control procedures and includes custom data analysis and reporting procedures. Water

[12] Although Hydstra© and KiWQM are Kisters proprietary data management systems, the program supports export of data in commonly used spreadsheet and database formats. The use of trademark or brand names does not connote a recommendation of a particular product.

quality data collected by other Permittees may also be stored in the District's database. The KiWQM database will incorporate a number of quality control checks and queries to further verify and validate data. The District's Database Manager will control the access to the project's database. Kisters' data entry procedures are provided in Appendix M. The laboratory EDDs will be maintained in a file separate to the cumulative database so the original ~~SWAMP compatible~~ EDDs are maintained and can be used as a reference. If data is reissued, the file name will include the date and the word "revised". The revised data will be imported to the database to overwrite the erroneous dataset. ~~To manage the revision and prevent duplicate entries, the erroneous dataset will be removed from the database prior to uploading the revised dataset.~~ Further details regarding analytical data imports into the database can be found in Appendix M.

19.4 Bioassessment Data

The District's Data Manager and/or consultant Project Manager will review all lab reports and EDDs for accuracy, completeness, and compatibility with SWAMP. Lab reports and EDDs will be stored by the District and/or consultant in the project file. Bioassessment and toxicity analytical results will be provided to the District in hard copy format and as an EDD within six (6) weeks of receipt of samples.

19.5 Technical Memorandums

Technical Memorandums will be developed by the consultant for monitoring projects under their charge to provide the District's Monitoring Program Manager with a summary of the activities conducted. These summaries will follow the general guidelines below unless otherwise specified in a task order.

Post-Event Technical Memorandum: Consultants will develop and submit a Post-Event Technical Memorandum (i.e., event summary package) to the District following each event for monitoring projects under their charge (e.g., wet weather monitoring, Stream Assessment/Bioassessment monitoring, and/or dry weather monitoring) as applicable. The deliverable will contain the following:

- An event summary table summarizing the details of the monitoring event: event type, sample team, locations monitored, flow, rainfall (if applicable), and types of samples collected, etc.
- Bioassessment/ Stream Assessment data (if applicable), not including chemistry, in a SWAMP-compatible EDD
- Field data in a SWAMP-compatible EDD
- Field data sheets (including any composite sampling flow data and %)
- Photographs
- Calibration logs

For wet weather and dry weather monitoring events (excluding Stream Assessment/Bioassessment) the deliverables will be submitted in *.pdf format along with the associated SWAMP-compatible EDDs within fourteen (14) calendar days after receipt of analytical files.

For Stream Assessment/ Bioassessment monitoring events, the deliverables will be submitted in *.pdf format within fourteen (14) calendar days. The associated SWAMP-compatible EDDs will be provided within ninety (90) calendar days or once available from the subcontracted laboratory.

GROUP C ELEMENTS: ASSESSMENTS AND RESPONSE ACTIONS

20. ASSESSMENTS AND RESPONSE ACTIONS

The Section Manager has the power to halt all sampling and analytical work by a consultant if the deviations noted are considered detrimental to data quality.

The District's Monitoring Program Manager will be responsible for the day-to-day oversight of consultant monitoring activities, laboratory analyses, and/or data reporting. Any failures (e.g., instrument failures) that occur during data collection and/or laboratory analyses will be the responsibility of the field crew or laboratory conducting the work, respectively. It is the responsibility of the consultant Project Mangers to report any assessments and proposed corrective actions to the District's Monitoring Program Manager and Data Manager.

Three types of assessments will be performed as part of this project to ensure that the sampling and analysis activities are in accordance with the approved QAPP. They are as follows:

1. **Surveillance of Sample Collection Activities:** The District's Monitoring Program Manager will be responsible for oversight of sampling activities. Jointly the District's Monitoring Program Manager and Data Manager will review field data to verify that the samples were collected in accordance with QAPP requirements. If the review identifies field activities to be in violation of QAPP requirements, the District's Monitoring Program Manager has the authority to stop these activities until corrective actions are successfully implemented. Corrective actions could include additional training to improve field team performance and QAPP compliance, or appropriate re-sampling of sites, as needed. The District's Data Manager will report all such actions to the District's Monitoring Program Manager and document it in the project file. This information will be communicated regularly between the Watershed Monitoring Section key monitoring staff, the District's Data Manager, and the District's Monitoring Program Manager.
2. **Data Quality Assessment:** Each Laboratory Manager will be responsible for providing a summary of QA/QC data to the District's Data Manager or other designated District project contact, who will consult as needed with the District's Monitoring Program Manager to verify that the performance criteria of the QAPP were met. This will occur following receipt of each report from the contract laboratory. If it is determined that the precision and accuracy objectives were not met the District's Data Manager will notify the Laboratory Manager, and the District's Division Chief on a case-by-case basis. The Laboratory Manager will review laboratory techniques to minimize errors, and samples will be re-analyzed, if possible.
3. **Assessment of Data Entry:** Once the performance criteria are met and the data has been submitted to the District, the District's Data Manager will review data files to ensure that errors are detected and corrected. If necessary, the District may request a revised dataset from the Consultant. The District will retain original data files and qualified data will be retained in the District's database. Data is qualified according to SWAMP protocols in the District's database.

21. REPORTS TO DISTRICT MANAGEMENT

This section describes internal processes for conducting interim progress reporting to District management. The District's Monitoring section staff ~~Program Manager~~ periodically provides informal progress reports to the Section Manager/Program Manager describing Monitoring Program implementation, field concerns, and interpretation of the monitoring results. The purpose of these reports is to brief the Section Manager in order to facilitate Monitoring Program oversight and assessment activities. Informal progress reports may be completed through internal meetings (i.e., undocumented), verbal communication, and/or written summary of current monitoring activities. Final Monitoring Program QA assessment and reporting will be submitted to the Section Manager in the form of the Draft Monitoring Annual Report for each region. The Section Manager will review the Draft Monitoring Annual Report(s) for completeness and consistency with program requirements and will work with the Monitoring ~~Program Manager~~ section staff to determine ways to improve program implementation as needed.

Table 21-1: Reports to Management

Type of Report	Frequency	Person(s) Responsible for Report Preparation	Report Recipients
Informal Progress Report	Quarterly or As needed	Watershed Monitoring Staff[(a)] ~~Monitoring Program Manager~~	Section Manager/ Monitoring Program Manager
Final Assessment Report	Annual (Based on Annual Reporting deadlines)	Contracted Consultant/ Watershed Monitoring Staff[(b)] ~~Monitoring Program Manager~~	Section Manager/ Monitoring Program Manager and Permit Manager (watershed-specific) / Compliance Section Supervisor

(a) Watershed Monitoring Staff are often tasked to draft the preliminary Informal Progress Reports. On occasion a contracted consultant may be tasked to develop a subject-specific Informal Progress Report. Upon review and approval the reports are accepted as final by the Monitoring Program Manager. The Informal Progress Reports are then ultimately used to provide updates to stakeholder groups, technical advisory committees, or other interested parties as presented by the Monitoring Program Manager or assigned designee.

(b) Final Assessment Reports are often drafted by a contracted consultant and on occasion may be prepared by Watershed Management Staff as assigned by the Monitoring Program Manager. Upon review, revision, and approval the reports are typically provided to the Monitoring Program Manager as a Draft Final and are then prepared for attachment to (or incorporation into) a watershed-specific Annual Progress Report. This last step is conducted in coordination with the District's watershed-specific Permit Manager or Compliance Section Manager and ultimately are made part of an annual compliance submittal to the corresponding Regional Board.

GROUP D ELEMENTS: DATA VALIDATION AND USABILITY

22. DATA REVIEW, VERIFICATION AND VALIDATION REQUIREMENTS

All analytical data will be reviewed and compared to the MQOs Data Quality Objectives described in Section 7 of this QAPP, along with the applicable QA/QC practices. If results fail to meet any MQO ~~Data Quality Objective~~, the District Monitoring Project Manager and/or the District Section Manager will flag them for further review. Batch QA samples will be reviewed to determine the potential cause of failure to meet the MQO ~~Data Quality Objective~~. Data will be separated into three categories: data meeting all MQO ~~Data Quality Objectives~~ (acceptable data), data failing precision or recovery criteria (further investigation warranted) and data failing to meet accuracy criteria (data is rejected).

If further investigation is warranted based on data failing precision or recovery criteria, all aspects of the data will be assessed for data quality by the District Monitoring Program Manager. At that point, the data will either be accepted or rejected. If accepted, the data will be appropriately flagged ~~with a "J" per USEPA specifications~~. If data fails to meet accuracy criteria, or the cause of the failure cannot be identified and rectified, the data will be excluded from inclusion in the study results. All rejected data will be retained in the Monitoring Program database, and qualified as "rejected". The ultimate decision of whether to accept or reject a data point will be made by the District Monitoring Program Manager in consultation with the District Section Manager.

If the analysis for more than ten percent of any given analyte fails to meet the MQO ~~Data Quality Objective~~, the Project Manager and Section Manager will meet to discuss the appropriateness of the MQO ~~Data Quality Objective~~ and any potential modifications. All proposed modifications of MQO ~~Data Quality Objectives~~ shall require a reissuance of the QAPP, which can be included as an update in attachment to the Annual Progress Report submittal.

23. VERIFICATION AND VALIDATION METHODS

Data verification is the process of evaluating the completeness, correctness and conformance of the dataset against the method, procedural or contractual requirements. The goal of data validation is to evaluate whether the data quality goals established during the planning phase have been achieved (USEPA 2002). Data quality indicators will be continuously monitored by the analyst producing the data (i.e., field and lab personnel), as well as the District Monitoring Program Manager, with assistance from the District Section Manager, throughout the project to ensure that corrective actions are taken in a timely manner. Data validation is an analyte- and sample-specific process that extends verification to determine the analytical quality of the dataset (USEPA 2002). Laboratory and field personnel responsible for conducting QA analysis will be responsible for documenting when data do not meet measurement quality objectives as determined by data quality indicators.

23.1 Data Verification and Validation Responsibilities

Data collected in the field will be validated and verified by the District's Monitoring Program Manager and the District's Data Manager, and/or the consultant Project Manager. The laboratories will maintain COCs and sample manifests.

Laboratory validation and verification of the data generated is the responsibility of the respective Project Manager. Laboratories will maintain analytical reports in a database format as well as all QA/QC documentation for the laboratory. The Laboratory QA Officer will perform checks of all of its records.

The District's Section Manager and Monitoring Program Manager are responsible for oversight of data collection and the initial analysis of the raw data obtained from the field and the contracted laboratory. All data records will be checked visually and/or electronically ~~and recorded as checked by initials and dates~~.

Reconciliation and correction of any data that fails to meet the MQOs ~~Data Quality Objectives~~ will be done by the District's Monitoring Program Manager in consultation with the District's Data Manager, the District's Section Manager, and consultant/agency Project Managers as appropriate. Any corrections require a unanimous agreement that the correction is appropriate.

23.2 Process for Data Verification and Validation

Data verification and validation for sample collection and handling activities will consist of the following tasks:

- Verification that the sampling activities, sample locations, number of samples collected and type of analysis performed is in accordance with QAPP requirements;
- Documentation of any field changes or discrepancies;
- Verification that the field activities (including sample location, sample type, sample date and time, name of field personnel, etc.) were properly documented;
- Verification of proper completion of sample labels and COC forms, and secure storage of samples; and
- Verification that all samples recorded on COC forms were received by the laboratory.

Data verification and validation for the sample analysis activities will include all of the following:

- Verification that appropriate methodology has been followed;
- Verification that instrument calibrations have been adequately conducted;
- Verification that QC samples meet performance criteria;
- Verification that analytical results are complete; and
- Verification that documentation is complete.

Verification and validation of data entry includes:

- Sorting data to identify missing or mistyped (too large or too small) values;
- Double-checking all typed values; and
- Verification that correct data types correspond to database fields (i.e., text for text, integers for integers, number for numbers, dates for dates, times for times, etc.).

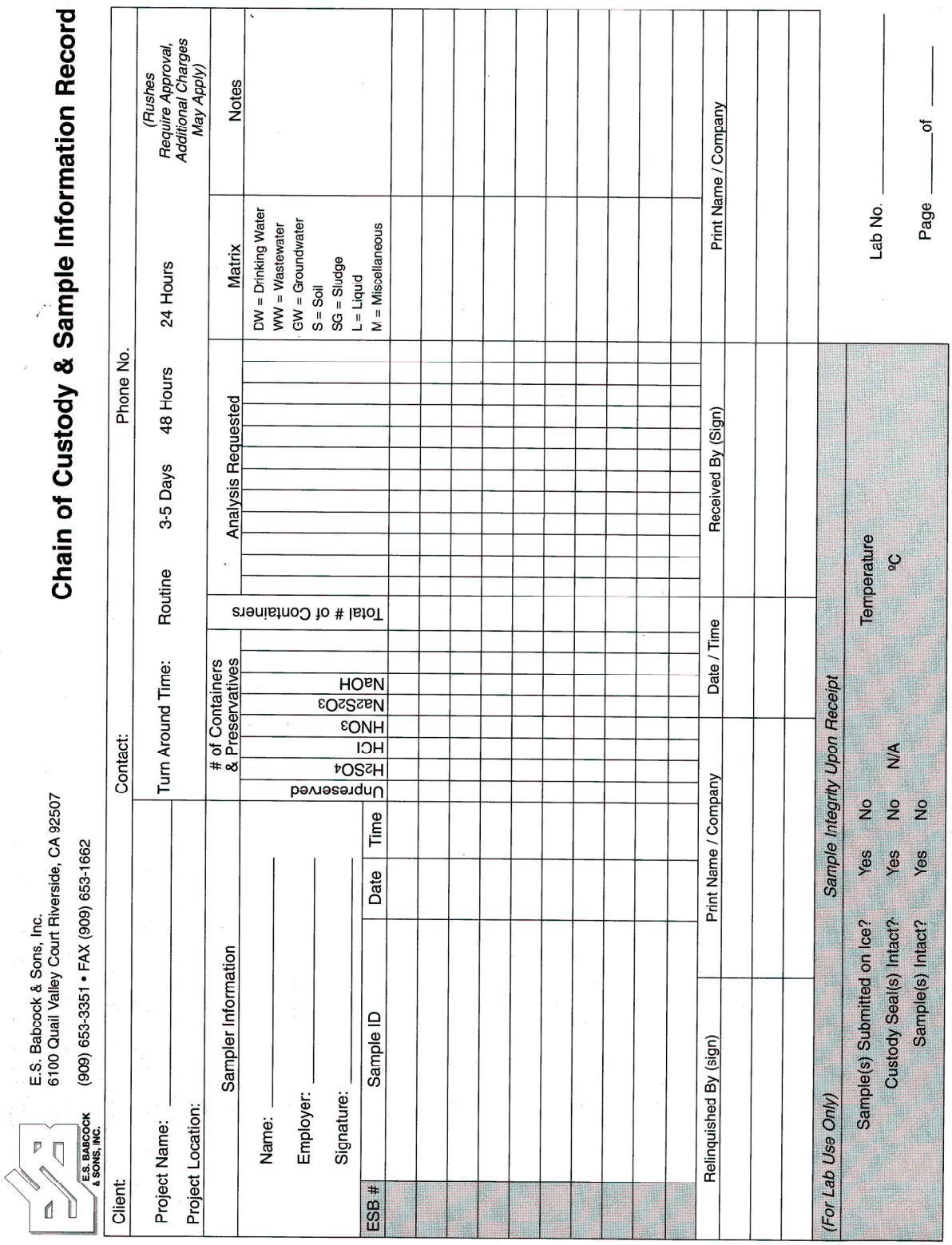
24. RECONCILIATION WITH USER REQUIREMENTS

The wet weather, dry weather, and extended flow monitoring data produced by this Monitoring Program will be used by the District to complete assessment and annual reporting. The Draft and Final Reports produced by the District will evaluate potential sources of the Pollutants-of-Concern throughout the MS4 and receiving water conditions using dry weather and wet weather monitoring data associated with this Program. Data will be evaluated to identify and prioritize locations that may need management actions and the sources of contaminants. The limitations and assumption of the data will be provided to allow the District to determine the data's usefulness. Data will be qualified in the Monitoring Program database to identify any data considered suspect, rejected or estimated.

APPENDIX A:

BABCOCK CHAIN-OF-CUSTODY, DRIVING DIRECTIONS, AND LABORATORY PROCEDURES (Procedures provided electronically by request only)

Babcock Chain of Custody Form



E.S. Babcock & Sons, Inc.
6100 Quail Valley Court Riverside, CA 92507
(909) 653-3351 • FAX (909) 653-1662

E.S. BABCOCK & SONS, INC.

Chain of Custody & Sample Information Record

Client: Contact: Phone No.

Project Name: Turn Around Time: Routine 3-5 Days 48 Hours 24 Hours *(Rushes Require Approval, Additional Charges May Apply)*

Project Location:

Sampler Information

Name:

Employer:

Signature:

ESB #	Sample ID	Date	Time	Unpreserved	H_2SO_4	HCl	HNO_3	$Na_2S_2O_3$	NaOH	# of Containers & Preservatives	Total # of Containers	Analysis Requested	Matrix	Notes

DW = Drinking Water
WW = Wastewater
GW = Groundwater
S = Soil
SG = Sludge
L = Liquid
M = Miscellaneous

Relinquished By (sign)	Print Name / Company	Date / Time	Received By (Sign)	Print Name / Company

(For Lab Use Only) *Sample Integrity Upon Receipt*

Sample(s) Submitted on Ice? Yes No Temperature

Custody Seal(s) Intact? Yes No N/A °C

Sample(s) Intact? Yes No

Lab No. _____

Page _____ of _____

Chain of Custody Form Instructions

Example filled-out Chain of Custody Forms are available in the monitoring location-specific binders at David Ortega's (951-955-4390) office. Additional, site specific instructions are provided for most CMP stations.

1. **Client**: **RCFC&WCD**

2. **Contact**: [name of monitoring program manager] **Rebekah Guill**

3. **Phone number**: The Contact's phone number **951-955-2901**

4. **Project Name**: SAR/SMR/WWR (note which one) or Complaint Response

5. **Project Location**: Brief description

6. **Turn Around Time**: Usually Routine.

7. **Sampler Name**: [name of lead sampler]

8. **Employer**: RCFC&WCD or the company name if other than a District employee collected the sample.

9. **Signature**: Signature of the lead sampler.

10. **Sample ID**: If at an existing MS4 monitoring station, note the station number here. If at a different location, use station number 823 for WWR complaints, 809 for SAR complaints, and 825 for SMR complaints. This number is used to enter the analysis into the database; **do not use other than the station number and a sequence number, if needed**. For example, the first of a sequence for a complaint sample collected in the Santa Ana Region would be labeled as "809-01".

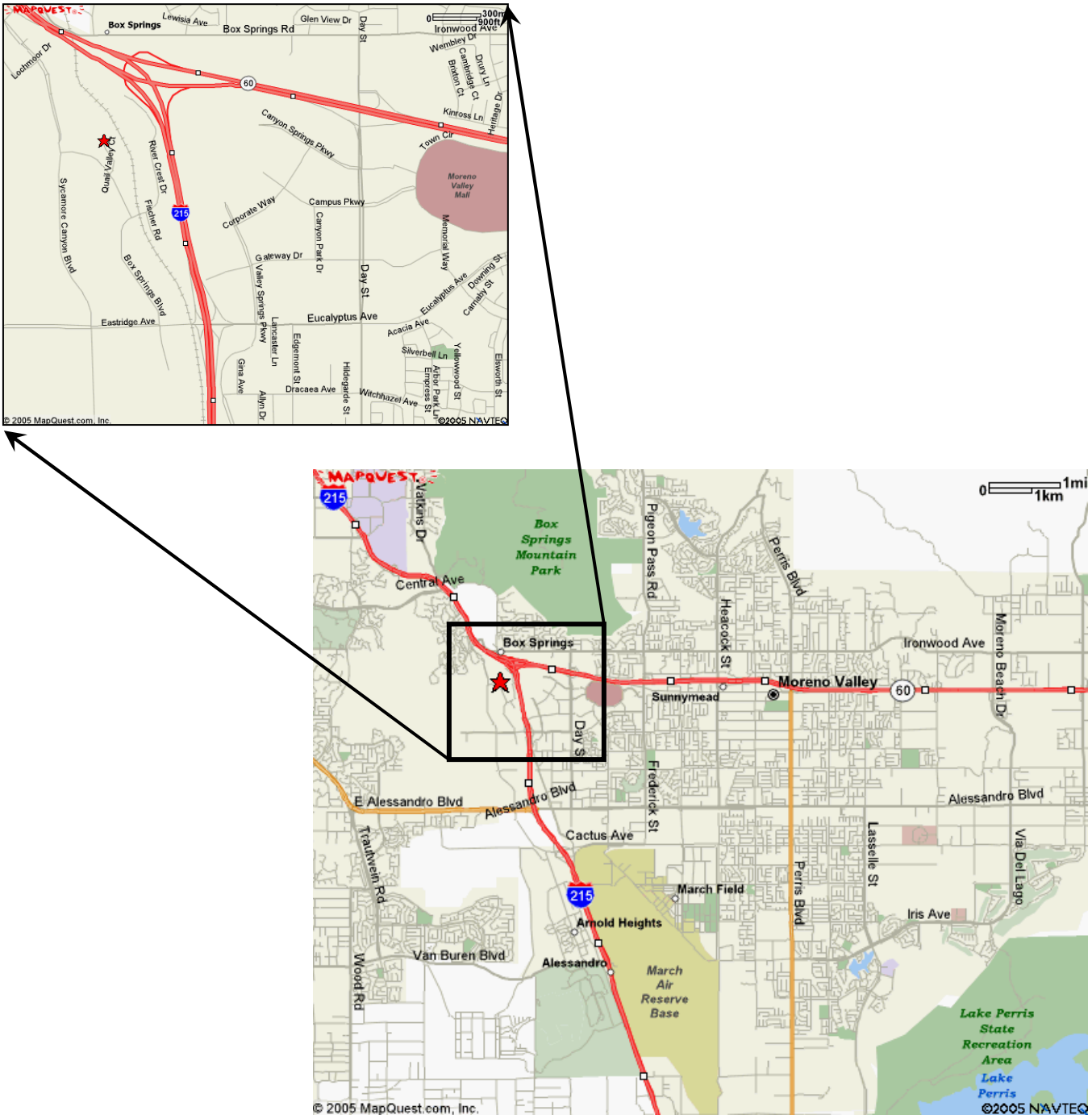
11. **# of Containers & Preservatives**: Write the number of bottles with a specific preservative under the preservative's column. Write the number of unpreserved bottles under the "Unpreserved" column. Write the total number of containers under the appropriate column as a check.

12. **Analysis Requested**: Indicate the pre-determined analyses for the samples or attach the specific watershed analyses sheet.

13. **Matrix**: Usually wastewater (WW) or soil (S)

14. **Relinquished By**: This area is important and must be filled out. When a person hands the sample to another person, the date and time the transfer took place and the signature of both parties involved in the transfer must be included. For example, when the samples are delivered to the lab, the District and lab staff people will sign and date the *Chain of Custody*. If someone outside of the District collects the sample, that person and you will be the first signatories.

Map to Babcock Laboratories



Driving directions to Babcock (taken from Mapquest)

From the South (e.g., Temecula):

Merge onto I-15 N	
Take I-215 N toward Riverside/San Bernardino	28.8 miles
Take the EUCALYPTUS AVE / EASTRIDGE AVE exit.	0.2 miles
Turn SLIGHT LEFT to take the EASTRIDGE AVE ramp.	<0.1 miles
Turn LEFT onto EUCALYPTUS AVE / EASTRIDGE AVE. Continue to follow EASTRIDGE AVE.	0.1 miles
Turn RIGHT onto BOX SPRINGS BLVD.	0.4 miles
Turn LEFT to stay on BOX SPRINGS BLVD.	0.1 miles
Turn RIGHT onto QUAIL VALLEY CT.	0.1 miles
End at **6100 Quail Valley Ct**	

From the West (e.g., Corona)

Take the CA-91 E toward SAN BERNARDINO	
Merge onto I-215 S / CA-60 E	4.2 miles
Take the BOX SPRINGS exit toward FAIR ISLE DR.	0.2 miles
Turn RIGHT onto BOX SPRINGS RD.	<0.1 miles
Turn LEFT onto SYCAMORE CANYON BLVD	0.5 miles
Turn LEFT onto BOX SPRINGS BLVD	0.2 miles
Turn LEFT onto QUAIL VALLEY CT.	0.1 miles
End at **6100 Quail Valley Ct**	

From the North (e.g., Norco)

Merge onto I-15 S toward SAN DIEGO	
Merge onto CA-60 E toward RIVERSIDE	16.5 miles
Take the BOX SPRINGS exit toward FAIR ISLE DR	0.2 miles
Turn RIGHT onto BOX SPRINGS RD	<0.1 miles
Turn LEFT onto SYCAMORE CANYON BLVD	0.5 miles
Turn LEFT onto BOX SPRINGS BLVD	0.2 miles
Turn LEFT onto QUAIL VALLEY CT.	0.1 miles
End at **6100 Quail Valley Ct**	

From the East (e.g., Banning)

Merge onto I-10 W toward LOS ANGELES	
Merge onto CA-60 W via the exit on the LEFT toward RIVERSIDE	18.4 miles
Take the BOX SPRINGS exit toward FAIR ISLE DR	0.1 miles
Turn LEFT onto BOX SPRINGS RD.	0.1 miles
Turn LEFT onto SYCAMORE CANYON BLVD.	0.5 miles
Turn LEFT onto BOX SPRINGS BLVD	0.2 miles
Turn LEFT onto QUAIL VALLEY CT	0.1 miles
End at **6100 Quail Valley Ct**	

APPENDIX B:

FIELD DATA SHEET AND EXAMPLE ELECTRONIC GUIDANCE

The District uses Esri's Survey123 application platform to record water quality monitoring field observations, measurements, and photographs. Using a smart device, such as a tablet or mobile phone, monitoring staff can collect real-time field data without dependency on additional handheld GPS equipment or paper forms. This provides efficiency while in the field and increases overall accuracy and completeness of the data collected. Once submitted, the data is uploaded to the ArcGIS Online cloud system and it can then be extracted by the District's KiWQM database for further processing (i.e., quality control, trend analysis, exporting, sharing, etc.) and converted to a *Field Data Sheet* PDF (shown below). The District's *Field Data Sheet* question set and data entry fields were used as a template for the development of the Survey123 app form.

Survey123 data can be previewed using the ArcGIS Online dashboard or by accessing KiWQM and downloading the excel data file containing results from a given sample event. Staff builds and maintains Survey123 forms within the app that are tailored to certain projects based on permit requirements, and the overall data collection purpose. Staff will ensure that the appropriate survey is selected for the intended field work. Revisions or updates to the survey forms will be done as needed to ensure accurate and complete data collection. In the event of technology failure paper, the *Field Data Sheet* will be used.

FIELD DATA SHEET

RIVERSIDE COUNTY
WATERSHED PROTECTION

STATION ID: _____ **SAMPLE DATE** (MM/DD/YYYY): _____

STATION NAME: _____ WATERSHED: ☐SAR ☐SMR ☐WWR

PROJECT NAME: _____ Within: ☐Unincorp. or

CONVEYANCE TYPE: _____ ☐City of _____

GPS INFO: Lat _____ Long _____ GPS Unit: _____ ☐Receiving Water ☐Within IAH

PRINTED NAMES of Sampling Team: _____ ☐ Outfall, Owner:_____

SIGNATURE of lead sampler: _____ Sampling AGENCY: _____

SAMPLE INFORMATION ☐ **VISITED, NOT SAMPLED (TIME:_____)**

EVENT CATEGORY: ☐ Wet Weather (Storm) OR ☐ Dry Weather ☐ Recon, IC/ID, or Complaint
☐1st ☐2nd ☐3rd ☐4th ☐ Other _____

SAMPLE ID(s) [# of Bottles**]: 1920-W1- 01 [__], 1920-W1- 01-C [__], 1920-W1- [__]**

STREAM FLOW:

Dry: ☐Yes ☐No Ponded: ☐Yes ☐No
Rising Groundwater: ☐Yes ☐No
Connects to Surface Receiving Water ☐Yes ☐No
Dry weather event u/s influence: ☐Yes ☐No

TYPE (check all that apply):

☐ **Primary-Grab** (-01) SAMPLE DATE: _____ SAMPLE TIME:_____
☐ **Primary-Composite** (-01-C) DATE: _____ TIME:_____ (COC last aliquot)
☐ **Field DUP-Grab** (-02) DATE: _____ TIME:_____
☐ **Field DUP-Composite** (-02-C) DATE: _____ TIME:_____ (COC last aliquot)
☐ **Field Blank** (-03) DATE: _____ TIME:_____
☐ **Travel Blank** (-04) DATE: _____ TIME:_____ ☐ Other:_____

FIELD PARAMETERS Time Measured: _____

	Result (primary/dup)	Units	Meter	Calibration Date
☐ **Water Temp**				
☐ **pH**				
☐ **EC**				
☐ **Turbidity**				
☐ **DO**				
☐ Salinity (RWs)				
☐				

FLOW ESTIMATION:

☐ USGS Gauge height/stage _____ ft Q (cfs) = _____
[Gauge Name/No.: _____]
☐ Calculation by visual measurement: Q (cfs) = _____
= [Coef(1,2/3,_____)]*[depth_____ft]*[width_____ft]*[vel_____fps]

Circular pipe: [vel_____fps][depth_____ft][width_____ft][R=_____ft]

COMPOSITE Samples: Auto/Grab, Flow/Time Weighted, ____Hrs

	Time	H(in.)	Flow(cfs)	%		Time	H(in.)	Flow(cfs)	%
1					13				
2					14				
3					15				
4					16				
5					17				
6					18				
7					19				
8					20				
9					21				
10					22				
11					23				
12					24				

SITE CONDITIONS

PRECIPITATION:
NOW: ☐ None ☐ Drizzle/Sprinkle ☐ Rain ☐ Hail/Snow
Is there >72 hrs since previous rainfall event? ☐Yes ☐ No
(A measurable rainfall event is an event with >0.1 inch of rain)
[~ Storm Start Time: _____]
[~ Storm End Time: _____]
Total Rainfall Estimate: _____

ODOR: ☐ None ☐ Sulfides ☐ Sewage ☐ Smoke ☐ Petroleum ☐ Other: _____
☐ Floatables_____ ☐ Settleables _____
☐ Vegetation_____ ☐ Staining _____

COLOR: ☐ Colorless ☐ Green ☐ Yellow ☐ Brown ☐ Other

CLARITY: ☐ Clear (see bottom) ☐ Cloudy ☐ Murky
Sheen Present: ☐ Yes ☐ No

TRASH: ☐ Yes ☐ No
From: ☐ Flows ☐ Litter ☐ Dumping ☐ Other_____

Observations/Notes ☐ **Photograph(s)**

☐ **Associated monitoring u/s, d/s** *(circle one or both and complete required FDS(s))* **at:**

- Field Data Sheet (FDS) Instructions -

Station ID – Enter station number and sampling date. **NOTE: These Station ID numbers must match bottle labels & COCs.** Remaining fields self-explanatory. Major land uses can be estimated in the field or back in the office.

Sample Information –Self-explanatory.

- Bottles must be stored on ice from when the sample is collected to when they reach the laboratory.
- Make sure the bottles are properly sealed (caps on snug).
- **Note all Sample IDs taken at this station, and specify the number of containers in each sample set after the ID in [__].** ***EXAMPLE, In the case where a primary sample, a duplicate, and a trip blank sample are collected for the same event:***
  1415-W1-746-01 [36], 1415-W1-746-02 [36], 1415-W1-746-04 [2]. (Note: -02 and -03 Require a Separate COC)
- A grab sample is a single sample collected at one time. **This must match bottle labels and chain of custody.**
- A composite sample is a series of grab samples collected over a period of time. The separate samples are combined into a single flow-proportioned sample prior to analysis, usually at the laboratory. Ensure that the sample times, flow heights and flow estimation columns are filled out at the bottom of the page.

Field Parameters – Note the time at which field parameters were measured for both primary and DUPLICATE samples. Field parameters must be measured, **bolded items** are the minimum. **Always include units!** Enter name (not type) of field meter used and its last calibration date in corresponding field. If field **DUPLICATES** are taken, a 2nd set of field parameters must be recorded in the results column, but not for field blanks. ***EXAMPLE: pH 6.77 / 6.91, where 6.77 is the -01 sample and 6.91 is the -02 sample.***

Flow Estimation

- If there is a USGS gauge, enter the gauge height. Discharge can be retrieved when back at the office. Note the name or gauge number in space provided.
- If needed, note the channel shape parameters so flow can be calculated. Flow speed can be measured with a leaf or stick and a stopwatch. Do not use trash as a floatable in estimating velocity!
  - Coef = 1 (straight wall/rectangular channel), $^2/_3$ (trapezoidal channel), ½ (triangular channel), 0.8 (rough bottom), 0.9 (smooth bottom).
  - Width: Use top width of flow
- ***Flow in circular pipes.*** Record velocity (vel, fps), depth of flow @ center of pipe (ft), top width of flow (ft), and Radius of pipe (R, ft). Flow will be calculated at the office using Table .

Site Conditions – Self-explanatory.

The date(s) of last rain/storm may be filled out at the office.

Use the categories below to assist in describing the flow and the surroundings and stream flow:

Odor: None, Musty, Sewage, Rotten Egg, Sour Milk, Fishy, Petroleum, Ammonia, Chlorine, Decaying Organisms, Other (describe)

Floatables: None, Oil, Foam, Animal Waste, Green Waste, Algae, Food, Paper, Plastic, Other (describe). Include estimated percentage and character of the floatables in observations field at bottom of sheet. (e.g., foam with approx. 1" high bubbles, trash is approx. 75% paper, light sheen oil, etc.)

Settleables: describe- sediment, biofilm, etc.

Vegetation: describe vegetation present- reeds, bushes, tree canopy

Staining: None, Salt, Clay, Oil, Rust, Microbes, Other (describe)

Color: None, Yellow, Brown, Grey, Red, Green, Amber, Blue, Olive Brown, Other (describe)

Sheen: Gasoline, Oil or other fuel

SMR (Only) Action Levels:
Notify Monitoring Manager if the following are exceeded.

Parameter	NAL (Dry)	SAL (Wet)
Turbidity	20 NTU	126 NTU
pH	6.5 - 8.5	--
DO	<5.0 mg/L (Warm Waters)	--

Composite Samples (cross out if not used)

Circle method(s): Auto or Grab, Flow or Time and provide duration (#hrs). Note the time and the flow for each sample collected. If available at the sampling site, note the height reading (H, feet) at the staff gauge. The composited sample will be flow-proportioned in the laboratory.

Notes/Observations – Check box if photographs were taken

Note any observations regarding the sampling location, *including any procedural variances* that occurred (i.e., sampling upstream, instrument malfunction, wildlife in area, safety, etc.). Make note of other conditions: *Sediments* [None, Normal, Excessive, Other (describe)], *Structural* [Normal, Cracking, Spauling, Other (describe)], *Biological* [Algal Bloom, Larvae, Crawfish, Frogs, Fish, Water Fowl, Other (describe)].

If associated monitoring (or additional sampling) is to be performed at another location, check the box and circle one or both (u/s, d/s), provide the Station ID(s) for the other station(s) and complete a separate FDS for each station (e.g., SMR MS4 Outfalls IAH sampling requires sampling at the Outfall site and at both the upstream and downstream proximate Receiving Water sites.

EXAMPLE: If sampling at Outfall 902MS4021, then note: ☒ **Associated monitoring u/s, d/s at: 902RW4020, 902RW4022.**

APPENDIX C:

MONITORING LOCATIONS BY PERMIT

Table C-1 Monitoring Locations by Permit*

Watershed	Station Name	Station Number	Station Type	Latitude	Longitude
Santa Ana River Region					
Santa Ana	Corona Storm Drain	801CRN040	Outfall	33.88533	-117.56878
Santa Ana	Sunnymead Channel	802SNY316	Outfall	33.91763	-117.24345
Santa Ana	Hemet Channel	802HMT318	Outfall	33.73464	-117.00618
Santa Ana	Magnolia Center Storm Drain	801MAG364	Outfall	33.96572	-117.41558
Santa Ana	University Wash	801UNV702	Outfall	33.99721	-117.37278
Santa Ana	North Norco Channel	801NNR707	Outfall	33.90748	-117.58328
Santa Ana	Perris Line J	802PLJ752	Outfall	33.80457	-117.20876
Santa Ana	Temescal Channel at Main	801TMS746	Receiving Water (Wet)	33.88951	-117.56384
Santa Ana	Perris Valley Channel at Nuevo	802NVO325	Receiving Water (Wet / Dry)	33.80126	-117.20619
Santa Ana	Perris Valley Channel 0.25 mi upstream of Nuevo Rd[3]	802NVO325a	Receiving Water (Wet / Dry)	33.804761	-117.206139
Santa Ana	Santa Ana River at Highgrove	801AHG857	Receiving Water (Dry)	34.01752	-117.36871
Santa Margarita River WMA (Riverside County) – WQIP					
Santa Margarita	Upper Santa Margarita River	902USM828[1,2]	Long-term Receiving Water	33.47403	-117.14233
Santa Margarita	Wilson Creek	902WLC650	NEW Long-term Receiving Water	33.47403	-117.14233
Santa Margarita	Outlet to W side of Tucalota Creek south of Murrieta Hot Springs Road	902MS41033	Outfall (Wet Weather)	33.55212	-117.13641
Santa Margarita	Outlet to Temecula Creek @ South of Breeze Way Pl and Summit View Pl	902MS42240	Outfall (Wet Weather)	33.48655	-117.06365
Santa Margarita	Outlet to Warm Springs Creek d/s of M.H.S. Rd.	902MS44034	Outfall (Wet Weather)	33.54753	-117.17189
Santa Margarita	Outlet to Murrieta Creek @ Diaz Rd behind RCWD pump station	902MS43015	Outfall (Wet Weather)	33.51649	-117.17233
Santa Margarita	Outlet to NW side of Wildomar Channel @ Gruwell Street	902MS45031	Outfall (Wet Weather)	33.60365	-117.27866

[1] Selected as the Long-term Receiving Water station as part of the WQIP.
[2] Historical receiving water station for stream assessment monitoring under the prior permit and during the Transitional monitoring requirement of the 2015 Regional Permit.
[3] Temporary relocation approved by the Regional Board in their letter dated September 01, 2020. Station may be used between October 2020 and February 2021 due to road construction.

Watershed	Station Name	Station Number	Station Type	Latitude	Longitude
Santa Margarita	Outlet to Santa Gertrudis Creek Channel West of I15 (Right Outlet)	902MS41025	Outfall (Dry Weather)	33.52413	-117.16518
Santa Margarita	Outlet to East side of Tucolata Creek South of Murrieta Hot Springs Road	902MS41032	Outfall (Dry Weather)	33.55210	-117.13610
Santa Margarita	Outlet to Tucolata Creek North West of Encanto Rd b/t Pereza Ct Castillo Rd	902MS41037	Outfall (Dry Weather)	33.56805	-117.11032
Santa Margarita	Outlet to Tributary of Murrieta Creek – California Oaks Spinning Wheel Drive Storm Drain South of Spinning Wheel Dr	902MS41060	Outfall (Dry Weather)	33.59447	-117.21376
Santa Margarita	Outlet to Tributary of Murrieta Creek - Nutmeg SD North of Lafayette Dr	902MS41061	Outfall (Dry Weather)	33.59424	-117.20662
Santa Margarita	Outlet to North side of Tucalota Creek East of Westridge Dr	902MS42207	Outfall (Dry Weather)	33.57613	-117.10513
Santa Margarita	Outlet to Benton Creek Channel East of Pourroy Rd	902MS42211	Outfall (Dry Weather)	33.59392	-117.10048
Santa Margarita	Outlet to French Valley Channel West @Skyview Rd (Right Outlet)	902MS42235	Outfall (Dry Weather)	33.60653	-117.10695
Santa Margarita	Outlet to French Valley Channel West @Skyview Rd (Left Outlet)	902MS42236	Outfall (Dry Weather)	33.60653	-117.10695
Santa Margarita	Outlet to North side of Morgan Valley Wash @ Chimisal Rd and Verde Rd	902MS42245	Outfall (Dry Weather)	33.46643	-117.06972
Santa Margarita	Outlet to Warm Springs Channel North West of Jefferson Ave	902MS44030	Outfall (Dry Weather)	33.53306	-117.17641
Santa Margarita	Outlet to East side of Warm Springs Creek South of Murrieta Hot Springs Road (Left Outlet)	902MS44038	Outfall (Dry Weather)	33.55677	-117.15994
Santa Margarita	Outlet to East side of Warm Springs Creek South of Murrieta Hot Springs Road (Right Outlet)	902MS44039	Outfall (Dry Weather)	33.55669	-117.15997

Watershed	Station Name	Station Number	Station Type	Latitude	Longitude
Santa Margarita	Outlet d/s Murrieta Creek MDP Line D @ Murrieta Hot Springs Rd (Left Box)	902MS44062	Outfall (Dry Weather)	33.58216	-117.25621
Santa Margarita	Outlet d/s Murrieta Creek MDP Line D @ Murrieta Hot Springs Rd (Right Pipe)	902MS44063	Outfall (Dry Weather)	33.58121	-117.25659
Santa Margarita	Outlet North of Rancho Crystalaire Dr and East of Honors Dr	902MS43038	Outfall (Dry Weather)	33.50957	-117.11595
Santa Margarita	Outlet North of Pachanga Pkwy East of Trotsdale Dr	902MS43082	Outfall (Dry Weather)	33.47177	-117.12212
Santa Margarita	Outlet to Santa Gertrudis Creek Channel North of Santa Gertrudis Creek Trail and Ynez Rd	902MS43119	Outfall (Dry Weather)	33.52570	-117.16112
Santa Margarita	Outlet to Santa Gertrudis Creek Channel West of Margarita Rd @ Santa Gertrudis Creek Trail	902MS43120	Outfall (Dry Weather)	33.53049	-117.15517
Santa Margarita	Outlet to Santa Gertrudis Creek @ Santa Gertrudis Creek Trail and Margarita Rd	902MS43123	Outfall (Dry Weather)	33.53346	-117.15253
Santa Margarita	Outlet East side of Elizabeth Lane South of Clinton Keith	902MS45012	Outfall (Dry Weather)	33.59669	-117.22815
Santa Margarita	Outlet South side of Country Park Dr East of Smith Ranch Rd	902MS45015	Outfall (Dry Weather)	33.60056	-117.22509
Santa Margarita	Outlet u/s Oak Creek Rd SD North of Clinton Keith @ Loring Rd	902MS45019	Outfall (Dry Weather)	33.60141	-117.22081
~~Santa Margarita~~	~~Outlet South side of La Estrella St b/t Trig Rd and Salida del Sol~~	~~902MS45024~~	~~Outfall (Dry Weather)~~	~~33.60506~~	~~-117.23376~~
Santa Margarita	Outlet u/s Oak Creek Rd SD South of Clinton Keith @ Hitching Post Ln	902MS45026	Outfall (Dry Weather)	33.59711	-117.22281
Santa Margarita	Outlet North of Clinton Keith Rd West of Stable Lanes Rd	902MS45028	Outfall (Dry Weather)	33.59250	-117.24972
Whitewater River Region					
Whitewater	Ramsey Street	719RMS782	Storm Drain	33.92516	-116.85851

Watershed	Station Name	Station Number	Station Type	Latitude	Longitude
Whitewater	Portola Avenue	719POR817	Outfall	33.73778	-116.37346
Whitewater	CVSC at Avenue 52 Bridge	719CVS884	Receiving Water	33.67247	-116.14939

Note: Monitoring locations for other efforts, such as Special Projects or Regional Programs are not included herein. Refer to the respective Workplans.

APPENDIX D:

CLEAN HANDS/ DIRTY HANDS SOP

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▶ Recommendation: Clean-sampling techniques are recommended when collecting samples for analysis of trace-organic compounds and major inorganic elements, particularly when the target analyte could be subject to contamination from field or laboratory procedures at a level that could exceed data-quality requirements.

Table 4-2. Clean Hands/Dirty Hands techniques for water-quality sampling

- Clean Hands/Dirty Hands techniques require two or more people working together.
- At the field site, one person is designated as Clean Hands (*CH*) and a second person as Dirty Hands (*DH*). Although specific tasks are assigned at the start to *CH* or *DH*, some tasks overlap and can be handled by either, as long as the prescribed care is taken to prevent contaminating the sample.
- Both *CH* and *DH* wear appropriate disposable, powderless gloves during the entire sampling operation and change gloves frequently, usually with each change in task. (Wearing multiple layers of gloves allows rapid glove changes.) Gloves must be appropriate to withstand any acid, solvent, or other chemical substance that will be used or contacted.
- *CH* takes care of all operations involving equipment that contacts the sample; for example, *CH*
  - Handles the surface-water sampler bottle.
  - Handles the discharge end of the surface-water or ground-water sample tubing.
  - Transfers sample to churn or cone splitter.
  - Prepares a clean work space (inside vehicle).
  - Sets up processing and preservation chambers.
  - Places equipment inside chambers (for example, sample bottles, filtration and preservation equipment).
  - Works exclusively inside chambers during collection/processing and preservation.
  - Changes chamber covers, as needed.
  - Sets up field-cleaning equipment and cleans equipment.
- *DH* takes care of all operations involving contact with potential sources of contamination; for example, *DH*
  - Works exclusively exterior to processing and preservation chambers.
  - Prepares and operates sampling equipment, including pumps and discrete samplers, peristaltic pump switch, pump controller, manifold system.
  - Operates cranes, tripods, drill rigs, vehicles, or other support equipment.
  - Handles the compressor or other power supply for samplers.
  - Handles tools such as hammers, wrenches, keys, locks, and sample-flow manifolds.
  - Handles single or multiparameter instruments for field measurements.
  - Handles the churn carrier, including outer protective bags.
  - Handles stream-gaging or water-level equipment.
  - Sets up and calibrates field-measurement instruments.
  - Measures and records water levels and field measurements.

APPENDIX E:

SOPS FOR CONDUCTING FIELD MEASUREMENTS AND FIELD COLLECTION OF WATER AND BED SEDIMENT SAMPLES IN SWAMP

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Collections of Water and Bed Sediment Samples with Associated Field Measurements and Physical Habitat in California.Version 1.1 updated March-2014

The SOPs below are for reference and information purposes only, the documents are recommended, not required by the Surface Water Ambient Monitoring Program (SWAMP). Please see the SWAMP Quality Assurance Program Plan at: http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa for more information regarding SWAMP QA/QC requirements.

Table of Contents

For the purpose of implementing the requirements of the Riverside County Flood Control and Water Conservation District's (District) Monitoring Programs, as described in the Consolidated Monitoring Program (CMP), the following SOP includes additional redlines and notes (for clarity) and highlights (for emphasis) describing adaptations to the procedures herein as specific to the District's monitoring staff. Otherwise all guidance provided herein should be considered as relevant to compliance monitoring activities as conducted by others.

Acknowledgements:

This procedure has been modified from the Texas Natural Resources Conservation Commission's Procedure Manual for Surface Water Quality Monitoring, with major input from the United State's Geological Survey's (USGS's) National Water Quality Assessment (NAWQA) Protocol for Collection of Stream Water Samples, for which due credit is here with given.

The current version of these protocols was written by Sean Mundell (Moss Landing Marine Labs MPSL Field Sampling Team) with most of the credit to Max Puckett(CDFW) for originally writing this document for part of the original SWAMP QAMP, 2001. Significant contributions also came from Eric von der Geest and the (SWAMP) Quality Assurance (QA) Team, The SWAMP Data Management Team(DMT), Billy Jakl(MPSL), Mary Hamilton (RWQCB 3), and Bettina Sohst(former MPSL employee),

Field Measurements

Field Data Sheets (Refer to the District's CMP Vol. II - Appendix B for equivalent Field Data Sheet)

Field data sheets are used to record field observations, probe measurements, and water and sediment chemistry sampling. Field data sheets are provided through the Marine Pollution Studies Laboratory website at http://swamp.mpsl.mlml.calstate.edu/resources-and-downloads/database-management-systems/swamp-25-database/templates-25/field-data-sheets#WQFieldData

Click on the correct field data sheet for the most recent version. There are guidelines provided below to standardize what is recorded on all data sheets and that should be helpful in completing each form. The entries discussed below and on the field data sheets are recorded at each sampling site.

Notes to Standardize SWAMP Field Data Sheets (For in the field use)

General details commonly relevant to the District's Monitoring Programs are highlighted in yellow for emphasis.

KEY REMINDERS to IDENTIFY SAMPLES:

1. **SAMPLE TIME** is the SAME for all samples (Water, Sediment, & Probe) taken at the sampling event. Use time of FIRST sample; important for COC (is used for identification of sample).
2. **LEFT BANK/RIGHT BANK**
   Left bank is defined as the bank to the left of the observer when facing downstream, and the *right bank* is to the right of the observer when facing downstream
3. **GROUP;** many different ways to do a group, one suggestion is to create groups which assign trips to assess frequency of field QA

SAMPLE TIME: The District's current practice is to record sample time as real time for field measurements via probe, grab sample, and/or last aliquot collected for the composite. These types of samples may be with 5-10 minutes of each other.

COLLECTION DETAILS:

1. **PERSONELL**: S. Mundell, G Ichikawa (first person listed is crew leader)
2. **LOCATION:** Bank, Thalweg, Mid-Channel, Open Water**.** Use "open water" in bay/estuary/harbor only if no distinguishable channel exists
3. **GRAB vs. INTEGRATED**: GRAB samples are when bottles are filled from a single depth; INTEGRATED sample are taken from MULTIPLE depths/grabs and combined.
   A. GRAB: use 0.1 for subsurface samples; if too shallow to submerge bottle; depth = 0
   B. INTEGRATED: -88 in depth sampled, record depths combined in sample comments
4. **TARGET LAT/LONG**: Refers to the existing station location that the sampling crew is trying to achieve; can be filled out prior to sampling
5. **ACTUAL LAT/ LONG**: is the location of the current sample event.
6. **HYDROMODIFICATION:** Describe existing hydro modifications such as a grade control, drainage pipes, bridge, culvert
7. **HYDROMOD LOC**: if there is an IMMEDIATE (with in range potentially effecting sample) hydro modification; Is the hydro modification upstream/downstream/within area of sample; if there is no hydro modification, NA is appropriate
8. **STREAM WIDTH and DEPTH**: describe in meters at point of sample.

FIELD OBSERVATIONS: (each one of these observations has a comment field in the database so use comment space on data sheet to add information about an observation if necessary)

1. **PICTURES:** use space to record picture numbers given by camera; be sure to rename accordingly back in the office. (StationCode_yyyy_mm_dd_unique code)
2. **WADEABILITY**: in general, is water body being sampled wadeable to the average person AT the POINT of SAMPLE **BEWARE OF VELOCITY!**
3. **DOMINANT SUBSTRATE**: if possible; describe DOMINANT substrate type; use UNK if you cannot see the dominant substrate type
4. **BEAUFORT SCALE**: use scale 0-12; refer to scales listed on page 28
5. **WIND DIRECTION**: records the direction from which the wind is blowing
6. **OTHER PRESENCE**: VASCULAR refers to terrestrial plants or submerged aquatic vegetation

ORDER OF ACTIVITIES:
(a) Sample
(b) Measurements
(c) Photo
(modify as necessary based on site conditions)

(SAV) and NONVASCULAR refers to plankton, periphyton etc. These definitions apply to vegetation IN the water at the immediate sampling area.

7. **OBSERVED FLOW**: Visual estimates of flow range in cubic feet/second. Flow severity should be noted for each SWAMP visit to non-tidally influenced flowing streams and submitted on the SWAMP Field Data Sheet. It should be recorded even if flow is visible but not measurable on that sampling visit. This is an observational measurement that is highly dependent on the knowledge of monitoring personnel.
8. **WATER COLOR**: This is the color of the water from standing creek side
9. **WATER CLARITY**: this describes the clarity of the water while standing creek side; clear represents water that is clear to the bottom, cloudy may not be clear to bottom but greater than 4 inches can be seen through the water column.
10. **PRECIPITATION LAST24hrs:** refers to field crew's best categorization of rainfall in the last 24 hrs; may or may not effect Overland Runoff Last 24 hrs
11. **OVERLAND RUNOFF LAST 24 hrs**: Significant precipitation is defined as any amount that visibly influences water quality. Light Precipitation = fog, drizzle, and/or light rain with no overland runoff; Mod to Heavy Precipitation = rain such that site probably or definitely received at least some overland runoff.
12. **SEDIMENT COMP**: generally described sediments used for chemistry sample Note: these reminders do not give all details needed to maintain equivalent SWAMP sampling protocols, they are strictly for "infield" use to help insure comparability of field observations.
13. **WATER APPEARANCE:** Note general appearance (e.g., color, unusual amount of suspended matter, debris or foam)
14. **SEDIMENT APPEARANCE** Color, Odor and sediment composition should be noted.
15. **WEATHER:** Note recent meteorological events that may have impacted water quality; (e.g., heavy rains, cold front, very dry, very wet)
16. **BIOLOGICAL ACTIVITY:** Note excessive macrophyte, phytoplankton or periphyton growth. The observation of water color and excessive algal growth is very important in explaining high chlorophyll a values. Other observations such as presence of fish, birds and spawning fish are noted.
17. **WATERSHED or INSTREAM ACTIVITIES:** Note in stream or drainage basin activities or events that is impacting water quality (e.g., bridge construction, shoreline mowing, livestock watering upstream).
18. **RECORD of PERTINENT OBSERVATIONS RELATED to WATER QUALITY and STREAM USES:** If the water quality conditions are exceptionally poor, note that standards are not met in the observations, (e.g., dissolved oxygen is below minimum criteria). Note uses (e.g., swimming, wading, boating, fishing, irrigation pumps, navigation). Eventually, for setting water quality standards, the level of use will be based on comments related to the level of fishing and swimming activities observed at a station.
19. **SPECIFIC SAMPLE INFORMATION:** Note specific comments about the sample itself that may be useful in interpreting the results of the analysis (e.g., number of sediment grabs, or type and number of fish in a tissue sample). If the sample was collected for a complaint or fish kill, make a note of this in the observation section.
20. **MISSING PARAMETERS:** If a scheduled parameter or group of parameters is not collected, make some note of this in the comments. If possible, request for lab to analyze any missed parameters and note on the COC.
21. **RECORD of DATA SUBMISSION:** Initials and date are recorded on the field data sheet showing a record that the data has been transcribed onto data forms and submitted to the ~~SWAMP~~ *Typical.* District's Data Manager data management staff.

Record of Samples Collected for Purposes of Chemical Analysis

The general types of chemical samples to be collected are listed for each site, since this may vary from site-to-site (e.g., metals-in-water, pesticides-in-sediments, conventional water quality). Analyses authorization forms are recommended since different authorized laboratories perform different chemical analyses. The method of preservation for each chemical sample is recorded, as appropriate on the Chain of Custody Form (COC).

Field Data Measurements

While collecting water samples (see Field Collection Procedures for Water Samples page 29), record appropriate field measurements. When field measurements are made with a multi-parameter instrument, it is preferable to place the sonde in the body of water to be sampled and allow the dissolved oxygen (D.O.) to equilibrate. D.O. usually takes the longest to equilibrate out of the probe measurements (pH, Temperature, Conductivity and Turbidity) Field measurements are made at the centroid of flow, if the stream visually appears to be completely mixed from shore to shore. *Centroid* is defined as the midpoint of that portion of the stream width which contains 50% of the total flow. Probe measurements and water sampling are best to collect in the stream location that best represents the entire stream. For routine field measurements, the date, time and depth are reported as a grab. Quality control requirements for field measurements are listed in Quality Control and Sample Handling Tables for Field Measurements in Fresh and Marine Water. ***WARNING** Due to potential safety concerns, (e.g., high velocity flows, hazardous debris, etc.) to avoid injury District staff shall NOT face backwards in streams, rivers, or channels. Probes will be faced upstream.***

Recommended Depths for Conducting Field Data Measurements

Water Depth Less than 5 ft (<1.5 m)

If the water depth is less than 5 ft (1.5 m), grab samples for water are taken at approximately 0.1 m (4 in.), and multi-probe measurements are taken at approximately 0.2 m (8 in.). This is because all sensors have to be submerged, so 0.1 m would not be deep enough. But taking a grab sample at 0.2 m is not always feasible, as it is difficult to submerge bottles to that depth, and in many cases the bottle will hit the stream bottom.

Water Depth Greater than 5 ft (>1.5 m)

If the water depth at the sampling point exceeds 5 ft (1.5 m) in depth, a vertical profile of dissolved oxygen, temperature, pH and specific conductance are made using the multi-parameter probe equipment. The depth of the sonde at the time of measurement is most accurately determined from the depth sensor on the multi-parameter sonde rather than depth labels on the cable.

~~**Vertical Depth Profiles and Depth-Integrated Sample Collection**~~

Vertical profile measurements are not part of the monitoring conducted by District staff.

~~If depth integration sampling is being conducted, or if vertical profile measurements are requested, multi-probe measurements are made starting at a depth of 0.2 m, and are then conducted at 1.0, 2.0, 3.0, 4.0, and 5.0 m depths after that until 5.0 m depth is reached. Beginning at 5.0 m, measurements are made every 5.0 m through depth profile.~~

Field data for multi-parameter vertical depth profiles are recorded in final form on the SWAMP Field Data Sheets and submitted to the SWAMP data management staff. Go to http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa for detailed information on data reporting.

Water Temperature (^{O}C)

Water temperature data are recorded for each site visit in final form on a Field Data Sheet and submitted to the ~~SWAMP~~ data management staff.

Temperature Sampling Procedures

Temperature is measured in-stream at the depth(s) specified above. Measuring temperature directly from the stream by immersing a multi-probe instrument or thermometer is preferred.

Hand Held Centigrade Thermometer

If an electronic meter is not available, the temperature is measured with a hand-held, centigrade thermometer (Rawson, 1982).

- < In wadeable streams, stand so that a shadow is cast upon the site for temperature measurement.
- < Hold the thermometer by its top and immerse it in the water. Position the thermometer so that the scale can be read.
- < Allow the thermometer to stabilize for at least one minute, then without removing the thermometer from the water, read the temperature to the nearest 0.1^{o} C and record.
- < Do not read temperature with the thermometer out of the water. Temperature readings made with modern digital instruments are accurate to within $\pm$ 0.1^{o} C.

Temperature Measurement from a Bucket

When temperature cannot be measured in-stream, it can be measured in a bucket-Nalgene or plastic container. Care must be taken to insure a measurement representative of in-stream conditions.

The following conditions must be met when measuring temperature from a bucket:

- ≤ The bucket must be large enough to allow full immersion of the probe or thermometer.
- ≤ The bucket must be brought to the same temperature as the water before it is filled.
- ≤ The probe must be placed in the bucket immediately, before the temperature changes.
- ≤ The bucket must be shaded from direct sunlight and strong breezes prior to and during temperature measurement.
- ≤ The probe is allowed to equilibrate for at least one minute before temperature is recorded.
- ≤ After these measurements are made, this water is discarded and another sample is drawn for water samples which are sent to the laboratory.

pH (standard units)

pH data is recorded for each SWAMP visit in final form on the Field Data Sheets and submitted to the SWAMP data management staff. Go to http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa for detailed information on data reporting.

pH Sampling Equipment

The pH meter should be calibrated according to the recommended procedures for calibration and maintenance of SWAMP field equipment. Calibration directions are listed in the manufactures field equipment operations manual. The pH function is pre and post calibrated every 24 h of use for multi-parameter instruments.

Typical - Follow the manufacturer's recommendations. Calibrate pH meter within 7 days of use. No post calibration unless an issue is identified in the field with a meter reading.

pH Sampling Procedures

In-stream Method

Preferably, pH is measured directly in-stream at the depth(s) specified earlier in this document. Allow the pH probe to equilibrate for at least one minute before pH is recorded to the nearest 0.1 pH unit.

pH Measurement from a Bucket

When pH cannot be measured in-stream, it can be measured in a bucket-Nalgene or plastic container. The following precautions are outlined above; “Temperature Measurement from a Bucket”.

Potential Problems

- If the pH meter value does not stabilize in several minutes, out gassing of carbon dioxide or hydrogen sulfide, or the settling of charged clay particles may be occurring (Rawson, 1982).
- If out gassing is suspected as the cause of meter drift, collect a fresh sample, immerse the pH probe and read pH at one minute.
- If suspended clay particles are the suspected cause of meter drift, allow the sample to settle for 10 min, then read the pH in the upper layer of sample without agitating the sample.
- With care, pH measurements can be accurately measured to the nearest 0.1 pH unit.

Dissolved Oxygen (mg/L)

Dissolved oxygen (D.O.) data is recorded for each SWAMP visit in final form on a Field Data Sheet and submitted to the SWAMP data management staff.
See http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa for detailed information on data reporting.

Dissolved Oxygen Sampling Equipment

The dissolved oxygen meter should be calibrated according to the recommended procedures for calibration and maintenance of SWAMP field equipment. Calibration directions are listed in the manufactures field equipment operations manual.

Multi-probe Instrument

Pre and post calibrate the D.O. sensor every 24 h and for elevations greater than 500 ft on the multi-probe instrument. Preferably, D.O. is measured directly in-stream at the depth(s) specified in the Field Measurements section above. The D.O. probe must equilibrate for at least 90 s before D.O. is recorded to the nearest 0.1 % saturation or mg/L. Care must be taken at profile stations to insure that the reading is stable for each depth. Since dissolved oxygen takes the longest to stabilize, record this parameter after temperature, conductivity and pH. If the D.O. probe has an operable, automatic stirrer attached, the D.O. probe does not have to be manually stirred. However, if the probe is not equipped with an automatic stirrer, manual stirring must be provided by raising and lowering the probe at a rate of 1 ft/s (0.3m/s) without agitating the water surface. If the stream velocity at the sampling point exceeds 1 ft/s, the probe membrane can be pointed upstream into the flow and manual stirring can be avoided (Rawson, 1982).

Typical - Follow the manufacturer's recommendations. Calibrate DO meter within 7 days of use. No post calibration unless an issue is identified with meter reading.

D.O. Measurement from a Bucket

When D.O. cannot be measured in-stream, it can be measured in a bucket-Nalgene or plastic container, following precautions outlined in the Temperature Measurement from a Bucket listed above. During equilibration and reading, water should be moved past the membrane surface at a velocity of 1 ft/s (0.3 m/sec), either by automatic stirrer or manual stirring. If stirred manually in a bucket, the water surface is not agitated (Rawson, 1982).

Meters are equipped with an automatic stirrer. Use the stirrer if measurements are NOT taken *in situ*.

24-Hour Average D.O. Continuous Monitoring (if requested in special study)

NOT APPLICABLE: This is not a current practice under the District's Monitoring Program.

Unattended 24-Hour D.O. Data Collection

Why Collect 24-Hour Data

Dissolved oxygen sampling for standards compliance is targeted to water bodies where low instantaneous D.O. levels indicate partial or nonsupport of designated aquatic life uses. Intensive monitoring is conducted with automated equipment that is preset to record and store field measurements hourly over one 24-h period. Four or more dissolved oxygen measurements may also be made manually at 4-6-h intervals over one 24-h period, as long as one is made near sunrise (0500-0900 h) to approximate the daily minimum. However, data collected with automated equipment is preferred.

When to Take Measurements

All 24-h D.O. monitoring events must be spaced over an index period representing warm-weather seasons of the year (approx March 15-October 15), with between one-half to two-thirds of the measurements occurring during the critical period (July 1-September 30). The ***critical period*** of the year is when minimum stream flows, maximum temperatures, and minimum dissolved oxygen concentrations typically occur in area streams. **A flow measurement must be taken at the time of deployment.** In a perennial stream, a 24-h data for standards compliance can not be used if the flow is less than the 7Q2. In perennial streams, the D.O. criterion to do not apply for flows under the 7Q2. A period of about one month must separate each 24-h sampling event. Additional samples may be collected outside the index period to further characterize a water body, but that information is generally not used for assessing standards compliance.

Frequency of Measurements

The measurement interval should be no more than once per 15 min and no less than once per hour.

NOT APPLICABLE: This is not a current practice under the District's Monitoring Program.

Where to Take Measurements

For purposes of determining standards compliance with the 24-h average criteria, samples collected near the surface will be considered representative of the mixed surface layer. In deep streams, reservoirs, and tidally influenced water bodies, automated equipment is positioned between 1 foot (from the surface) to one-half the depth of the mixed surface layer. At least 10 24-h monitoring events (using the 24-h criteria and/or absolute minimum criteria) at each site within a 5-year period are recommended to provide adequate data for assessment.

When to Collect Other Routine Samples, if doing 24-hour D.O. measurements

Other routine field measurements and water samples should be collect at either the time of deployment, at the reference check, or when the multi-probe recording 24-h data is retrieved. When ever possible, flow must be measured at the 24-h site.

Priority for Scheduling 24-Hour Sampling Events

- < 303d listed waterbodies
- < Waterbodies with Concerns for DO problems (too few samples available for full use assessment).
- < Occurrence of low D.O. concentrations observed during the day
- < Waterbodies with trends indicating declining D.O. concentrations
- < Waterbodies which would contribute to an Eco-region data set

Data Reporting for 24-hour D.O. measurements

Dissolved oxygen values recorded over the 24-h period are summed and divided by the number of measurements to determine the average concentration, which is compared to the 24-h criterion. The lowest D.O. value from each 24-h set is compared to the minimum criterion. There will be occasions when a complete 24-h data set won't be possible. For example, if there are 18 measurements instead of 24, a time weighted diurnal average needs to be calculated. This can be easily done using GW Basic.

Support of assigned aquatic life use is based on 24-h D.O. average and minimum criteria for each monitoring event. Report the 24-h average D.O. value, number of measurements over a 24-h period, and the minimum, and maximum values. Report data as a time composite sample with a beginning and ending date and time, covering the 24-h period measured.

Specific Conductance (µS/cm)

Specific conductance should be recorded for each SWAMP visit in final form on a Field Data Sheet and submitted to the ~~SWAMP~~ data management staff.
See http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa for detailed information on data reporting.

Specific Conductance Sampling Equipment

The conductivity meter should be calibrated according to the recommended procedures for calibration and maintenance of SWAMP field equipment. Calibration directions are listed in the manufactures field equipment operations manual.

Specific Conductance Sampling Procedure

Preferably, conductivity is measured directly in-stream at the depth(s) specified earlier in this document. Allow the conductivity probe to equilibrate for at least one minute before specific conductance is recorded to three significant figures (if the value exceeds 100). The primary physical problem in using a specific conductance meter is entrapment of air in the conductivity probe chambers. The presence of air in the probe is indicated by unstable specific conductance values fluctuating up to +/-100 µS/cm. The entrainment of air can be minimized by slowly, carefully placing the probe into the water; and when the probe is completely submerged, quickly move it through the water to release any air bubbles.

If specific conductance cannot be measured in-stream, it should be measured in the container it can be measured in a bucket-Nalgene or plastic container. The following precautions are outlined above; "Temperature Measurement from a Bucket".

Salinity (parts per thousand--ppt, or ‰) This only applies to SMC Bioassessment - conducted by others

The value for salinity is computed from chloride concentration or specific conductance. The calculation assumes a nearly constant ratio for major ions in an estuary when seawater is diluted by river water. This assumption does not hold for cases where salinity is less than about three parts per thousand. Salinity determinations at such low values are only approximate. In estuarine waters, salinity is a relevant and meaningful parameter. Often the salinity may be low, approaching that of freshwater. Nevertheless, this is useful information. Determine if a station is estuarine from historical records (i.e., experiences cases where salinity is >2.0 ppt) and always report salinity at this station, regardless of the salinity during periods of high flow.

Salinity is measured directly in-stream at the depth(s) specified earlier in this document. Salinity data should be recorded for each SWAMP visit in final form on a Field Data Sheet and submitted to the SWAMP data management staff. See http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa for detailed information on data reporting.

Values between 2.0 ppt and 1.0 ppt should be reported as <2.0 ppt rather than the actual value and values <1.0 ppt should be reported as <1.0 ppt. The field instruments compute salinity from specific conductance and temperature, and display the value in parts per thousand. Report salinity values above 2.0 ppt to the nearest 0.1 ppt.

NOT APPLICABLE: This is not a current practice conducted by District field staff.
However, it may used for TMDL monitoring - conducted by others.

Secchi Disc Transparency (meters)--if requested in special study

NOT APPLICABLE: This is not a current practice conducted by District field staff.
However, it may used for TMDL monitoring - conducted by others.

Secchi disk transparency should be recorded for each SWAMP visit in final form on a Field Data Sheet and submitted to the SWAMP data management staff. See http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa for detailed information on data reporting.

Secchi Disk Sampling Equipment

- Secchi disk, 20 cm in diameter
- Measuring tape

Secchi Disk Transparency Sampling Procedures

Preferably, Secchi disk transparency is measured directly in-stream wherever conditions allow. The Secchi disk should be clean, weighted and suspended with chain, wire, or Dacron line (the line used to suspend the Secchi disk should not be nylon or cotton; stretching may cause erroneous readings). Another option is to attach the Secchi disk to a metal rod calibrated in metric units.

Average Turbidity

The Secchi disk should be lowered vertically in a location shielded from direct sunlight. Glare from the water's surface will affect the accuracy of the measurement. Don't wear sunglasses.

Slowly lower the disk until it disappears from view. The person viewing the disk should maintain an eye level of less than two meters above the water's surface. Note the depth at which the disk disappears from view.

Slowly raise the disk until it becomes visible. Note the depth at which the disk reappears.

Compute the mathematical average of the two depths noted and record the average value to two significant figures on the field data sheet. The recorded average value is the Secchi disk transparency.

High Turbidity (Muddy Water)

In streams with very high turbidity, high velocity, and/or poor access, it may be necessary to measure Secchi disk transparency in a bucket. Fill the bucket from the centroid of flow being careful not to disturb the substrate.

Follow steps above for measuring the Secchi disk depth within 30 s after raising the filled bucket from the water's surface. Or, re-suspend the solids by stirring, then quickly make the measurement.

Record Secchi disk transparency to two significant figures.

Low Turbidity (Clear Water)

Some bodies of water will be so clear and shallow that it will not be possible to lower the Secchi disk until it disappears from view.

Measure and record the depth at the deepest point accessible. Report Secchi disk transparency as greater than the deepest depth measured.

Example (Low Turbidity): South Fork Rocky Creek is a small (<1 ft^3/s) clear stream. The stream in the vicinity of the sampling site was less than 1 m deep and the bottom was clearly visible everywhere. However, a pool was located in the stream next to a bridge. The maximum depth of the pool was 2.6 m at which depth the Secchi disk was still visible. Therefore, Secchi disk transparency for South Fork Rocky Creek was recorded as > 2.6 m.

Importance of Secchi Disk Data

Eutrophication, the natural aging process in reservoirs and lakes is accelerated by human activities which add nutrients to lakes, reservoirs, and the surrounding watersheds. Section 314 of the Clean Water Act (CWA) of 1987 requires all states to classify lakes and reservoirs according to trophic state. Although chlorophyll a is the most direct measure of algal biomass, other indices and programs utilize Secchi disk depth as the primary factor.

Turbidity Measurement with Turbidity Meter

Nephelometric Turbidity (turbidity standard unit is called Nephelometric Turbidity Units (NTU)) can be determined by measuring the amount of scatter when light is passed through a sample using a turbidity meter. The LaMotte 2020 Turbidity meter is a suitable instrument for example. There are also turbid-ometers attached to multi-probe instruments like YSI or Hydro-Lab.

Turbidity meters should be calibrated using a standard close to the expected sample value. Calibration standards should be used that are relative to the suspended sediment particles in the sampleable water column. Typical calibration standard values are 1, 10, 100, and 1000 NTU's.

For instructions on how to operate the instruments refer to the manufacturer's manual. Turbidity measurements can be executed together with water sampling. The turbidity sample has to be representative for the sampled water mass. Make sure that no gas bubbles are trapped in the vial for the reading and that the outside of the vial is wiped completely clean (i.e., meaning free of moisture, lint and fingerprints). Take several measurements to assure an accurate reading. Do not record values that vary greatly. If variations are small, record an average. If settling particles are present, record a reading before and one after settling. The meter might have to be recalibrated with a different standard, if the sample water readings are outside of the calibration standard limits.

Flow

Sampling crews should be notified on reconnaissance forms if it is known that there is an operational United States Geological Survey (USGS) gage located at or nearby a sampling site. If there is a USGS gage nearby, a gage height in feet is recorded and later converted to an instantaneous flow value and recorded on the field data sheet. The gage height is always to be reported to the USGS for conversion to flow. If a USGS gage is not available, a flow measurement should be taken, if requested. See Instantaneous Flow Measurement information starting on page 13 in this document. In addition, it is recommended that a flow severity value is recorded at each stream or river station that is not tidally influenced. See the Flow Severity section starting on page 13 of this document. Centroid velocity measurements may also be taken as a minimum acceptable rough characterization of the stream flow as requested, although this measurement is not to be recorded as a flow, since it is only a velocity measurement
Flow information for over 200 USGS sites is available on the Internet. The address is **http://water.usgs.gov/index.html**. This is useful information in determining flow conditions prior to sampling. This information may be included in general observations.

Flow Measurement Method (Reporting)

This section contains several options for flow measurement approaches; however, per the District's Consolidated Monitoring program, taking in situ flow measurements via 'orange peel method is standard.

The method used to measure flow is noted by reporting which instrument or gage is used. Examples are, Flow Gage Station (USGS/IBWC), Electric Marsh-McBirney flo mate 4000, Mechanical (ex. Pigmy meter), Weir/Flume, Other (orange peel, etc.) Flow data transformers are used to enter flow data into the SWAMP database. Please contact the SWAMP data management team to obtain the flow data transformer.

Flow (ft^3/s)

If requested, flow data should be recorded for each monitoring visit to non-tidal, flowing streams. Flow data should be recorded in final form on a Field Data Sheet and submitted to the ~~SWAMP~~ data management staff. See http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa for detailed information on data reporting. The following are two exceptions to the flow reporting requirement:

No Flow/ Pools — If there is no flow at a stream site and accessible, isolated pools remain in the stream bed, collect and report the required field data and laboratory samples from the pools and report instantaneous flow. Under these conditions, flow (ft^3/s) should be reported as zero. The reported flow severity value should be one. Pools may represent natural low-flow conditions in some streams and the chemistry of these pools will reveal natural background conditions.

Dry — If the stream bed holds no water, the sampling visit is finished. Report that the stream was "dry" in the observations and record a value of six (meaning "dry") for flow severity. No value is reported for flow since there is no water.

Flow Measurement

See Page 20 & 21 - Flow Estimate Procedure
(District standard practice)

If a flow measurement is required at a site, measure and record flow after recording visual observations. The intent of measuring flow first is to delay collection of chemical and biological water samples with limited holding times. Care must be taken not to collect water samples in the area disturbed during flow measurement. There are several acceptable flow measurement methods that can be used.

This is an option for some sites for data confirmation; however, per the District's Consolidated Monitoring program, taking in situ flow measurements via 'orange peel method is a standard practice.

U.S. Geological Survey (USGS) Gaging Station

Some SWAMP Stations are sampled at sites where the USGS maintains flow gaging equipment. On any type of sampling visit to a site that has a USGS flow gage, observe and record the gage height to the nearest hundredth of a foot in the field logbook. Upon return to the office, contact the USGS office responsible for maintaining the gage. USGS personnel can provide the flow value in cubic feet per second (ft^3/s) that corresponds to the gage height. Although SWAMP personnel may have a rating curve available to them, shifts associated with changes in the stream bed may occur over time. Always call the USGS to determine the shift. At some sites the shift changes frequently. At others, the relation between stream flow and gage height is almost unchanging. If a gage is no longer maintained by USGS, cross out the recorded gage height and be prepared to measure flow by another method on the return visit to that site.

Several factors may influence the accuracy of the USGS rating curves that are used to convert gage height to flow. If there is any doubt about the accuracy of a USGS gage height reading or flow rating curve, sampling personnel should measure the flow if possible.

Gage height may be indicated at a USGS gage by one of three methods:

Staff Gage

Staff gages are enameled steel plates (with the appearance of large measuring tapes) bolted to some stable structure. For example, staff gages may be bolted to concrete bridge abutments, pillars, or docks. The staff gage face is white with black lettering and gradations. The gradations shown are feet, tenths of a foot, and 0.02 of a foot. The point at which the water level crosses the staff gage should be recorded to the nearest hundredth of a foot.

Wire Weight Gage

Wire weight gages are locked, metal boxes with approximate dimensions of 15 in. long x 12 in. tall x 12 in. deep. Wire weight gages are usually affixed to bridge rails near mid-stream. They must be unlocked with a USGS key. The wire weight gages house a weight attached by wire cable to a graduated reel (gradations are tenths and hundredths of feet) with a counter at one end.

When the reel is released the weight can be gradually lowered until the bottom of the weight contacts the water surface. At the point of contact, the weight causes the water surface to ripple slightly. Maintaining the weight in that position, record the counter value to the nearest whole number and the point indicated by the stylus on the graduated reel to the nearest hundredth of a foot. Determine if the gage is the movable type that can be moved to multiple locations on the bridge. This type is common on braided streams. A correction value is stamped on the bridge near each point that the gage can be attached.

Record the corrected value as the gage height in feet.

Bubble Gage

Bubble gages are locked in metal sheds that are approximately 4 ft wide x 4 ft deep x 6.5 ft tall. The gage houses are most frequently located on the shore near a bridge but sometimes are attached to bridge pillars near mid-stream or established on the stream bank far from any bridge. The gage house must be unlocked with a USGS key. Bubble gages in gage houses usually indicate the gage height in two or three locations. A counter attached to the manometer system indicates gage height in feet. Some gage houses have stilling wells that can be entered. Often there is a staff gage on the inside wall.

Most bubble gages are also equipped with digital recorders. Digital recorders consist of two white, coded discs, approximately 4 in. in diameter with a punch tape overlapping a portion of each disc. The discs are marked with 100 gradations. As the front of the digital recorder is viewed, the stylus at the disc on the left indicates height in feet. The stylus at the disc on the right indicates gage height in hundredths of feet. The gage height from both discs should be added and the number recorded in the field logbook as gage height to the nearest hundredth of a foot.

Many USGS metal sheds also contain a surface level recorder. This devise can be opened to determine how stable stream flow has been prior to the sampling event. Record observations concerning the flow hydrograph.

See Page 20 & 21 - Flow Estimate Procedure
(District standard practice)

Instantaneous Flow Measurement

Water quality monitoring visits to sites where there are no nearby USGS flow gauges will require water quality monitoring personnel to measure flow, when requested by Regional Water Quality Control Boards (Regional Boards).

Flow Measurement Equipment

Flow meter

One of the following or an equivalent:

- Marsh-McBirney Electronic meter
- Montedoro-Whitney Electronic meter
- Price Pigmy meter (with timer and beeper)
- Price meter, Type AA (with Columbus weight)

Additional Equipment

- Top-setting wading rod (preferably measured in tenths of feet)(see Figure 1).
- Tape measure (with gradations every tenth of a foot or every centimeter).

Flow Measurement Procedure (USGS, 1969)

Select a stream reach with the following characteristics:

- Straight reach with laminar flow (threads of velocity parallel to each other) and bank to bank. These conditions are typically found immediately upstream of riffle areas or places where the stream channel is constricted.

- The site should have an even streambed free of large rocks, weeds, and protruding obstructions that create turbulence. The site should not have dead water areas near the banks, and a minimum amount of turbulence or back eddies.

Flat Streambed Profile (cross section)

Stretch the measuring tape across the stream at right angles to the direction of flow. When using an electronic flow meter, the tape does not have to be exactly perpendicular to the bank (direction of flow). When using a propeller or pigmy type meter, however, corrections for deviation from perpendicular must be made.

If necessary and possible, modify the measuring cross section to provide acceptable conditions by building dikes to cut off dead water and shallow flows, remove rocks, weeds, and debris in the reach of stream one or two meters upstream from the measurement cross section. After modifying a streambed, allow the flow to stabilize before starting the flow measurement.

Record the following information on the flow measurement form (see example Flow Measurement Forms at end of this document):

- Station Location and Station ID
- Date
- Time measurement is initiated and ended
- Name of person(s) measuring flow
- Note if measurements are in feet or meters
- Total stream width and width of each measurement section
- For each cross section, record the mid-point, section depth and flow velocity

Measuring the Stream Width

Measure and record the stream width between the points where the tape is stretched (waters edge to waters edge).

Determining the Number of Flow Cross Sections

Determine the spacing and location of flow measurement sections. Some judgment is required depending on the shape of the stream bed. Measurements must be representative of the velocity within the cross-section. If the stream banks are straight and the depth is nearly constant and the bottom is free of large obstructions, fewer measurements are needed, because the flow is homogeneous over a large section. Flow measurement sections do not have to be equal width. However, they should be unless an obstacle or other obstruction prevents an accurate velocity measurement at that point. ***No flow measurement section should have greater than 10% of the total flow.***

If the *stream width is less than 5 ft*, use flow sections with a width of 0.5 ft (See example 1 on page 23 of this document). If the *stream width is greater than 5 ft*, the minimum number of flow measurements is 10. The preferred number of flow measurement cross sections is 20-30 (See Example 2 on page 24 on this document). The total stream width is 26 ft with 20 measurements, section widths will be 1.3 ft (26/20 = 1.3).

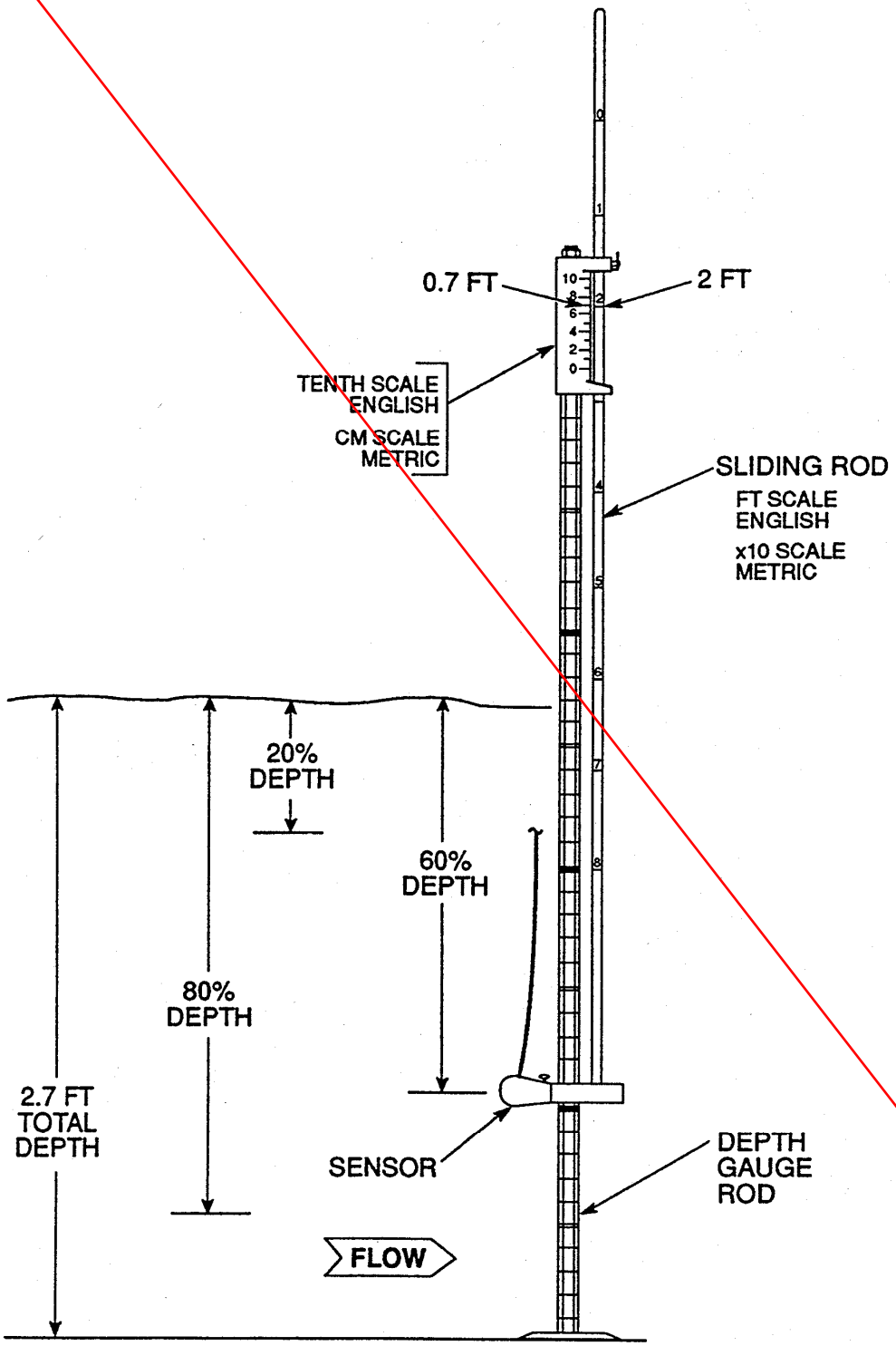
Determining the Mid-Point of the Cross Section

To find the mid-point of a cross section, divide the cross section width in half. Using Example 2 (see forms at end of document);

- The total stream width is 26 ft with 20 cross sections and each cross section width is equal to 1.3 ft.

- Divide 1.3 ft in half and the mid-point of the first section is 0.65 ft. In this example the tape at waters edge is set at zero (0) ft.
- By adding 0.65 to zero the mid-point of the first section is 0.65 ft.
- Each subsequent mid-point is found by adding the section width (1.3 ft) to the previous mid-point. For example; MIDPOINT #1 is 0.65 + 0.0 = 0.65; MIDPOINT #2 is 0.65 + 1.3= 1.95 ft; MIDPOINT #3 is 1.95 + 1.3 = 3.25 ft and … MIDPOINT # 20 is 24.05 +1.3.
- Place the top setting wading rod at 0.65 ft for the first measurement.
- Using a top setting wading rod, measure the depth at the mid-point of the first flow measurement section and record to the nearest 0.01 ft.

Figure 1. Top-Setting Wading Rod (Marsh-McBirney)



Adjusting the Sensor Depth at a Cross Section

Adjust the position of the sensor to the correct depth at each mid-point. The purpose of the top setting wading rod is to allow the user to easily set the sensor at 20%, 60%, and 80% of the total depth. The total depth can be measured with the *depth gage rod*. Each single mark represents 0.10 foot, each double mark represents 0.50 foot, and each triple mark represents 1.00 foot (see Figure 2).

For Depths < 2.5 Ft	If the depth is less than 2.5 ft, only one measurement is required at each measurement section. To set the sensor at 60% of the depth, line up the foot scale on the *sliding rod* with the *tenth scale*, located on top of the depth gage rod. If, for example, the total depth is 2.7 ft (as shown on Figure 2), then line up the 2 on the foot scale with the 7 on the tenth scale (Marsh-McBirney 1990).
For Depths > 2.5 Ft	If the depth is greater than 2.5 ft, measurements should be taken at 20% and 80% of the total depth.

Measuring Velocity (this has typically been measured at 6/10 of the total depth, for velocity-only measurements)

- Position the meter at the correct depth and place at the mid-point of the flow measurement section. Measure and record the velocity and depth. The wading rod is kept vertical and the flow sensor kept perpendicular to the tape rather than perpendicular to the flow while measuring velocity with an electronic flow meter. When using a propeller or pigmy-type meter, however, the instrument should be perpendicular to the flow.
- Permit the meter to adjust to the current for a few seconds. Measure the velocity for a minimum of 20 s with the Marsh-McBirney and Montedoro-Whitney meters. Measure velocity for a minimum of 40 s (preferably 2 min with the Price and pigmy meters).
- When measuring the flow by wading, stand in the position that least affects the velocity of the water passing the current meter. The person wading stands a minimum of 1.5 ft downstream and off to the side of the flow sensor.
- A flow sensor, equipped with cable and weight may be used to measure flows where the water is too deep to wade. Follow the procedure involving meters attached to wading rods.
- Report flow values less than 10 ft^2/s to two significant figures. Report flow values greater than 10 ft^3/s to the nearest whole number, but no more than three significant figures.
- In cases where the flow is low and falling over an obstruction, it may be possible to measure the flow by timing how long it takes to fill a bucket of known volume.

Avoid measuring flow in areas with back eddies. The first choice would be to select a site with no back eddy development. However, this can not be avoided in certain situations. Measure the

negative flows in the areas with back eddies. These negative values will be included in the final flow calculation.

Calculating Flow

To calculate flow, multiply the width x depth (ft^2) to derive the area of the flow measurement section. The area of the section is then multiplied by the velocity (ft/s) to calculate the flow in cubic feet per second (cfs or ft^3/sec) for that flow measurement section. When flow is calculated for all of the measurement sections, they are added together for the total stream flow (see Figure 2). Flow data transformers are also provided by the SWAMP data management team. The transformer provides the calculations needed to obtain a final flow value in cubic feet per second.

Q=Total Flow (or discharge), W=Width, D=Depth, V=Velocity.

$Q = (W_1 * D_1 * V_1) + (W_2 * D_2 * V_2) + ... (W_n * D_n * V_n)$

What to Do with Negative Values

Do not treat cross sections with negative flow values as zero. Negative values obtained from areas with back eddies should be subtracted during the summation of the flow for a site.

Flow Estimate (ft^3/s)

Flow estimate data may be recorded for a non-tidally influenced stream when it is not possible to measure flows by one of the methods described above. Flow estimates are subjective measures based on field personnel's experience and ability to estimate distances, depths, and velocities. If flow can not be measured at a routine non-tidal station, a new site should be selected where flow can be measured.

Flow Estimate Procedure

- Observe the stream and choose a reach of the stream where it is possible to estimate the stream cross section and velocity.
- Estimate stream width (ft) at that reach and record.
- Estimate average stream depth (ft) at that reach and record. Estimate stream velocity (ft/s) at that reach and record. A good way to do this is to time the travel of a piece of floating debris. If doing this method from a bridge, measure the width of the bridge. Have one person drop a floating object (something that can be distinguished from other floating material) at the upstream side of the bridge and say start. The person on the downstream side of the bridge will stop the clock when the floating object reaches the downstream side of the bridge. Divide the bridge width by the number of seconds to calculate the velocity. The velocity can be measured at multiple locations along the bridge. These velocities are averaged. ~~If this is done alone, watch for road traffic.~~
- Multiply stream width (ft) time's average stream depth (ft) to determine the cross sectional area (in ft^2) which when multiplied by the stream velocity (in ft/s) and a correction constant, gives an estimated flow (ft^3/s).

Example: A stream sampler conducted a sampling visit to a stream while the flow meter was being repaired. The sampler looked at the creek downstream from the bridge and saw a good place to estimate flow. The stream width was around 15 ft. It appeared the average depth on this reach was about 0.75 ft. The sampler timed a piece of floating debris as it moved a distance of 10 ft in 25 s downstream over the reach. An estimated flow with a smooth bottom was calculated using the following formula.

Width x Depth x Velocity x A (correction factor)= estimated flow
15 ft (width) x 0.75 ft (depth) x 2.5 ft/s (velocity) x A =25 ft^3/s (cfs)

A is a correction constant: 0.8 for rough bottom and 0.9 for smooth bottom

Estimated flow should be reported to one or two significant figures.

Experienced field personnel are able to estimate flow to within 20% of actual flow for total flows less than 50 ft^3/s. The best way to develop this skill is to practice estimating flow before making measurements at all monitoring visits to non-tidally influenced flowing streams and then compare estimated flows with those obtained from USGS gages or from instantaneous flow measurements

Figure 2. Stream Flow (Discharge) Measurement

District staff will use the program standard Field Data Sheet for collection and calculation of flow measurement.

Example 1.

Stream Flow (Discharge) Measurement

Small Stream < 5 Ft Wide and #2.5 Ft Deep

Stream:___**OAK CREEK**_____Date:__**5/29/91**___

Station Description:_____**at US Hwy 90A**_____

Time Begin:__**1545**_____Time End:__**1630**_____Meter Type:_**Marsh-McBirney**_____

Observers:_____**BK/MK**_____Stream Width*:____**5 ft**_____ Section Width:____**0.5 ft**_____

Observations:_____

Section Midpoint (ft)	Section Depth (ft)	Observational Depth** Ft	Velocity		Area W x D (ft^2)	Discharge (Q) V x A (ft^3/s)
			At Point (ft/s)	Average (ft/s)		
0.25	**0.55**			**0.05**		**0.01375**
0.75	**0.80**			**0.11**		**0.044**
1.25	**0.85**			**0.27**		**0.42635**
1.75	**0.90**			**0.49**		**0.2205**
2.25	**1.10**			**0.58**		**0.275**
2.75	**1.50**			**0.72**		**0.540**
3.25	**1.20**			**0.76**		**0.456**
3.75	**0.90**			**0.76**		**0.342**
4.25	**0.75**			**0.44**		**0.165**
4.75	**0.30**			**0.00**		**0.00**

m^3/s x 35.3 = ft^3/s

Total Discharge (3Q) (ft^3/s) **2.4826**

District staff will use the program standard Field Data Sheet for collection and calculation of flow measurement.

Example 2: Stream Discharge Measurement Example (Larger Stream > 5 Ft and #2.5 Ft Deep)

Stream:___**RED RIVER**_____Date:__**5/28/91**___

Station Description:_____**Post Oak Creek 40 m Below Sherman WWTP Outfall**_____

Time Begin:__**1542**_____Time End:__**1601**_____Meter Type:_**Marsh-McBirney**_____

Observers:_____**CM, EW, DO**_____Stream Width*:____**26 ft**___ Section Width:___**1.3 ft**_____

Observations:

Section Midpoint (ft)	Section Depth (ft)	Observational Depth** ft	Velocity		Area W x D (ft^2)	Discharge (Q) V x A (ft^3/s)
			At Point (ft/s)	Average (ft/s)		
0.65	0.55			2.03	0.715	1.451
1.95	0.40			2.04	0.520	1.061
3.25	0.42			2.02	0.546	1.103
4.55	0.38			1.77	0.494	0.874
5.25	0.40			1.75	0.520	0.910
7.15	0.42			1.93	0.546	1.054
8.45	0.40			1.99	0.52	1.035
9.75	0.37			1.92	0.481	0.924
11.05	0.37			1.56	0.481	0.750
12.35	0.43			1.32	0.559	0.738
13.65	0.40			1.36	0.520	0.707
14.95	0.42			1.33	0.546	0.726
16.25	0.40			1.35	0.520	0.702
17.55	0.45			1.64	0.585	0.959
18.85	0.48			1.70	0.624	1.061
20.15	0.48			2.00	0.624	1.248
21.45	0.50			1.95	0.650	1.268
22.75	0.40			2.18	0.520	1.134
24.05	0.48			1.71	0.624	1.067
25.35	0.50			0.60	0.650	0.390
m^3/s x 35.3 = ft^3/s				**Total Discharge (3Q) (ft^3/s)**		**19.162**

District staff will use the program standard Field Data Sheet for collection and calculation of flow measurement.

Example 3: Stream Flow (Discharge) Measurement (Larger Stream > 5 Ft and >2.5 Ft Deep)

Stream:____ARROYO COLORADO_____Date:__**6/16/98**__

Station Description:_____Downstream of Harlingen WWTP_____

Time Begin:__**1400**_____Time End:__**1445**_____Meter Type:__**Marsh-McBirney**_____

Observers:_____**JD, CK**_____Stream Width*:___**47.5 ft**___ Section Width:___**2.375 ft**_____

Observations: *Note that the starting point is at 4.7 ft on the measuring tape and not zero.

Section Midpoint (ft)	Section Depth (ft)	Observational Depth** ft	Velocity		Area W x D (ft^2)	Discharge (Q) V x A (ft^3/s)
			At Point (ft/sec)	Average (ft/sec)		
4.70	0.73			0.65	1.73	1.127
7.08	1.10			1.08	2.61	2.822
9.45	1.85			0.90	4.39	3.954
11.83	2.20			1.05	5.23	5.486
14.20	2.20			1.44	5.23	7.531
16.58	2.45			1.09	5.82	6.342
18.95	2.55	0.20	1.75	1.76	6.06	10.659
		0.80	1.76			
21.33	2.60	0.20	1.79	1.56	6.18	9.633
		0.80	1.32			
23.70	2.70	0.20	1.63	1.45	6.41	9.298
		0.80	1.26			
26.10	3.05	0.20	1.68	1.42	7.24	10.286
		0.80	1.15			
28.48	3.10	0.20	1.23	0.96	7.36	7.068
		0.80	0.69			
30.85	2.90	0.20	1.22	1.06	6.89	7.301
		0.80	0.89			
33.23	2.84	0.20	0.60	0.49	6.75	3.305
		0.80	0.37			
35.60	2.65	0.20	0.80	0.51	6.29	3.210
		0.80	0.21			
37.98	2.65	0.20	0.85	0.91	6.29	5.727
		0.80	0.96			
40.35	2.20			0.28	5.23	1.464
42.73	2.30			0.16	5.46	0.874
45.10	2.05			0.51	4.87	2.483
47.48	1.10			0.49	2.61	1.280
49.86	0.65			0.62	1.54	0.957

m^3/s x 35.3 = ft^3/s **Total Discharge (3Q) (ft^3/s)**

District staff will use the program standard Field Data Sheet for collection and calculation of flow measurement.

Stream Flow (Discharge) Measurement Form

Stream:____Date:______________

Station Description:____

Time Begin:__________ Time End:____________ Meter Type:_______________________

Observers:___________________Stream Width*:_____________ Section Width:___________

Observations:____

Section Midpoint (ft) (m)	**Section Depth (ft) (m) (cm)**	**Observational Depth** ft-m-cm**	**Velocity**		**Area W x D (ft^2) (m^2)**	**Flow (Q) V x A (m^3/s) (ft^3/s)**
			At Point (ft/s) (m/s)	**Average (ft/s)(m/s)**		

$m^3/s \times 35.3 = ft^3/s$

Total Flow (Discharge) (3Q) (ft^3/s)	

Make a minimum of 10 measurements when the total width is > 5.0 ft, 20 measurements preferred.

If the depth is less than 2.5 ft, only one measurement is required at each measurement section. To set the sensor at 60% of the depth, line up the foot scale on the *sliding rod* with the *tenth scale*, located on top of the depth gage rod. If, for example, the total depth is 2.7 ft (as shown on Figure 2), then line up the 2 on the foot scale with the 7 on the tenth scale (Marsh-McBirney 1990). If the depth is greater than 2.5 ft, measurements should be taken at 20% and 80% of the total depth.

Summary of Significant Figures for Reporting Field Parameters

Parameter	Field Data Reporting Requirements
Water Temperature (^{o}C)	Report temperature to the nearest tenth of a degree. Round insignificant figures 0 through 4 down and 5 thru 9 up.
pH (s.u.)	Report pH to the nearest tenth of a pH standard unit.
D.O. mg/L **D.O.** (% saturation)	Report dissolved oxygen to the nearest tenth of a mg/L. Report % saturation to the nearest tenth of a percent
Specific Conductance (micro siemens/cm)	Report specific conductance to only three significant figures if the value exceeds 100. Do not report ORP which is displayed by some multi-probes.
Salinity (ppt)	Report salinity values above 2.0 ppt to the nearest tenth of a part per thousand. In estuarine waters report the actual values displayed by the multi-probe above 2.0 ppt and values less than 2.0 as <2.0 or <1.0 only. Determine if a station is estuarine (i.e., experiences cases where salinity is >2.0 ppt) and always report salinity at this station, regardless of the salinity during periods of high flow.
Secchi Disk (meters)	Report Secchi depth transparency in meters to two significant figures.
Flow (ft^3/s)	Report instantaneous flow values less than 10 ft^3/s to two significant figures. Report flow values greater than 10 ft^3/s to the nearest whole number, but no more than three significant figures. When there is no flow (pools), report as 0.0. When there is no water, don't report a value, but report as "dry" in the observations.

NOT APPLICABLE: This is not a current practice under the District's Monitoring Program.

BEAUFORT SCALE: Specifications and equivalent speeds for

NOT APPLICABLE: This is not a current practice under the District's Monitoring Program.

use at sea

FORCE	EQUIVALEN SPEED 10 m above ground		DESCRIPTION	SPECIFICATIONS FOR USE AT SEA
	Miles/hour	knots		
0	0-1	0-1	Calm	Sea like a mirror
1	1-3	1-3	Light air	Ripples with the appearance of scales are formed, but without foam crests.
2	4-7	4-6	Light Breeze	Small wavelets, still short, but more pronounced. Crests have a glassy appearance and do not break.
3	8-12	7-10	Gentle Breeze	Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered white horses.
4	13-18	11-16	Moderate Breeze	Small waves, becoming larger; fairly frequent white horses.
5	19-24	17-21	Fresh Breeze	Moderate waves, taking a more pronounced long form; many white horses are formed. Chance of some spray.
6	25-31	22-27	Strong Breeze	Large waves begin to form; the white foam crests are more extensive everywhere. Probably some spray.
7	32-38	28-33	Near Gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.
8	39-46	34-40	Gale	Moderately high waves of greater length; edges of crests begin to break into spindrift. The foam is blown in well-marked streaks along the direction of the wind.
9	47-54	41-47	Severe Gale	High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble, and roll over. Spray may affect visibility.
10	55-63	48-55	Storm	Very high waves with long over- hanging crests. he resulting foam, in great patches, is blown in dense white streaks along the direction of the wind. On he whole the surface of the sea takes on a white appearance. The 'tumbling' of the sea becomes heavy and shock-like. Visibility affected.

Last edited on 09 January, 1999 Dave Wheeler weatherman@zetnet.co.uk
Web Space kindly provided by Zetnet Services Ltd, Lerwick, Shetland.
http://www.zetnet.co.uk/sigs/weather/Met_Codes/beaufort.htm

Field Collection Procedures for Water Samples

Scope and Application

This protocol describes the techniques used to collect water samples in the field in a way that neither contaminates, loses, or changes the chemical form of the analytes of interest. The samples are collected in the field into previously cleaned and tested (if necessary) sample bottles of a material appropriate to the analysis to be conducted. Pre-cleaned sampling equipment is used for each site, whenever possible and/or when necessary. Appropriate sampling technique and measuring equipment may vary depending on the location, sample type, sampling objective, and weather. ~~Trade names used in connection with equipment or supplies do not constitute an endorsement of the product. Safety equipment is always used while water sampling including gloves, waders and eye protection. Safety equipment helps to protect the sampler from potential contaminants and to prevent sample contamination~~.

Safety requirements pursuant to the District's internal policies and procedures.

Summary of Method

Appropriate sample containers and field measurement gear as well as sampling gear are transported to the site where samples are collected according to each sample's protocol. Water velocity, turbidity, temperature, pH, conductivity, dissolved oxygen as well as other field data are measured and recorded using the appropriate equipment. These field data measurement protocols are provided in this Field Measurement SOP. Samples are immediately put on ice and appropriately shipped to the authorized laboratories. This procedure has been modified from the Texas Natural Resources Conservation Commission's Procedure Manual for Surface Water Quality Monitoring, with major input from the United State's Geological Survey's (USGS's) National Water Quality Assessment (NAWQA) Protocol for Collection of Stream Water Samples.

WATER SAMPLE COLLECTION

Water chemistry and bacteriological samples, as requested, are collected at the same location. *Water samples are best collected before any other work is done at the site*. If other work (e.g., sediment sample collection, flow measurement or biological/habitat sample collection or assessment) is done after or downstream of the collection of water samples, it might be difficult to collect representative samples for water chemistry and bacteriology from the disturbed stream. Care must be taken, though, to not disturb sediment collection sites when taking water samples. Don't be trampling where you are sampling.

The following general information applies to all types of water samples, unless noted otherwise:

Sample Collection Depth

Sub-Surface Grab Sample Samples are collected at 0.1 m below the water surface. Containers should be opened and re-capped under water in most cases. ... as site conditions allow.

Depth-integrated Sample If a depth-integrated sample is taken, the sample is pumped from discrete intervals within the entire water column.

Surface Grab Sample Samples are collected at the surface when water depth is <0.1 m. Since there is a difference in water chemistry on the surface, compared to subsurface, surface water should be noted on the field data sheet as 0 m.

Where to Collect Samples

Note: Due to safety concerns and site constraints, District staff may use scoops and/or buckets to collected water quality samples from flood control facilities, outfalls, and/or channels.

Water samples are collected from a location in the stream where the stream visually appears to be completely mixed. Ideally this would be at the centroid of the flow (*Centroid* is defined as the midpoint of that portion of the stream width, which contains 50% of the total flow), but depth and flow do not always allow centroid collection. For stream samples, the sampling spot must be accessible for sampling physicochemical parameters, either by bridge, boat or wading. Sampling from the shoreline of any water body (meaning standing on shore and sampling from there) is the least acceptable method, but in some cases is necessary.

In reservoirs, lakes, rivers, and coastal bays, samples are collected from boats at designated locations provided by Regional Water Quality Control Boards (Regional Boards). Samples from boats should be collected where the vessel does not interfere with the water being collected.

Sampling Order if Multiple Media are Requested to be Collected

The order of events at every site has to be carefully planned. For example, if sediment is to be collected, the substrate can not be disturbed by stepping over or on it; water samples can not be collected where disturbed sediment would lead to a higher content of suspended matter in the sample. *For the most part, water samples are best collected before any other work is done at the site*. This information pertains to walk-in sampling.

Sample Container Labels

Secure labels

Label each container with the station ID, sample code, matrix type, analysis type, project ID, and date and time of collection (in most cases, containers will be pre-labeled). After sampling, secure the label by taping around the bottle with clear packaging tape. ... unless said labels are waterproof and presented no prior issues.

Procedural Notes

Rinse scoops/buckets in ambient water before decanting sample water into bottles.

Do not rinse:
Bottles marked as having a preservative, and or they have a seal to be broken upon use, signifying sterilization.

For inorganic and organic water samples, bottles do not have to be rinsed if they are I-Chem 200 series or higher or ESS PC grade or higher. This means that the sample bottles are analyzed for contamination, and a certification of analysis is included with the bottles. Other sample containers are usually rinsed at least three times if the bottles do not meet these requirements. See filling instruction for each type of analyses if there is uncertainty. If applicable to the sample and analysis type, the sample container should be opened and re-capped under water. ... as site conditions allow.

Sample Short-term Storage and Preservation

Pack it on ice.

Properly store and preserve samples as soon as possible. Usually this is done immediately after returning from the collection by placing the containers on bagged, crushed or cube ice in an ice chest. Sufficient ice will be needed to lower the sample temperature to at least 6 °□C within 45 min after time of collection. Sample temperature will be maintained at 6 °□C until delivered to the laboratory. Care is taken at all times during sample collection, handling and transport to prevent exposure of the sample to direct sunlight. Samples are preserved in the laboratory, if necessary, according to protocol for specific analysis (acidification in most cases).

Field Safety Issues

Follow District Safety Procedures

Proper gloves must be worn to prevent contamination of the sample and to protect the sampler from environmental hazards (disposable polyethylene, nitrile, or non-talc latex gloves are recommended, **however, metals and mercury sample containers can only be sampled and handled using clean polyethylene gloves as the outer layer**). Wear at least one layer of gloves, but two layers help protect against leaks. One layer of shoulder high gloves worn as a first (inside) layer is recommended to have the best protection for the sampler. Safety precautions are needed when collecting samples, especially samples that are suspected to contain hazardous substances, bacteria, or viruses.

Sample Handling and Shipping

Not typical. District staff routinely deliver samples directly to the primary contracted laboratory.

Due to increased shipping restrictions, samples being sent via a freight carrier require additional packing. Although care is taken in sealing the ice chest, leaks can and do occur. Samples and ice should be bagged placed inside a large trash bag inside the ice chest for shipping. Ice should be double bagged to prevent melted ice water from leaking into the sample. The large trash bag can be sealed by simply twisting the bag closed (while removing excess air) and taping the tail down. Prior to shipping the drain plug of the ice chests have to be taped shut. Leaking ice chests can cause samples to be returned or arrive at the lab beyond the holding time.

Although glass containers are acceptable for sample collection, bubble wrap must be used when shipping glass.

Chain of Custody (COC) Forms

Every shipment must contain a complete Chain of Custody (COC) Form that lists all samples collected and the analyses to be performed on these samples.

Make sure a COC is included for every laboratory, every time you send a shipment of samples. Electronic COC's can also be emailed to the various laboratories but must be sent before the samples arrive at their destinations.
Include region and trip information as well as any special instructions to the laboratory on the COC.

The original COC sheet (not the copies) is included with the shipment (insert into ziplock bag) One copy goes to the sampling coordinator, and the sampling crew keeps one copy.

~~Samples collected should have the salinity (in parts per thousand) or specific conductivity (µS/cm), depth of collection, and date/time collected for each station on every COC~~.

Write a comment on this form, if you want to warn the laboratory personnel about possibly hazardous samples that contain high bacteria, chlorine or organic levels.

Field QC Samples for Water Analyses

Field duplicates are currently submitted at an annual rate of 5%. Field travel blanks are required for volatile organic compounds at a rate of one per cooler shipped. Field blanks are required for trace metals (including mercury and methyl mercury), DOC, and volatile organic compounds in water at a project rate of 5%. See the SWAMP Quality Control and

Sample Handling Guidelines for information regarding frequency and types of field QC samples.

SWAMP Field Data Sheets

The District's program standard Field Data Sheet (FDS) will be used per the District's Consolidated Monitoring Program, in lieu of a SWAMP Field Data Sheet.

~~Each visited field site requires a field observation completed SWAMP Field Data Sheet, even if no samples are collected (i.e. at a site which is found to be dry). If water and/or sediment samples are collected,~~ all elements of the ~~SWAMP~~ Field Data Sheet must be completely filled out. ~~Data sheets are provided from the SWAMP MPSL MLML website: http://swamp.mpsl.mlml.calstate.edu/resources-and-downloads/database-management-systems/swamp-25-database/templates-25/field-data-sheets#WQFieldData~~

FDSs will be submitted to the Data Manager for QA/QC.

General Pre-Sampling Procedures

District staff shall follow the manufacturer's recommendations for use and maintenance of field equipment. Refer to CMP Volume II (QAPP) Appendix H for Calibration instructions.

Instruments. All instruments must be in proper working condition. Make sure all calibrations are current. Multi-probe sondes should be pre-calibrated every morning prior to sampling and post-calibrated within 24 h of the original calibration. Conductivity should also be calibrated between stations if there is a significant change in salinity. Dissolved oxygen sensors should be re-calibrated if there is a 500 ft change in elevation.

Calibration Standards. Pack all needed calibration standards.

Sample Storage Preparations. A sufficient amount of cube ice, blue ice and dry ice as well as enough coolers of the appropriate type/size must be brought into the field, or sources for purchasing these supplies identified in advance.

Sample Container Preparation. After arriving at the sample station, pack all needed sample containers for carriage to the actual collection site, and label them with a pre-printed label containing Station ID, Sample Code, Matrix info, Analysis Type info, Project ID and blank fields for date and time (if not already pre-labeled).

Safety Gear. Pack all necessary safety gear like waders, protective gloves and safety vests.

Walk to the site. For longer hikes to reach a sample collection site, large hiking backpacks are recommended for transport of gear, instruments and containers. Tote bins can be used, if the sampling site can be accessed reasonably close to the vehicle.

GPS. At the sampling site, compare/record reconnaissance GPS reading with current site reading and note differences. GPS coordinates should be in Decimal Degrees (e.g. 38.12345 -117.12345).

COLLECTION OF WATER SAMPLES FOR ANALYSIS OF CONVENTIONAL CONSTITUENTS

In most streams, sub-surface (0.1 m below surface) water is representative of the water mass. A water sample for analysis of conventional constituents is collected by the grab method in most cases, immersing the container beneath the water surface with the cap on to a depth of 0.1 m. Remove cap and fill container replacing the cap before removing the container from the water. Sites accessed by bridge can be sampled with a sample container-suspending device. Extreme care must be taken to avoid contaminating the sample with debris from the rope and bridge. Care must also be taken to rinse the device between stations. If the centroid of the stream cannot be sampled by wading, sampling devices can be attached to an extendable sampling pole. It should be noted on the field data sheet if using a bucket sampler that surface water is entering the sample bottle.

In some cases, depth-integrated sampling is required, as requested by Regional Boards. This is useful when lakes or rivers are stratified and a sample is wanted that represents the entire water column. Depth-integrated sample collection is explained later in this document.

Conventional Water Constituents, Routinely Requested in SWAMP	Chloride, sulfate, nitrite, nitrate (or nitrate+nitrate), ortho-phosphate, fluoride, total phosphorus, ammonia, TKN, alkalinity, chlorophyll a. Parameter lists are program-specific.
Conventional Water Constituents, Occasionally Requested in SWAMP	Total Suspended Solids (TSS) or Suspended Sediment Concentration (SSC), Total Dissolved Solids (TDS--especially if total metals requested), Total Organic Carbon (TOC), Dissolved Organic Carbon (DOC), hardness (if trace metals analysis is requested).
Conventional Water Constituents Sample Volume This is coordinated with the labs thru obtaining the bottle list.	Due to the potential for vastly different arrays of requested analyses for conventional constituents, ~~please refer to table at the end of this document, as well as the~~ Quality Control and Use District bottles lists as developed by the contracted laboratory for each region's monitoring program.

~~Sample Handling Guidelines for Conventional Parameters~~, ~~for information on the proper volume to collect for the various types of analyses~~.

Conventional Water Constituents Sample Container Type

This is coordinated with the labs thru obtaining the bottle list.

Due to the potential for vastly different arrays of requested analyses for conventional constituents, ~~please refer to table at the end of this document, as well as the~~ ~~Quality Control and Sample Handling Guidelines for Conventional Parameters~~, ~~for information on the proper type of sample containers~~.

Use District bottles lists as developed by the contracted laboratory for information on the proper type of sample containers.

Chlorophyll a Syringe Sample Method

Not conducted by District staff. May be conducted for TMDL Monitoring - sampling conducted by others.

Chlorophyll a syringe method: Chlorophyll a is sampled by forcing water with a 60-mL syringe through a filter holder containing a 25-mm glass microfiber filter. The 60-mL syringe and an in-line filter holder are rinsed three times with the ambient water before filtration. The syringe is then filled with 60 mL of ambient water. The filter holder is then removed and a 25-mm glass microfiber filter is placed inside. The filter holder is then screwed onto the syringe and the ambient water is then flushed through the filter. The filter holder is removed every time more water needs to be drawn into the syringe. The process is then repeated until the desired amount of Chlorophyll a is present (usually 60 to 360 mL depending on the water clarity). When filtering is complete the filter holder is opened and the filter is removed with tweezers without touching the Chlorophyll a. The filter is then folded in half, then again, in half with the Chlorophyll a inside the folds. The folded filter is then wrapped in aluminum foil and placed in an envelope labeled with the site information and the volume filtered. The envelope is then immediately placed on dry ice until transferred to the lab.

Collection of Water Samples for Analysis of Trace Metals (Including Mercury)

When deciding to measure total and dissolved metals in water the purpose of the sampling must be considered. Water quality standards for the protection of aquatic life are determined for the dissolved form of heavy metals in most cases, although this, too, can vary within different Basin Plans for different regions. The exception to routinely conducting dissolved metals analyses is usually mercury (and often selenium). Water quality standards usually apply to the total form of mercury (and often selenium), and not the dissolved form of these elements. Several regions are interested in conducting total metals analyses, in order to address specific issues. In order to budget inputs, transport, and accumulation of metals, it is necessary to know the concentration of total metals in the water column, sediments, effluent, etc. Sample collection for trace metals and mercury in water requires "Clean Hands/Dirty Hands" methodology.

Metals-in-water:

General Information

Sampling is based on District program frequency and required compliance activities.

Unless otherwise requested to collect for total metals analysis, dissolved metals are collected for all elements with the exception of mercury. Metals-in-water samples should **not** be collected during periods of abnormally high turbidity if at all possible. Samples with high turbidity are unstable in terms of soluble metals, and it is difficult to collect a representative grab sample. Special study sampling, however, may be an exception. For example, wet weather sampling is likely to include some samples with high turbidity.

Metals-in-water:

Sample Collection Depth

Collect a metals sample from a depth of 0.1 m using a sub - surface grab method, or at discrete depths using a depth-integrated sampling method with a peristaltic pump (described further down). In most streams, sub-surface water is representative of the water mass. For the purpose of determining compliance with numerical toxic substance standards, a sample taken at the surface is adequate.

Metals-in-water:

Sample Volume

This is coordinated with the labs thru obtaining the bottle list.

Refer to table at end of this document for specific information on the proper volume to collect for trace metals analyses. Generally, for procedures most commonly used for analysis of metals in water (total or dissolved metals); one 60-mL polyethylene container is filled with the salinity recorded on the field data sheet and COC. Generally, for the procedures most commonly used for analysis of mercury in water (whether total or dissolved), one 250-mL glass or teflon container is filled, regardless of the salinity. All containers are pre-cleaned in the lab using HNO_3.

Metals-in-water:

Sampling Equipment

The filtration is completed by the District's contracted laboratory(s). These grab samples are collected into a preserved container.

The method of choice for the collection of water samples for trace metals analysis in small, wadeable streams is the grab method, where the sampler submerges the sample bottle or syringe beneath the surface of the water until filled. The procedure for filtration of water samples for trace metals analysis must be performed within 15 minutes of collection to meet the required filtration holding time. For Mercury(Hg) samples, preservation may take place in the field or at the laboratory within 48 hours of collection. Extreme care must be taken to avoid contamination of the water sample. Considering these factors, it is best to use a **field** filtration system, such as a set-up with peristaltic pump with in-line filter, or a set-up with a syringe filter, if filtered water is required. Samples are pumped and/or filtered directly into the sample container. This minimizes contamination by using no intermediate sampling device. Samples can also be filtered in lab if need be Un-powdered (no-talc) polyethylene gloves are always worn during sampling for metals-in-water.
Depth-integrated sampling is useful when lakes or rivers are stratified and a representative sample is wanted which represents the entire water column. The method involves a peristaltic pump system with enough Teflon tubing to pump at the desired depth with an inline filter. Filter equipment blanks are analyzed for five percent of all cleaned equipment.

Equipment Preparation

Dissolved metals and total metals are collected in a conventional grab method, no filtration is conducted by District staff. These grab samples are collected into a preserved container.

It is best if the metals-in-water sampling materials are prepared by a laboratory that can guarantee contamination-free sampling supplies. If a laboratory assembles a Metals-in-Water Sample Collection Kit, it should contain the following items packaged together **for each sample**:

- Tubing with an in-line filter (disposable, 0.45 µm) attached for dissolved metals-in-water sampling. This same tubing is used for total metals-in-water samples without filter. If an in-line pumping system is not used, an acid cleaned syringe and filter are packed.
- Sample containers- polyethylene for total and dissolved samples and blanks; Glass or Teflon for total and dissolved mercury.
- Acid preservation is performed in the laboratory.
- Metals-free DI water (for blanks).
- Powder-free polyethylene gloves

If a laboratory is not assembling collection kits, individuals should take care to keep containers in the original packaging. When removed from the box, sample containers are placed in clean plastic bags (zipper closure bags). Although filters come individually wrapped, they should also be stored in new zipper closure bags to avoid possible contamination.

The filtering equipment is pre-cleaned according to laboratory protocol. Clean tubing is put into clean containers, such as large zipper closure bags. Metals-free filter cartridges with the capacity to filter several liters are commercially available. Equipment blanks are run at the laboratory on batches of metals-in-water sampling equipment prior to their distribution to field staff. One to two liter containers with metals-free deionized water are taken into the field for travel blanks. Metals-free deionized water is supplied by the laboratory performing metals analysis. The deionized water containers are kept clean and dust-free on the outside by wrapping in two

Dissolved metals and total metals are collected in a conventional grab method, no filtration is conducted by District staff. These grab samples are collected into a preserved container and submitted to the laboratory for filtration and analysis.

Dissolved and Total Metals-in-Water: Detailed Collection Techniques

- ***Sub-Surface Grab Method***
- ***Syringe Filtration Method (for sub- surface collection)***
- ***Peristaltic Pumping Method (Using Tubing/In-line Cartridge Filters)for sub- surface collection or for depth-integrated collection***

Metals-in-water Sample Collection:

Sub-Surface Grab Method

Clean Hands/Dirty Hands Technique

Note: Due to safety concerns, District staff may use scoops and/or buckets to collected water quality samples from flood control facilities, outfalls, and/or channels.

Unfiltered Samples (for total metals analysis, if requested, and for mercury almost always, unless otherwise requested): Some samples can be sampled directly from the ambient water either by wading into the stream and dipping bottles under the surface of the water until filled, or by sampling from a boat and dipping the bottle under the surface of the water until it is filled. The bottles are cleaned according to laboratory protocol. It is very critical that all the acid is rinsed out of the bottles before the samples are collected. Personnel involved in field sample collection/processing wear polyethylene gloves. The laboratory pre-cleaned glass or Teflon™ 250 mL (for mercury) or polyethylene 60 mL (for metals) sample bottles are taken from the double-wrapped

zipper closure plastic bags using "Clean Hands/Dirty Hands" techniques. The dirty hands collector opens the first outer bag, and the clean hands collector opens the inner bag around the bottle. The clean hands collector then removes the bottle from the inner bag. Clean hands collector then places the inner bag back inside the outer bag while sampling occurs. The clean hands collector dips the bottle into the ambient water, with the cap on, to approximately 0.1 m (avoiding disturbing surface scums), placing the cap back on the bottle before being removed from the water, rinses the bottle five times with ambient water, making sure the threads of the bottle get rinsed as well, and fills the bottle to the top. The lid is secured under the water surface and the bottle is put back into the inner clean bag and sealed by the clean hand collector. The sealed clean bag is then placed back inside the outer bag by the clean hands collector. The dirty hands collector then seals the outer bag.

Metals-in-water Sample Collection:

Syringe Filtration Method (for sub-surface collection)

The Laboratory conducts the filtration for District samples.

Filtered Samples (for dissolved metals analyses): Sub-surface water samples are filtered for dissolved trace metals analysis (not for mercury, however, in almost all cases) using the following syringe filtration method.

The syringe (60 cc size, pre-cleaned in the laboratory) and in-line filter are pre-packed in two zipper closure bags. The syringe and filter are taken out of the bags using "Clean Hands/Dirty Hands" technique, as previously described. The sub-surface water sample is collected by 1) wading out into the centroid portion of the stream, or by leaning over the edge of the boat, and aspirating water into the syringe, filling and rinsing the syringe five times with ambient water; 2) attaching the filter onto the syringe and filling the syringe body; 3) rinsing the filter with a few milliliters of the sample; 4) rinsing the sample bottle five times with the filtered ambient water; and 5) extruding the sample through the syringe filter and completely filling each bottle. The bottles are taken out of and put back into their bags using "Clean Hands/Dirty Hands".

Metals-in-water Sample Collection--

Peristaltic Pump

The basic "Clean Hands/Dirty Hands" technique is also applied in the use of a peristaltic pump with an in-line filter cartridge for metals-in-water sample collection. Dirty Hands removes the plastic cover from the end of the pump tubing and inserts the tubing into the sampling container. Dirty Hands holds the tubing in place. The in-line cartridge filter is attached to the outlet end of the tubing.

Clean Hands takes the plastic cover off the other end of the tubing. Dirty Hands turns on the pump and flushes lL of ambient water through the tubing to purge it for dissolved metals.

Clean Hands removes the cap from the sample bottle and uses the pump to fill it with ambient water. Clean Hands puts the cap back on the bottle and places it in the plastic bag.

Metals-in-water Sample Collection:

Depth-Integrated Sampling, using In-line Cartridge Filter and Peristaltic Pump

Not Applicable - Not a standard practice under the District's Monitoring Programs

Preparation for Depth-integrated sample collection:
Depth-integrated sampling is useful when lakes or rivers are stratified, and a representative sample is wanted that represents the entire water column to the extent possible. The method utilized to date for SWAMP involves a peristaltic pump system with enough Teflon tubing to pump from the desired depth. Regional Boards must request depth-integrated sampling.

The tubing set consists of a small length of CFLEX tubing that fits in the peristaltic pump, with an appropriate length of Teflon tubing on the suction side of the pump and a 3-ft section of Teflon tubing on the discharge side of the pump.

The tubing set is pre-cleaned in 10% reagent grade HCL at the laboratory, and to date in SWAMP, a new pre-cleaned tubing set is used for each site. However, the same peristaltic tubing set can be used at multiple sites, as long as it has been cleaned in the field between stations, according to protocol as outlined below. If this is to be done, however, and Dissolved or Total Organic Carbon samples are collected, equipment blanks should be collected at each site until it is determined that the blanks are acceptably low.

The field cleaning procedure for tubing that is to be re-used is:

- Pump phosphate free detergent through tubing.
- Pump 10% HCL through tubing.
- Pump methanol through tubing.
- Pump 1 l of blank water (Milli-Q) through.

All reagents must be collected in appropriate hazardous waste containers (separated by chemical), and transport, as well as disposal, must follow appropriate local, state, and federal

regulations.

If a field blank is needed, collect it after the 1 L of blank water is pumped through. Pump the amount of ambient water equivalent to 3 times the volume of the tubing before sampling the next site.

Filtered and Unfiltered Samples, Depth-integrated:
It is recommended to attach the tubing to a line with depth measurement markers (preferably in meters). At the end of this line should be a trace metal-safe weight, which hangs about one meter below the tubing end, avoiding any sediment intake from the bottom of the water column with the pump tubing.

At the site, Dirty Hands sets up the pump, while Clean Hands takes a bottle from the plastic bag and places it in a container holder or on a clean surface. A container holder can be anything trace metal clean that supports the bottle, freeing up the collector's hands. Clean Hands takes the outlet-end of the tubing (with the in-line filter cartridge attached) out of the bag, and places it in the peristaltic pump head. The outlet end is long enough to allow easy bottle filling; the other end is long enough to easily reach beneath the water surface and to the desired depth. Dirty Hands closes the pump head, locking the tubing in place.

Make sure that all bottles are filled with a depth-integrated water sample. This can be accomplished by dividing the total vertical length of the water column into 2 to 10 equal intervals, and sampling each interval equally, filling the bottles at each depth proportional to the number of intervals sampled. For example, if 10 intervals are sampled, every bottle is filled $1/10^{th}$ full at each depth sampled. A very common method of dividing the water column is by first determining the depth of the thermo-cline. Samples are taken at the midpoint between the surface and the thermo-cline, at the midpoint between the top of the thermo-cline and the bottom of thermo-cline, and at the midpoint between the bottom of the thermo-cline and just above the bottom of the water column. For these methods, all containers have to be filled at the same time. Note the number of intervals sampled on the data sheet.

When filling bottles, Clean Hands immerses the intake tube directly into the water at the appropriate depth, and Dirty Hands operates the pump to flush the tubing with a minimum of 1L of ambient water through the tubing and filter.

Clean Hands removes the cap from the sample bottle, holds the tubing outlet with the in-line filter cartridge over the container opening (without touching the container), and allows the container to fill. The container is filled and rinsed five times with ambient water, and is then filled to the top for the actual sample. Clean Hands puts the cap back on the bottle, and places the bottle back it in the zipper closure plastic bag. Whenever Clean Hands touches the boat or equipment, which may be contaminated, gloves should be changed immediately.

(Note for Unfiltered samples: *If an unfiltered sample is required for total metals, total mercury, conventional constituents, toxicity, or synthetic organics, the same procedure is used as described above, except the filter is detached from the end of the tubing before filling the bottles.)*

When sampling is finished, the tubing is brought to the surface, clean water (Milli-Q or deionized) is pumped through system, and the tubing is stored in a polyethylene bag.

The tubing set can be used at multiple sites, as long as it has been cleaned in the field between stations (see field cleaning procedure above). However, if Dissolved or Total Organic Carbon samples (in water) are collected, equipment blanks should be collected at enough sites until it is determined the blanks are appropriate.

Metals-in-water Sample Collection:

Collecting the Sample:

Composite Bottle

The sample collection methodologies are identical to those described above except the sample is collected first into a composite bottle(s). The sample is collected in an amber glass 4-L bottle for mercury and methyl mercury, and a 4-L polyethylene bottle for other trace metals. The compositing bottle is cleaned according to SWAMP SOP.SC.G.1. It is very critical that all the acid is rinsed out of the bottle and that the bottle is rinsed with sample water (five times) before the sample is taken. The sample is collected by the grab or pumping method after being rinsed five times with ambient

water and is brought inside the water quality vehicle or sampling box for processing. Personnel involved in sample processing don polyethylene gloves. During sampling the dirty hands person opens the bag holding the composite bottle and opens the outer plastic bag. The clean hands person opens the inner plastic bag, removes the bottle and holds the bottle while the Dirty Hands sampler controls the flow of water through the pump into the bottle.

Preparing sample aliquots from a composite bottle into smaller sample bottles using an inline pump and filter:

The dirty hands person opens the first bag, and the clean hands person opens the inner bag around the composite bottle. The clean hands person then removes the bottle from the inner bag and places the bags and the bottle in a designated clean place.

This process is repeated until all sample bottles are lined up on the clean bench with their tops still on.

The top of the bottles are loosened so that they fit very loosely on top of the bottles so the clean hands person can remove the caps and pour or pump water into the bottles easier.

The clean hands person shakes the 4-L sample in a steady and slow up and down motion for two full minutes.

Samples that are not to be filtered (including TSS/SSC) are sub-sampled out of the bottle by pouring out of the large compositing bottle into the sample bottles. The compositing bottle is shaken for 15 s between these subsamples.

Each sample bottle is rinsed five times with ambient water before filling.

For the clean pumping system setup procedure, see above.

(The equipment or field blank is processed exactly like a sample following the same steps.)

The clean end of the tubing used for suction is placed into 1 L bottle. Approximately 750 mL of Milli-Q are then pumped through the system to purge any residual contamination.

The 250-mL sample bottles are then filled to the neck and capped as soon as possible.

Note: if volatile organics are to be collected they should be pumped directly into the sample containers before the compositing procedure.

Metals-in-water: Short-term Sample Preservation

After collecting the sample, the double-bagged container is placed in another plastic bag for shipping, and placed on ice in the ice chest, cooled to 6 °C. This is to prevent possible contamination from other samples in the ice chest. Metals-in-water samples are acid-preserved in the lab.

Metals-in-water: Sample Container Label

Label each outer sample-bag with the station ID, sample code, matrix type, analysis type, project ID, and date and time of collection.

Metals-in-water: Field Equipment Blank

Pumping Method. If required, field blanks are collected at the last site of a sampling trip, with the same tube and filter used to collect the last dissolved metals-in-water sample of the day (before the ambient sample is collected); and with the tube used for the last total metals-in-water sample of the day. If each sample is taken using a new set of tubing, a separate tubing-set should be used for the blank.

The same Clean Hands/Dirty Hands collection techniques are followed for the field blank as the samples, pumping trace metal-free water from a clean container supplied by the laboratory.

Syringe Method. If required, field blanks are collected in much the same way as in the pumping method. "Clean Hands/ Dirty Hands" techniques are used. The syringe is taken out of the double bags, deionized water is aspirated into the syringe, syringe is rinsed five times with ambient water, the filter is attached, and the blank water is extruded into a sample bottle. A minimum of one blank per trip is taken, if required.

Grab Method. Bottles full of deionized water or Milli-Q are opened at the site for the same length of time the sample bottles are open.

COMPANION SAMPLES FOR METALS-IN-WATER

A hardness analysis should be requested by the Regional Water Control Board whenever metals-in-water are to be analyzed from an inland (freshwater) site. Estuarine/marine sites do not require hardness analysis.
If a total metals sample is collected, it is recommended to submit a sample for total suspended solids/suspended sediment concentration (TSS/SSC) in a companion sample for "conventionals in water".

Hexavalent Chromium

Very rarely, a request may be made for conducting hexavalent chromium analysis in water samples. Acidification alters the hexavalent form of chromium. A separate (un-acidified) sample must be submitted if hexavalent chromium is to be analyzed. Filter and submit a minimum of 500 mL water. The sample is collected in a DI-water-rinsed polyethylene or glass container, placed on ice, and shipped to the lab in time for analysis to begin within 24 h of collection. The lab must be notified when a hexavalent chromium sample will arrive. Hexavalent chromium is not usually analyzed on unfiltered samples.

FIELD QC SAMPLE COLLECTION REQUIREMENTS FOR METALS-IN-WATER

In order to assess contamination, "blanks" are submitted for analysis. Special projects may have other requirements for blanks. The same group of metals requested for the ambient samples are requested for the blank(s). Run a blank for each type of metal sample collected. Blanks results are evaluated (as soon as available) along with the ambient sample results to determine if there was contamination or not. See the Quality Control and Sample Handling Guidelines for Inorganic Analytes for information regarding frequency and types of field QC samples.

Field Equipment Blank (Ambient Blank) Equipment blank frequencies are specified by the District CMP.	Submit an equal volume (equal to the ambient sample) of metals-free deionized water that has been treated exactly as the sample at the same location and during the same time period. Use the same methods as described above (Grab sample, pumping method, syringe method). At least one ambient blank per field trip is required each for trace metal and Mercury samples in water. *If contamination is detected in field equipment blanks, blanks are required for every metals-in-water sample until the problem is resolved.*
Laboratory Equipment	Laboratory Equipment Blanks for pumping and sampling equipment (Metals-in-Water Sample Collection Kits and

Blank	Syringe Filtration Kits) are run by the laboratory that cleans and distributes the collection materials. It documents that the materials provided by the laboratory are free of contamination. When each batch of tubes, filters, bottles, acid and deionized water are prepared for a sampling trip, about five percent of the Mercury sampling materials are chosen for QC checks. Trace metal equipment needs to be subjected to an initial blank testing series. If these blanks are acceptable only occasional re-testing is required for TM equipment. The QC checks are accomplished by analyzing metals-free water which has been pumped through the filter and tube; collected in a sample container; and preserved.
Field Duplicates	Five percent Field Duplicates are submitted every year. (If fewer than 20 samples are collected during an event, submit one set of duplicates per event.)

Collection of Water Samples for Analysis of Synthetic Organic Compounds

Where site conditions allow...

Collect organic samples at a depth of 0.1 m by submerging the sample container by hand. If depth-integrated sampling is required, use the in-line peristaltic pump methodology described previously. Since organic compounds tend to concentrate on the surface of the sampling device or container, the sampling device and sample container are ***not*** to be rinsed with ambient water before being filled.

Container type and sample volumes are coordinated with the labs thru obtaining the bottle list.

Sample Containers and Collection

Also refer the Quality Control and Sample Handling Guidelines for Synthetic Organic Compounds in Fresh and Marine Water for a list of recommended container types.

The following are constituent specific and may not apply to all of the District's programs.

Pesticides/ Herbicides

The sample container for pesticides and herbicides is a new, clean, unused amber glass jar with a Teflon-liner inside the cap. Collect one liter of water for each of the three sample types (Organophosphorus Pesticides, Organochlorine Pesticides and Chlorinated Herbicides). **EACH ANALYSIS TYPE REQUIRES A SEPARATE JAR**. Minimize the air space in the top of the jar. Preserve immediately after collection by placing on ice out of the sunlight.

Semi-volatile Organics

The sample container for semi-volatile organics must also be new, clean, unused amber glass bottles with a Teflon-liner inside the cap, and pre-rinsed with pesticide-grade hexane, acetone, or methylene chloride. Fill jars to the top and place on ice in the dark. In addition to other sample information, label the jar Semi-volatiles.

Volatile Organics:

Volatile Organic Carbon (VOC), Methyl-Tert Butyl Ether (MTBE) and (BTEX)

The sample containers for volatiles are VOA vials. Fill the 40-mL VOA vials to the top and cap without trapping any air bubbles. If possible, collect directly from the water, keeping the vial under water during the entire collection process. To keep the vial full while reducing the chance for air bubbles, cap the vials under the water surface. Fill one vial at a time and preserve on ice. The vials are submitted as a set.

District staff may collect samples by submerging the bottles if conditions allow and preservatives are not compromised.

If the vial has been pre-acidified for preservation, fill the vial quickly, without shaking using a separate clean glass jar. Fill the vial till the surface tension builds a meniscus, which extends over the top end of the vial, then cap tightly and check for bubbles by turning the vial on its head. Ensure that the pH is less than 2. If the water may be alkaline or have a significant buffering capacity, or if there is concern that pre-acidified samples may have the acid wash out, take a few

practice vials to test with pH paper. It may take more than two drops, and it will then be known how to preserve the other samples that are being submitted to the lab. If an alternative method has proven successful, continue with that method.
Note: If vigorous foaming is observed following acidification, discard that sample and collect another set. Do not acidify the second set. Mark the sample clearly "not acidified" and the lab will run them immediately. Holding time is 14 days with acid, 7 days without acid.
Collect three VOA vials, if VOC, MTBE and BTEX are required, two vials, if only VOC is required and two vials, if only MTBE and BTEX are require. The vials may be taped together to keep them together.

Perchlorate

Surface water samples for perchlorate should be collected in a new unused polyethylene or glass container. Perchlorate samples should be placed immediately on ice to maintain temperature at 6 ^{o}C. The sample holding time is 28 days, under refrigeration.

Sample Treatment in Presence of Chlorine

If in stream chlorine residual is suspected, measure the chlorine residual using a separate water subsample. Free chlorine will oxidize organic compounds in the water sample even after it is collected. If chlorine residual is above a detectable level, (i.e., the pink color is observed upon adding the reagents) immediately add 100 mg of sodium thiosulfate to the pesticides, herbicides, semi-volatiles and VOA samples; invert until sodium thiosulfate is dissolved. Record the chlorine residual concentration in field logbook. If chlorine residual is below detectable levels, no further sample treatment necessary.

VOA Trip Blank

Per laboratory recommendations two trip blanks are used (one with preservative and one without).

Submit one Trip Blank for VOA samples (2- 40 mL VOA vials) for each sampling event. Trip Blanks are prepared in advance just before the sampling trip and transported to the field. Ask the laboratory for DI water and specify that it is for a VOA trip blank. VOA blanks require special purged water. Trip blanks demonstrate that the containers and sample handling did not introduce contamination. The trip blank vials are never opened during the trip.

Field QC Samples

If required, field Duplicates and field blanks are submitted at a rate subject to the discretion of the project manager. ~~Refer to the SWAMP Quality Control and Sample Handling Guidelines for details on required blanks and duplicates~~.

BACTERIA AND PATHOGENS IN WATER SAMPLES

Summary of Collection Procedure (Based on EPA water quality monitoring procedures)

Make sure the containers are sterilized; either factory-sealed or labeled.

Whirl-pak® bags

- Label the bottle as previously described for SWAMP.
- Tear off the top of the bag along the perforation above the wire tab just prior to sampling. Avoid touching the inside of the bag. If you accidentally touch the inside of the bag, use another one.
- If wading into the stream, try to disturb as little bottom sediment as possible. Be careful not to collect water that has sediment from bottom disturbance. Stand facing upstream. Collect the water sample on your upstream side, in front of you.
- If taking sample from a boat, carefully reach over the side and collect the water sample on the upstream side of the boat.
- Hold the two white pull-tabs in each hand and lower the bag into the water on your upstream side with the opening facing upstream. Open the bag midway between the surface and the bottom by pulling the white pull-tabs. The bag should begin to fill with water. You may need to "scoop" water into the bag by drawing it through the water upstream and away from you. Fill the bag no more than 3/4 full.
- Lift the bag out of the water. Pour out excess water. Pull on the wire tabs to close the bag. Continue holding the wire tabs and flip the bag over at least 4-5 times quickly to seal the bag. Don't try to squeeze the air out of the top of the bag. Fold the ends of the wire tabs together at the top of the bag, being careful not to puncture the bag. Twist them together, forming a loop.
- If the samples are to be analyzed in the lab, place them in a cooler with ice or cold packs for transport to the lab.

Screw cap containers

- ~~Label the bottle as previously described for SWAMP~~.
- Remove the plastic seal from the bottle's cap just before sampling. Avoid touching the inside of the bottle or cap. If you accidentally touch the inside, use another bottle.
- If wading into the stream, try to disturb as little bottom

sediment as possible. Be careful not to collect water that has sediment from bottom disturbance. Stand facing upstream. Collect the water sample on your upstream side, in front of you.

- ~~If taking sample from a boat, carefully reach over the side and collect the water sample on the upstream side of the boat~~.
- Hold the bottle near its base with polyethylene gloves and submerge the bottle in the water with the cap on. Open the bottle collecting the water sample 0.1m beneath the surface. When the bottle is filled to the desired level recap the bottle and remove from water. You can only use this method if the sample bottles do not contain sodium thiosulfate.
- Turn the bottle underwater into the current and away from you. In slow moving stream reaches, push the bottle underneath the surface and away from you in an upstream direction.

It is District standard practice to void lose of container preservatives. Scoops are typically used to decant sampling into the appropriate containers.

- Alternative sampling method: In case the sample bottle contains preservatives/chlorine removers (i.e. Sodium-Thiosulfate), it cannot be plunged opening down. In this case hold the bottle upright under the surface while it is still capped. Open the lid carefully just a little to let water run in. Fill the bottle to the fill mark and screw the lid tight while the bottle is still underneath the surface.
- Leave a 1-in. air space so that the sample can be shaken just before analysis. Recap the bottle carefully, remembering not to touch the inside.
- If the samples are to be analyzed in the lab, place them in a cooler with ice or cold packs for transport to the lab. Samples should be placed immediately on ice to maintain temperature at 6 ^{o}C

Pouring from another clean bottle

- Due to different sampling conditions (high turbidity, rough water etc.) it is sometimes easy to pour water from another clean bottle into the bacteria bottle. This helps to make sure that the sample water is only being filled to the desired line and no overfilling occurs.

TOXICITY IN WATER

Sample Collection

Using the standard grab sample collection method described previously for water samples, fill (for typical suite of water toxicity tests conducted) the required amount of 2.25-L amber glass bottles with sub surface water. Since the size of the 2.25-L amber bottle is bigger than your average sample bottle, find a spot in the centroid of the stream to completely submerge the toxicity bottle if possible. A clean water organics(1-L glass amber) bottle can be used if there is no sampling point deep enough to submerge a large toxicity bottle. If the stream is not deep enough to submerge any bottle, then comments should be made on the field data sheets that surface water was collected. Depth should also equal 0 for the sampling depth. All toxicity samples should be. put on ice, and cooled to 4 °C. Label the containers as described above and notify the laboratory of the impending sample delivery, since there is a 48-hr maximum sample hold time. Sample collection must be coordinated with the laboratory to guarantee appropriate scheduling.

Summary of Sample Container, Volume, Initial Preservation, and Holding Time Recommendations for Water Samples

Parameters for Analysis in WATER Samples	Recommended Containers (all containers pre-cleaned)	Typical Sample Volume (mL)	Initial Field Preservation	Maximum Holding Time (analysis must start by end of max)
Conventional Constituents in Water				
Alkalinity	Polyethylene bottles (see **NOTE(1)** below)	100 mL	Cool to ≤ 6 °C, dark	14 days at ≤ 6 °C, dark
Chloride (Cl), Sulfate (SO_4) and Fluoride (F)	Polyethylene bottles (see **NOTE(1)** below)	300 mL	Cool to ≤ 6 °C, dark	28 days at ≤ 6 °C, dark
Ortho-phosphate (OPO_4)	Polyethylene bottles (see **NOTE(1)** below)	150 mL	Filter within 15 minutes; Cool to ≤ 6 °C, dark	48 h at ≤ 6 °C, dark
Nitrate + Nitrite (00630) ($NO_3 + NO_2$)	Polyethylene bottles (see **NOTE(1)** below)	150 mL	Cool to ≤ 6 °C, dark	48 h at ≤ 6 °C, dark
Total Keldjahl Nitrogen (TKN)	Polyethylene bottles (see **NOTE(1)** below)	600 mL	Cool to ≤ 6 °C, dark; H_2SO_4 to pH<2	Unacidified: 7 days Acidified: 28 days Either one at ≤ 6 °C, dark
Total Dissolved Solids (TDS)	Polyethylene bottles (see **NOTE(1)** below)	1000 mL	Cool to ≤ 6 °C, dark Cool to 4°C, dark	7 days at ≤ 6 °C, dark
Ammonia (NH_3)	Polyethylene bottles (see **NOTE(1)** below)	500 mL	Cool to ≤6 ˚C; samples may be preserved with 2 mL of H_2SO_4 per L	Unacidified: 48 h Acidified: 28 days Either one at ≤ 6 °C, dark
Total Phosphorus (TPO_4)	Polyethylene bottles (see **NOTE(1)** below)	300 mL	Cool to ≤ 6 °C, dark	28 days at ≤ 6 °C, dark
(1)NOTE: **The volume of water necessary to collect in order to analyze for the above constituents is typically combined in four 1-L polyethylene bottles, which also allows enough volume for possible re-analysis and for conducting lab spike duplicates. This is possible since the same laboratory is conducting all of the above analyses; otherwise, individual volumes apply.**				
Total Organic Carbon (TOC), **Dissolved Organic Carbon (DOC)**	125 mL amber glass vial 250 ml amber for TOC/DOC	125 mL for TOC only 250 mL for TOC/DOC	Cool to ≤6 ◦C; acidify to pH<2 with HCl, H_3PO_4, or H_2SO_4 within 2 hrs Filter and preserve to pH<2 within 48 hours of collection; cool to ≤6 ˚C	28 days 28 days
Total Suspended Solids (TSS)	250 mL plastic bottle	250 mL	Cool to ≤6 ˚C, dark	7 days at ≤6 ˚C, dark
Suspended Sediment Concentration (SSC)	125 mL polyethylene bottle	Up to 125ml depending on	Cool to ≤6 ˚C, dark	7 days at ≤6 ˚C, dark

Parameters for Analysis in WATER Samples	Recommended Containers (all containers pre-cleaned)	Typical Sample Volume (mL)	Initial Field Preservation	Maximum Holding Time (analysis must start by end of max)
		turbidity of water		
Chlorophyll *a* **Pheophytin *a*** **Chlorophyll a** **Pheophytin *a***	1-L amber polyethylene bottle Aluminum Foil, GFC Filters	1000 mL (one bottle) 20-420 mL	Centrifuge or filter as soon as possible after collection; if processing must be delayed, keep samples on ice or at ≤6 °C; store in the dark	Samples must be frozen or analyzed within 4 hours of collection; filters can be stored frozen for 28 days
Non-Routine Compounds in Water Samples				
OIL AND GREASE	1-L glass jar with Teflon lid-liner, rinsed with hexane or methylene chloride	1000 mL (one jar)	Cool to ≤6 °C; HNO_3 or H_2SO_4 to pH<2	28 days at ≤6 °C, dark
PHENOLS	1-L glass jar with Teflon lid-liner	1000 mL (one jar)	Cool to ≤6 °C; H_2SO_4 to pH<2	28 days at ≤6 °C, dark
CYANIDE	1-L cubitainer	1000 mL (one cubitainer)	Cool to ≤6 °C; NaOH to pH>10; add 0.6 g $C_6H_8O_6$ if residual chlorine is present	14 days at ≤6 °C, dark
BIOCHEMICAL OXYGEN DEMAND (BOD)	4-L cubitainer	4000 mL (one cubitainer)	Cool to ≤6 °C; add 1 g FAS crystals per liter if residual chlorine is present	48 h at ≤6 °C, dark
CHEMICAL OXYGEN DEMAND (COD)	1-L cubitainer	110 mL (one cubitainer)	Cool to ≤6 °C; H_2SO_4 to pH<2	28 days at ≤6 °C, dark; biologically active samples should be tested as soon as possible
Trace Metals in Water Samples				
DISSOLVED METALS (except Dissolved Mercury)	60 mL polyethylene bottle, pre-cleaned in lab using HNO_3	60 mL (one bottle)	Filter at sample site using 0.45 micron in-line filter, or syringe filter (within 15 minutes of collection). Cool to 6°C, dark. Acidify in lab, within 48 hrs, using pre-acidified container (ultra-pure HNO_3) for pH<2.	Once sample is filtered and acidified, can store up to 6 months at room temperature

Parameters for Analysis in WATER Samples	Recommended Containers (all containers pre-cleaned)	Typical Sample Volume (mL)	Initial Field Preservation	Maximum Holding Time (analysis must start by end of max)
DISSOLVED MERCURY	250 mL glass or Teflon bottle, pre-cleaned in lab using HNO_3	250 mL (one bottle)	Filter within 15 minutes of collection. Cool to 6°C, dark. Acidify in lab within 48 hrs, with pre-tested HCL to 0.5%.	Once sample is filtered and acidified, can store up to 90 days at room temperature
TOTAL METALS (except Total Mercury)	60 mL polyethylene bottle, pre-cleaned in lab using HNO_3	60 mL (one bottle)	Cool to ≤6 ˚C, dark. Acidify in lab within 48 hrs, with pre-acidified container (ultra-pure HNO_3), for pH<2.	Once sample is acidified, can store up to 6 months at room temperature
TOTAL MERCURY	250 mL glass or Teflon bottle, pre-cleaned in lab using HNO_3	250 mL (one bottle)	Cool to ≤6 ˚C, dark. Acidify in lab within 48 hrs, with pre-tested HCL to 0.5%.	Once sample is acidified, can store up to 90 days at room temperature.
HEXAVALENT CHROMIUM (filtered)	600 mL plastic or glass bottle	600 mL (one bottle)	Cool to ≤6 ˚C, dark No acid	Keep at ≤6 ˚C, dark for up to 24 h; must notify lab in advance.
HARDNESS	200 mL polyethylene bottle	200 mL (one bottle)	Cool to 6°C, dark OR Cool to ≤6 ˚C; HNO_3 or H_2SO_4 to pH<2	48 h at 6°C, dark 6 months at ≤6 ˚C, dark
Synthetic Organic Compounds in Water Samples				
VOLATILE ORGANIC ANALYTES (VOA's) including VOC, MTBE and BTEX	40 mL VOA vials	120 mL (three VOA vials)	All vials are pre-acidified (50% HCl or H_2SO_4) at lab before sampling. Cool to 6°C, dark	unacidified: 7 days acidified: 14 days Both at 6°C, dark
PESTICIDES & HERBICIDES* □Organophosphate Pesticides □Organochlorine Pesticides □Chlorinated Herbicides **SEMI-VOLATILE ORGANICS*** **POLYCHLORINATED* BIPHEYNYL AND AROCHLOR COMPOUNDS** **TPH, PAH, PCP/TCP***	1-L I-Chem 200-series amber glass bottle, with Teflon lid-liner (per each sample type)	1000 mL (one container) ***Each sample type requires 1000 mL in a separate container**	Cool to 6°C, dark If chlorine is present, add 0.1g sodium thiosulfate	Keep at 6°C, dark, up to 7 days. Extraction must be performed within the 7 days; analysis must be conducted within 40 days.

Parameters for Analysis in WATER Samples	Recommended Containers (all containers pre-cleaned)	Typical Sample Volume (mL)	Initial Field Preservation	Maximum Holding Time (analysis must start by end of max)
Toxicity Testing Water Samples				
TOXICITY IN WATER	Four 2.25 L amber glass bottles	9000 mL	Cool to 4°C, dark	48 hrs at 4°C, dark
Bacteria and Pathogens in Water Samples				
E. Coli	Factory-sealed, pre-sterilized, disposable Whirl-pak® bags or 125 mL sterile plastic (high density polyethylene or polypropylene) container	100 mL volume sufficient for both E. coli and Enterococcus analyses	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to ≤ 10°C; dark.	STAT: 8 hrs at ≤ 10°C, dark if data for regulatory purposes; otherwise, 24 hrs at ≤ 10°C, dark if non-regulatory purpose.
Enterococcus	Factory-sealed, pre-sterilized, disposable Whirl-pak® bags or 125 mL sterile plastic (high density polyethylene or polypropylene) container	100 mL volume sufficient for both E. coli and Enterococcus analyses	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to ≤ 10°C ; dark.	STAT: 8 hrs at ≤ 10°C, dark if data for regulatory purposes; otherwise, 24 hrs at ≤ 10°C, dark if non-regulatory purpose.
FECAL COLIFORM	Factory-sealed, pre-sterilized, disposable Whirl-pak® bags or 125 mL sterile plastic (high density polyethylene or polypropylene) container	100 mL volume sufficient for both fecal and total coliform analyses	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to ≤ 10°C; dark.	STAT: 8 hrs at ≤ 10°C, dark if data for regulatory purposes; otherwise, 24 hrs at ≤ 10°C, dark if non-regulatory purpose.
TOTAL COLIFORM	Factory-sealed, pre-sterilized, disposable Whirl-pak® bags or 125 mL sterile plastic (high density polyethylene or polypropylene) container	100 mL volume sufficient for both fecal and total coliform analyses	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to ≤ 10°C; dark.	STAT: 8 hrs at ≤ 10°C, dark if data for regulatory purposes; otherwise, 24 hrs at ≤ 10°C, dark if non-regulatory purpose.

Field Collection Procedures for Bed Sediment Samples

Not Typical. This is not a standard practice of District staff, rather it may be conducted for a special effort under TMDL Monitoring Program or a special Study conducted by others. Refer to the corresponding project-specific sample and analysis plan as appropriate.

Not Typical. This is not a standard practice of District staff, rather it may be conducted for a special effort, refer to the corresponding project's sample and analysis plan as appropriate.

Bed sediment (hereafter termed "sediment") samples are collected after any water samples are collected where water and sediment are taken in the same reach. Care must be taken not to sample sediments that have been walked on or disturbed in any manner by field personnel collecting water samples. Sediment samples are collected into a composite jar, where they are thoroughly homogenized in the field, and then aliquoted into separate jars for chemical or toxicological analysis. Sediment samples for metals and organics are submitted to the respective analytical laboratories in separate glass jars, which have been pre-cleaned according to laboratory protocol.

Sediment chemistry samples give information regarding both trends in contaminant loading and the potential for adverse effects on sediment and aquatic biota. In order to compare samples over time and from site to site, they must be collected in a consistent manner. Recently deposited fine grain sediments (see attached table) are the target for sediment collection. If a suitable site for collecting sediments cannot be found at a station (it only contains larger grain material), sampling personnel should not collect the sediment sample, and should instead attempt to reschedule the sample collection or move to a different area that has more recently deposited fine sediment. If this is not possible, make a note so that the missing sample is accounted for in the reconciliation of monitoring events during preparation of sample collection "cruise reports". Sites that are routinely difficult to collect should be considered for elimination or relocation from the sample schedule, if appropriate.

Characteristics of Ideal Sediment Material to be Collected

Many of the chemical constituents of concern are adsorbed onto fine particles. One of the major objectives in selecting a sample site, and in actually collecting the sample while on site, is to obtain recently deposited fine sediment, to the extent possible. Avoid hard clay, bank deposits, gravel, disturbed and/or filled areas. Any sediment that resists being scooped by a dredge is probably not recently deposited fine sediment material. In following this guidance, the collection of sediment is purposefully being biased for fine materials, which must be discussed thoroughly in any subsequent interpretive reporting of the data, in regards to representation of the collected sample to the environment from which it was collected.

Characteristics of an Ideal Site

Quiescent areas are conducive to the settling of finer materials (EPA/USACOE, 1981).
Choose a sampling site with lower hydrologic energy, such as the inner (depositional) side of bends or eddies where the water movement may be slower. Reservoirs and estuaries are generally depositional environments, also.

Selecting the

Sediment will vary from site to site and can vary between sample

Appropriate Sediment Type for Analysis

events at a particular site.

Streams and Rivers: Sediment collection in flowing streams is often a challenge. In areas of frequent scouring there may not be sufficient sediment for collection during or following periods of high flow. Sediment collection during these times may prove unsuccessful and may have to be rescheduled or cancelled.

When the suspended load in rivers and streams precipitates due to reduction of velocity, most of the resulting sediment will be fine-grained. More often than not, a dredge or mechanical grab device does not function well for collection of sediment in smaller streams. In many cases, sediment will have to be collected using a pre-cleaned polyethylene scoop. Collect the top 2 cm for analysis. Five or more (depending on the volume of sediment needed for conducting analyses) fine-sediment sub-sites within a 100-m reach are sampled into the composite jar.

Reservoirs and Estuaries: Collect the top 2 cm for analysis. Grabs are composited for the sediment sample, depending on the volume of sediment needed for conducting analyses.

GENERAL PROCEDURE FOR COLLECTION OF BED SEDIMENT

After choosing an appropriate site, and identifying appropriate fine-grained sediment areas within the general reach, collect the sample using one or more of the following procedures, depending on the setting:

A. Sediment Scoop Method—Primary Method for Wadeable, Shallow Streams

- The goal is to collect the top 2 cm of recently-deposited fine sediment only.
- Wear gloves and protective gear, in areas of potential exposure hazards, per appropriate protocol (make sure gloves are long enough to prevent water from overflowing gloves while submerging scoop).
- Survey the sampling area for appropriate fine-sediment depositional areas before stepping into the stream, to avoid disturbing possible sediment collection sub-sites.
- Carefully enter the stream and start sampling at the closest appropriate reach, then continue sampling UPSTREAM. Never advance downstream, as this could lead to sampling disturbed sediment.
- Stir, do not shake, collected sediment with a polyethylene scoop for at least 5 min making sure all sediment is completely homogenized.
- Quickly scoop sediment out of the homogenizing jar into desired sampling jars making sure

to stir the sediment in the homogenizing jar in between each aliquot.

- Inspect each individual sediment jar making sure of consistent grain size throughout the entire sample collection.
- Single bag all sediment containers to prevent cross contamination.
- Make sure all containers are capped tightly and stored in a cooler on cube ice at 6 °C.

B. Hand Core Method-Alternate method for wadeable shallow streams with fine sediment

- A hand core is used in wadeable streams where there is very fine sediment.
- The hand core sampler consists of a 3-in. diameter polycarbonate core that is 8 inches long. Samplers push the core into the sediment to the desired depth, pull the core out of the sediment, and cap the bottom with a polyethylene core cap or by placing their hand underneath the cap to hold the sediment in place.
- Hand cores are usually measured and marked at 2 cm length so the sampler knows how far to deploy the core into the sediment.
- Sediment is then emptied into a homogenizing jug and aliquoted accordingly.

C. Sediment Grab Method—Primarily for Lake, River, Bridge, and Estuarine Settings (or deeper streams)

Description of sediment grab equipment:

- A mechanical sediment grab is used for the SWAMP bed sediment collection field effort for lake, river, bridge, and estuarine/coastal settings (or deeper, non-wadeable streams).
- The mechanical grab is a stainless steel “Young-modified Van Veen Grab", and is 0.5 m^2 in size.
- The mechanical grab is deployed primarily from a boat, and is used in deeper, non-wadeable waters, such as lakes, rivers, estuaries, and coastal areas.
- It is also deployed by field personnel from land in settings which allow its use: primarily from bridges; from smaller vessels in streams or drainage channels too deep or steep to wade into, but too shallow for a larger boat.

Deploying and retrieving the grab:

- Slowly lower the grab to the bottom with a minimum of substrate disturbance.
- Retrieve the closed dredge at a moderate speed (e.g., less than two feet per second).
- Upon retrieval, open the lids of the sediment grab, examine the sample to ensure that the sediment surface is undisturbed and that the grab sample should not be rejected.

Rejection Criteria—reject the sample if the following are not met:

- Mud surface must not be pressing out of the top of the sampler. If it is, lower the grab more slowly.
- Overlying water must not be leaking out along the sides of the sediment in the grab. This

ensures the surficial sediment is not washed out.

- Sediment surface is flat and level in the sampler. If it is not level, the grab has tilted over before closing.

Processing the sediment sample from the grab equipment:

- The water overlying the sediment in the grab is very gently decanted by slightly tipping the grab with the lid closed until the water runs out the top.
- The decanting process should remove all of the overlying water but not remove the surficial sediments. The laboratory reports percent water for the sample, so overlying water is not included in the sample container.
- The sediment is examined for depth of penetration, color and thickness of top aerobic zone, and texture. These observations are recorded on the field data sheet.
- Collect the top 2 cm from at least five sub samples, and otherwise, exclude the bottom-most layer and composite.
- In streams or other settings with excessive bottom debris (e.g., rocks, sticks, leaves) where the use of a grab is determined to be ineffective (e.g., dredge does not close, causing loss of sediment), samples may be collected by hand using a clean plastic scoop, or by a variety of coring methods, if appropriate for the situation.
- Sediment is handled as described below in the metals and organic sections.

Cleaning the Grab Equipment and Protection from Potential Contaminating Sources:

- The sediment sampler will be cleaned prior to sampling EACH site by: rinsing all surfaces with ambient water, scrubbing all sediment sample contact surfaces with Micro™ or equivalent detergent, rinsing all surfaces with ambient water, rinsing sediment sample contact surfaces with 5% HCl, and rinsing all sediment sample contact surfaces with methanol.
- The sediment grab will be scrubbed with ambient water between successive deployments at ONE site, in order to remove adhering sediments from contact surfaces possibly originating below the sampled layer, thus preventing contamination from areas beyond target sampling area.
- Sampling procedures will attempt to avoid exhaust from any engine aboard any vessel involved in sample collection. An engine will be turned off when possible during portions of the sampling process where contamination from engine exhaust may occur. It is critical that sample contamination be avoided during sample collection. All sampling equipment (e.g., siphon hoses, scoops, containers) will be made of non-contaminating material and will be appropriately cleaned before use. Samples will not be touched with un-gloved fingers. In addition, potential airborne contamination (e.g., from engine exhaust, cigarette smoke) will be avoided.

D. Core Method--alternative for fast-moving, wadeable streams

The core method is used in soft sediments when it is difficult to use the other methodologies. The cores can be used in depths of water from 0 to 10 ft by using a pole deployment device or in deeper water using SCUBA divers. The pole deployment device consists of a pole that attaches to the top

of the core. The top of the core is fitted with a one-way valve, which allows the core to be filled with sediment, but when pulled from the sediment catches the sediment within the core. The core is then brought to the surface and the sediments within the core are extruded out the top of the core so that 2 cm of sediment is above the top of the plastic core. The 2 cm of sediment is then sliced off and placed in the homogenizing jar. A new core, homogenizing jar, and device used to slice off the top two cm. are used at each station unless the equipment is cleaned using laboratory protocols.

E. Sediment Grab Method – Primarily used from bridges or for streams with restricted bank access.

Description and sampling procedure for the Eckman sediment grab

- The Eckman grab is 0.2 m^2 in size with a lead "messenger" that triggers the spring loaded doors.
- The primary use is for sampling from bridges or from small vessels in streams or drainage channels too deep or steep to wade into, but too shallow for a larger boat.
- The grab must be cleaned with a Micro™ and tap water rinse before sampling and in-between sample stations.
- To deploy the grab, pull the spring loaded doors open and hook the cables on the actuator plate.
- With a rope, lower the grab to the desired sample reach making sure that the grab has penetrated the sediment. Clip the "messenger" on the rope and release it while maintaining tension on the rope. Pull up the grab once the "messenger" has activated the doors.
- While wearing clean poly gloves, open the top hatch and remove the top 2 cm of sediment with a clean polyethylene scoop. Place the sediment into the homogenizing jug and repeat the sampling process until there is enough desired sediment. See general procedures for processing of bed sediment samples, once they are collected for sediment homogenization and aliquoting into sample jars.

GENERAL PROCEDURE FOR PROCESSING OF BED SEDIMENT SAMPLES, ONCE THEY ARE COLLECTED

Sediment Homogenization, Aliquoting and Transport

For the collection of bed sediment samples, the top 2 cm is removed from the scoop, or the grab, or the core, and placed in the 4-L glass compositing/homogenizing container. The composited sediment in the container is homogenized and aliquoted on-site in the field. The sample is stirred with a polyethylene scoop until sediment/mud appears homogeneous. All sample identification information (station numbers, etc.) will be recorded prior to homogenizing and aliquoting. Sediment samples will immediately then be cooled to 6 °□C and separated for preservation according to the: Summary of Sample Container, Volume, Preservation, and Storage Requirements for SWAMP Bed Sediment, Biota, and Tissue Samples (for contaminant analysis).Each container will be sealed in one large plastic bag to prevent contact with other samples or ice or water.

Metals and Semi-volatile Organics in Sediment	For trace metals and semi-volatile organics, a minimum of three grabs is distributed to the composite bottle and/or sample containers. Mixing is generally done with a polyethylene scoop. Make sure the sample volume is adequate, but the containers do not need to be filled to the top. Seal the jars with the Teflon liner in the lids.
Sediment Conventionals	Sediment conventionals are sometimes requested when sediment organics, sediment metals, and/or sediment toxicity tests are requested for analysis of samples. The collection method is the same as that for metals, semi-volatile organics, and pesticides. Sediment conventionals include: grain size analysis and total organic carbon. These are used in the interpretation of metals and organics in sediment data.
Sample Containers	See "Sediment Sample Handling Requirements" table at end of this document.
Sediment Sample Size	Must collect sufficient volume of sediment to allow for proper analysis, including possible repeats, as well as any requested archiving of samples for possible later analysis. See "Sediment Sample Handling Requirements" Table at end of this document.
Labeling	Label the jars with the station ID, sample code, matrix type, project ID, time, and date of collection, as well as the type of analysis requested (e.g., metals, conventionals, organics, or archives).
Short-term Field Preservation	Immediately place the labeled jar on ice, cool to 6 °□C, and keep in the dark at 4 °□C until delivery to the laboratory.
Field Notes	Fill out the SWAMP Sediment Data Sheet. Make sure to record any field notes that are not listed on the provided data sheets. This information can be reported as comments with the sediment analytical results.

Summary of Sample Container, Volume, Preservation, and Storage Requirements for SWAMP Bed Sediment, Biota, and Tissue Samples (for contaminant analysis)

Parameters for Analysis	Recommended Containers	Typical Sample Volume (mL)	Initial Field Preservation	Maximum Holding Time

Parameters for Analysis	Recommended Containers	Typical Sample Volume (mL)	Initial Field Preservation	Maximum Holding Time
Bed Sediment Samples				
Trace Metals, including Hg and As (except for Se--see below)	60-mL I-Chem 300- series clear glass jar with Teflon lid-liner; Pre-cleaned	60 mL (one jar)	Cool to ≤6 °C within 24 hours, then freeze to ≤-20 °C	12 months(1) (-20 °C)
Methylmercury	60-mL I-Chem 300- series clear glass jar with Teflon lid-liner; Pre-cleaned	60 mL (one jar)	Freeze to ≤-20 °C immediately	12 months(1) (-20 °C)
Selenium (separate container required)	60-mL I-Chem 300- series clear glass jar with Teflon lid-liner; Pre-cleaned	60 mL (one jar)	Cool to ≤6 °C within 24 hours, then freeze to ≤-20 °C	12 months(1) (-20 °C)
Synthetic Organic Compounds	250-mL I-Chem 300-series amber glass jar with Teflon lid-liner; Pre-cleaned	500 mL (two jars)	Cool to ≤6 °C within 24 hours, then freeze to ≤-20 °C	12 months(1) (-20 °C)
Sediment TOC	250-mL(3) clear glass jar; Pre-cleaned	125 mL (one jar)	Cool to ≤6 ˚C or freeze to ≤-20 ˚C	28 days at ≤6 ˚C; 1 year at ≤-20 ˚C (2)
Sediment Grain Size	250-mL(3) clear glass jar; Pre-cleaned	125 mL (one jar)	Wet ice to ≤6 ˚C in the field, then refrigerate at ≤6 ˚C	1 year (≤6 ˚C) ***Do not freeze***
Sediment Toxicity Testing	1-L I-Chem wide-mouth polyethylene jar with Teflon lid-liner; Pre-cleaned	2 (two jars filled completely)	Cool to 4 °C, dark, up to 14 days	14 days (4 °C) ***Do not freeze***

(1) Sediment samples for parameters noted with one asterisk (*) may be refrigerated at 6 °C for up to 14 days maximum, but analysis must start within the 14-day period of collection or thawing, or the sediment sample must be stored frozen at minus (-) 20 °C for up to 12 months.

(2) Sediment samples for sediment TOC analysis can be held at 4°C for up to 28 days, and should be analyzed within this 28-day period, but can be frozen at any time during the initial 28 days, for up to 12 months at minus (-) 20 °C.

(3) Sediment samples for TOC AND grain size analysis can be combined in one 250 mL clear glass jar, and sub-sampled at the laboratory in order to utilize holding time differences for the two analyses. If this is done, the 250 mL combined sediment sample must be refrigerated only (not frozen) at 4 °C for up to 28 days, during which time the sub-samples must be aliquoted in order to comply with separate storage requirements (as shown above).

APPENDIX F & G:

SWAMP BIOASSESSMENT SOP & SWAMP ALGAE FIELD SOP

This document consolidates two previous, closely related SOPs and supersedes the previous version of them.

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SWAMP Surface Water Ambient Monitoring Program

SWAMP Bioassessment Procedures 2016

Standard Operating Procedures (SOP) for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat

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ABBREVIATIONS AND ACRONYMS

AFDM	Ash-Free Dry Mass
BMI	Benthic Macroinvertebrate
chl *a*	Chlorophyll *a*
CPOM	Coarse Particulate Organic Matter
CSBP	California Stream Bioassessment Procedure
DI	Deionized water
DO	Dissolved Oxygen
DFW	(California) Department of Fish and Wildlife
EMAP	Environmental Monitoring and Assessment Program (of the U.S. EPA)
EPA	Environmental Protection Agency (of the United States)
GPS	Global Positioning System
IBI	Index of Biotic Integrity
LRBS	Log Relative Bed Stability
MCM	Margin-Center-Margin
NAD	North American Datum
NBO	Neutrally Buoyant Object
NNE	Nutrient Numeric Endpoints
NRSA	National Rivers and Streams Assessment (of the U.S. EPA)
PHab	Physical Habitat
QA	Quality Assurance
QAPrP	Quality Assurance Program Plan (of SWAMP)
RBP	Rapid Bioassessment Procedures
RWB	Reachwide Benthos
SOP	Standard Operating Procedures
SCCWRP	Southern California Coastal Water Research Project
SWAMP	Surface Water Ambient Monitoring Program (of the California State Water Resources Control Board)
TRC	Targeted Riffle Composite
VAM	Velocity-Area Method (for determining stream discharge)

1. INTRODUCTION

This document describes the Standard Operating Procedures (SOP) for bioassessment of wadeable streams for the California State Water Resources Control Board's Surface Water Ambient Monitoring Program (SWAM). These procedures are recognized by the US Environmental Protection Agency (EPA) as California's standard bioassessment procedures and are designed to support general assessment of the ecological condition of wadeable streams and rivers based on the composition of the benthic macroinvertebrate and benthic algal assemblages. The procedures also produce standardized measurements of instream and riparian habitat and ambient water chemistry to support interpretation of the biological data.

Instructions are provided for collection of the following:

- samples for taxonomic analysis of benthic macroinvertebrate (BMI) assemblages
- samples for taxonomic analysis of benthic algal assemblages (diatoms & non-diatom (soft) algae (including cyanobacteria))
- samples for determination of biomass based on benthic chlorophyll *a* and benthic ash-free dry mass (AFDM)
- stream physical habitat (PHab) data
- water chemistry samples

1.1 Previous SOPs

This document represents a consolidation of two closely related previous SOPs, and supersedes them:

- **Ode (2007)**, which focused on stream BMI sampling and associated PHab data collection and replaced previous bioassessment protocols referred to as the California Stream Bioassessment Procedure (CSBP, Harrington 1995, 1999, 2002), and
- **Fetscher et al. (2009)**, which focused on stream benthic algae and biomass sampling, and associated PHab data collection.

Most of the methods described here are close adaptations of those developed by the EPA's Environmental Monitoring and Assessment Program (EMAP) and currently used by the EPA's National Rivers and Streams Assessment (NRSA) surveys. Table 1 provides a summary of the major changes to field procedures since the previous SOPs.

Summary of Changes

Table 1 Summary of Changes

Section	Category	Current Protocol	Previous Versions (Ode 2007 & Fetscher et al. 2009)
General	General	For SWAMP, the "Full" set of PHab modules must be carried out, even if just collecting algae (and not BMIs) as the biotic assemblage.	Previously, modules such as Riparian Vegetation and Instream Habitat Complexity were not required if only algae were

			being collected for bioassessment.
1.4	Diagnosing Recent Scour	Guidance is now provided for diagnosing recent scour, which may be of concern under the rare circumstance in which sampling must occur shortly following a large storm or discharge release (e.g., from a dam); field sheets now include a place to mark for scour so that applicable analytes are flagged in the database.	No previous guidance provided for diagnosing scour; no data flags for influence of recent scour.
1.8	QA	For SWAMP, duplicate sampling of BMIs and benthic algae is required at 10% of study sites.	No previous requirement for duplicate sampling.
2	Notable Field Conditions	Field forms and database now allow users to mark whether or not the sampling reach lies within an engineered channel.	No place for recording this information was previously available.
3	Water Chemistry	For SWAMP, TN and TP are now required if collecting algae for bioassessment.	No previous requirement for TN/TP.
4.5	Algae sample collection - sediment	Delimiter (coring device) to collect sediment is now properly termed "ABS delimiter".	Was previously (erroneously) called "PVC delimiter".
5.2	Soft Bodied Algae Processing	If there appears to be more than one type of macroalgae (i.e., obviously different species based on color/texture) in the sample, separate cylinders should be made for each one.	Previous version had all soft algae rolled together into a single cylinder.
5.2	Processing Quantitative Benthic Algal Taxonomy and Biomass Samples	The final concentration of glutaraldehyde required for the fixed (quantitative) soft-algae sample is now 2% (qualitative samples are still to be left *unfixed*). **This change will be realized by using a more dilute (20%) stock solution of glutaraldehyde, rather than changing the volume of stock fixative added to the soft-algae sample.**	The final concentration of glutaraldehyde required in the fixed (quantitative) soft-algae sample was previously 2.5%. The previous concentration of stock solution for glutaraldehyde was 25%.
5.2	Processing Quantitative Benthic Algal Taxonomy and Biomass Samples	The final concentration of formalin required in the diatom sample is now 1%; also, the formalin used no longer needs to be buffered, *but* if it is, then phosphate buffer, **NOT BORAX** should be used; COCs should indicate whether phosphate buffer has been added to the formalin or not. **This change will be realized by using a more dilute (5%) stock solution of formalin, rather than changing the volume of stock fixative added to the diatom sample.**	The final concentration of formalin required in the diatom sample was previously 2% and the formalin was buffered with borax. The previous concentration of stock solution for formalin was 10%.
6.2	Pebble Count	In the Pebble Count, users must now circle "D" (dry) for CPOM and Macrophytes when they correspond to a point that is not submerged/moist.	Those fields were previously left blank when the point was dry.
6.2	Pebble Count	In the Pebble Count, SWAMP now requires that users measure pebbles rather than simply putting them into bins.	Previously, users reporting to SWAMP had the option to bin or measure the

		However, binning is still allowed when, for some reason, particles cannot be measured.	pebbles.
6.2	Pebble Count	For SWAMP, presence/absence of macroalgae is recorded during the pebble count, even if only BMIs (and not algae) are being sampled.	No previous requirement for recording macroalgae presence/absence if only collecting BMIs for bioassessment.
6.4	Pebble Count; Coarse particulate organic matter	Size for coarse particulate organic matter has been changed to those which are >1 mm in size, but no larger than 10.	Previous version had no maximum size.
6.4 , 6.8	Pebble Count; Instream Habitat Complexity	Mosses are explicitly not included in macrophytes (regardless of the module).	In the previous BMI SOP (Ode 2007) mosses were included in the macrophytes.
6.5	Bank Stability	Bank stability is now assessed along the imaginary line running from where the transect ends meet the wetted margin, to the bankfull boundary.	Previously, bank stability was estimated in the area between the upstream and downstream inter-transects.
6.8	Instream Habitat Complexity	For instream habitat complexity, estimates should include only those features within the stream's wetted margin.	Previous guidance was that estimates should include features within the banks and outside the wetted margins of the stream.
6.9	Stream shading	For SWAMP, 6 densiometer readings (four in the center of the stream and one at each bank) are now required in streams > 10 m wide.	Previously, users reporting to SWAMP could collect only the four center-stream densiometer readings, with the bank readings optional.

1.2 Sampling Overview

This SOP describes methodology for biotic sampling procedures as well as for assessing instream and riparian habitats and ambient water chemistry associated with biotic assemblage samples (Table 2). The sampling layout described in this SOP provides a framework for systematically collecting a variety of biotic, physical, and chemical data. The biotic sampling methods are designed to nest within the overall framework for assessing the biotic, physical, and chemical condition of a reach. The physical habitat characterization methods can be implemented for a stand-alone evaluation or in conjunction with a bioassessment sampling event. This information can be used to characterize stream reaches, associate physical and chemical condition with biotic condition, and explain patterns in the biotic data. Measurements of instream and riparian habitat and ambient water chemistry are essential to interpretation of bioassessment data, and must always accompany bioassessment samples for SWAMP projects.

Because bioassessment data requirements vary widely across different applications, this document describes the component measures of instream and riparian habitat as independent "modules", which may be implemented as needed for each application. For instance, if the goal is to evaluate stream primary production, one may wish to collect only biomass samples and algal cover point-intercept data, and exclude modules focusing on instream habitat complexity. Alternatively, one may need to collect BMI and/or algal taxonomic samples in order to make more refined inferences about stream condition (e.g., by applying a multimetric index based on community composition). Recommendations for modules to include in a reduced-effort ("Basic") version of this SOP, e.g., for citizen monitoring groups on a limited budget, are provided in the Guidance Document.

In order to ensure high-quality bioassessment data, certain tasks must be carried out prior to others. A work-flow diagram depicting the order in which tasks should be undertaken is provided in Figure 1 (see Guidance Document for suggestions to maximize efficiency).

Assuming an adequate crew size, the total time required to carry out the full suite of field procedures described in this SOP is approximately 2 to 4 hours in a typical stream, or up to 6 hours in a complex stream. These estimates include only the time spent at the site, not travel time (which varies widely). Table 2 provides a rough breakdown of time requirements per module.

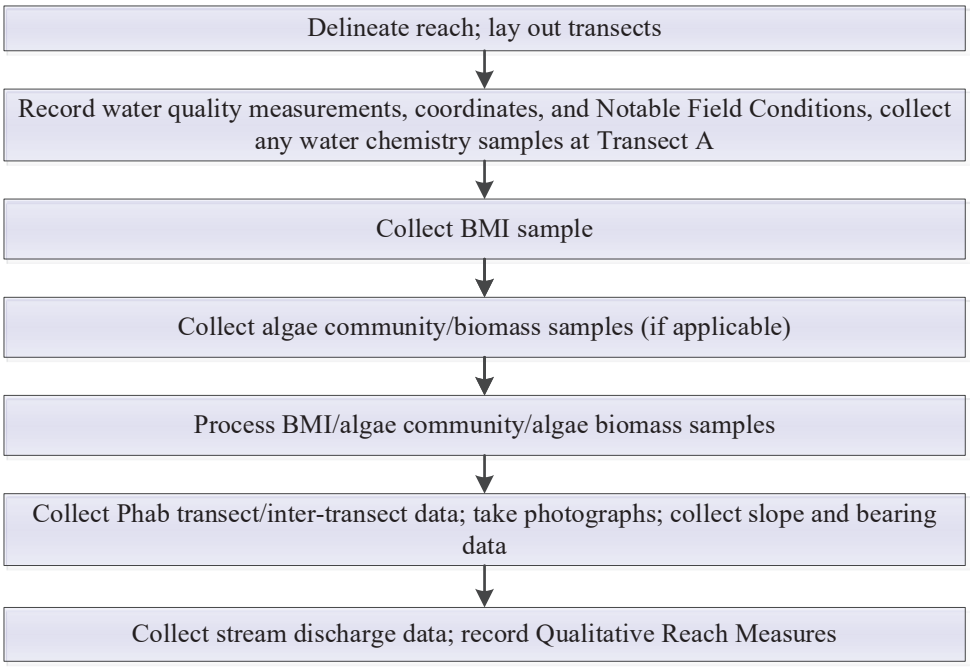

Figure 1. Recommended work flow (order of tasks) for conducting stream bioassessment.

1.3 Scope and Applicability

This SOP is intended for use in ambient monitoring of California wadeable streams that are flowing at the time of assessment, meaning that it may be used in both perennial and nonperennial streams as long as sampleability criteria are met[1]. A reach is considered "sampleable" with this protocol if at least half of the reach has a wetted width of at least 0.3 m (the width of a D-frame net) and there are no more than three transects that are completely dry within the monitoring reach at the time of assessment. If more than three transects are completely dry, then the stream reach should not be sampled for biota; however, if the monitoring program allows it, the reach may be shifted in order to reduce the number of dry transects, thus allowing biota to be sampled (for more details, see Section 2 on reach delineation and transect placement). The wadeability limitation is determined by the practical ability to safely obtain a consistent sample of the benthic community from a reach. In general, a reach is considered wadeable if it is less than one meter deep for at least half the length of the reach.

It is recommended that biotic sampling be carried out during the period from May through September, depending upon the region (i.e., toward the earlier end of this range in southern California, and later in the range for higher latitudes). See Figure 2. Samples intended for ambient bioassessments are generally collected when streams are at or near base flow (i.e., not influenced by storm runoff), as sudden flow increases can displace benthic organisms from the

[1] The sampleability criteria defined here are intended to ensure comparability of data collected for ambient monitoring or regulatory compliance monitoring. Less restrictive criteria may be acceptable for other uses.

stream bottom and dramatically alter local community composition. To be conservative, it is strongly recommended that sampling be carried out at least two, and preferably three, weeks after any storm event that has generated enough stream power to mobilize cobbles and sand/silt capable of scouring stream substrates. See Section 1.4, below, for tips on how to evaluate a site for recent scour. Two to three weeks will usually allow time for benthic fauna and algae to recolonize scoured surfaces (Round 1991; Kelly *et al*. 1998; Stevenson and Bahls in Barbour *et al*. 1999). Ultimately, the time of delay from a scouring event to the acceptable window for sampling will depend on environmental setting and time of year. The project manager should consult with the SWAMP bioassessment coordinator in questionable cases.

1.4 Diagnosing Recent Scour

As mentioned above, ideally, a stream reach should ***not*** be sampled for bioassessment shortly following a scour event that has mobilized bed materials and potentially disrupted benthic communities. However, for certain applications (e.g., wet-weather monitoring), sampling may need to occur under such circumstances. When this happens, a note must be made in the field sheets and the database that flags applicable analytes as having potentially been subjected to recent scour conditions. If a suspected recent scour has occurred, mark "Yes" in the **Notable Field Conditions** section of the bioassessment field form that says, "Site is affected by recent scouring event". High-flow/scour indicators that can be assessed to make the determination include:

- Lack of slime/color coating on the streambed (this may be inferred by a high frequency [i.e., near 100%] of microalgal cover scores of "0"; see Section 6.4)
- Lack of macroalgal mats, OR if present, mats displaced, as indicated by being "unnaturally" bunched up against fixed objects within the stream (like tree roots, large boulders) away from centroid of flow
- Non-rigid instream vegetation (e.g., emergent macrophytes like cattails and tules) bent over or lying down within the stream
- Absence of leaves and other detritus in pools, despite riparian cover

Following the sampling visit, under "Field Notes/Comments" on the field sheet, field crews or the project manager can add the size of, and actual time since, storms or discharge releases.

Figure 2. Index Period by Ecoregion

Table 2. Sample and data collection modules for BMI and algal bioassessment. The estimated time each task takes on average is provided after each Module name in parentheses. Very experienced crews may be faster in some settings.

Survey Task	Module	Time	Notes
REACH DELINEATION and WATER QUALITY	Layout of reach, marking transects, recording GPS coordinates	15 min	Use 150m reach length if wetted width ≤10 m or 250m if wetted width > 10 m
Conducted before entering stream to sample biota or collect PHab data	Temperature, pH, specific conductance, salinity, DO, alkalinity	10 min	Alkalinity, conductance, pH, and salinity may be measured in in the laboratory from collected samples if SWAMP holding times are met whereas DO and temperature must be measured in the field
	Turbidity	5 min	Use test kit/meter or collect samples for laboratory analysis
	Notable field conditions	5 min	
	Water chemistry for laboratory analysis (total phosphorus and total nitrogen)	15 min	Required by SWAMP when algae are sampled
BIOTIC ASSEMBLAGE/ ALGAL BIOMASS AND PHAB SAMPLING AT CROSS-SECTIONAL TRANSECTS	BMI Sampling for Taxonomic IDs	45 min	
	Algal Sampling for Taxonomic IDs and biomass assessment	45 min	
Measurements (BMIs, algae, PHab) at 11 main transects (A – K), or 21 transects (11 main plus 10 inter-transects for wetted width, substrate size, algal cover, and flow habitat)	Depth and Pebble Count + CPOM	35 min	5-point substrate size, depth, and CPOM records at all 21 transects and intertransects

BIOTIC ASSEMBLAGE/ ALGAL BIOMASS AND PHAB SAMPLING AT CROSS-SECTIONAL TRANSECTS (Continued)	Cobble Embeddedness (incl. in "Pebble Count" time)		Include all cobble-sized particles in pebble count. Supplement with "random walk" if needed for 25, total
	Percent Algal Cover (part of pebble count)		Attached/unattached macroalgae presence/absence; microalgal thickness codes
	Bankfull Dimensions (10-20 min)	60-70 min	
	Wetted Width (5 min)		
	Bank Stability (5 min)		
	Human Influence (5 min)		
	Riparian Vegetation (5 min)		
	Instream Habitat Complexity (5 min)		
	Stream Shading (10 min)		6 densiometer readings required at streams where mean wetted width is > 10m; the 4 center points are sufficient in narrower streams
	Flow Habitat Delineation (15 min)		Record proportion of habitat classes in each inter-transect zone
	Slope (%) (25 min for autolevel method; 15 min for clinometer method)	15-25 min	Average slope calculated from 10 transect-to- transect slope measurements. Use autolevel for slopes ≤ 1% (clinometer acceptable for steeper gradients); time requirements increase considerably in complex streams
	Sinuosity	10 min	Record compass readings between transect-to-transect centers
	Excess Sediment Transect Measures		Optional measure: Bankfull width and height, bank angles; Large woody debris counts (tallies of woody debris in several size classes); thalweg profile (100 equidistant points along thalweg); refer to NRSA SOP for details.

DISCHARGE TRANSECT	Discharge measurements (15 min for velocity-area method; 10 min for neutrally-buoyant-object method)	10-15min	Velocity-Area Method (VAM; preferred) or Neutrally Buoyant Object Method, somewhere within, or very near to, the monitoring reach; VAM may not be feasible in all streams
REACH-SCALE MEASUREMENTS	Qualitative Reach Measures (subset of Rapid Bioassessment Procedure, RBP, visuals)	5 min	Channel alteration, sediment deposition, epifaunal substrate
	Photo documentation	5 min	Upstream (Transects A, F), Downstream (Transects F, K) at minimum, but ideally add an overview picture

1.5 Training

Procedures described here are designed to produce repeatable, quantitative measures of a stream's BMI and algal assemblages and physical/habitat condition. *It is important to note that in order to generate usable data, formal field training of sampling crews is required, and Quality Assurance (QA) measures must be implemented throughout the field season*. Training courses are made available by the Water Boards Training Academy. Courses are posted regularly at: http://www.waterboards.ca.gov/water_issues/programs/academy/home.htm.

In addition, regular (e.g., yearly) field audits of sampling crews, conducted by an experienced individual, are highly recommended, with additional training and follow-up auditing carried out as necessary depending upon audit outcomes. Annual intercalibration events involving multiple crews with experience in different regions of California are strongly recommended. Contact the Department of Fish and Wildlife's Aquatic Bioassessment Laboratory to participate in intercalibration events.

1.6 Permitting

Collection of benthic samples in California waterbodies without a valid California Department of Fish and Wildlife (DFW) Scientific Collection Permit is illegal. Prior to the onset of fieldwork, a Scientific Collecting Permit (for sampling of stream biota) MUST be acquired from DFW for at least one member of the field crew. Additional information on requirements and how to obtain permits can be found in the Guidance Document. Likewise, for streams supporting species listed as sensitive under the State or Federal Endangered Species Act (including, but not limited to, California red-legged frog, least Bell's vireo, southwestern willow flycatcher, arroyo toad, and salmonids), sampling cannot be conducted at certain times of the year, or a permitted escort may be required to supervise sampling activities to ensure that resident sensitive species are not impacted. More information can be found at http://www.fws.gov/ENDANGERED/permits/index.html and https://www.dfg.ca.gov/wildlife/nongame/research_permit/.

1.7 Avoiding the Transfer of Invasive Species and Pathogens Amongst Sites

Proper field hygiene must be practiced at all times in order to avoid transferring invasive organisms or pathogens between sites. Examples include, but are not limited to, New Zealand mud snail and chytrid fungus. Before approaching any stream, precautions must be taken to ensure that all equipment that will come into contact with the stream or its immediate surroundings has been properly decontaminated. Such equipment includes, but is not limited to, footwear, D-frame net, algae sampling devices, water chemistry sample fill bottle, transect tape, flags, stadia rod, flow meter, water chemistry probes, and autolevel tripod. Furthermore, under no circumstances shall stream water (e.g., from water bottles used for algae sample processing) or other material collected at one site be introduced into another stream. Detailed information on acceptable decontamination procedures is provided in the Guidance Document.

1.8 SWAMP Requirements

The "reachwide benthos" (RWB) sampling procedure, as described in this SOP, is the required sampling method for ambient bioassessment under the SWAMP program. However, other sampling methods (e.g., Targeted Riffle Composite (TRC)) may be desirable if data comparability within long-term monitoring projects that have historically used other methods is sought. In general, SWAMP-funded projects must adhere to the directives of the SWAMP Quality Assurance team as detailed in: *Amendment to SWAMP Interim Guidance on Quality Assurance for SWAMP Bioassessments 9-17-08*. This memo can be found in the Guidance Document. The project manager must have the approval of the SWAMP Bioassessment Program Lead Scientist and the SWAMP Quality Assurance Officer **before** the use of alternative methods that deviate from this SOP and the above-referenced memo will be accepted. For other projects and/or programs desiring SWAMP comparability, deviations should be approved by the project manager and project QA officer.

SWAMP requires that duplicate sampling of BMIs and benthic algae occur at 10% of study sites (preferably at the same set of sites, when both assemblages are being sampled together). The recommended location for collecting duplicates is at adjacent positions along the sampling transects (described in Section 4). In addition, regular (e.g., yearly) field audits of sampling crews should be conducted by an authorized individual (e.g., qualified personnel of DFW). Note also that SWAMP requires 5% field duplicates for water chemistry measurements. In general, the SWAMP Quality Assurance Program Plan (QAPrP) in place at the time of monitoring or subsequent revisions to that QAPrP and the SMC Bioassessment QAPP (2009) should be followed for quality assurance procedures, when applicable. For more information, refer to: http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa

SWAMP participants collecting water-quality and water-chemistry measurements may reference the California Department of Fish and Wildlife - Marine Pollution Studies Laboratory SOP: *Collections of Water and Bed Sediment Samples with Associated Field Measurements and Physical Habitat in California. Version 1.1, updated March-2014*. This procedure may be used to collect samples for a number of analyses covered by the SWAMP

Quality Assurance program. Use of this procedure is a recommendation and not a requirement for SWAMP projects. Prior to sample collection, participants using this procedure shall check its requirements against the latest SWAMP *Quality Control and Sample Handling Guidelines*.

SWAMP is planning to develop additional guidance for bioassessment quality assurance and control procedures. This may include more specific information covering personnel qualifications, training and field audit procedures, procedures for field calibration, procedures for chain of custody documentation, requirements for measurement precision, health and safety warnings, cautions (to avoid actions that would result in instrument damage or compromised samples), and interferences (regarding consequences of not following the SOP).

1.9 Supplemental Guidance

A companion document, SWAMP Bioassessment Supplemental Guidance (herein referred to as the "Guidance Document"), is referenced throughout this SOP. It provides more detailed information on the various applications of the modules described here, as well as recommendations for where, when, and/or how to implement the procedures. It also provides suggestions for how to deal with special circumstances that may be encountered during stream bioassessment sampling and more detailed information to aid in interpretation of PHab field indicators. The Guidance Document is a "living" supplement to the field sampling protocol, in the sense that it is regularly updated (unlike this SOP, which is static between versions) and serves as a repository for implementation advice. The Guidance Document is posted on the SWAMP website at
Http://www.waterboards.ca.gov/water_issues/programs/swamp/bioassessment/sops.shtml
Please check this site regularly in order to review the most recent information on execution of the SOP.

2. REACH DELINEATION AND SCORING NOTABLE FIELD CONDITIONS

Before biotic sample and PHab data collection can begin, the monitoring reach must be identified and delineated, information about reach location and condition is to be documented, water chemistry parameters are to be recorded, and water samples may also be collected. A set of field forms for recording information about monitoring sites, biotic samples, and associated water chemistry and PHab data is available on the SWAMP website at http://www.swrcb.ca.gov/water_issues/programs/swamp/tools.shtml#methods. Field crews using paper forms must designate someone (other than the field recorder) to review the forms for completeness[2] and legibility. It is imperative to confirm throughout the data collection effort at each site that all necessary data have been recorded on the field forms correctly by double-checking values and confirming spoken values with field partner(s). All SWAMP data management tools including an electronic data entry interface of the field forms are available

[2] If parameters cannot be measured for some reason, "NR" (i.e., "Not Recorded") should be entered in the corresponding field.

from the SWAMP website for use on a portable field computer. Please visit the SWAMP Data Management Resources website for webinar training, tools, templates, and more. http://www.waterboards.ca.gov/water_issues/programs/swamp/data_management_resources/index.shtml A list of supplies needed for sampling and data collection is provided in the Guidance Document.

Step 1. Upon arrival at the site, fill out the "Reach Documentation" section of the field forms. Record the Station Code following SWAMP formats[3]. Record the geographic coordinates of the **downstream end** (Transect A) of the reach (in decimal degrees to at least five decimal places) with a Global Positioning System (GPS) receiver and record the datum setting (preferably NAD83) of the unit. Coordinates are to be averaged based on procedures outlined in the GPS device manual. This average is recorded as actual coordinates on field sheet. Target coordinates need to be determined before the field sampling, and should be placed on a map (paper or digital) for visual orientation in case the GPS is not functioning in the field (e.g., in steep canyons or in mountainous regions). Sampling locations for probability sites can be moved up or downstream as much as **300 m** from the target location for reasons such as avoiding obstacles, mitigating issues regarding safety or permission to access, and GPS error. If for some reason the GPS measurements for the actual site assessed are not taken at Transect A (e.g., if no GPS signal was available at Transect A), then the actual site location must be noted on the field data sheets.

For probabilistically selected sites "target coordinates" are selected at random. Because GIS information about stream locations is imperfect, the target coordinates may not fall exactly on a streambed, but rather nearby, requiring a geospatial shift in order to correspond to the nearest streambed. The potential discrepancy between the target coordinates and where sampling actually occurs makes it essential to record the actual field coordinates on the field sheet.

Step 2. To delineate the monitoring reach, first scout it to ensure it is of adequate length for sampling biota. The length to use depends upon the average "wetted width" of the stream reach. The "wetted channel" is the zone that is inundated with water, and "wetted width" is the distance between the sides of the channel at the point where substrates are no longer surrounded by surface water. If the average wetted width $\leq$ 10 m, delineate a 150 m reach for sampling. If the average wetted width > 10 m, delineate a 250 m reach. When delineating the reach, *stay out of the channel as much as possible* to avoid disturbing the stream bottom, which could compromise the water and biotic samples, and PHab data, that will subsequently be collected.

Starting at one end of the reach, walk along the stream bank, taking large steps (for most adults, a large step is roughly equal to a meter) and count the steps until reaching 150 m (or 250 m for larger streams). This will give a rough idea about the location of the ends of the sampling reach. If the monitoring program affords flexibility in terms of where the sampling reach can be placed, scout for any features that should ideally be excluded (e.g., tributaries, "end-of-pipe" outfalls feeding into the channel, bridge crossings, major changes between natural and artificial channel structures, waterfalls, and impoundments). If any such features are near the target sampling location, and there is not enough room to accommodate a full 150 m reach or 250 m reach

[3] Before going in the field, a station code needs to be assigned to each of the sampling sites. For SWAMP-funded projects, please contact the SWAMP database management team for station codes.

entirely upstream or downstream of the feature(s), then the reach may be shortened (to as little as 100 m) in order to exclude them. Record on the datasheet under "Actual Reach Length" the length of the reach that has been delineated.

Step 3. Use markers (e.g., wire-stemmed flags) to indicate locations of transects and intertransects. The standard sampling layout consists of 11 "main" transects (A-K) interspersed with 10 "inter-transects", all of which are arranged perpendicularly to the primary direction of stream flow (usually the thalweg), and placed at equal distances from one to the next (Figure 3). The first flag should be installed at water's edge on one bank at the downstream limit of the sampling reach to indicate the first main transect ("A"). The positions of the remaining transects and inter-transects are then established by heading upstream along the bank and using the transect tape or a segment of rope of appropriate length to measure off successive segments of 7.5 m (if sampling reach is 150 m), or 12.5 m (if it is 250 m). [4]

Step 4. Under "Notable Field Conditions", record evidence of recent flooding, fire, or other disturbances that might influence bioassessment samples, such as scour, for which specific guidance is provided in Section 1.4, above. These are subjective determinations, so use whatever cues are available to make the call. If unaware of recent fire or rainfall events, select the "no" option on the form. Also, to the best of your ability, record the dominant land use and land cover in the area surrounding the reach (*i.e.*, evaluate land cover within 50 m of either side of the stream reach). Use a scaled aerial photograph of the site and vicinity as an aid. Finally, mark whether or not the sampling reach occurs within an engineered channel[5].

[4] Although it is usually easiest to establish transect positions from the banks (this also prevents disturbance to the stream channel), this can result in uneven spacing of transects in complex stream reaches. To avoid this, estimate transect positions by projecting from the mid-channel to the banks. Refer to Figure 3 for a visual clarification of proper transect alignment relative to the stream's direction of flow. For monitoring reaches of non-standard length (*i.e.*, < 150 m; see Step 2 above), divide the total length of the reach by 20 to derive the distance between the adjacent main, and inter-, transects. Alternating between two different flag colors (e.g., orange and yellow, or blue), to demarcate main- vs. inter-transects is recommended, as well as writing the transect/inter-transects names on the flags.

[5] Engineered channels include streams that have been straightened or armored (with riprap, rocks, grout, concrete, or earthen levees) on the banks, streambed, or floodplain of the channel. Partially armored channels (e.g., armored only at bridge abutments) are considered to be "engineered".

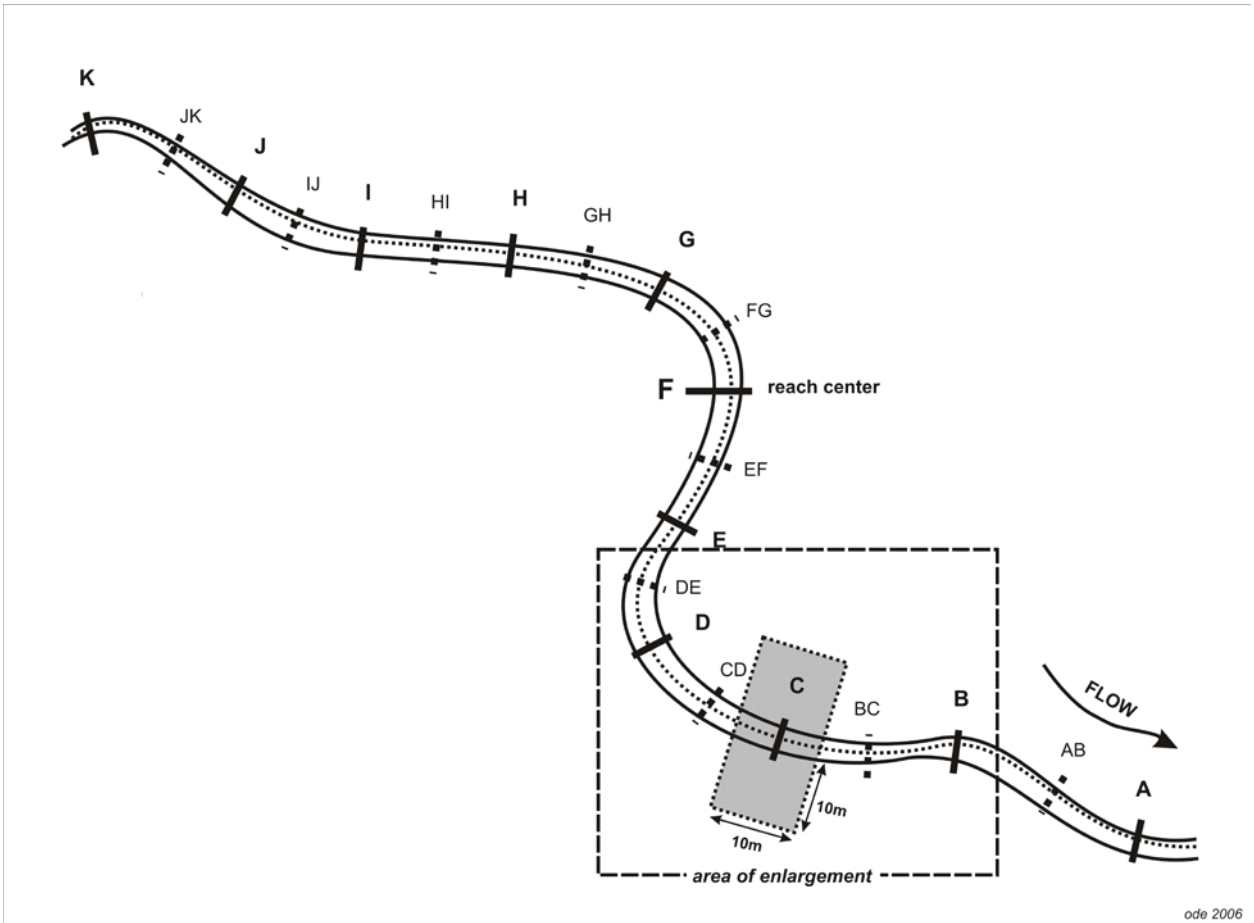

Figure 3. Reach layout geometry for physical habitat (PHab) and biotic sampling showing positions of 11 main transects (A-K) and the 10 inter-transects (AB-JK). The "area of enlargement" highlighted in the figure is expanded in Figure 17. *Note*: reach length = 150 m for streams ≤ 10 m average wetted width, and reach length = 250 m for streams > 10 m average wetted width.

3. WATER CHEMISTRY SAMPLING

Before entering the stream to sample water, remember to adhere to proper field hygiene practices (see Section 1.7 for more details) at all times. In addition, be sure to sample water in such a way that it does not interfere with subsequent biotic sampling and PHab data collection, but also in such a way that water samples are not compromised by other sampling activities upstream (e.g., by suspension of matter from the stream bottom into the water column, and the consequent introduction of this matter into the water chemistry samples). All water chemistry/toxicology samples should be collected prior to stepping in the water anywhere upstream of the water/toxicology sampling spot and should not be collected in a location where subsequent biotic samples or PHab data are to be collected. Sampling water chemistry just downstream of Transect A, the same general location as where the GPS coordinates were taken[6], and before any other sampling activities take place, achieves both of these goals.

Step 1. Calibrate probes as necessary (some require daily calibration) and record the calibration date on the field form. For calibration procedures, follow the SWAMP QAPrP in place at the time of monitoring or subsequent revisions to that QAPrP (http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#qa), or the manufacturer's guidelines, whatever is more stringent. Field measurements in this SOP are typically taken with a handheld water-quality meter (e.g., YSI, Hydrolab), but field test kits (e.g., Hach) may provide acceptable information as well.

Step 2. Measure and record common ambient water-chemistry parameters[7]:

- Turbidity (NTU)
- Water temperature (°C)
- Specific conductivity (µS/cm)
- Salinity (ppt)
- Alkalinity (mg/L)
- pH
- Dissolved oxygen (mg/L and % saturation)

Because it may be affected by disturbance of the streambed that occurs during sampling, measure turbidity (if applicable) first. If water samples are also to be collected, such sampling should also occur at this location and time, and collection should also precede probe measurements. Measurements and water chemistry sample collection should take place in areas with flowing water, avoiding depositional zones (e.g., pools), if possible.

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[6] If, for whatever reason, measurements are not taken at Transect A before biotic sampling in the reach has begun, they should be taken immediately upstream of Transect K (the most undisturbed transect), and this change of sampling location should be noted on the field sheet.

[7] SWAMP-required ambient water chemistry parameters measured in the field are: pH, DO, specific conductivity, salinity, alkalinity, and water temperature. Samples for all other ambient water chemistry should be analyzed in the laboratory (except for silica, which can be measured in the field with kits *or* in the laboratory). Turbidity and silica are optional measurements for SWAMP purposes.

Turbidity can be measured with a multi-probe (e.g., YSI) or a turbidimeter, or it can be analyzed in the laboratory. If using a portable meter, collect approximately 250 mL of water for turbidity measurements approximately 10 cm below the water surface (if possible), and take two separate readings from subsamples of the same grab sample and report the average. Likewise, all probe measurements should be made 10 cm below the water surface.

Alkalinity (mg/L) may be measured with a field test kit (e.g. Hach AL-AP #2444301) or in the laboratory. A digital titrator (e.g., Hach) using low-concentration acid (such as 0.16N H_2SO_4) as the titrant is recommended for determining alkalinity in low-alkalinity streams (i.e., < ~100 mg/L $CaCO_3$). If algae samples are being collected, SWAMP requires that samples also be collected for analysis of water-column total nitrogen (TN) and total phosphorus (TP); nitrate-nitrite, and orthophosphate are also recommended. TN/TP samples should not be filtered. Sample holding times, field preparation, bottle types, and recommended volumes for each water-chemistry analyte can be found in the Quality Control and Sample Handling Guidelines [8] (http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#field). Greater detail on field sampling methods for water chemistry can be found at: http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/final_collect_water_sed_phys_habitat.pdf.

[8] Crews can opt to collect water at the end of sampling for holding time purposes, in which case sampling should be conducted in undisturbed water.

4. BIOTIC COMMUNITY SAMPLING

Once the transects have been laid out and water sampling is complete, the biotic samples (BMIs and/or algae) can be collected. On a transect-by-transect basis, any biotic sampling should occur before PHab data are collected, and BMIs should always be collected before algae because BMIs are often highly motile and could be flushed by the algae sampling activity.

4.1 The Reachwide Benthos (RWB) Method for Biotic Sample Collection

The RWB procedure employs an objective method for selecting subsampling locations that is built upon the layout of the 11 main transects that will be also used for physical habitat measurements. This method can be used to sample any wadeable stream reach, since it does not target specific habitats. Because sampling locations are defined by the transect layout, the position of individual sub-samples may fall in a variety of "erosional[9]" or "depositional[10]" habitats.

For the RWB method, the sub-sampling position alternates between left, center, and right portions of the main transects, as one proceeds upstream from one transect to the next. These sampling locations are defined as the points at 25% ("left[11]"), 50% ("center") and 75% ("right") across the wetted width in most systems. The left and right sides of the stream are determined when facing downstream.

SWAMP programs should employ a modified version of the RWB method, called the Margin-Center-Margin (MCM) method when all three of the following stream conditions are met: 1) very low slope (generally < ~ 0.3%); 2) uniform sandy/fine-substrate; and 3) stable habitat at stream margins. The MCM protocol modification is to collect subsamples at 0%, 50%, and 100% of wetted width instead of 25%, 50%, and 75%, to ensure collection of biota from marginal habitats. There is no hard rule for using the MCM variation, but in general it should be reserved for reaches where the bulk of the streambed consists of unstable habitat (e.g., shifting sands), and the only stable microhabitats (e.g., macrophytes, algae) are restricted to the margins and would otherwise be missed. The type of sampling method used (RWB, MCM, or TRC) should be circled on the field sheet under "collection method".

The recommended method for collecting duplicate biotic samples is at adjacent positions along the sampling transects according to the scheme depicted in Figure 3 (the duplicates are shown in light grey, with dashed-line outlines). Both samples should be collected at each transect before moving on to the next transect.

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[9] Erosional – habitats in the stream that are dominated by fast-moving water, such as riffles, where stream power is more likely to facilitate erosion (suspension) of loose benthic material than deposition; examples of "erosional" substrates include cobbles and boulders.

[10] Depositional – habitats in the stream that are dominated by slow-moving water, such as pools, where deposition of materials from the water column is more likely to occur than erosion (or (re)suspension) of bed materials; examples of "depositional" substrates include silt and sand.

[11] Conventionally, "left bank" has been defined as the left bank when facing *downstream* (i.e., in the direction of the current).

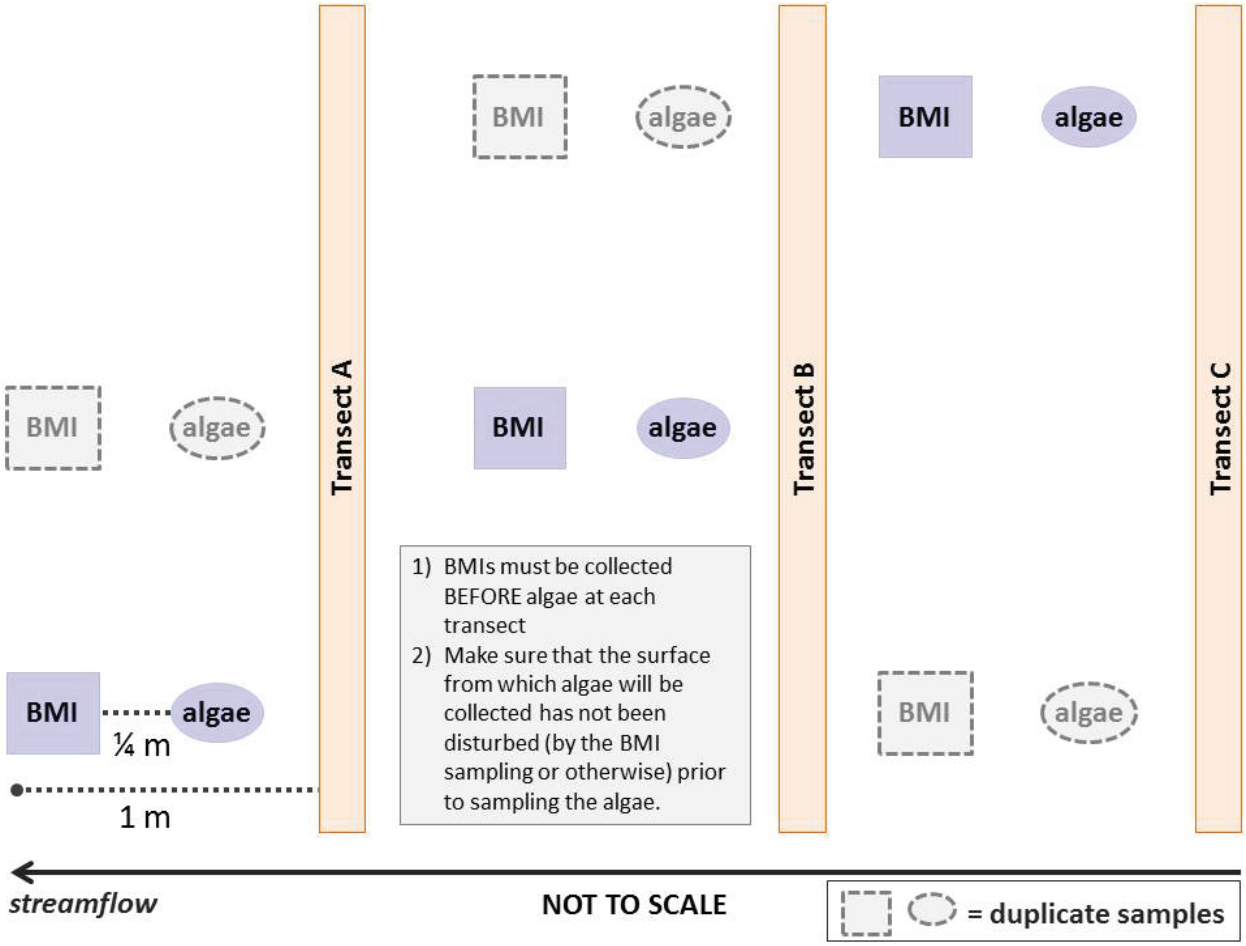


Figure 4. Sampling array for collection of BMIs, algae, and duplicate samples (outlined with dashed lines) for each assemblage. The lower left corner of diagram shows distances between BMI and algae sampling points relative to a transect (i.e., one sample collected at the Left location while the duplicate is collected at the Center). For convenience, only Transects A through C of the sampling reach are shown, but the same pattern of placement should be rotated across all 11 transects.

4.2 General Considerations for Sampling BMIs

While TRC sampling for BMIs may be considered useful for some programs, RWB is the required procedure for SWAMP programs. The following section describes only the RWB method. Supplemental information on TRC can be found in the Guidance Document.

Before sampling BMIs at any given site, be sure to thoroughly inspect the D-frame net to ensure that no organisms are carried over from previous sites, which could contaminate the sample.

4.3 Module A: RWB Sampling Procedure for BMIs

Step 1. Starting with the downstream transect (Transect A), identify a point that is 25% (or 0% for the MCM modification) of the stream width from the left bank. If it is not possible to collect

a sample at the designated point because of deep water, obstacles, or unsafe conditions, adjust the sampling spot while keeping the point as close as possible to the designated position. Always be as objective as possible when identifying the sampling spot; resist the urge to sample the "best looking" or most convenient area of the streambed.

Step 2. Once the sampling spot is identified, place the 500-µm D-frame net in the water 1 m downstream of the target transect. In order to avoid affecting subsequent PHab data collection, do not sample directly on the transect. Position the net so its mouth is perpendicular to, and facing into, the flow of the water. If there is sufficient current in the area at the sampling spot to fully extend the net, use the normal D-net collection technique (as described in steps 3-6 below) to collect the sub-sample.[12]

Step 3. Holding the net in position on the substrate, visually define a square shape (a "sampling plot") on the stream bottom upstream of the net opening, approximately one net-width wide and one net-width long. Because standard D-nets are 12 inches wide, the area within this plot is $1ft^2$ ($0.09\ m^2$). Restrict sampling to within that area.

Step 4. Working backward from the upstream edge of the sampling plot, check the sampling plot for heavy organisms such as mussels, caddis cases, and snails. Remove these organisms from the substrate by hand and place them into the net. Carefully pick up and rub stones directly in front of the net to remove attached animals. Pick up and clean all of the rocks larger than a golf ball within the sampling plot such that all the organisms attached to them are washed downstream into the net. Set these rocks outside the sampling plot after they have been cleaned. Large rocks that protrude less than halfway into the sampling area should be pushed aside. If the substrate is consolidated, bedrock, or comprised of large, heavy rocks, kick and dislodge the substrate (with the feet) to displace BMIs into the net. If a rock cannot be removed from the stream bottom, rub it with your hands or feet (concentrating on cracks or indentations), thereby loosening any attached insects. While disturbing the plot, let the water current carry all loosened material into the net. Do not use a brush to dislodge organisms from substrates.

Step 5. Once the coarser substrates have been removed from the sampling plot, dig through the remaining underlying material with fingers or a digging tool (e.g., rebar or an abalone iron) to a depth of about 10 cm (less in sandy streams), where gravels and finer particles are often dominant. Thoroughly manipulate the substrates in the plot to encourage flow to dislodge any resistant organisms. Note: the sampler may spend as much time as necessary to inspect and clean larger substrates, but should take a standard time of 30 seconds for the digging portion of this step. To the extent practical, reduce the amount of sand particles in the net, as they damage organisms and degrade taxonomic data quality.

[12] When sampling in slack water and flow volume is insufficient to use a D-frame net to capture dislodged BMIs drifting downstream, spend 30 seconds hand picking a sample from $1ft^2$ area of substrate at the sampling location. Then stir up the substrate with gloved hands and use a sieve with 500-µm mesh size to collect the organisms from the water in the same way the net is used in larger pools to wash the organisms to the bottom of the net.

For slack-water habitats, vigorously kick the remaining finer substrate within the plot using the feet while dragging the net repeatedly through the disturbed area just above the bottom. Keep moving the net so that the organisms trapped in the net will not escape. Continue kicking the substrate and moving the net for 30 seconds. For vegetation-choked sampling points, sweep the net through the vegetation within a 1-ft^2 (0.09 m^2) plot for 30 seconds. After 30 seconds, remove the net from the water with a quick, upward motion to wash the organisms to the bottom of the net.

Step 6. Let the water run clear before carefully lifting the net. Dip the lower portion of net in the stream several times to remove fine sediments and to concentrate organisms into the end of the net, while being careful to prevent water or foreign material from entering the mouth of the net. ***Be particularly careful to avoid "backflow" situations, in which collected material restricts flow through the net and the resulting turbulent flow causes collected material to escape the net; this is a major potential source of loss of BMIs during sampling.***

Step 7 Move on to the next transect to repeat the sampling process across all 11 main transects. The sampling position within each transect is alternated between the left, center, and right positions along a transect (25%, 50%, and 75% of wetted width, respectively, for standard RWB, or 0%, 50%, and 100% if using the MCM collection method), then cycling through the same order over and over again while moving upstream from transect to transect. Ultimately, you will collect from the left and center 4 times each, and the right 3 times. [13]

Step 8. Fill and label sample jars. Once all 11 subsamples have been collected, proceed to Section 5.1 "Processing Benthic Macroinvertebrate Samples".

4.4 General Considerations for Sampling Benthic Algae

The following is a short introduction to several types of algal indicators that can be monitored as part of a bioassessment effort. For a more detailed discussion, see Fetscher and McLaughlin (2008). The most appropriate indicators to include in a given program will ultimately depend upon that program's goals, because the various indicators provide information at varying levels of resolution and applicability to different uses. Likewise, the various indicators require different levels of investment in terms of fieldwork and laboratory work. Percent algal cover, for instance, is a rapid means of estimating algal primary production that can be carried out entirely in the field and is conducted in tandem with the PHab pebble count. Therefore, the percent algal cover is an appropriate, fast, and inexpensive parameter for citizen monitoring groups if they are concerned about increased algal biomass. Other estimators of algal biomass include chlorophyll *a* and AFDM, which involve quantitative collection of algae, preservation, and subsequent laboratory analysis. Algal biomass is a key component of the California Nutrient Numeric Endpoints (NNE) framework (Tetra Tech 2006). Higher resolution taxonomic information about algal assemblages can be used in algal Indices of Biotic Integrity (IBIs; *e.g.*, Fetscher *et al*. 2014), and offers more in-depth insight into water quality. For this type of data, algal specimens

[13]Care should be taken in transporting samples between reaches. The use of a reachwide sample bucket can help minimize any possible sample loss. Samples from each transect can be placed in the bucket for transport. This method would be similar to the reach wide sample bucket used for algae sampling.

must be collected quantitatively (and qualitatively, in the case of soft-bodied algae). The quantitative samples are fixed (preserved) and both quantitative and qualitative samples are subjected to taxonomic analysis. While the percent algal cover data are recorded in conjunction with standard PHab procedures and do not require the collection of samples, all the other types of algal data described in this SOP require RWB or MCM sampling of algal specimens in a manner analogous to that which is carried out for BMIs.

With the exception of the qualitative soft-algae sample, all of the algae samples described in this SOP can be obtained from a single "composite sample" (Figure 5) generated by the RWB (or MCM) method. Which combination of these samples to prepare and submit for laboratory processing will depend on the needs of the monitoring program. To aid in the selection of algal indicators, Table 3 provides a summary of their attributes.

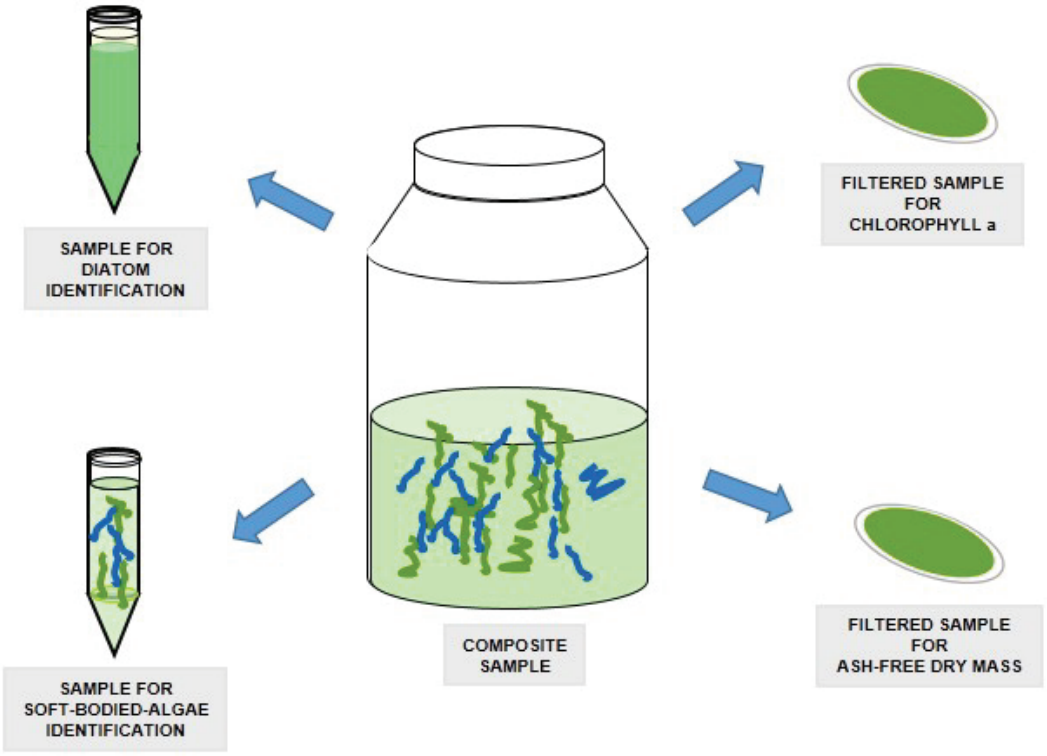


Figure 5. The four sample types that can be prepared from the algae "composite sample".

Table 3. Types of algal indicators and considerations for their assessment.

	Algal indicator for	Collection method	Collection vessel	Preservation / fixation method / holding times
Percent Algal Cover	Stream primary production measured as algal abundance	Point-intercept component of the PHab pebble count	N/A	N/A
Chlorophyll *a*	Stream primary production measured as algal biomass; key indicator for the Nutrient Numeric Endpoints (NNE) framework	RWB or MCM sample collection	Glass-fiber filter	Filter, wrap in foil, store on wet ice in the field, but freeze (pref. -80ºC) within 4h of collection; analyze within 28d
AFDM	Stream primary production measured as biomass of organic matter, including algae; indicator for the NNE framework	RWB or MCM sample collection	Glass-fiber filter (pre-combusted[14])	Filter, wrap in foil, store on wet ice in the field, but freeze (pref. -80ºC) within 4h of collection; analyze within 28d
Diatoms	Indicative of factors such as trophic status, organic enrichment, low DO, siltation, pH, metals.	RWB or MCM sample collection	50 mL centrifuge tube	Add 5% formalin for a 1% final concentration immediately after collection; keep dark and away from heat; fixed samples can be stored for at least 2 years
Soft-bodied algae <u>quantitative</u> sample[15]	Indicative of factors such as nitrogen limitation/ trophic status; siltation; pH; temperature, light availability, nuisance/ toxic algal blooms	RWB or MCM sample collection	50 mL centrifuge tube	Keep unfixed samples in dark on wet (not dry) ice; add glutaraldehyde (to a 2% final concentration) *under a fume hood*, as soon as possible, but no later than 96 hours after sampling; after fixing, refrigerate and keep in dark; fixed samples can be stored for at least 2 years
Soft-bodied algae <u>qualitative</u> sample	Used for IBI calculation as well as to help laboratory identify specimens in the quantitative sample (above)	By hand	Whirl-Pak™ bag	No fixative; keep fresh sample on wet ice (or refrigerated) and in the dark; tally species present within 2 weeks of collection (preferably much sooner)

[14] Pre-combustion removes any possible residual organic matter from the filter.
[15] For the purposes of this SOP, the soft-bodied assemblage includes cyanobacteria

During all phases of algae sampling and processing, in order to preserve specimen integrity, every attempt should be made to keep the sample material out of the sun, and in general, to protect the algae from heat and desiccation, as much as possible. This is necessary in order to reduce the risk of chlorophyll *a* degradation, limit cell division post-collection, and curb the decay of soft-bodied algae (especially for the fresh qualitative samples; see Section 4.6, "Procedure for Collecting and Storing Qualitative Benthic Algal Samples").

4.5 Module B: RWB Sampling Procedure for Benthic Algae – Quantitative Samples

As with the RWB and MCM methods for BMIs, a quantitative subsample of benthic algae is collected at each of the 11 main transects, and these are combined into a single composite sample. Up to four aliquots are then drawn from the composite sample, and these can be used for analysis of the following: diatom assemblage, soft-bodied algae assemblage, benthic chlorophyll *a* concentration, and benthic AFDM concentration. A qualitative sample of soft bodied algae is collected in addition to the quantitative sample (see Section 4.6, below). Also, as with BMIs (see Section 4.3, Step 1; and Fig. 4), algae sample collection should begin at Transect A and proceed upstream to Transect K, rotating through the "left", "center", "right", "left", etc. positions along the 11 main transects. At each transect, BMIs must be collected before algae in order to minimize the chances of disturbing BMIs (potentially causing some to flee the area) during collection of algae. It is likewise important to make sure that the surface from which algae will be collected has not been recently disturbed (by the BMI sampling, or otherwise) prior to sampling the algae.

After the BMIs are collected at a given spot, the algae sample should be taken ¼ m upstream from the center of the upper edge of the scar in the stream bottom left from the BMI sampling, according to the schematic in Figure 3. The best way to guarantee that BMI sampling does not interfere with algae sampling is for the person sampling algae to witness exactly where the BMI collector is disturbing the stream bottom in the process of sampling the BMIs. One should not rely upon guessing where the BMIs were collected in order to determine this. Sometimes the "scar" where BMIs were collected will be obvious, but often it will not. If only algae (and not BMIs) are being collected, then the specimens should be collected 1 m downstream of the transects. If only algae (and not BMIs) are being collected in a low-slope reach in which the MCM method is employed, the collection location should be 1 m downstream of the main transect and, for each of the "margin" positions, at a distance of 15 cm (i.e., ½ the width of a D-frame net) inward from the wetted margin of the bank.

To ensure that samples of the stream's algal community and algal biomass concentration are representative of the sampling reach, samples should always be collected by centering the sampling device on the specific point indicated in the above guidelines (*i.e.*, resisting the urge to subjectively choose where to sample). This is particularly important for yielding a representative biomass sample, because subjectively choosing or avoiding spots with high or low levels of algal growth can easily bias the results.

Because in the RWB and MCM methods, subsample locations are objectively defined by the transect layout, the position of individual subsampling points may fall within a variety different types of habitats, each of which has implications for the type of substrate likely to be encountered and therefore the type of algae sampling device to use. When confronted with a

situation in which an algae sampling location straddles two substratum types, overlay a sampling device (e.g., the rubber delimiter) centered on the sampling spot and determine which substrate occupies the majority of the area inside the delimiter, then shift the sampling spot the minimal distance necessary for that substrate type to be entirely within the delimiter, and sample there. Three devices are possible: a syringe scrubber (for hard, immobile surfaces, such as bedrock), a rubber delimiter (for hard, mobile surfaces, such as cobbles and small boulders), and an ABS delimiter (for soft, particulate substrates, such as sand). As the subsamples are collected, a tally must be taken of the number of times each of the classes of sampling device is used: 1) delimiter (either ABS or rubber), and 2) the syringe scrubber. The tallies are used to estimate the total surface area sampled (i.e., 12. 6 cm^2 for each use of the rubber or ABS delimiter and 5.3 cm^2 for each use of the syringe scrubber). The tallies are recorded in the "Algae Samples" field form under "Collection Device". The total surface area is used to estimate the soft-bodied algal total biovolume and the chlorophyll a and AFDM values. Instructions for making all algae-sampling devices are provided in the Guidance Document.

The recommended method for collecting duplicate algae samples is analogous to that described for BMIs: at adjacent positions along the sampling transects according to the scheme depicted in Figure 3. Both the sample and the duplicate should be collected at each transect before moving on to the next transect.

Before sampling, the dish tub or bucket that will contain the material to be collected must be scrubbed with a ***stiff-bristled brush or scouring pad*** and thoroughly rinsed with stream water from the site to be sampled, so that no algal material is carried over from the previous site to contaminate the current sample. The same applies to all other algae sampling apparati (e.g., toothbrushes, graduated cylinders, delimiters, trowels, syringe scrubbers, turkey basters).[16]

4.5.1 Collecting from Cobbles, Large Gravel, and Wood Using the Rubber Delimiter

Step 1. If the substrate type corresponding to the algae sampling point is located on a large piece of hard substrate that can be easily removed from the stream (*e.g.*, a cobble, a piece of wood, or a piece of large gravel), use the rubber delimiter. These substrates typically occur in erosional habitats, such as riffles and runs. Carefully lift the substrate, moving slowly to avoid disturbing its top surface as much as possible, and remove it from the water. Always collect the algae sample from the substrate that is most exposed to the sun. If a sampling point is covered by a thick mat of macroalgae, the "substrate" collected at that point would be macroalgae itself (see Section 4.5.3), not the material that lies beneath it.

Step 2. Hold the substrate over a dish tub or bucket and wrap a rubber delimiter (Figure 6) around the piece to expose the sun-exposed surface through the hole. Center the hole on the exact point on the cobble that had been identified as the "algae sampling point" for that transect, and avoid subjectively choosing the spot that is easiest to sample or has the most algae.

[16] Scrubbing of the collection bucket/tub can be done prior to arriving at the site but must be checked upon arrival.

Step 3. Dislodge attached algae from this area by brushing it with a clean, firm-bristled toothbrush. If there is a thick mat of attached algae on the piece of substrate, or the algae is firmly encrusted on its surface, use forceps or a razor blade first to scrape the larger algal matter and place this in the dish tub. Then scrub the area with the brush. Collect only algal material that is visible within the area defined by the hole, as the algal filaments are laying down on the surface of the substrate and within the delimiter. Portions of algae filaments that extend beyond the opening of the hole are not part of the sample. Make sure that the entire surface within the delimiter has been scrubbed well in order to remove all the algae in that area.

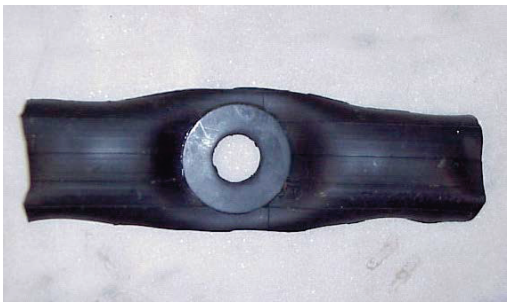


Figure 6. Rubber delimiter

Step 4. Fill a wash bottle or turkey baster with stream water from the current site. Using as small a volume of water as possible, rinse the scrubbed algae from both the toothbrush and the sample area on the piece of substrate into the dish tub. Take care to squirt water only on the surface that is showing through the hole in the delimiter, and not anywhere else on the substrate's surface. It is helpful to invert the rock when rinsing so that the target surface is facing down toward the dish tub, and the rinsate drips off the sampling point directly into the tub rather than flowing along the (non-target) sides of the substrate. Use water sparingly for each piece of substrate, because ideally less than 500 mL water, total, should be used for the full set of 11 samples collected along the transects; this includes any water used for rinsing algae off of sampling devices into the dish tub. The scrubbed part of the substrate should feel relatively rough, indicating that most of the algae have been removed. Several rounds of scrubbing and toothbrush-rinsing may be required in order to achieve this state. After thoroughly scrubbing and rinsing the sampling area on the piece of substrate, return it to the stream.

4.5.2 Collecting from Sediment

Step 1. If the substrate type that falls under the sampling point is made of particulate matter, such as silt and fine gravel, use the ABS delimiter. Typically, this occurs in depositional habitat, such as pools. The ABS delimiter is a plastic corer with an internal diameter of 4 cm (Figure 6). Quantitatively isolate sand/silt/gravel, centered on the sampling point, by pressing into the top 1 cm of sediment with the delimiter. A brightly colored line painted around the periphery of the delimiter, at 1 cm above the lip of the opening, is helpful for confirming insertion depth.

Figure 7. ABS delimiter, showing pink line at 1cm depth mark

Step 2. Gently slide a pointed, flat masonry trowel beneath the delimiter, being careful to keep the collected sediment contained within the area demarcated by the delimiter. Lift the delimiter,

keeping a tight seal between the delimiter and trowel to prevent the water inside from leaking out, resulting in loss of sample material.

Step 3. Remove sediment around the outside of the delimiter, and then empty the entire delimiter's contents into the dish tub. Using water sparingly, rinse any leftover sediment from the trowel into the tub.

4.5.3 Collecting a Mass of Macroalgae Using the ABS delimiter

Step 1. If the target substrate on a given transect is a mass of macroalgae (*e.g.*, a mass of attached filamentous algae underwater, or an unattached, floating mat that is believed to be native to the reach being sampled), position the trowel directly under the macroalgae and press the ABS delimiter into the algae to define a 12.6 cm^2 area. Note: when collecting a mass of macroalgae, it is important to capture the full thickness of the macroalgae within the delimiter. To do this, from the side of the sampling area, feel under the mat to determine where the bottom is, slide the trowel down to that spot, and then press the ABS delimiter downward slowly to "sandwich" the targeted section of macroalgae between the delimiter and the trowel. The goal is to collect a representative sample of the algae, by stream bottom area, as it exists in the stream.

Step 2. Use a sharp razor blade or knife to cut away and discard algae material from around the edges of the delimiter. Do not pull filaments without cutting them, and do not bunch the macroalgae up nor stretch it out during this process.

Step 3. Add the macroalgal specimen that was isolated by the ABS delimiter to the dish tub.

4.5.4 Collecting from Macrophytes

Step 1. If the material to be sampled is part of a submerged, living macrophyte, or old, dead leaves settled at the bottom of a pool, use the ABS delimiter/trowel combination to isolate a 12.6 cm^2 section of macrophyte that has been exposed to the surface of the stream.

Step 2. As with the macroalgae (Section 4.5.3), cut away and discard the extra material that falls outside the delimiter.

Step 3. Add the macrophyte specimen that was isolated by the ABS delimiter to the dish tub.

4.5.5 Collecting from Hard, Submerged, Anchored Substrates: Concrete, Bedrock, and Boulders

Step 1. If the substrate at a sampling point cannot be removed from the water (as in the case of bedrock, a large or deeply embedded boulder, a concrete channel bottom, or hardpan), use a "syringe scrubber" device (Davies and Gee 1993; Figure 7) to collect a sample underwater. To use this device, affix a fresh, white scrubbing pad circle onto the bottom of the syringe

Figure 8. Syringe scrubber.

plunger using the Velcro hooks on the end of the plunger. Submerge the device in the stream and work the plunger up and down a couple times to lubricate it. Then press the plunger down so that the bottom of the scrubbing pad is flush with the bottom of the barrel.

Step 2. Submerge the syringe in the stream again, this time pressing the syringe bottom firmly against the substrate, centered on the sampling point. Once a good seal with the substrate is achieved, rotate the syringe scrubber completely 3 times in order to collect the biofilm from the substrate surface onto the pad. If the surface of the substrate where the sampling point fell is not flat enough to allow for a tight seal with the syringe barrel, move the collection point to the nearest area that is sufficiently flat and collect the sample there.

Step 3. After rotating the syringe scrubber, and before removing it from the substrate, gently retract the plunger slightly (e.g., <5 mm), so that the pad is no longer touching the substrate, but not so much that a lot of water enters the barrel. Carefully slide the trowel under syringe barrel, slightly tilting the barrel to allow the trowel to enter. If there is a strong current, lift the downstream side of the barrel. Then pull the instrument back out of the water with the trowel still firmly sealed against the syringe-barrel bottom.

Step 4. Hold the syringe scrubber over the dish tub and remove the trowel, allowing any water that was between the trowel and the scrubber pad to fall into the tub (but discard the water inside the plunger-handle end of the barrel—there is no need to add this water to the dish tub, as it does not contain sample material and will only serve to dilute the sample).

Step 5. Carefully detach the pad from the plunger and hold the pad over the tub. Using rinse water sparingly, remove as much algal material from the pad as possible by rinsing it off with the wash bottle filled with stream water from the current site, and wringing the pad into the dish tub before discarding it. Start this process by rinsing from the backside of the pad (the side that had been affixed to the plunger) to push the collected algae forward out of the front surface of the pad. If there are filaments of algae entrained within the pad, remove these using pointed-tip forceps, and place these in the dish tub, before wringing the pad out. It is recommended that a fresh (new) pad be used each time a sample is collected, even within the same stream reach. After completing sampling at a site, discard all used pads—they should never be reused between sites.

4.5.6 Collecting from Other Substrate Types

If other substrate types are encountered, they can be sampled from as long as there is good reason to believe that they were not recently introduced into the stream (*e.g.*, by flowing from the upstream regions, or by recently falling into the stream), as they would then not be representative of the local instream environment.

Use the collection instrument deemed to be most appropriate to sample the substrate and, as with any substrate, be sure to account for the surface area sampled (in this case, using the "*Other"* box on the *Collection Device* portion of the field forms).

As with BMIs, after collecting at each sampling spot, move on to the next transect to repeat the sampling process across all 11 main transects. The sampling position within each transect is alternated between the left, center, and right positions along a transect (25%, 50% and 75% of wetted width, respectively, or corresponding to the 0%, 50%, and 100% points across the stream if using the MCM protocol for BMI sampling), then cycling through the same order over and over again while moving upstream from transect to transect. Once all 11 subsamples have been collected, proceed to Section 5.2, "Processing Quantitative Benthic Algal Taxonomy and Biomass Samples".

4.6 Module B (continued): Procedure for Collecting and Storing Qualitative Soft Algae Samples

Whenever quantitative soft algae samples (Section 5.2) are collected for taxonomic analysis, a "qualitative" soft algae sample must also be collected. The qualitative sample consists of a composite of all types of soft-bodied algae observed within the reach. This sample is required for calculation of some of the metrics for the IBIs that use soft algae data, such as "H20" and "S2" (Fetscher et al. 2014). The qualitative sample can also aid identification of taxa captured in the RWB sampling, since it allows larger, more intact specimens to be collected than those that may end up in the more heavily processed quantitative sample. In addition, if the qualitative sample is kept cool and in the dark, and is delivered to the laboratory in a timely manner (*i.e.*, within two weeks of collection), there is a possibility of culturing live specimens, which is sometimes essential for standard taxonomic effort-level identifications.

Collection of the qualitative soft-bodied algae sample can be conducted at any time during the field visit, as long as its collection does not in any way interfere with the water chemistry, biotic, and PHab sampling/data collection (i.e., by kicking up sediment, displacing BMIs, and/or disturbing the stream bottom). It helps to have the collection bag on hand at all times so that it can be used for spontaneous grabs of specimens that are spotted during the course of the other fieldwork (e.g., conducting PHab data collection). However, the entire sampling reach should be visually scoured at least one time during the course of the day's fieldwork in an effort to see, and collect samples from, all patches of distinct soft-bodied-algal specimens therein.

Step 1. Using a thick, waterproof marker, label a Whirl-Pak™ bag with the Station Code, Date, and Sample ID.

Step 2. Hand-pick specimens of all visibly different types of macroalgal filaments and mats, as well as microalgae (in the forms of scrapings using a razor blade or knife), and depositional samples (suctioned from along the surface of sediments using a clean turkey baster). The Guidance Document includes photos that will help collectors develop an eye for the variety of types of algae that may be encountered in streams. A few helpful tips:

- Some algae (*e.g.*, species of *Chara*, *Paralemanea*, and *Vaucheria*) look like submerged macrophytes or mosses.
- Algae come in many colors, and may be green, dark-brown, golden, red, black, or bluish-green.
- Some cyanobacteria, such *Nostoc* spp., look like gelatinous globules or "deflated" sacs, ranging in size from smaller than a pea to larger than a lime.

- Collect from as many distinct locations as possible throughout the reach so as to capture as much of the apparent diversity as possible.
- Include any holdfast structures that had attached the macroalgae to the substrate, as these structures can be useful for taxonomic identification.
- Since these samples are merely qualitative, it is not necessary to collect them in a manner that is representative of their relative abundances within the reach.
- When in doubt as to whether a candidate specimen qualifies as "algae", add it to the sample; final determinations will be made by the taxonomist.
- A qualitative sample should be collected at *every* site for which soft-bodied algae are being sampled, whether or not macroalgae are visible in the reach. In the absence of macroalgae, rock scrapings, substrate particles, and CPOM should still be collected (as described above).
- Macroalgae growing within 10 m of the reach may also be added to the qualitative sample.

Step 3. Fill the bag with a total volume of up to 100 mL of qualitative algae sample + stream water. Purge extra air from the bag, and seal with the wire tabs by twisting them together (not just folding them over, as this can result in leakage). Tuck the ends of the wire tabs inward so that they cannot poke holes in the bag. Collect as many bags as needed, based on the variety of algae visible in the stream reach. If multiple bags are collected, number them accordingly (e.g., "bag 2 of 4") so that the laboratory will know how many bags to process for that site.

Step 4. Double-bag the qualitative samples, and slip a filled-out (with pencil) label (Figure 9) printed on waterproof paper into the outer bag. Store in cool, dark conditions (i.e., in the wet ice cooler,not on dry ice). Do not let the bags touch ice (or 'blue-ice" packs) directly, which could cause the samples to freeze, thus destroying them. Do not add any fixative to these samples.

Step 5. Refrigerate the qualitative samples immediately upon return to the laboratory. Because they are not preserved, these samples should be examined by a taxonomist as soon as possible (and within two weeks, at most), as they can decompose rapidly. Coordinate beforehand with the receiving laboratory, as necessary, in order to ensure that samples are processed in a timely fashion.

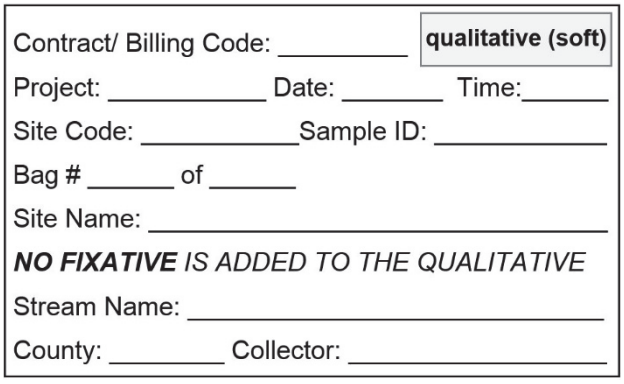


Figure 9. Label for soft-bodied algae qualitative sample.

5. BIOTIC SAMPLE PROCESSING

5.1 Module A (continued): Processing Benthic Macroinvertebrate Samples

Step 1. Once all BMI subsamples (11 for RWB or MCM) have been collected and composited, transfer the composited sample to one or more 500-mL wide-mouth plastic sample jar, preferably one with straight edges. Never fill a jar more than halfway with sampled material; use as many jars as necessary in order to prevent this.

Samples with a lot of organic material (e.g., plants, algae, leaf litter) tend to contain a lot of water that may inhibit sample preservation. Gently squeeze out as much water as possible (through the mesh of the D-frame net) before placing the sample in the jar, to prevent diluting the alcohol too much. Approach this task gingerly, so as not to damage invertebrates during this process.

Invert the contents of the D-frame net into the sample jar. Perform this operation over a large, white tray to avoid loss of any sampled material and make recovery of spilled organisms easier. If possible, remove the larger twigs and rocks by hand after carefully inspecting for clinging organisms. Use forceps to remove any organisms clinging to the net and place these in the sample jar. All samples should be completely transferred to the sample jar without elutriation.

If the samples contain a lot of fine particles, confirm that the sampling procedure is being executed correctly (i.e., use care to disturb the substrate as gently as possible and avoid kicking).[17]

Step 2. Place a date/locality label (Figure 10), filled out in pencil, on the inside of the jar and completely fill the jar with 95% ethanol[18]. To ensure proper preservation of BMIs, gently rotate jars that contain mostly mud or sand so that the ethanol is well distributed. Affix a second waterproof label on the outside of the jar. It is recommended that the label for the outside of the jar be printed with a laser printer (with alcohol-proof toner); otherwise, fill the label out by hand in pencil. Tape the label with transparent tape. Make sure all samples have both internal and external labels.

[17] Samples with an abundance of sand or organic material should be processed expeditiously at the lab, as specimens in these samples can degrade quickly. Therefore, the presence of these kinds of samples should be communicated to the taxonomy lab as soon as possible and they should not be stored for a long time before delivering to the taxonomy lab for processing. See Woodard et al. 2012 for details

[18] Note that the target concentration of ethanol is 70%, but 95% ethanol is used in the field to compensate for dilution from water in the sample. Final concentration of ethanol can be confirmed in the laboratory upon receipt of samples.

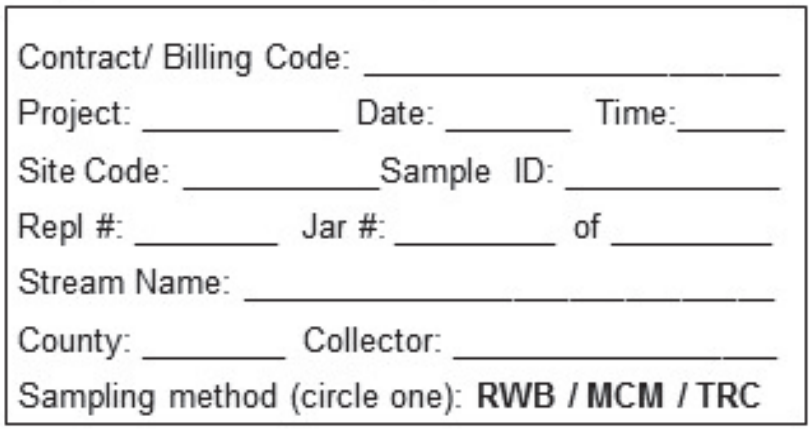


Figure 10. Example date/locality label for BMI samples.

If field crews do not ship samples directly to the laboratory, then section 2.3 of the SOP for laboratory processing and identification of benthic macroinvertebrates in California (Woodard et al. 2012; http://www.swrcb.ca.gov/water_issues/programs/swamp/docs/bmi_lab_sop_final.pdf) should be followed for long-term storage of the samples.

5.2 Module B (continued): Processing Quantitative Benthic Algal Taxonomy and Biomass Samples

After having sampled substrates across the monitoring reach, there should be material from all 11 transects in the dish tub. Depending on the types of habitats in the stream and substrates encountered, the dish tub may contain stream water with suspended microalgae, and silt, and/or sand, and/or fine gravel, and/or small pieces of wood or macrophyte. The algae clinging to these substrates must be detached and suspended into the water to form a "composite sample".

Step 1. Any pieces of macrophyte (i.e., vascular plants, not algae), twigs, or dead leaves that had been collected with the ABS delimiter should be massaged thoroughly between the fingers and rinsed into the tub in order to remove the algae coating them. These vascular plant fragments can then be discarded. If there are any clumps of macroalgae in the dish tub, there is a special step required for processing them. The procedure is described in detail below.

Step 2. Systematically massage all the sand and/or silt in the dish tub between the fingers to dislodge clinging microalgae (to be thorough, try to make contact with "every grain" while doing this). For pieces of gravel, use a toothbrush to remove algal material from surfaces. Rinse toothbrush and brushed gravel into the tub. Rinse the sediment thoroughly (but as sparingly as possible) with stream water so as to create a suspension of the dislodged microalgae (*i.e.*, the sample).

The final volume of the *liquid* in the dish tub will be measured before the algal taxonomic and biomass samples are prepared. To do this, the liquid in the tub will be separated from the rinsed sediment such that the volume measured does not include sediment (see below). After the liquid

sample has been retrieved and measured, the rinsed sediment will be discarded back into the stream. Whereas a single sample type is collected for BMIs, 4 different types of quantitative[19] laboratory samples may be prepared from the composite sample when collecting algae (Figure 4):

- for taxonomic ID/enumeration
    1. diatoms
    2. soft-bodied algae
- for biomass
    3. chlorophyll *a* ("chl *a*")
    4. ash-free dry mass ("AFDM")

The general process for sample preparation is as follows. The taxonomic ID/enumeration samples are each aliquoted into 50 mL centrifuge tubes and chemically fixed (preserved). Diatom samples are fixed in the field with formalin immediately following collection, and soft-bodied algae samples are fixed with glutaraldehyde in a laboratory under a fume hood within 96 hours of collection. The chl *a* and AFDM biomass samples are collected on filters in the field and stored on wet ice, and then frozen as soon as possible after returning from the field (and within four hours of collection). The filters are kept frozen until analysis, which must occur within 28 days of collection. If the filters will not be brought to the laboratory freezer on the same day they were collected, they should be kept on dry ice. The taxonomic ID samples are kept on wet ice until they are fixed, and then stored in the refrigerator (never frozen).

Algae sample labels are shown in Figure 11. Recorded on each sample label are the volume of the composite sample (see below), as well as the volume aliquoted (for the taxonomic ID samples) or filtered (for the chl *a* and ADFM samples). All of these volumes are recorded on the field forms, as well, under the "Algae Samples" section. On the sample labels, the sample type: "chl *a*", "AFDM", "diatoms", or "soft" is circled, and all the remaining information on each label (Station Code, Date, stream name, etc.) is filled out.

[19] Qualitative samples are also collected, when soft-bodied algae are to be analyzed (Section 4.6)

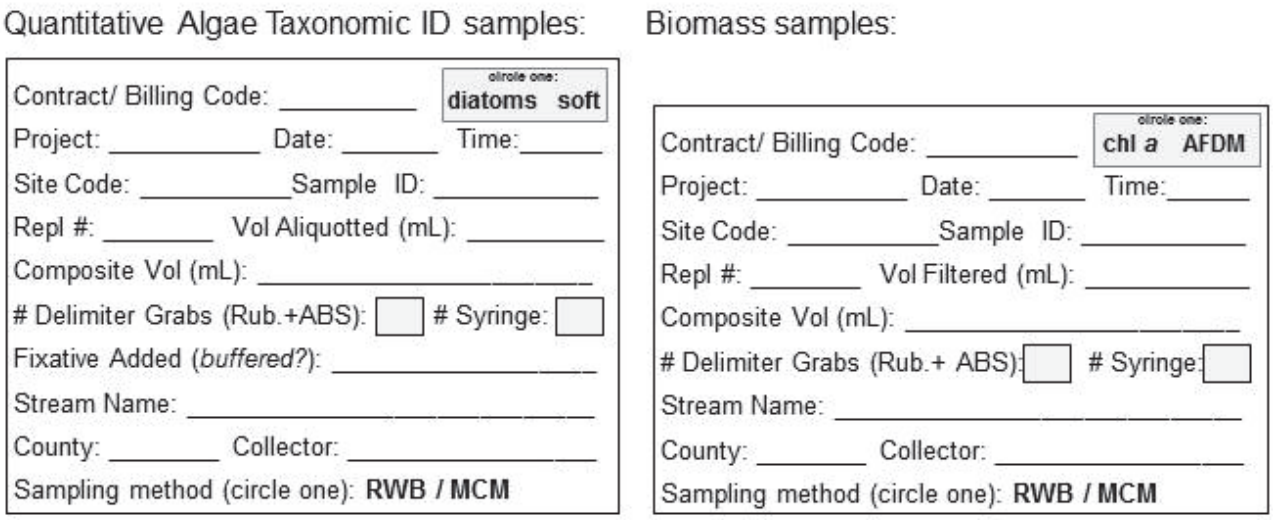


Figure 11. Labels for algae quantitative taxonomic identification (left) and biomass samples.

Before preparing the algae samples, it is necessary to determine two things:

- **Are there any clumps of macroalgae in the composite sample (as opposed to just microalgae suspended in liquid)?**

AND

- **Is a soft-bodied algae taxonomic sample going to be prepared?**

The answers to these questions will determine the course of action for preparing the algae samples for a given site**.** Figure 12 provides a decision tree for how to proceed with the algal sample-processing steps.

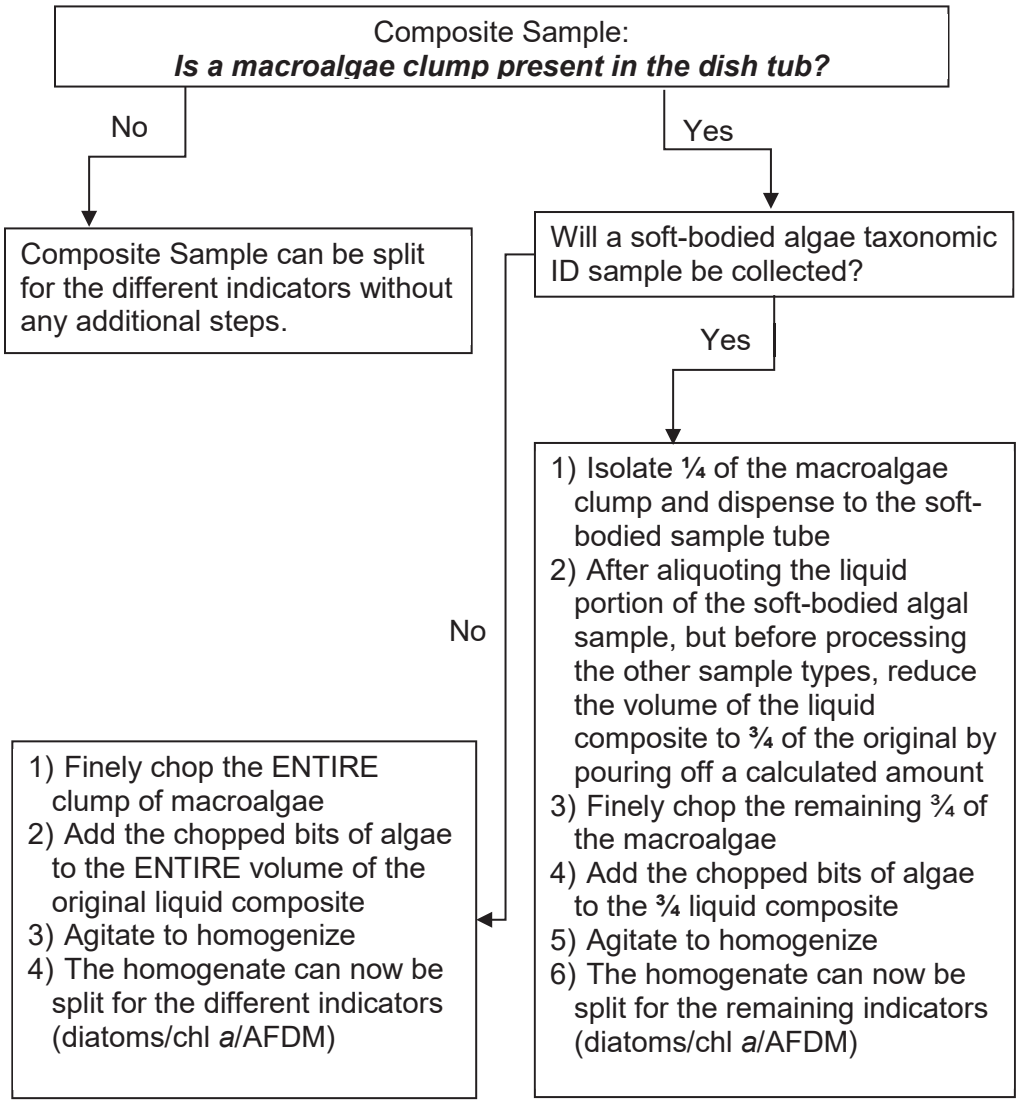
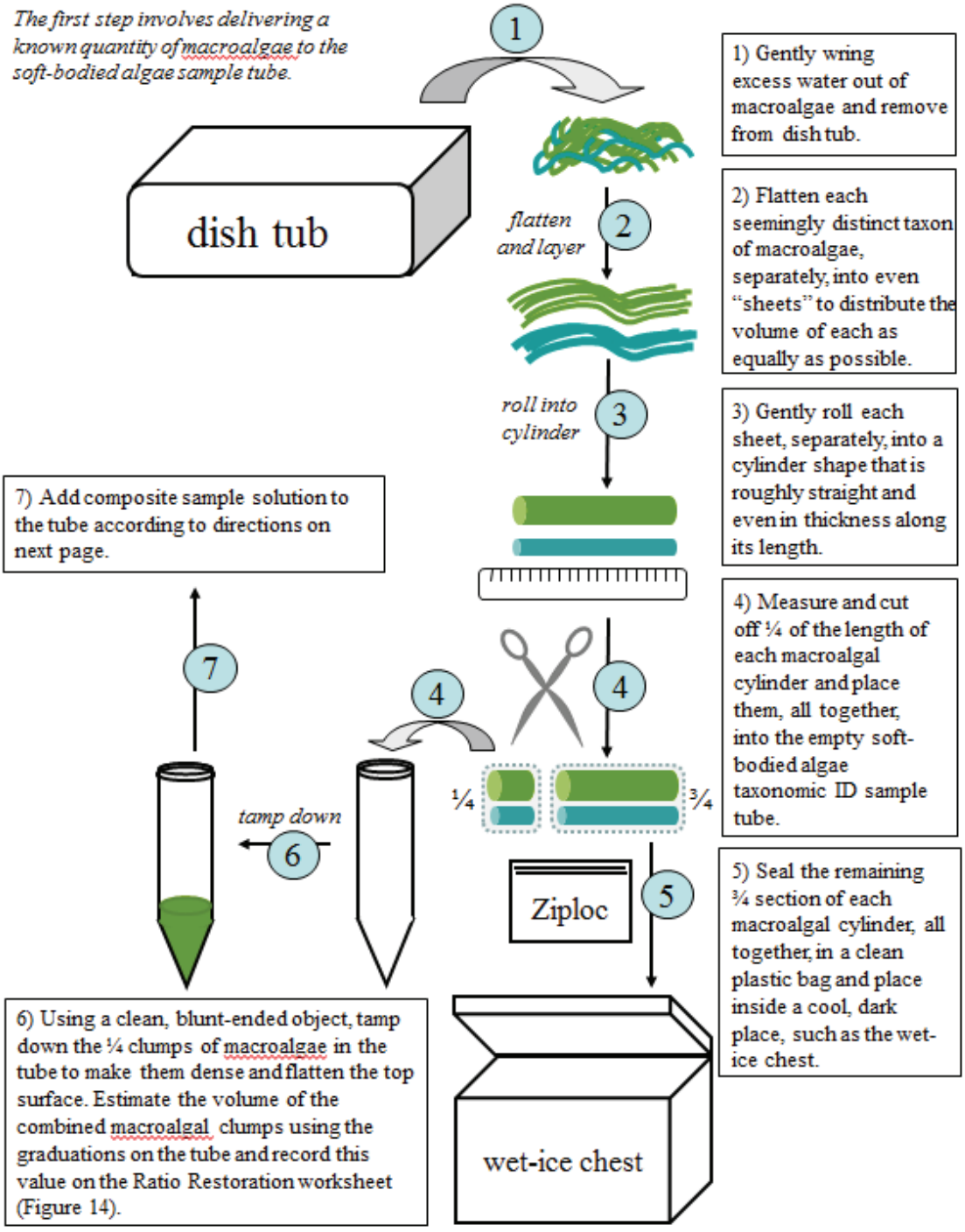


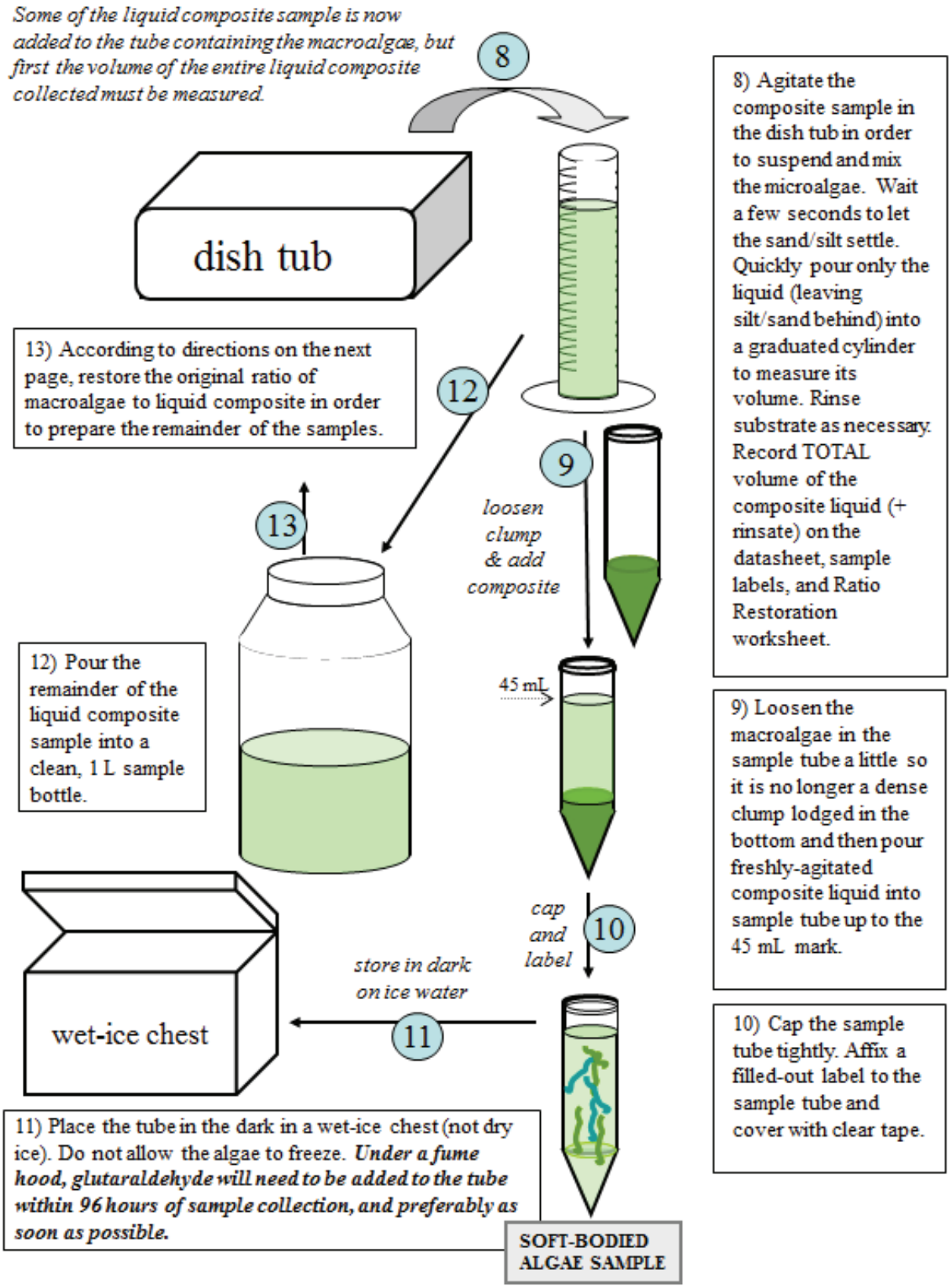
Figure 12. Summary of major sample-processing decision points based on presence of macroalgal clump(s) and need to prepare a soft-bodied algal sample.

The following is a description of how to proceed when a soft-bodied algal taxonomic ID sample is to be prepared AND macroalgal clump(s) are present in the sample in the dish tub. A flowchart of this procedure is provided in Figure 13. *It is recommended that this flowchart be printed in color, laminated (if possible) or printed on water-proof paper, and brought along to the field for a quick reference on handling macroalgal clumps in the composite sample.*

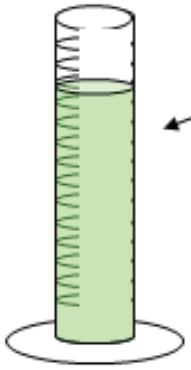
Note: It is unlikely that the ¼ macroalgal clump will occupy all the space in the soft-bodied algae quantitative sample tube, but if it does, a second tube will be needed in order to accommodate all the sample material plus liquid. If such an action is taken, it should be noted in the Comments section of the field sheets and the tubes should be clearly identified as belonging to the same sample, for record-keeping purposes. Do not fill either tube so full that there will not be enough room for the fixative.

Figure 13. Processing Soft-Bodied Algal and Diatom Samples When Macroalgal Clumps are in the Sample




Some of the liquid composite sample is now added to the tube containing the macroalgae, but first the volume of the entire liquid composite collected must be measured.
8
dish tub
13) According to directions on the next page, restore the original ratio of macroalgae to liquid composite in order to prepare the remainder of the samples.
12
9
loosen clump & add composite
13
12) Pour the remainder of the liquid composite sample into a clean, 1 L sample bottle.
45 mL
cap and label
10
store in dark on ice water
wet-ice chest
11
11) Place the tube in the dark in a wet-ice chest (not dry ice). Do not allow the algae to freeze. Under a fume hood, glutaraldehyde will need to be added to the tube within 96 hours of sample collection, and preferably as soon as possible.
SOFT-BODIED ALGAE SAMPLE
8) Agitate the composite sample in the dish tub in order to suspend and mix the microalgae. Wait a few seconds to let the sand/silt settle. Quickly pour only the liquid (leaving silt/sand behind) into a graduated cylinder to measure its volume. Rinse substrate as necessary. Record TOTAL volume of the composite liquid (+ rinsate) on the datasheet, sample labels, and Ratio Restoration worksheet.
9) Loosen the macroalgae in the sample tube a little so it is no longer a dense clump lodged in the bottom and then pour freshly-agitated composite liquid into sample tube up to the 45 mL mark.
10) Cap the sample tube tightly. Affix a filled-out label to the sample tube and cover with clear tape.

The remainder of the macroalgae is now cut into tiny bits, which are added back to the liquid composite. ***But the original ratio of macroalgae:liquid must first be restored.*** *The diatom and biomass samples are then prepared.*



14

measure & discard calculated volume

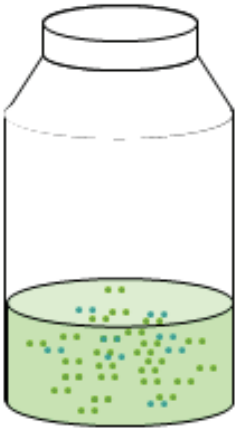
14) Use your *Ratio Restoration* worksheet to determine how much of the liquid composite to pour off and discard. First agitate the bottle thoroughly, then immediately measure and discard the appropriate volume.

¾

15

chop into fine bits

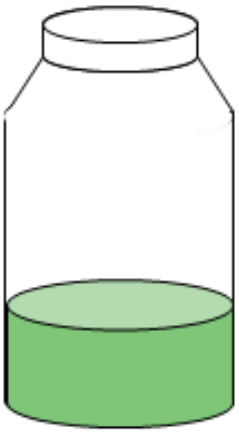
15) Remove the combined ¾ macroalgal cylinder pieces from the wet-ice chest. Chop the algae into *very fine pieces* and add these to the liquid composite.



agitate

16

16) Cap and agitate the bottle sufficiently to homogenize the chopped algae into the liquid as thoroughly as possible.



17) Pour 40 mL of the freshly-agitated homogenate into the diatom sample tube. Add 10 mL 5% formalin solution, observing all formalin safety precautions. Cap the tube, agitate, and affix the sample label.

17

dispense homogenate, add formalin, cap and mix to distribute formalin throughout

DIATOM SAMPLE

18

18) After both taxonomic ID samples have been prepared, the remainder of the homogenate is used for the biomass samples (chl *a* and AFDM). 25 mL of freshly agitated homogenate is filtered for each biomass sample. See text for details.

Step 3. If one or more macroalgal clumps are present in the dish tub, first remove them from the dish tub, wring them out gently into the tub, and roll them into cylinder shapes that are relatively even in thickness along their length. If there appears to be more than one type of macroalgae (i.e., obviously different species based on color/texture) in the sample, separate cylinders should be made for each one.

Step 4. Measure the length of the cylinder(s) with a ruler and cut a quarter off of each one, lengthwise, with scissors. Place all the quarter pieces together into the (still empty) soft-bodied algae ID sample (50 mL centrifuge) tube. Push the clump of combined macroalgal specimens down into the sample tube, and flatten the top so that the volume of the clump can be estimated using the graduations on the tube. The estimated volume of this clump will be used in a calculation (see Equation 1 and Figure 13).

Step 5. Place the remaining three-quarters length of the cylinder(s) in a Whirl-Pak™ bag. Seal and label the bag and store it in the wet ice cooler.

Step 6. Once algal specimens have been removed from all the substrates (sand, gravel, cobble, wood, leaves) in the dish tub, according to the procedure described in Steps 1 and 2 at the beginning of Section 5.2, gently agitate the dish tub to suspend the microalgae in the liquid, and then start pouring this suspension into a clean graduated cylinder to measure the volume of the liquid. Try to leave all sediment (silt, sand) behind. Transfer the measured liquid into a clean 1L plastic bottle. Rinse the sediment once or twice until it appears that little to no additional suspended material (microalgae) is coming off because the rinsate is clear (or nearly clear). Add this rinsate to the graduated cylinder to measure it also. If necessary, repeat this process (regularly agitating the dish tub) until all the liquid has been measured and transferred to the sample bottle. *Note: use water sparingly, because the total sample volume plus rinsate should be no more than about 400-500 mL.* Because as much of the silt and sand as possible is being left behind, the final volume should ideally reflect only the liquid component of the sample. On the field sheet, under the Algae Samples section, record the total volume of all the liquid that had been in the dish tub, plus the water used for rinsing the substrates and sampling devices. This is the "**composite volume**". Record this value on *all* algae sample labels (biomass and taxonomic samples).

Step 7. Pour freshly-agitated liquid composite sample from the 1 L bottle into the soft-bodied algae sample tube (on top of the clump of macroalgae, if present) up to the 45 mL mark. If no macroalgal clumps had been collected during sampling, simply pour the liquid sample into the empty soft-algae sample tube to the 45 mL mark. Midway through pouring, swirl the composite sample some more (first clockwise, then counter-clockwise) to ensure that the microalgae are still fully suspended. Cap the tube tightly. Fill out a sample label and affix it to the sample tube. Cover the label completely with clear plastic tape to prevent the writing on the label from smearing. Place the tube in the wet ice chest to keep it in the dark and as cold as possible, but make sure it is never allowed to freeze.

Glutaraldehyde is necessary for fixing soft-bodied algae samples in order to preserve fine morphological features and pigment colors, as both can be crucial characters for taxonomic determination. *However, glutaraldehyde is a hazardous substance that poses a number of safety risks.* As such, it must be handled only in a fume hood, by trained personnel wearing appropriate protective gear. Refer to the Guidance Document for an SOP on handling glutaraldehyde.

To fix the soft-bodied algae sample: working under a fume hood, add glutaraldehyde to the tube to a final concentration of 2%. This can be achieved, for example, by adding 5 mL of 20% glutaraldehyde to 45 mL of sample. Distribute the glutaraldehyde throughout the sample by inverting the tightly closed tube repeatedly. Once the samples are fixed, they must be stored in the dark in a refrigerator. Wrap the tubes in foil, if necessary, to maintain darkness.

If no fume hood is available, arrangements should be made for the glutaraldehyde to be added to the samples by personnel with access to a hood (e.g., the taxonomy lab). In the meantime, the unfixed samples must be kept in the dark and on wet ice (but not allowed to freeze), and must be fixed within 96 hours of collection (and preferably sooner). Therefore, if the taxonomy laboratory or another party will be adding the fixative, it is imperative to plan ahead to arrange for this to be done in a timely manner, and also to clearly mark which tubes will need to have fixative added to them.

Step 8. In the field, after the (unfixed) soft-bodied algal sample has been prepared, and before preparing the diatom sample (and biomass samples, which will be discussed in the next steps), *if* a macroalgal clump had been present in the dish tub, then the volume of the remaining composite liquid must be reduced to equal ¾ of the original volume. This is necessary because ¼ of the macroalgal clump was taken out of the composite sample but a full ¼ was not removed from the liquid portion. As such, the original ratio between liquid and macroalgae must be restored before further sample preparation. The following procedure is used to reduce the volume of liquid composite to ¾ of the original. For convenience, the following formula (Equation 1) can be used to calculate how many mL to pour off and discard from the composite:

Equation 1. Adjusting the volume of composite sample. (Be sure to honor the rules governing algebraic "order of operations" in calculating the volume to pour off.)

volume (mL) of composite to pour off = (0.25 * C) – 45 + A

where "**C**" is the original composite volume and "**A**" is the approximate volume of the (combined) clump(s) of macroalgae placed in the soft-bodied algae sample tube (tamped down and flattened). A copy of the Ratio Restoration worksheet shown in Figure 14 can be used to calculate the amount of composite to pour off.

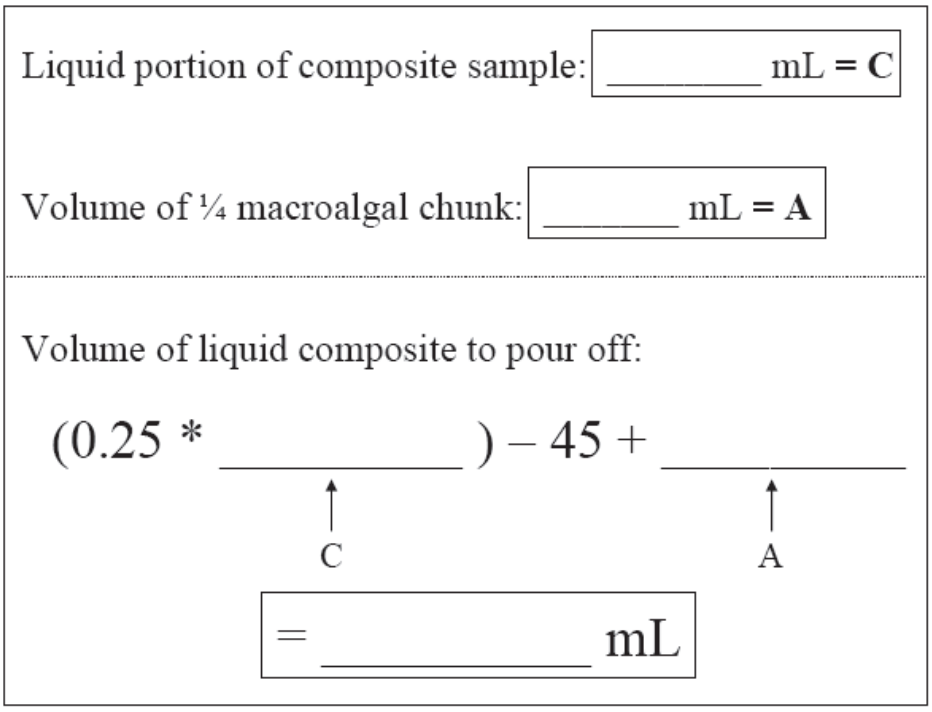


Figure 14. Ratio Restoration worksheet. Be sure to honor the rules governing "order of operations" in calculating the volume to pour off.

As always whenever pouring off aliquots, be sure to agitate the composite liquid adequately in order to resuspend any settled microalgae before pouring off the calculated volume.

Step 9. Once the required amount of composite liquid has been discarded, the remaining ¾ of the macroalgal cylinder (from the bag in the wet ice cooler) is cut with scissors into fine pieces (resulting in strands that are no more than ~3 mm long), and these are added to the reduced-volume composite liquid. The pieces should be chopped small enough so that they practically "blend" into the liquid such that distinct fragments of macroalgae are not easily discernible, because the goal is to "homogenize" the macroalgae into the liquid as much as possible. If a macroalgal clump was present in the dish tub, but no sample is to be prepared for analysis of the soft-bodied algal community, then ALL of the macroalgal clump should be finely chopped into the full volume of measured composite liquid. In this case, there would be no need to discard ¼

of the composite volume before introducing the (full amount of) chopped macroalgal into the liquid.

Step 10. After introducing the finely chopped macroalgae into the composite liquid, cap the composite bottle and agitate sufficiently to homogenize the tiny bits of algae into the liquid as much as possible, while not agitating so hard as to risk busting cells and releasing chl *a*.

Step 11. To prepare the diatom sample, aliquot 40 mL of freshly-agitated sample homogenate into the diatom ID sample tube, swirling the composite sample bottle again midway through pouring to keep the algae suspended. Add 10 mL of the 5% formalin to the sample (for a final concentration of 1%). *Fixatives such as formalin must be used with great care. Be sure to wear formalin-safe gloves and safety goggles when using the fixative, as it should never be touched with bare hands or allowed to splash onto skin or into eyes. Also make sure it is used only in a very well-ventilated place and avoid breathing in any fumes. Minimize the amount of time that vessels containing formalin are open. Fixative added to the sample must not be allowed to ooze outside the vessel that contains it, including the sample tubes.* Refer to the Guidance Document for instructions on preparing the buffered formalin solution and for an SOP on handling formalin.

Step 12. Cap the tube tightly and invert it several times to mix the formalin into the sample. Fill out a sample label and affix it to the sample tube. Cover the label completely with clear plastic tape to prevent the writing on the label from smearing. Keep the fixed diatom samples in the dark and away from heat. The remaining composite sample homogenate can be used to prepare the chl-*a* and AFDM filters as described below.

If no algal taxonomic data are required for the project at hand, and only biomass data are needed, finely chop *all* macroalgae (if present) directly into the *entire* volume of liquid (which must still be measured and recorded). Then proceed to Step 13.

Step 13. Now the biomass samples can be prepared. The procedure to filter chl *a* samples should be carried out quickly, and in the shade as much as possible, to minimize exposure of the sample to light/heat, thus minimizing chl *a* degradation. Use clean filter forceps to center a glass fiber filter (47 mm, 0.7 μm pore size) onto the mesh platform of a clean filtering apparatus, and rinse the filter a little with DI water to seat it well into the mesh before attaching the filter chamber on top. Never touch the filters with hands or anything other than clean forceps. Agitate the sample homogenate to resuspend all the macroalgal fragments and microalgal material. Measure 25 mL using a small, clean graduated cylinder. Midway through pouring the 25 mL, swirl the homogenate again to ensure that the material is still fully suspended. Pour the remainder of the 25 mL into the filter chamber. Once empty, rinse the graduated cylinder with a few mL of DI water, and add this to the filter chamber.

Step 14. To filter the sample, create a *gentle* vacuum with the hand pump. Be sure to proceed very slowly, and pump only one stroke at a time until all of the liquid in the sample is passed through the filter. *Pressure on the sample should never exceed 7 psi, as this could cause cells to burst and release contents, including chl a, into the filtrate and be lost.* If it becomes impossible to filter a whole 25 mL of the sample and remove the water efficiently, discard the filter and try

again with a smaller volume (*e.g.,* 10 mL). It is not necessary to collect on multiple filters to try to achieve a total volume of 25 mL. Simply filter as much as possible on a single filter, up to 25 mL, and then use that filter as the sample. Be sure to record the volume of the composite sample that was actually filtered, both on the datasheet, and on the sample label.

Rinse the sides of the filter chamber with a few mL of DI water, and continue filtering until the water is drawn down. The filter should not be sucked dry, but rather left slightly moist, in order to avoid applying excessive pressure to the sample, which could cause algal cells to burst. After all the liquid has passed through, check the filter to see if there are any bits of non-algal plant matter (like tiny seedlings or bits of leaves). If so, remove them with clean, pointed forceps, being careful not to remove any algae in the process. Remove the filter from the filtering device. Always thoroughly rinse the sides of the filter chamber and the interface between the mesh filter seating and the screw-on part of the apparatus with DI water between samples.

Step 15. Fold the filter in half (with the sample material on the inside, like a taco) using the forceps, and place it inside a clean, snap-top Petri dish. Envelope the Petri dish completely within a small sheet of aluminum foil in order to prevent any light from reaching the filter. Place the covered Petri dish and its corresponding, filled-out sample label (face outward) into a 100 mL Whirl-Pak™ bag, purge as much of the air out of the bag as possible, "whirl" it shut, and seal it tightly by twisting its wire tabs *together*, so that water in the cooler will not be able to enter the bag. Shove the sample packet down into the ice in the cooler to make sure it stays submerged and does not float to the top. This may be achieved by sealing the sample bags in a large Ziploc™ bag with a rock in it. Keep chlorophyll *a* filters as cold as possible and place them in the freezer (-80º, if available) or on dry ice as soon as possible (and within four hours of collection); the analytical holding time for the chl *a* filters is 28 days from collection, when kept frozen.

Step 16. For the AFDM samples, use glass-fiber filters (47 mm, 0.7 μm pore size) that have been pre-combusted[20]. Never touch the filters with hands or anything other than clean forceps. Follow the same process as that used for chl-*a* sample filtering. Record the volume filtered for the AFDM sample. Keep AFDM filters as cold as possible until the samples can be frozen back at the laboratory that evening, or place on dry ice until they can be stored in the laboratory freezer. The analytical holding time for the AFDM samples is 28 days from collection, when kept frozen.

[20] Check with the laboratory that will be analyzing the samples about obtaining pre-combusted filters.

6. PHYSICAL HABITAT TRANSECT-BASED MEASUREMENTS

After all biotic samples have been collected at a given transect, PHab data collection may begin. These data are designed to characterize a stream reach's physical habitat, knowledge about which can aid interpretation of the biotic data. In some cases, however, PHab data may be desired for a site assessment even when biotic/biomass samples are not being collected.

The majority of PHab measurements in this SOP are gathered relative to the 11 main transects (Figure 3), and data for the PHab parameters described in this section are entered on transect-specific field sheets (and in the case of the "Pebble Count" data, also on the inter-transect field sheets). PHab data collection starts at the downstream transect (Transect A) and proceeds working upstream along the monitoring reach. Some programs (*e.g.*, citizen monitoring efforts) may elect to collect a less-intensive subset of PHab data than the full suite described here. To this end, the Guidance Document provides suggestions for a "Basic" protocol.

6.1 Module C: Wetted Width and Bankfull Dimensions

Step 1. Measure the *wetted width* associated with the transect and record this (in meters) in the box at the top of the transect form. The wetted channel is the zone that is inundated with water and the *wetted width* is the distance between the sides of the channel at the point where substrates are no longer surrounded by surface water (Figure 15). The wetted width can include emergent, unvegetated sandbars or boulders in the middle of a channel, but should not include emergent, vegetated "islands" (defined as features that are not flooded during average year high-water events). When a transect crosses an island, subtract the width of the island from the distance between the wetted margins.

Step 2. Scout beyond the wetted channel along the stream reach to identify the location of the *bankfull* margins on either bank by looking for evidence of annual or semi-annual flood events. The bankfull channel is the zone of maximum water inundation in a normal-flow year (i.e., one- to two-year flood events; see Figure 15 and the Guidance Document for a depiction of wetted width and bankfull dimensions). Because most channel-formation processes are believed to act when flows are within this zone (Mount 1995), bankfull dimensions provide a valuable indication of stream power during high-flow events and therefore relative size of the water body.

Examples of evidence for bankfull location include topographic, vegetation, and geologic cues (changes in bank slope, changes from annual to perennial vegetation, changes in the size distribution of surface sediments, location of water stains on concrete and bedrock channels, etc.). Although it is tempting to use the position of drift material caught in vegetation to identify bankfull location, it only indicates the discharge height during extreme recent flow events, and should not be used as an indicator by itself. Note that, perhaps more than any other component of PHab assessment, identification of bankfull location requires extensive experience in multiple ecoregions and stream types, and *training in the field under the supervision of experienced bioassessment practitioners is essential*.

It is helpful during the initial reach delineation to investigate the entire reach when attempting to interpret evidence for bankfull location, because the true bankfull margin may be obscured at various points along the reach. However, bear in mind also that bank dimensions may change in the middle of a sampling reach.

Step 3. Stretch a tape or stadia rod from bank to bank at the bankfull position along the transect. Record this distance (in meters) as bankfull width at the top of the transect form. If using flexible tape, make sure the tape is taut before taking a reading.

Step 4. Record bankfull height (in meters) as the vertical distance between the water surface and the height (Figure 15) of the bank at bankfull position. This can be done by standing at the wetted edge or transect center holding a meter stick vertically from the water surface to the stretched tape to measure the height.

Step 5. Carry out the above steps at each of the 11 main transects.

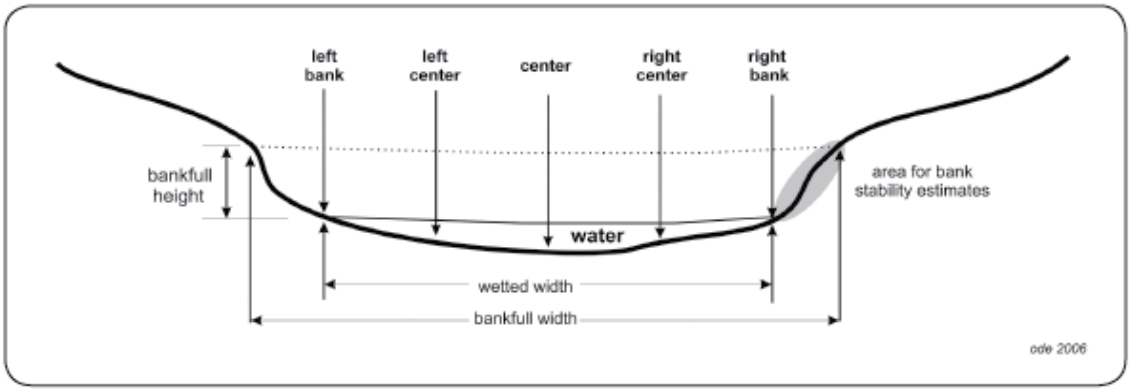


Figure 15. Cross sectional diagram of a typical stream channel showing locations of wetted and bankfull width measurements, substrate measurements, and bank stability visual estimates.

6.2 Module D: Substrate Size, Depth, and Coarse Particulate Organic Matter (CPOM)

Particle size frequency distributions often provide information about instream habitat conditions that affect BMI distributions, and may also reflect the stream's ability to accrue algal biomass. Changes in particle size distributions often accompany stream disturbances, and may be a key source of stress to benthic organisms.

The Wolman "pebble count" technique (Wolman 1954) is a widely used and cost-effective method for estimating the particle-size distribution that produces data that correlate with costly, but more precise, bulk-sediment samples. The method described here follows the NRSA protocol (which is a version of the Wolman count) and records sizes of 105 particles in a reach: five particles, equidistant from one another, along each of the 11 main transects and 10 inter-transects. Depth refers to the depth of surface water in the stream at each of these points. Coarse particulate organic matter (CPOM; small particles of organic material, such as leaves/twigs, that are >1 mm in size, but no larger than 10 mm) is an indicator of the amount of allochthonous

organic matter available at a site. Because CPOM is food resource for certain benthic macroinvertebrates, its abundance can provide information about the quality of the food web in a stream reach. Pebble count, depth, and CPOM are all measured in tandem at each of the 105 points along the sampling reach.

Step 1. At each transect (and inter-transect), use a stadia rod or tape measure to divide the wetted stream width by four to get the distance between the five points (Left, Left Center, Center, Right Center and Right; Figure 15) and locate the positions of these points along the transect. Once the positions are identified, lower a graduated rod (e.g., a waterproof meter stick) straight down though the water column to identify the particle located at the tip of the rod

Step 2. Measure the depth from the water surface to the top of the particle with the graduated rod and record to the nearest cm.

Step 3. Record the presence or absence of CPOM within 1 cm from the edge of the rod.

Step 4. Remove the particle from the streambed and measure and record the length of its intermediate axis (Figure 16) to the nearest mm. Actual measurements should always be recorded, whenever possible (i.e., for the fine gravel through large boulder-sized bed materials). If a direct measurement is impossible (e.g., the particle is deeply embedded or in a deep pool), an approximate size may be designated by assigning a particle size classes listed in Table 4 based on visual estimation. Regardless of the method, all particles < 0.06 mm should be recorded as fines, and all particles between 0.06 mm and 2.0 mm recorded as sand. “Wood” applies to woody material, living or dead. “Hardpan” applies to consolidated fines, where individual particles cannot be easily separated or dispersed. Substrates (e.g., trash, macrophytes, live tree roots, and any other substrate not captured by the other available categories) that do not fall into any of the categories should be recorded as “other” (OT).

Record particle measurement (or size class) on the transect sheet under “mm/size class” in the “Transect Substrates” portion of the form. If recording particle size class, use only the standard codes in Table 4 to record the information.

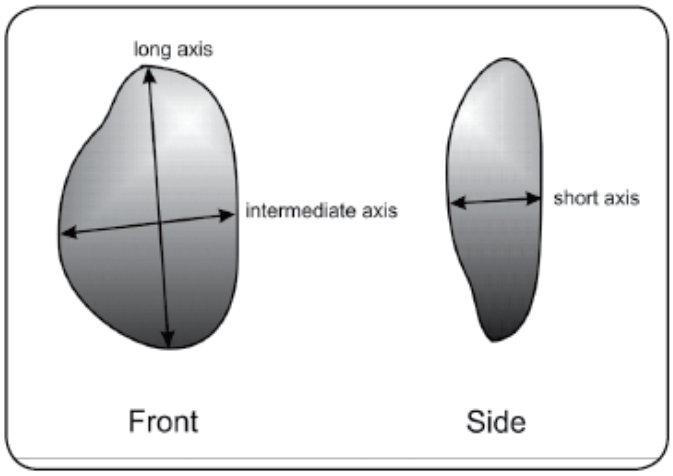


Figure 16. Diagram of three major perpendicular axes of substrate particles. The intermediate axis is recorded for pebble counts.

Table 4. Particle size class codes, descriptions, and measurements. SWAMP requires that actual measurements be recorded, whenever possible (i.e., for the fine gravel through large boulder-sized bed materials).

Size Class Code	Size Class Description	Intermediate Axis Common Size Reference	Size Class Range
RS	bedrock, smooth	larger than a car	> 4 m
RR	bedrock, rough	larger than a car	> 4 m
RC[21]	concrete/ asphalt	larger than a car	> 4 m
XB	boulder, large	meter stick to car	1 - 4 m
SB	boulder, small	basketball to meter stick	250 mm - 1 m
CB	cobble	tennis ball to basketball	64 - 250 mm
GC	gravel, coarse	marble to tennis ball	16 - 64 mm
GF	gravel, fine	ladybug to marble	2 - 16 mm
SA	sand	gritty to ladybug	0.06 - 2 mm
FN	fines	not gritty	< 0.06 mm
HP	hardpan (consolidated fines)		< 0.06 mm
WD	wood		
OT	other		

Step 5. If the particle is cobble-sized (64 - 250 mm diameter), record to the nearest 5% the percent of the cobble surface that had been embedded by fine particles (< 2 mm diameter; see Cobble Embeddedness measurement procedure, Section 6.3, below).

[21] Only continuous sections of concrete (e.g., concrete channel) should be coded as "RC". Concrete agglomerations smaller than 4 m should be treated as a single particle, and measured accordingly.

Sometimes points with dry (not submerged or moist) substrates are encountered during the course of PHab data collection along transects/inter-transects. To determine how to collect data at dry sampling points, it is necessary to first establish whether the dry area in question lies within the stream's active channel (i.e., therefore regularly inundated during storms), or whether the point is on a stable island (i.e., therefore rarely, if ever, inundated). Stable islands are typically vegetated, often with woody shrubs or trees, and have heights near or exceeding bankfull height. Pebble counts should not be conducted on stable islands. If the transect spans a portion of the study reach in which the channel is bifurcated such that there are two channels with an intervening island, the entire transect should be placed across the dominant channel, and all five pebble count points should be located on that side.
If the point falls on a dry surface that is within the usual active channel (i.e., subject to regular disturbance by flows), then pebble count and primary-producer cover data from the dry point should be recorded as follows:

- score Depth as 0
- score Particle Size/Class and Embeddedness as described above for wet particles
- score all the algae variables (Microalgae, Macroalgae Attached, and Macroalgae Unattached), as well as Macrophytes and CPOM, as "D" for "dry"

Ordinarily, the sampling transect would span the wetted width of the channel, but when no water is present at a given transect, evidence of the typical wetted extent of the active channel will need to be used to infer appropriate transect boundaries. Such indicators can include the transition from vegetated to unvegetated area (i.e., moving from banks toward the active channel), as well as the presence of dried algae, water stains, micro-topographic transitions, changes in substrate composition, soil cracks, and others.

6.3 Module E: Cobble Embeddedness

The degree to which fine particles fill interstitial spaces in the streambed has a significant impact on the ecology of benthic organisms and fish, but techniques for measuring this impact vary greatly (this is summarized by Sylte and Fischenich 2002, http://stream.fs.fed.us/news/streamnt/pdf/StreamOCT4.pdf). Here we define embeddedness as the percent of the surface area (not volume) of cobble-sized particles (64 - 250 mm) that is buried by fines or sand particles (< 2.0 mm diameter). Ideally, at least 25 cobbles are assessed for embeddedness in each sampling reach: Embeddedness is determined for each cobble that is measured for particle size, up to a total of 25 cobbles. If < 25 cobbles are encountered during the pebble count, the remainder are "made up" by assessing cobbles that lie outside of the PHab data collection transects (see Step 3, below). In certain streams, it may not be possible to find 25 cobbles.

Step 1. Every time a cobble-sized particle is encountered during the pebble count, remove the cobble from the stream bed and visually estimate the percentage of the cobble's surface area that had been buried by fine particles. If removal of the cobble is impossible, approximate embeddedness to the best extent possible. In the rare circumstances that multiple sample points

land on the same cobble, do not take a second embeddedness measurement. Once embeddedness has been assessed for 25 cobbles, no more need be assessed.

Step 2. Record the embeddedness values for the first 25 cobble-sized particles encountered during the pebble count in the "% Cobble Embed" field in the "Transect Substrates" portion of the transect sheet.

Step 3. If 25 cobbles are not encountered during the pebble count by the time Transect K has been sampled, supplement the data by conducting a "random walk" [22]. Starting at a random point in the reach, follow a line from one bank to the other at a randomly chosen angle, recording embeddedness of any cobbles encountered (that were not previously recorded) along the way. Upon arriving at the other bank, reverse the process with a new randomly chosen angle. Spend a maximum of 10 minutes on the random walk, even if 25 cobbles have not been encountered by that time. Embeddedness for any cobbles encountered outside of the pebble count locations should be recorded in the "Additional Cobble Embeddedness" section of the field sheets.[23]

6.4 Module F: Algal and Macrophyte Cover

Algal cover refers to the amount of algae in the stream reach, both in terms of 1) microalgal coatings ("slimy-ness") on stream substrates and 2) macroalgae (*e.g.*, filaments, mats, globules)[24]. It is a reflection of stream primary production and has implications for the health of food webs as well as the damaging effects of eutrophication stimulated by excess nutrients in concert with other environmental co-factors (e.g., loss of canopy cover).

Algal cover is estimated by a point-intercept approach that entails collecting information about the presence/absence of both types of algae (as well as thickness, for the microalgae) at each of the 5 points along the transects associated with the pebble count. If the point corresponding to each pebble in the pebble count intercepts algae, then algae is recorded as "present" at that point.

Step 1. For each point along the pebble count, record information about algae as follows. For any film-like coating of algae (referred to as "Microalgae" on the datasheet) present on the surface of the substrate at that point, estimate the presence / thickness category according to the scheme in Table 4. For thicker microalgal layers, a small ruler can be used for measurement. For layers too thin to measure, use the indicators listed in the last column of Table 4. Note that these thickness codes refer only to microalgal film, not macroalgal mats (macroalgal thickness is not assessed in this protocol).

[22] It is preferable to wait until the rest of the PHab transect/inter-transect measures are complete before doing this, so as not to trample any as-yet unsampled transects in the course of the random walk.
[23] An easy way to ensure that 25 embeddedness measurements are taken is to put an X in one of the boxes on the first data sheet each time a cobble is encountered during normal transect measurements. Then, after all transects are complete, fill in the remaining boxes with embeddedness estimates.
[24] Refer to the glossary for comprehensive definitions of microalgae and macroalgae and the Guidance Document for photos

Be sure to collect microalgal thickness data from whatever substrate is topmost within the stream, and therefore is most likely to be exposed to sunlight. Sometimes this substrate is not the actual pebble used in the pebble count, but rather a substrate type that occurs above the pebble, such as a thick mat of macroalgae that is above (and obscuring) the stream bottom. Microalgal species can grow as epiphytes upon macroalgal filaments and mats, coating them with a slimy, brown-tinted film. The Guidance Document provides some additional information to help distinguish between microalgae and macroalgae.

Table 5. Microalgal thickness codes and descriptions (modified from Stevenson and Rollins 2006).

Code	Thickness	Indicators
0	No microalgae present	The surface of the substrate is not at all slimy.
1	Present, but not visible	The surface of the substrate feels slimy, but the microalgal layer is too thin to be visible.
2	<1mm	Rubbing fingers on the substrate surface produces a brownish tint on them, and scraping the substrate leaves a visible trail, but the microalgal layer is too thin to measure.
3	1-5mm	
4	5-20mm	
5	>20mm	
UD	Cannot determine if a microalgal layer is present	(see explanation in text)
D	Dry point	

Sometimes, due to the nature of the substrate, it can be difficult to discern whether a microalgal layer is present. For example, deposits of very fine sediments might obscure the diagnostic color of a microalgal layer, and the slipperiness of very fine silt may make tactile determination of microalgae impossible. If presence/absence of a microalgal layer cannot be determined with confidence, score microalgal thickness as “UD”.

Step 2. In addition to recording the presence and thickness of microalgae on the surfaces of substrates, record the presence/absence of attached macroalgae in the water column, as well as unattached, floating macroalgal mats on the water’s surface, corresponding to each pebble count sampling point. Do this by envisioning an imaginary line extending from the water’s surface down to the stream bottom where the target pebble lies (particularly in turbulent water, it may be helpful to use a viewing bucket (Guidance Document) in order to see below the water’s surface). If this line intercepts macroalgae, either floating on the water’s surface, or somewhere within the water column, the appropriate algal class(es) should be recorded as “present”. Attached macroalgal filaments have an obvious, current, physical connection to something (like a cobble, boulder, or a gravel bed) lying on the bottom of the stream, whereas for unattached macroalgae, there is no obvious physical connection with the streambed at the time of the assessment, and the algae is freely floating at or near the water’s surface. The data-collection point does not need to intercept attached algae at its point of attachment in order for it to be scored as “Attached”; all that is required is for the algae to be attached to the streambed somewhere, even if the attachment occurs far from the sample point. For each class of macroalgae (Attached and Unattached), mark

"P" (for "present") if intercepted by the sampling point and "A" (for "absent") if not intercepted.[25]

If any portion (above- or underwater) of a macrophyte is intercepted by the imaginary line associated with the pebble count point, mark "P" for "present" under "Macrophytes". Otherwise, mark "A" for absent. Macrophytes are defined as herbaceous, vascular plants rooted or floating within the stream's wetted channel, such as sedge, cattail, knotweed, *Arundo donax*, watercress, water-primrose, duckweed, etc. Our definition of aquatic macrophytes excludes trees, root mats, shrubs, mosses, and algae. This is the same as the definition of macrophytes used for Module J (Instream Habitat Complexity).

6.5 Module G: Bank Stability

The vulnerability of stream banks to erosion is often of interest in bioassessment because of its direct relationship with sedimentation. For each transect, record a visual assessment of bank vulnerability along an imaginary line between the wetted width and bankfull width of the stream channel (Figure 15)[26]. Choose one of three vulnerability states: *eroded* (evidence of mass wasting), *vulnerable* (unprotected banks), or *stable*. All three states may be evident in a single reach at both natural and highly modified streams. The following indicators help describe the states:

- Eroded: Exposed tree roots, obvious bank slumps, fallen trees.
- Vulnerable: Sparse vegetation
- Stable: Bank armoring, robust vegetation, few exposed tree roots

6.6 Module H: Human Influence

The influence of human activities on stream biota is a central question in bioassessment analyses. Quantification of human activities is used to evaluate stress and to identify minimally disturbed reference sites. Reach-scale observations provide a crucial supplement to data provided by aerial imagery and GIS analysis.

Anthropogenic features and activities associated with each main transect (for a distance of 5 m upstream and 5 m downstream from the transect, totaling a width of 10 m centered on the transect; Figure 17) are recorded in terms of zones based on how close they are to the wetted margins.[27] The area in which human influence is measured extends outward 50 m in both directions from the bank along the entire reach.

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[25] Because pebble counts span the "wetted width" of each transect, pebbles at the margin positions will often be at least moist, and sometimes even submerged. As such, it is important to realize that algal cover can occur at the bank positions of the pebble count as well as intermediate positions across the stream. Algal cover should therefore be recorded at all five observation points along each transect.

[26] Note that sandbars are not considered part of the bank.

[27] The relative distance between the wetted and bankfull margins can complicate the assessment of human influence. If the wetted edge and the bankfull margin are at the same point, then land uses between the wetted edge and bankfull margin are not present, and that location cannot be scored. Conversely, in some streams, the bank and the wetted edge may be many meters apart. In that situation, the wetted edge should be used as a consistent point for defining the area.

For each human disturbance feature/activity class, circle “Y” if it is present between the wetted margins; otherwise, circle “N”, and then assess each side of the stream as follows: If the feature/activity is present between the wetted edge and bankfull margin, circle “B”; if it is outside within 10 m of the bank circle “C”; if it is within 50 m of the bank, circle “P”; otherwise, circle 0. The relative distance between the wetted and bankfull margins can If the wetted edge and the bankfull margin are at the same point, then land uses between the wetted edge and bankfull margin are not present, and that location cannot be scored. Conversely, in some streams, the bank and the wetted edge may be many meters apart. In that situation, the wetted edge should be used as a consistent point for defining the area.

For each feature/activity, the most proximal category takes precedence and therefore is the distance at which that feature/activity should be scored. For example, if a feature/activity is observed within the channel, as well as on the banks, circle “Y” to denote the channel, and move on to scoring the next feature/activity class. Note that certain features (e.g., parks) are not applicable within the channel, and for these, “B” would represent the most proximal location possible.

Table 6 provides definitions of Human Influence features/activities. Circle only the closest location for each impact that applies, being careful not to double-count any human influence observations. [28]

[28] Double counts are prevented by SWAMP electronic forms.

Table 6. Definitions of Human Influence features/activities.

Feature/Activity	Description/Indicators
Walls/Rip-rap/Dams	Artificial stone, concrete, or cement structures that are built into the stream, including check dams
Buildings	(self explanatory)
Pavement/Cleared lot	Vacant land with disturbed soil or ruderal vegetation, or paved
Roads or Railroads	Includes unpaved roads and high use trails
Pipes (inlet/outlet)	A physical structure discharging into, or withdrawing from, the stream; does not need to be active and can include pipes within the banks
Landfill/Trash	Garbage; can include large, stable (e.g., cars) items, as well as ephemeral (candy wrappers)
Park/Lawn	Managed active or passive recreation areas; often irrigated.
Row crops	Agricultural fields; generally includes annual crops that are replanted each season or year
Pasture/Range	Areas where cattle, sheep, or other livestock are actively grazed; evidence includes manure, hoof prints, terracing of hillslopes, and reduced vegetation
Logging operations	Places where trees are cut down; evidence includes stumps, clearcuts, woodchips, slash, flumes
Mining activity	Tailings, borrow-pits, spoils, prospecting mines, sluices
Vegetation Management	Removal or reduction of vegetation for purposes (e.g., flood control, fuel reduction) other than logging; lawn maintenance should be covered under park/lawn
Bridges/Abutments	(self explanatory)
Orchards/Vineyards	Agricultural fields with woody vegetation that is infrequently replanted

6.7 Module I: Riparian Vegetation

Riparian vegetation has a strong influence on the composition of stream communities through its roles in directly and indirectly controlling the food base, moderating sediment inputs, and acting

as a buffer between the stream channel and the surrounding environment. These methods provide a cursory survey of the condition of the riparian corridor[29]. Observations are made in the same 10 m x 10 m riparian area, on either side of the wetted channel, used for assessing human influence "C" zone (Figure 17).

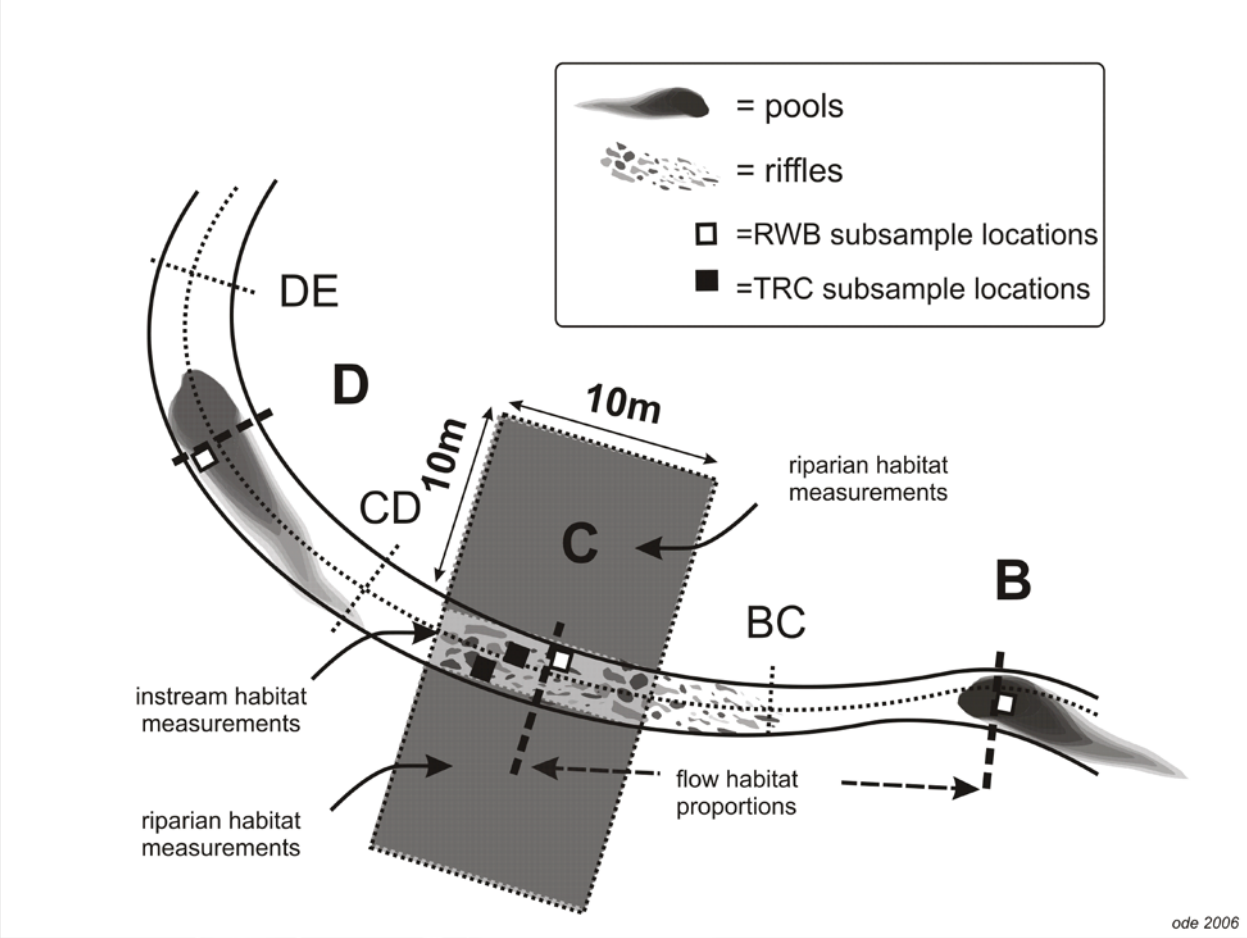

Figure 17. Section of the standard reach expanded from Figure 1 showing the appropriate positions for collecting riparian habitat and flow habitat proportion measurements. Also shown here is the human-influence zone corresponding to the area within 10m of the wetted width (i.e., zone "C").

Step 1. Mentally divide the riparian area into three elevation zones relative to the ground surface:

- Ground cover (< 0.5 m high)
- Lower canopy (0.5 m - 5 m)
- Upper canopy (> 5 m).

Within each zone, record the density of the following riparian classes:

[29] Programs may want to consider adding the California Rapid Assessment Method for wetlands (CRAM; http://www.cramwetlands.org/) to their stream bioassessment data collection efforts in order to obtain more comprehensive information on riparian condition of monitoring sites.

- Upper Canopy: Trees and Saplings
- Lower Canopy: Woody Shrubs and Saplings
- Ground cover:
    - Woody Ground Cover
    - Herbaceous Ground Cover
    - Barren, Bare Soil and Duff (artificial banks, rip-rap, concrete, asphalt, etc. should be recorded as "barren").

An individual plant may contribute to multiple elevation zones. However, low-hanging canopy vegetation should not contribute to groundcover.

Step 2. Indicate the areal cover (i.e., shading) by each riparian vegetation class as either: 1) absent, 2) sparse (< 10%), 3) moderate (10-40%), 4) heavy (40-75%), or 5) very heavy (> 75%).

Each of the elevation zones (upper canopy, lower canopy, and ground cover) should be evaluated independently of the others. All together, they do not need to total to 100%. However, the total for the three ground cover categories (Woody Ground Cover; Herbaceous Ground Cover; Barren, Bare Soil and Duff Ground Cover) should equal 100%.

6.8 Module J: Instream Habitat Complexity

The instream habitat complexity measure was developed by the EMAP program to quantify fish concealment features in the stream channel, but it also provides valuable information about the general condition and complexity of the stream channel for other fauna. Estimates should include only those features that are found between the stream's wetted margins.

Record the category (Table 7) best approximating percentage of areal cover of nine different instream (wetted channel) features within a zone 5 m upstream and 5 m downstream of the transect (Figure 17).Indicate the areal cover of each feature as either: 1) absent, 2) sparse (< 10%), 3) moderate (10-40%), 4) heavy (40-75%), or 5) very heavy (> 75%). Note that the sum of the percentages of the different features does not necessarily need to equal 100%.

Table 7. Instream Habitat Complexity components and descriptions.

Component	Description and Comments
Filamentous algae	• Visible growths of macroalgae. • Do not include non-filamentous macroalgae (e.g., *Nostoc* spp.)
Aquatic macrophytes and emergent vegetation	Herbaceous plants rooted or floating within the stream's wetted channel, such as sedge, cattail, knotweed, watercress, water-primrose, duckweed, etc.; our definition of aquatic macrophytes excludes trees, shrubs, mosses, and algae
Boulders	Intermediate axis ≥ 25 cm (Figure 16)
Small woody debris	< 30 cm diameter
Large woody debris	≥ 30 cm diameter
Undercut banks	• Banks providing sufficient cover for an item at least the size of a fist. • Estimate as an areal (not linear) feature: % of streambed area covered by undercut banks.
Overhanging vegetation	• Vegetation within 1 m of the surface of the water. • Estimate as an areal (not linear) feature: % of streambed area covered by overhanging vegetation.
Live tree roots	(self-explanatory)
Artificial structures	• Any items with an anthropogenic origin. • In concrete channels, do not count the channel itself. • In restored channels, do not count natural items introduced as part of restoration activities (e.g., root wads) • Include stable trash items (e.g., cars, tires, shopping carts) expected to remain in place after a typical storm, but do not include ephemeral trash items (e.g., soda cans, candy wrappers, diapers)

6.9 Module K: Stream Shading (Densiometer Readings)

The amount of sunlight that can reach the stream is important because it influences stream temperature as well as primary productivity, which in turn affects food webs and constrains eutrophication. Using a convex spherical densiometer, stream shading is estimated in terms of percent cover of objects (vegetation, buildings, etc.) that block sunlight. The method described uses the Strickler (1959) modification of a densiometer to correct for over-estimation of stream shading that occurs with unmodified readings. Taping off (Figure 18) the lower left and right portions of the mirror emphasizes overhead structures over foreground structures (the main source of bias in stream shading measurements).

The densiometer is read by counting the number of line intersections on the mirror that are obscured by overhanging vegetation or other features that prevent sunlight from reaching the stream. All densiometer readings should be taken at 0.3 m above the water surface, and with the bubble on the densiometer leveled. The densiometer should be held just far enough from the squatting observer's body so that his/her forehead is just barely obscured by the intersection of the two pieces of tape, when the densiometer is oriented so that the "V" of the tape is closest to the observer's face.

Take and record four 17-point readings from the center of each transect: a) facing upstream, b) facing downstream, c) facing the left bank, d) facing the right bank. The observer should revolve around the densiometer (i.e., the densitometer pivots around a point) over the center point of the transect (as opposed to the densiometer revolving around the observer).

For sites with a mean wetted width > 10 m, two additional readings must be taken: one at the left bank and one at the right, standing at the water's edge and facing away from the stream, toward the floodplain. These additional readings are useful in the case of larger streams and rivers, where the center of the channel does not provide adequate information about the degree to which shading is affecting the stream. For smaller streams, these additional two measures are recommended, but optional.

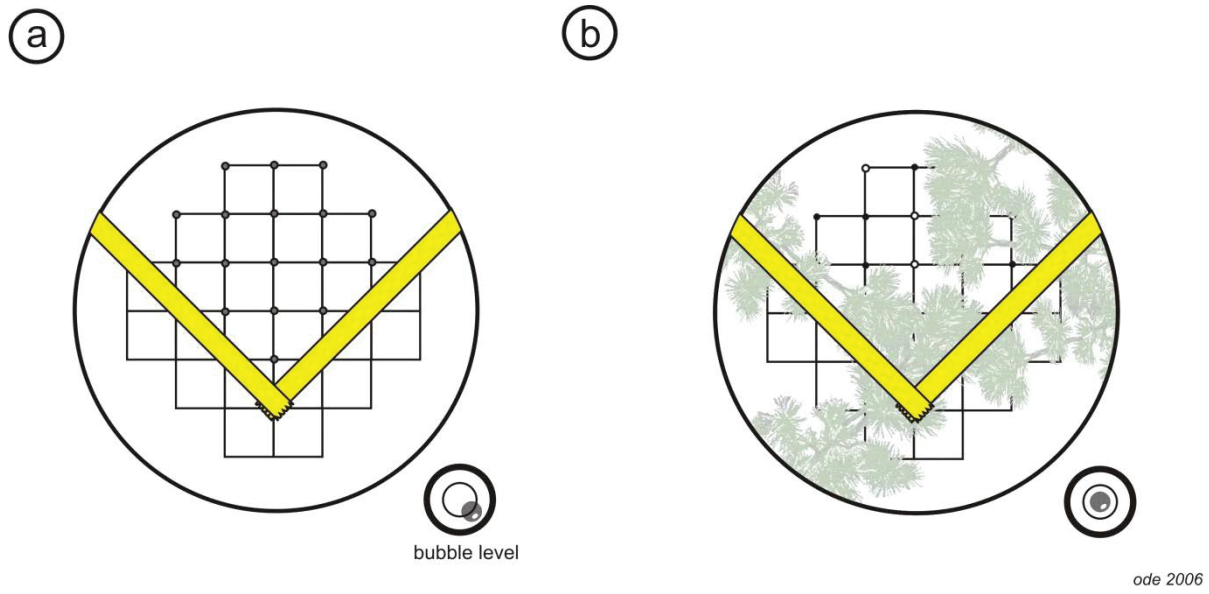

Figure 18. Representation of the mirrored surface of a convex spherical densiometer showing the position for taping the mirror and the intersection points used for the densiometer reading. The score for the hypothetical condition in (b) is 9 covered intersection points out of 17 possible (within the "V" formed by the two pieces of tape). Note the position of the bubble in (b) which indicates that the densiometer is leveled, as opposed to (a), which indicates it is not leveled.

6.10 Module L: Slope and Sinuosity

The slope of a stream reach is one of the major stream classification variables, being a primary determinant of potential water velocities and stream power, which are in turn important controls on aquatic habitat and sediment transport within the reach. The slope of a stream reach is often strongly correlated with many biotic metrics and other PHab measures, and is therefore very useful when interpreting biotic data.

The "Full" PHab method described in this SOP uses transect-to-transect measurements to calculate the average slope through a reach. Although this is more time-intensive than the reach-scale transect measures outlined in the "Basic" protocol (see Guidance Document), it results in more precise slope determination and affords the ability to quantify slope variability within a reach. Sinuosity (calculated as the ratio of the length of the flow path between the ends of the reach and the straight line distance between the ends of the reach; Kaufmann et al. 1999) is measured at the same time as slope. These two measurements work best with two people: one taking the readings at the upstream transect ("backsighting") and the other holding a stadia rod at the downstream transect (Figure 19).[30]

In small, highly sinuous or densely vegetated streams, it may not be possible to obtain a clear line of sight from one transect to the next. If the midpoint of the next transect is not visible from the starting point, divide the inter-transect distance into sub-sections, using the "Supplemental Sections" (indicating the proportion of the total length represented by each section) on the field sheet. Otherwise, leave Supplemental Sections blank. Do not measure slope across dry land/meanders in the stream.

[30] Slope measurements can be measured from a point on the transect at water's edge, but sinuosity measurements should be taken from mid channel. If water depth or obstructions prevent this, attempt to estimate the correct bearing.

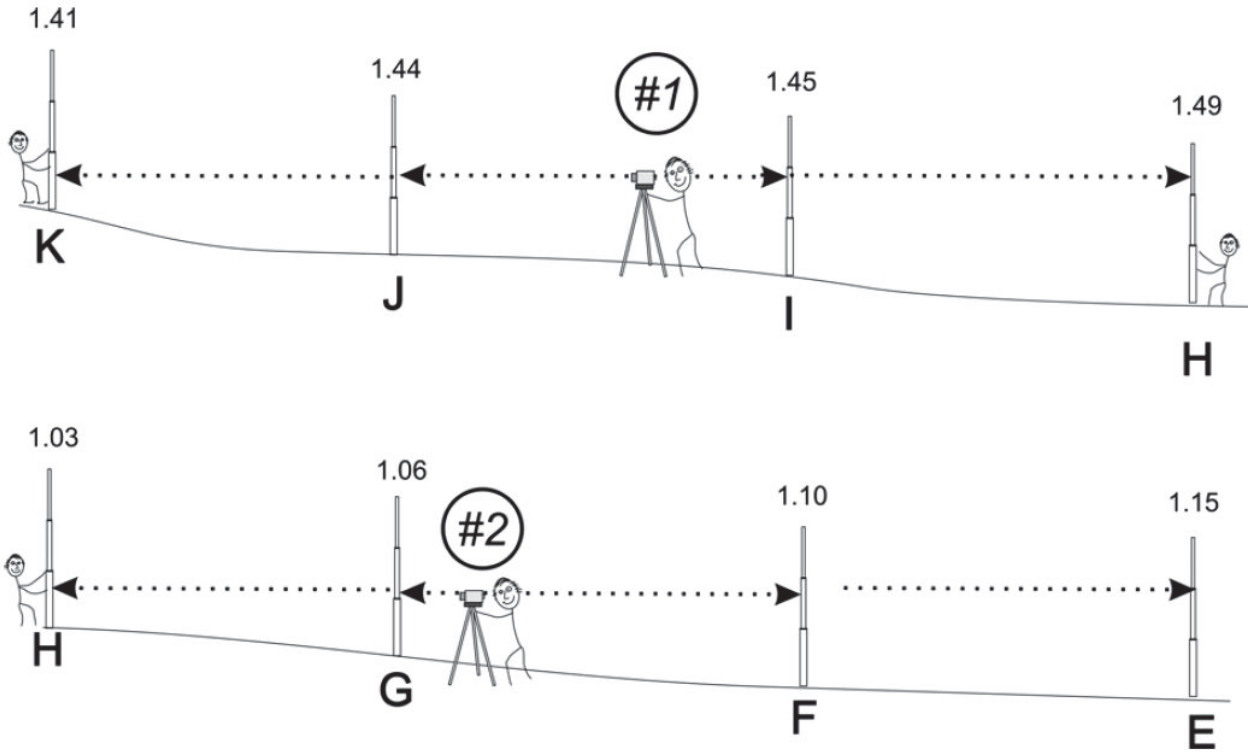

Figure 19. Use of an autolevel to measure slope of sampling reach.

Although slope and sinuosity are measured independently, always record the two data points at each location.

An autolevel should always be used for reaches with a slope of ≤ 1. Either a clinometer or an autolevel may be used for reaches with a slope of > 1%, and sometimes (*e.g.*, in steep areas that are also heavily vegetated) a clinometer is preferable for logistical reasons. If a reach is visually estimated to be close to 1%, use the autolevel. An autolevel or hand level measures the elevation difference (rise) between transects; the distance between transects (run) is also required for a slope calculation. Conversely, if a clinometer is used, the percent slope is recorded directly.

Do not measure slope across dry land (e.g., across a meander bend).

6.10.1 Slope - autolevel method

Step 1. Identify a good spot to set up the autolevel (ideally near the middle of the reach, if there is good visibility from this location to both Transects A and K). The autolevel should be positioned on stable, and preferably flat, ground. Set the height of the autolevel to comfortable eye level for the operator. Level the plane of view of the autolevel by centering its bubble. Start by adjusting placement and length of the tripod legs, and then fine-tune the adjustment using the knobs on the autolevel.

Step 2. Begin "shooting" the change in elevation of the water level of the stream from transect to transect. Try to start with one of the outer transects (like K)[31]. Have a crew member at Transect K hold the stadia rod at water's edge and perpendicular to the ground. Viewing through the autolevel (and focusing as necessary), look at the stadia rod and record, to the smallest demarcation on the stadia rod, the height at which the autolevel line of view (*i.e.*, the middle line in the viewfinder) hits. Record this information on the "Slope and Bearing Form" on the field sheet[32], and then have the stadia rod holder proceed to the next transect (*e.g.*, Transect J), again holding the base of the stadia rod at water's edge. Very carefully, rotate the head of the autolevel so that it points to the new stadia rod location. If executed correctly, the bubble should still be centered while in this new orientation, without any further height adjustments to the autolevel or tripod. If the autolevel is displaced from its original position, it will no longer be possible to take a height measurement of Transect J's water surface, relative to that of Transect K, to determine the slope between the two transects. In this case, the elevation must be measured anew (see Step 3).

Step 3. If there is a point along the reach at which there is no longer a clear line of sight from the autolevel to the stadia rod positioned at the transect, at water's edge (or if the length of the stadia rod is exceeded in a steep reach, or if the autolevel is bumped out of position before all the measurements are done), a new location must be set up for the autolevel. In order to maintain a relationship with water heights of the various transects already measured, it will be necessary to "re-shoot" the height of the water at the last transect for which a valid measurement was attained. From there, assuming there is no more disturbance to the position of the autolevel, the remaining transects can be sighted from the new position. On the Slope and Bearing Form corresponding to autolevel use, indicate the transect at which the autolevel's position has been changed (i.e., list the transect that was measured from the original and the new positions twice on the datasheet: once for the original position, and once for the new).

Also indicate the segment lengths or distance between main transects (*i.e.*, 15 m, 25 m or other). These data will later be used to determine the slopes between transects and for the reach as a whole.

6.10.2 Slope - clinometer method

Step 1. Stand erect next to the stadia rod (held perpendicularly to the ground) on level ground and a tie a highly visible piece of flagging around the rod at eye level. Then, beginning with the upper transect (Transect K), stand where the wetted margin intersects with the transect, and have a second person hold the flagged stadia rod perpendicularly to the ground at the wetted margin of the next downstream transect (Transect J).

Step 2. Use the clinometer to measure the percent slope of the water surface between the upstream transect and the downstream transect by sighting to the flagged position on the stadia

[31] It does not matter if the measurements of slope and/or elevation difference are determined starting at the upstream or downstream end of the reach, but they must be reported as positive numbers.
[32] Only the elevation difference (cm) will be recorded in the database. "Raw" stadia rod readings can be written on the hard copy sheets for reference and calculations but they will not be stored in the database.

rod, and record the value in the "Slope and Bearing Form" section of the field sheets. The clinometer gives both percent slope and degree of the slope (the measurements differ by a factor of ~2.2), so be careful to read and record ***percent slope*** rather than degrees slope. Percent slope is read from the scale on the right hand side when looking through most clinometers (but confirm this with the owner's manual for your own model).

Step 3. Continue measuring slope at each one of the transects. Note that when moving from transect to transect, the clinometer reader must stand exactly where the stadia rod had been placed during the previous reading.

Step 4. If the stream reach geometry makes it difficult to sight a line between transects, divide the distance into two or three sections and record the slope and the proportion of the total segment length between transects for each of these sections in the appropriate boxes on the slope form ("Supplemental Segment").

6.10.3 Sinuosity

Step 1. Take a compass reading from the center of each main transect to the center of the next main transect downstream and record this bearing to the nearest degree in the "Slope and Bearing Form" section of the field sheet. Bearing measurements should always be taken from the upstream to downstream transect.

Step 2. Proceed downstream to the next transect pair (I-J) and continue to record slope and bearing between each pair of transects until measurements have been recorded for all transects.

6.11 Module M: Photographs

Take a minimum of four (4) photographs of the reach at the following locations: a) Transect A, facing upstream, b) Transect F, facing upstream, c) Transect F, facing downstream, and d) Transect K, facing downstream. It is also desirable, albeit optional, to take a photograph at Transect A, facing downstream and Transect K, facing upstream to document conditions immediately adjacent to the reach. Use digital photographs. Record the image numbers on the front page of the field form under "Photographs". An easy way to keep track of which site each series of photographs belongs to is to take a close-up of the front data sheet (containing legible station code and date) for that site prior to taking the series of photos.

7. PHYSICAL HABITAT INTER-TRANSECT-BASED MEASUREMENTS

Although most measures are taken near the main transects, a few measures are also recorded at the "inter-transects" located at the midpoint between main transects. These measures are: 1) Wetted Width, 2) Substrate Measurements ("Pebble Count")/Depth/CPOM/Cobble Embeddedness/Algal and Macrophyte Cover, and 3) Flow Habitats.

7.1 Module C (part two): Inter-transect Wetted Width

Measure wetted width the same way it was measured for the main transects.

7.2 Modules D, E, and F (part two): Substrate Measurements, Depth, CPOM, and Algal/Macrophyte Percent Cover

Collect particle size measurements, water depth, CPOM, embeddedness and algal and macrophyte cover data the same way they were collected for the main transects.

7.3 Module N: Flow Habitats

Because many BMIs and algae prefer specific flow and substrate microhabitats, the proportional representation of these habitats in a reach is often of interest in bioassessments. Like the riparian and instream PHab measures, this procedure produces a semi-quantitative measure consisting of 10 transect-based visual estimates. A description of flow habitat types used for this SOP is provided in Table 7. These flow habitat types are products of geology, slope, and discharge, and one habitat type may change into another as water levels increase or decrease; therefore, the habitat types should be recorded at the time of sampling.

On the inter-transect field sheet, record to the nearest 5% percentages of the various flow habitats present within the region between the upstream inter-transect and downstream inter-transect bracketing each main transect (the total percentage of flow habitats for each stream section must total 100%). Although these definitions differ from geomorphological definitions presented in other hydrologic references, they were developed to produce more easily standardized and objective categories that improve data comparability. Please adhere to the definitions used in this text when employing this SOP.

Table 7. Flow habitat types

Type	Description
cascade/falls	Short, high-slope drops in stream bed elevation often accompanied by boulders and considerable turbulence. In high-slope streams, cascades and falls are often associated with step-pools. To qualify for this category, water must drop > 0.5 m in height within a short longitudinal distance (< 0.5 m).
rapid	Sections of stream with deep (>0.5 m), swiftly flowing (>0.3 m/s) water and considerable surface turbulence. Rapids tend to have larger substrate sizes than riffles.
riffle	"Shallow/fast" (< 0.5 m deep, > 0.3 m/s); riffles are shallow sections where the water flows over coarse stream bed particles that create mild to moderate surface turbulence.
runs/step-runs	"Deep/fast" (> 0.5 m deep, > 0.3 m/s); long, relatively straight, low-slope sections without flow obstructions. The streambed is typically even and the water flows faster than it does in a pool. Unlike rapids, runs have little surface turbulence.
glide	"Shallow/slow" (< 0.5 m deep, < 0.3 m/s); sections of stream with little or no turbulence, but faster velocity than pools. Includes still or slow-moving shallow backwaters and shallow margins of pools.
pool	"Deep/slow" (> 0.5 m deep, < 0.3 m/s); a reach of stream that is characterized by deep, low-velocity water and a smooth surface.
dry	Any surface area within the channel's wetted width that is above water (e.g., mid-channel point bars). When assessing dry habitats, only count areas with particulate substrate; do not count tops of emergent rocks and boulders.

8. PHYSICAL HABITAT REACH-BASED MEASUREMENTS

8.1 Module O: Stream Discharge

Stream discharge is the volume of water that moves past a point in a given amount of time and is generally reported as cubic feet per second. Discharge affects the concentration of nutrients, fine sediments, and pollutants, and its measurement is critical for understanding impacts of disturbances such as impoundments, water withdrawals, and water augmentation. Discharge is also closely related to many habitat characteristics including temperature regimes, physical habitat diversity, and habitat connectivity. As a direct result of these relationships, stream discharge is often also a strong predictor of biotic community composition. Since stream volume can vary significantly on many temporal scales (diurnal, seasonal, inter-annual), it can also be very useful for understanding variation in stream condition.

For this SOP, a single discharge measurement is conducted in order to estimate discharge through the sampling reach. There is no prescribed point in the reach where the measurement should be taken; rather, it is up to the discretion of the field crew, depending upon streambed morphology and flow. It is preferable to take the discharge measurement in a section where flow velocities are > 0.15 m/s and most depths are > 15 cm, but slower velocities and shallower depths can be used, if necessary. If flow volume is sufficient for a transect-based "velocity-area" discharge calculation (Section 8.1.1), this is the preferred method. If the velocity meter probe cannot be submerged, but there is visible flow, the following two options are available: 1) use of the Neutrally Buoyant Object approach (which is the second most preferred method to measure flow) OR 2) a visual estimation of the velocity based on best professional judgment. In small, shallow streams with complex substrate, it may still be difficult to accurately measure discharge, even where water movement is obvious. If visual estimation is used, the velocity measurement must be denoted with a "visual estimate" flag in the data base.

Data for this parameter are entered in the "Discharge Measurements" section of the field sheet.

8.1.1 Velocity Area Method

The layout for discharge measurements under the velocity-area method is illustrated in Figure 20. Flow velocity should be measured with either a Swoffer Instruments propeller-type flow meter or a Marsh-McBirney inductive probe flow meter with a top-setting rod. Refer to the manufacturer instrument manual for calibration procedures.

Step 1. Select the best location (cross-section) in the reach to place a transect across which to measure discharge. This does not need to coincide with any of the main or inter-transects where other PHab measurements were taken, however it should lie within, or very near, the stream reach being assessed. Choose a cross section with flow that is as uniform as possible (i.e., hydraulically smooth), and with the simplest possible cross-sectional geometry. It is helpful to move bed material or other obstacles to create a more uniform cross-section before beginning the discharge measurements, but this cannot be done after measurements have begun, or it will skew results.

Step 2. Measure the wetted width of the discharge transect and divide this into 10 to 20 equal segments. The use of more segments gives a better discharge calculation, but is impractical in small channels. At least 10 intervals should be used when stream width permits, but interval width should not be < 15 cm.

Step 3. Record the distance from the bank to the end of the first interval. Using the top-setting rod, measure and record the median depth of the first interval (Figure 20).

Step 4. Stand downstream of the transect and off to the side of the probe in order to avoid interfering with the flow measurement. Set the probe of the flow meter at the midpoint of the first interval along the discharge transect, facing upstream perpendicularly to the direction of flow. If necessary, a thin piece of flagging tape can be attached to the top-setting rod and submerged to identify the direction of flow and thus inform proper angling of the probe. Determine the depth of the water and adjust the top-setting rod accordingly, such that the probe is held at a depth of 0.6 of the total stream depth. This position generally approximates average velocity in the water column. See Figure 20 for positioning detail. Refer to the top-setting rod owner's manual for further instructions on positioning of probe height.

Step 5. Allow the flow velocity meter to equilibrate for at least 15 seconds, and then record velocity to the nearest ft/s. If the option is available, use the flow-averaging setting on the flow meter[33]. Record the flow velocity. Under very low flow conditions, flow velocity meters may register readings of zero even when there is noticeable flow. In these situations, record the appropriate ResQualCode (ND, Not Detected) and QACode (FLV, Velocity too low to be measured) and leave the Result field blank in the database. The Instrument Detection Limit (IDL) should be noted for the instrument used. In areas that are too shallow to measure velocity, use the Neutrally Buoyant Object method.

If the flow is moving upstream (such as near banks or in an eddy), point the probe into the flow and record the velocity with a negative symbol on the field sheet. Record an "NG" QA flag with this result in the database in order to identify the result as a negative value.

Step 6. Complete Steps 3 through 5 on the remaining intervals. Frequently, the first and last intervals have depths and velocities of zero.

[33] Set the averaging interval to at least 15 seconds (30 seconds if velocity is > 2 ft/s) and record the 15secondaverage velocity measurement for each segment.

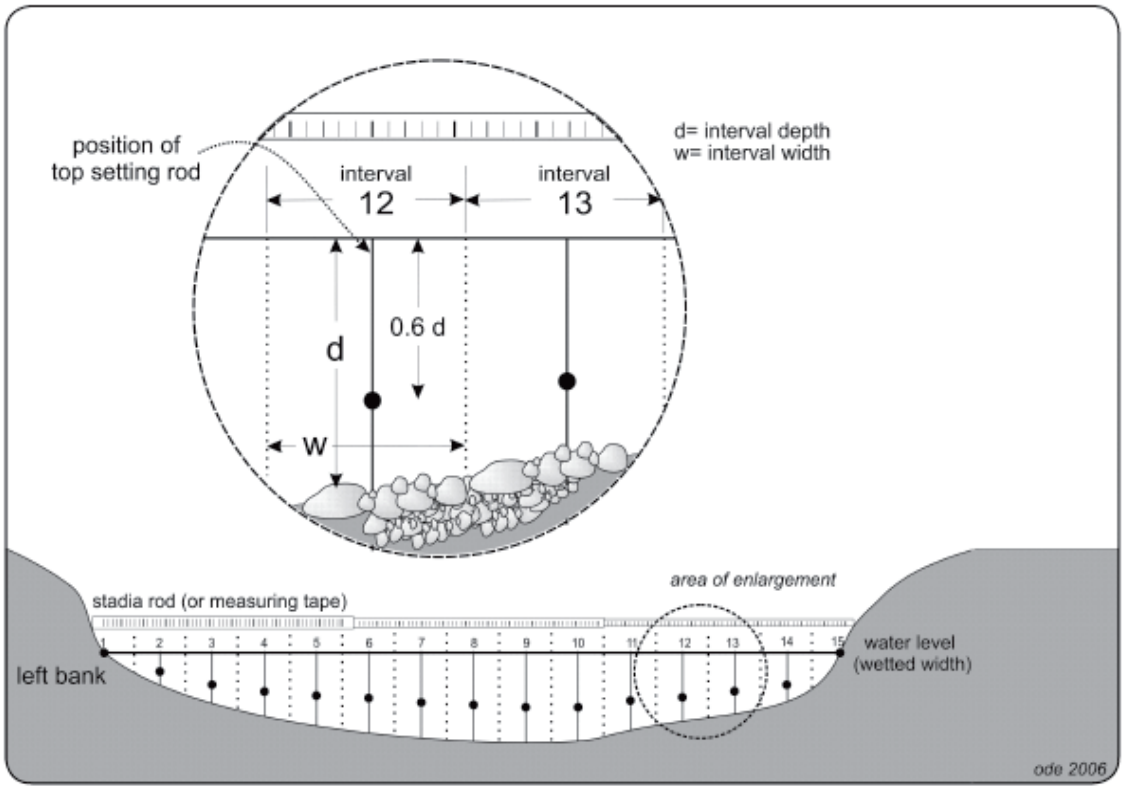

Figure 20. Diagram of layout for discharge measurements under the velocity-area method showing proper positions for velocity probe (black dots).

8.1.2 Neutrally Buoyant Object Method

If the reach is too shallow to use a flow velocity meter, the neutrally buoyant object (NBO) method can be used to measure flow velocity. However, since this method is less precise than the flow velocity meter, it should be used only if the velocity-area method will not work. The movement of an NBO (one whose density allows it to just balance between sinking and floating) will approximate that of the water it floats in better than a light object. Examples of NBOs include a large piece of fresh orange peel, a rubber ball, and a moderately heavy piece of wood.

To estimate the flow velocity, three transects are used to measure the cross-sectional areas within the test reach, and three flow velocity estimates are used to measure average velocity of water passing through it. To improve precision in velocity measurements, the test reach should be long enough for the float time to last at least 10-15 seconds. This will allow for an average of the instantaneous variation in flow and minimize the influence of error in the stopwatch timing. The use of longer times is recommended, when possible.

Step 1. Identify a sufficiently long test reach that has relatively uniform flow and a uniform cross-sectional shape. (The same criteria for selection of a discharge reach apply to selecting a test reach for the NBO method.)

Step 2. Record the length of the test reach.

Step 3. Measure the cross sectional area of the test reach in three places (an "Upper Section", a "Middle Section" and a "Lower Section"). Three evenly-spaced cross sections are preferred, but a single one may be used if the cross section through the test reach is uniform (*e.g.*, in a concrete channel). On the "Float Reach Cross Section" of the field sheet, record the width once, and the depth at five equally-spaced positions, across each of the three cross sections of the test reach.

Step 4. Place the NBO in the water upstream of the test reach and record the length of time (in seconds) that it takes for the object to pass between the reach's upstream and downstream boundaries. Repeat this twice more for a total of three timed "floats".

8.2 Module P: Post-Sampling Observations: Qualitative Reach Measures

EPA's Rapid Bioassessment Procedures (RBPs, Barbour et al. 1999) include a set of 10 visual criteria for assessing instream and riparian habitat. The RBP has been used in the CSBP since its first edition (1995), and thus this information is often valuable for comparison to legacy datasets. The criteria also have a useful didactic role, since they help force the user to quantify key features of the physical environment where bioassessment samples are collected. The full suite of RBP stream habitat visual estimates are not covered in this SOP because they are generally replaced by more quantitative measurements of similar variables. However, three of the RBP measures ("Epifaunal Substrate/Cover", "Sediment Deposition", and "Channel Alteration") have been found to be reasonably repeatable and thus are included.

Record observations in the "Additional Habitat Characterization" section of the field sheet.

8. OPTIONAL SUPPLEMENTAL MEASURES

Optional measures to supplement this SOP may be included in stream assessments according to program needs. These include the excess sediment index (sometimes referred to as log relative bed stability, LRBS) and additional measurements collected for the LRBS calculations (Kaufmann et al. 1999), such as tallies of woody debris and thalweg. The NRSA Field Operations Manual (USEPA 2009) provides more details on collecting these data types.

Large woody debris (logs, snags, branches, etc.) that is capable of obstructing flow when the channel is at bankfull (i.e., just short of flood) stage contributes to the "roughness" of a channel. The effect of this variable is to reduce water velocity and thereby reduce the stream's competence to move substrate particles. The NRSA (Section 6.2.4.2) protocol tallies all woody debris with a diameter > 10 cm (~4") into one of 12 size classes based on the length and width of each object. Tallies are conducted in the zone between the main transects.

A stream's thalweg is a longitudinal profile that connects the deepest points of successive cross-sections of the stream. The thalweg defines the primary path of water flow through the reach. Thalweg measurements (NRSA; Section 5.2.7) perform many functions in the NRSA protocols, producing measurements for the excess sediment calculations (residual pool volume, stream size, channel complexity) and flow habitat variability.

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10. GLOSSARY

Aliquot – a measured portion of a sample, or subsample

Allochthonous – derived from a source external to the stream channel (e.g., riparian vegetation as a source of organic matter) as opposed to autochthonous, which indicates a source inside the stream channel (e.g., algae or macrophytes rooted in the stream)

Ambient bioassessment – monitoring that is intended to describe general biotic condition as opposed to a diagnosis of sources of impairment

Ash-free dry mass (AFDM) – the portion, by mass, of a dried sample that is represented by organic matter; the concentration of AFDM per stream surface area sampled is often used as a surrogate for algal biomass

Bankfull – the bankfull channel is the zone of maximum water inundation in a normal flow year (one- to two-year flood events)

Benthic algae – algae that are attached to, or have at one point been anchored to, the stream bottom, in contrast to planktonic algae which are free-floating in the water column

Benthic macroinvertebrates (BMI) – bottom-dwelling invertebrates large enough to be seen with the unaided eye

Biofilm – a matrix/film adhering to stream substrates and consisting of microorganisms (*e.g.*, algae, fungi, bacteria, protozoans) and detritus

Chlorophyll *a* – primary light receptor/photosynthetic pigment in algae and cyanobacteria and higher plants; the concentration of this pigment per stream surface area sampled provides an estimate of algal biomass

Coarse particulate organic matter (CPOM) –particles of decaying organic material, such as leaves and twigs, that are between 1 and 10 mm in diameter and suitable for consumption by BMIs in the "shredder" functional feeding group

Cobble embeddedness – The percent of surface area of cobble-sized particles (64-250 mm) buried by fine particles (<2.0 mm diameter)

Composite sample - volume of all the liquid material amassed during sampling, including water used for rinsing substrate and sampling devices.

Cyanobacteria – historically referred to as "blue-green" algae, but actually chlorophyll-*a* containing prokaryotes that are capable of photosynthesis and co-occur with "true" (i.e., eukaryotic) benthic algae in streams; useful as a bioindicator, and field-sampled and laboratory-processed as soft-bodied algae

Depositional – habitats in the stream that are dominated by slow-moving water, such as pools, where deposition of materials from the water column is more likely to occur than erosion (or (re)suspension) of loose bed materials

Diatom – a unicellular golden-brown alga (Bacillariophyta) that possesses a rigid, silicified (silica-based) cell wall in the form of a "pill box"

Elutriation – the process of using a liquid (water) to separate denser material (e.g., stream sediments) from lighter materials (organic particles and benthic organisms). **-**.

Erosional – habitats in the stream that are dominated by fast-moving water, such as riffles, where stream power is more likely to facilitate erosion (suspension) of loose benthic material than deposition

Fines – substrate particles < 0.06 mm diameter (not gritty to the touch)

Guidance Document – a companion document to this SOP that provides more information on the various applications of the indicators described herein, as well as recommendations for where and when to use this SOP. It also provides more detailed information on how to deal with special circumstances that may be encountered during bioassessment sampling.

Homogenate – mixture of algae liquid composite sample and finely chopped fragments of macroalgae that comprises the quantitative sample for the diatom taxonomic ID, chlorophyll a, and AFDM subsamples

Index of Biotic Integrity (IBI) – a quantitative assessment tool that uses information about the composition of one or more assemblages of organisms to make inferences about condition, or ecological health, of the environments they occupy (*e.g.*, algae or benthic macroinvertebrates)

Inter-transects – transects established at points equidistant between the main transects

Macroalgae – soft bodied algae that form macroscopically discernible filaments, mats, or globose structures

Macrophyte, aquatic – herbaceous, vascular plant rooted or floating within the stream's wetted channel, such as sedge, cattail, knotweed, watercress, water-primrose, duckweed, etc.; our definition of aquatic macrophytes excludes trees, shrubs, mosses, and algae

Microalgae – diatoms and microscopic soft-bodied algae (can co-occur with other microorganisms in a biofilm)

Prospecting mine – a hand-excavated, hard-rock mining hole that is open to the surface (common in the Sierra Nevada)

Reach – a linear segment of the stream channel

Reachwide benthos (RWB) – method for biotic assemblage sample collection that does not target a specific substrate type, but rather objectively selects sampling locations across the reach, allowing for any of a number of substrate types to be represented in the resulting composite sample

Riparian – an area of land and vegetation adjacent to a stream that has a direct effect on the stream by providing shade, habitat for wildlife, contributing allochthonous organic matter, modulating water levels via evaporative transpiration, etc.

Sinuosity – the ratio of the length of the flow path between the ends of the reach and the straight line distance between the ends of the reach (Kaufmann et al. 1999)

Soft-bodied algae – non-diatom algal taxa; for the purposes of this SOP, cyanobacteria are included in this assemblage

Substrate – the composition of a streambed, including both inorganic and organic particles

Target coordinates – the nominal or tentative location of a sampling site, which may differ from the actual location from which samples are collected

Thalweg – the thalweg defines the primary path of water flow through the reach; it is often inferred by depth for practical purposes, but is not always the deepest point

Transects – lines drawn perpendicular to the path of flow used for standardizing biotic sampling and data collection locations

Wadeable stream – a stream that can be sampled by field crews wearing chest waders (generally < 1 meter deep for at least half the reach)

Wetted width – the width of the channel containing water (the active channel), defined as the distance between the sides of the channel at the point where substrates are no longer surrounded by surface water

APPENDIX H:

INSTRUMENT CALIBRATION AND MEASUREMENTS

This Appendix represents current equipment used by the District which may change as programmatic updates are implemented.

In-Situ AquaTROLL 500 Multiparameter Sonde

For detailed instructions with graphics, along with important notes, please refer to the Operator's Manual. **https://in-situ.com/pub/media/support/documents/at500-manual.pdf .**

A. Connecting to Troll Com

1. Attach rugged cable to Wireless TROLL Com. Attach opposite end of cable to the AquaTROLL 500.
2. Press power button.
3. Ensure tablet or mobile device Bluetooth is turned **ON** and the device has the VuSitu Mobile app downloaded. Open VuSitu Mobile app.
4. Select Add New Device when connecting for the first time.
5. Select Choose or Add a Device.
    a. Tap mobile device's back button and tap serial number from list.
    b. Tap mobile device's back button to view Connected Instrument screen.

B. Calibration

1. Connect sonde to Wireless TROLL Com and pair with VuSitu.
2. In VuSitu, click Calibrations from the Connected Instrument screen and choose sensor to calibrate.
3. Remove cap from instrument and pour 10-20 ml of DI water into restrictor.
4. Gently shake the sonde in a circular motion to rinse the inside of restrictor and sensors.
5. Discard the DI water and repeat rinsing procedure two more times with 10-20 ml of your first calibration standard.
6. Follow the instructions in VuSitu to perform the calibration.

C. Measurement

1. To take live readings with the Aqua TROLL 500 and VuSitu mobile app, the sonde must be connected to a Wireless TROLL Com.
2. Ensure restrictor guard end with holes is open to the sensors.
3. On VuSitu Main Menu, click Live Readings.
4. Record the field measurements on the *Field Data Sheet* or Survey123 Form while in the field.
5. After taking field measurements:
    a. Go back to VuSitu Main Menu, click Disconnect.
    b. Press and hold power button on Wireless TROLL Com to turn receiver off.
    c. Spray sonde sensors and restrictor cap with DI water to remove sample residuals.
    d. Gently wipe sonde of excess water with Kimwipes.
6. Once cleaned, place restrictor cap in storage mode and pour about 15 mL DI water (about 2 cm from the bottom), covering sensors.
7. Screw the end cap onto the restrictor.

8. Store instrument in the carrying case.

D. Specifications

In-Situ
YOUR EYES IN THE FIELD

Aqua TROLL® 500 Multiparameter Sonde

GENERAL	AQUA TROLL 500 MULTIPARAMETER SONDE			
OPERATING TEMP. (NON-FREEZING)	-5 to 50°C (23 to 122°F) ISE: Ammonium and Nitrate 0 - 40°C, Chloride 0 - 50°C	EXTERNAL POWER VOLTAGE EXTERNAL POWER CURRENT[1]	8-36 VDC; Required for normal operation Sleep: < 0.2 mA typical; Measurement: 40 mA typical, 75 mA Max	
STORAGE TEMP.	Components Without Fluid -40°C to + 65°C (Non Freezing Water) pH/ORP Sensors -5°C to + 65°C Ammonium/Nitrate: 0 - 40°C Chloride: 0 - 50°C	INTERNAL MEMORY AND DATA LOGGING	Use external datalogger or telemetry	
DIMENSIONS	Length: 46 cm (18.145") (includes connector). With bail: 59 cm (23.25") Diameter: 4.7 cm (1.860")	READING RATES	1 reading every 2 seconds	
WEIGHT	0.978 kg / 2.15 lbs. (includes instrument, sensors, restrictor and bumpers)	COMMUNICATION DEVICE	Wireless TROLL Com	
WETTED MATERIALS (SONDE AND SENSORS)	PC, PC alloy, Delrin, Santoprene, Inconel, Viton, Titanium, Platinum, Ceramic, Nylon, PVC, Graphite	CABLE OPTIONS	Vented or non-vented polyurethane or vented Tefzel®	
SENSOR HEX SCREW DRIVER	0.050, 1.3 mm	LCD DISPLAY	Integrated display shows status of sonde, sensor ports, power voltage and connectivity, enable/disable BT.	
ENVIRONMENTAL RATING	IP68 with all sensors and cable attached IP67 without the sensors or cable attached	SOFTWARE	Android™: VuSitu through Google Play and Amazon® App Store iOS: VuSitu through Apple® App Store, Windows: Win-Situ 5 Data Services: HydroVu	
MAX PRESSURE RATING	Up to 150 PSI Ammonium/Nitrate up to 30PSI	INTERFACE	Android, and iOS through VuSitu. PC through Win-Situ 5. Requires BlueTooth 2.0.	
OUTPUT OPTIONS	RS-485/MODBUS, SDI-12, Bluetooth	CERTIFICATIONS	CE, FCC, WEEE, RoHS Compliant	

STANDARD SENSORS	ACCURACY	RANGE	RESOLUTION/PRECISION	RESPONSE TIME	UNITS OF MEASURE	METHODOLOGY
TEMPERATURE[2]	± 0.1°C	-5 to 50°C (23 to 122°F)	0.01°C	T63<2s, T90<15s, T95<30s	Celsius or Fahrenheit	EPA 170.1
BAROMETRIC PRESSURE (VENTED MODELS ONLY)	± 1.0 mBars	300 - 1100 mBars	0.1 mBar	T63<1s, T90<1s, T95<1s	Pressure: psi, kPa, bar, mbar, inHg, mmHg;	Silicon strain gauge
pH[3]	±0.1 pH unit or better	0-14 pH	0.01 pH	T63<3s, T90<15s, T95<30s	pH, mV	Std. Methods 4500-H+, EPA 150.2
ORP[4]	+/- 5 mV	± 1400 mV	0.1 mV	T63<3s, T90<15s, T95<30s	mV	Std. Methods 2580
CONDUCTIVITY[5]	±0.5% of reading plus 1 µS/cm from 0 to 100,000 µS/cm; ±1.0% of reading from 100,000 to 200,000 µS/cm; ±2.0% of reading from 200,000 to 350,000 µS/cm	0 to 350,000 µS/cm	0.1 µS/cm	T63<1s, T90<3s, T95<5s	Actual conductivity (µS/cm, mS/cm); Specific conductivity (µS/cm, mS/cm); Salinity (PSU, ppt); Total dissolved solids (ppt, ppm); Resistivity (Ohms-cm); Density (g/cm3)	Std. Methods 2510/ EPA 120.1
TDS (DERIVED FROM CONDUCTIVITY AND TEMP)	–	0 to 350 ppt	0.1 ppt	–	ppt, ppm	–
SALINITY (DERIVED FROM CONDUCTIVITY AND TEMP)	–	0 to 350 PSU	0.1 PSU	–	PSU, ppt	Std. Methods 2520A
RUGGED DISSOLVED OXYGEN (RDO) WITH RDO-X OR FAST CAP[6]	±0.1 mg/L ±2% of reading	0 to 20 mg/L 20 to 60 mg/L	0.01 mg/L	RDO-X: T63<15s, T90<45s, T95<60s Fast Cap: T63<3s, T90<30s, T95<45s	mg/L, % saturation, ppm	EPA-approved In-Situ Methods: 1002-8-2009, 1003-8-2009, 1004-8-2009
TURBIDITY	±2% of reading or ±0.5 NTU, FNU, w.i.g.[12]	0 - 4,000 NTU 0-1,500 mg/L	0.01 NTU (0-1,000); 0.1 NTU (1,000-4,000) 0.1 mg/L	T63<1s, T90<1s, T95<1s	NTU, FNU ppt, mg/L	ISO 7027
TSS (TOTAL SUSPENDED SOLIDS)[7]	–	0 to 1,500 mg/L	0.1 mg/L	–	ppt, mg/L	–
AMMONIUM (NH_4^+ - N)[8,9] RATED TO 25 M DEPTH -Unionized Ammonia, Total Ammonia (requires salinity, temperature and pH)	±10% or ± 2 mg/L, w.i.g.[12]	0-10,000 mg/L as N	0.01 mg/L	T63<1s, T90<10s, T95<30s	mg/L, ppm, mV	–
	–	0-10,000 mg/L as N	0.01 mg/L	–	mg/L, ppm	–
NITRATE (NO_3^- - N)[8] RATED TO 25 m DEPTH	±10% or ± 2 mg/L, w.i.g.[12]	0-40,000 mg/L as N	0.01 mg/L	T63<1s, T90<1s, T95<1s	mg/L, ppm, mV	Std. Methods 4500-NO3 D
CHLORIDE (Cl^-)[8]	±10% or ± 2 mg/L, w.i.g.[12]	0-150,000 mg/L	0.01 mg/L	T63<1s, T90<10s, T95<30s	mg/L, ppm, mV	Std. Methods 4500-Cl- D
PRESSURE (OPTIONAL)[10]	±0.1% FS from -5 to 50°C	Non-Vented or Vented 9.0 m (30 ft.) - Burst: 27 m (90 ft.) 30 m (100 ft.) - Burst: 40 m (130 ft.) 76 m (250 ft.) - Burst: 107 m (350 ft.) 100 m (325 ft.) - Burst: 200 m (650 ft.)	0.01% full scale	T63<1s, T90<1s, T95<1s	Pressure: psi, kPa, bar, mbar, inHg, mmHg; Level: in, ft., mm, cm, m; Level: in, ft., mm, cm, m	Piezoresistive; Ceramic
WARRANTY[11]	2 year - Sonde, RDO and Sensor Cap, Temperature/Conductivity, Temperature only, Turbidity (excluding pH/ORP), Wiper; 1 year - pH/ORP, Chloride ISE, Accessories; 90 Days - Nitrate and Ammonium ISE sensors; See warranty policy (www.in-situ.com/warranty)					
NOTES	[1]External power current dependent on display and wiping. [2]Typical system response with instrument, sensors and restrictor when changing approximately 15°C in moderate flow. [3]pH sensor Response time at thermal equilibrium. [4]ORP sensor Accuracy from calibration standard @ 25C, response at thermal equilibrium immediately following calibration in ZoBell's measuring from air to +400 mV. [5]Conductivity Accuracy at calibration points. [6]RDO sensor full range 0-60 mg/L, 0-600% sat. EPA-approved under the Alternate Test Procedure process. [7]TSS User defined reference. [8]ISE Between 2 calibration points immediately following proper conditioning and calibration. Varies on site conditions and environmental interferents. See sensor summary sheet for potential interferences. [9]Ammonia Average response, can be longer with increasing concentrations of ammonium. [10]Pressure Typical performance across full temperature and pressure calibrated range. [11]Warranty Extended warranty option for sonde only (1-3 year extension for up to 5 years total). [12]Whichever is greater.					

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For operational instructions with graphics, along with important notes, please refer to the **Operation Manual which can be found online at the following website**
http://www.omega.com/manuals/manualpdf/M5098.pdf

ISCO 3700 Portable Sampler

For operational instructions with graphics, along with important notes, please refer to the **Operation Manual which can be found online at the following website**
http://www.isco.com/pcfiles/PartPDF/SL000004/UP0019H4.pdf .

Hydrolab Quanta Multi-Parameter Water Quality Monitor

For detailed instructions with graphics, along with important notes, please refer to the **Operation Manual**.

A. Calibration
   1. Ensure that the sensor probe is connected.

   2. Wash the sensor in distilled water a few times and put some of the pH 4 standard solution into the calibration beaker to the marked line.

   3. Immerse the sensor in the calibration beaker.

   4. Press the **POWER** key.
      a. Use arrow keys to select 'CALIB' and press Enter
      b. Select parameter you wish to calibrate and press Enter
      c. Use arrow keys to adjust reading to standard solution press Enter

5. Fully rinse probe and calibration cup with DI water then dry before filling with next standard solution.
      a. When calibrating pH calibrate 7.0 first then 10.0 or 4.0. (NOTE Quanta only does 2 point pH calibration)
      b. When calibrating DO sensor fill cup with DI water to O-ring of membrane on DO probe. Use accurate mmHg to calibrate %DO this will calibrate mg/L DO at the same time.

B. Measurement
   1. Always attach the Guard to protect to the sensors before taking measurements.

   2. Slowly immerse the sensor in the sample.

   3. Turn the power on and allow measurements to stabilize.

   4. Record the measurements on the *Field Data Sheet* while out in the field. Select the SCREEN icon and use the **ENTER** key to switch measurement items.

   5. After taking the measurement:

      5.1 Turn the power off.

      5.2 Use DI water to completely wash off the sample on the sensor and then wipe water drops.

      5.3 Pour about 20 mL (about 2 cm from the bottom) of distilled water in the storage cup and install it on the sensor probe and store the instrument in the carrying case.

C. Specifications

Performance Specifications

	Range	Accuracy	Resolution
Temperature	-5°C to 50°C	±0.2°C	0.01°C
Dissolved Oxygen	0 to 50 mg/L	±0.2 mg/L ≤ 20 mg/L ±0.6 mg/L > 20 mg/L	0.01 mg/L
Specific Conductance	0 to 100 mS/cm	±1% of reading ±1 count	4 digits
pH	2 to 12 units	±0.2 units	0.01 units
ORP	-999 to 999 mV	±25 mV	1 mV
Vented Depth (10m)	0 to 10 m	±0.003 m (±0.01 ft)	0.001 m
Depth (25m)	0 to 25 m	±0.1 m	0.1 m
Depth (100m)	0 to 100 m	±0.3 m	0.1 m
Turbidity	0 to 1000 NTU	±5% of reading ±1 NTU	0.1 NTU < 100 NTU 1 NTU ≥ 100 NTU
Salinity	0 to 70 PSS	±1% of reading ±1 count	0.01 PSS

YSI 6920 V2 Multi-Parameter Water Quality Sonde

For detailed instructions with graphics, along with important notes, please refer to the **User Manual**.

A. Calibration

1. Ensure that the sensor probe is connected and sensor probe is fully immersed in standard solution.

2. Press the **POWER** key.
   d. Select Sonde Menu and press Enter
   e. Select Calibrate and press Enter
   f. Select parameter you wish to calibrate and press Enter
   g. Select 1-3 point calibration dependent on parameter and press Enter
   h. Type in standard solution value and press Enter
   i. Wait for readings to stabilize then press Enter to calibrate sensor

3. Fully rinse probe and calibration cup with DI water then dry before filling with next standard solution.
   a. When calibrating pH calibrate 7.0 first then 10.0 or 4.0.
   b. When calibrating optical sensors (DO or Turbidity clean optics before calibrating)
   c. When calibrating DO sensor allow atmosphere in calibration cup to stabilize for 15 mins with DI water before calibration.

B. Measurement

1. Always attach the flow-thru Guard to protect to the sensors before taking measurements.

2. Slowly immerse the sensor in the sample.

3. Turn the power on and allow measurements to stabilize.

4. Record the measurements on the *Field Data Sheet* while out in the field.

5. After taking the measurement:

   5.1 Turn the power off.

   5.2 Use DI water to completely wash off the sample on the sensor and then wipe water drops.

   5.3 Pour about 20 mL (about 2 cm from the bottom) of distilled water in the storage cup and install it on the sensor probe and store the instrument in the carrying case.

C. Specifications

6920V2-2 SONDE

Available Sensors	Temperature, Conductivity, pH, ORP, one ion selective electrode (ammonium, nitrate, or chloride), and Depth (shallow, medium, shallow vented). Two total optical sensors (ROX Optical DO, Turbidity, Chlorophyll, Rhodamine WT, BGA-PC, or BGA-PE).
Operating Environment	Medium: fresh, sea, or polluted water Temperature: -5 to +50 °C for most sensors Depth: 0 to 200 feet (61 meters)
Storage Temperature:	-40 to +60 °C for sonde and all sensors except pH , pH/ORP, ISE and optical sensors -10 to +60 °C for pH, pH/ORP, ISE, and optical sensors
Material:	Polyurethane, PVC, Stainless Steel
Diameter:	2.9 inches (7.4 cm)
Length:	Approximately 18.25 inches (46.4 cm) with no depth, 19.63 inches (49.9 cm) with depth
Weight:	Approximately 3.74 pounds (1.7 kg)
Computer Interface:	RS-232C, SDI-12
Internal logging memory size:	384 kilobytes (150,000 individual parameter readings)
Power:	8 AA-size Alkaline Batteries or External 12 VDC
Battery Life:	Approximately 32 days at 20 C at a 15 minute logging interval with ROX Optical DO, another optical sensor (turbidity, chlorophyll, Rhodamine WT, BGA-BC, or BGA-PE), temperature, conductivity, and pH active. Battery life is heavily dependent on sensor configuration and is given above for a typical sensor ensemble. If you have a different sensor configuration, set up your sonde for a deployment in the Run|Unattended menu and check the projected approximate battery life.

Temperature

Sensor Type.....Thermistor
Range.....-5 to 50 °C
Accuracy.....+/- 0.15 °C
Resolution.....0.01 °C
Depth.....200 meters

ROX Optical Dissolved Oxygen, mg/L (Calculated from % air saturation, temperature and salinity)
Sensor Type..... Optical, Luminescence Lifetime
Range.....0 to 50 mg/L
Accuracy.....0 to 20 mg/L, +/- 1 % of the reading or 0.1 mg/L, whichever is greater
20 to 50 mg/L, +/- 15 % of the reading; Relative to Calibration Gases.
Resolution.....0.01 mg/L
Temperature Range -5 to 50 C

pH
Sensor Type.....Glass combination electrode
Range.....0 to 14 units
Accuracy.....+/- 0.2 units
Resolution.....0.01 units
Temperature Range -5 to 50 C
Depth.....200 meters

Turbidity
Sensor type..... Optical, 90 ° scatter, with mechanical cleaning
Range..... 0 to 1000 NTU
Accuracy.....+/- 2% of the reading or 0.3 NTU (whichever is greater), in YSI AMCO-AEPA standards
Resolution.....0.1 NTU
Temperature Range -5 to 50 C
Depth..... 61 meters

Conductivity*
Sensor Type.....4 electrode cell with autoranging
Range.....0 to 100 mS/cm
Accuracy.....+/- 0.5% of reading + 0.001 mS/cm
Resolution.....0.001 mS/cm to 0.1 mS/cm (range dependent)
Temperature Range -5 to 60 C
Depth.....200 meters

Horiba U-22XD Multi-Parameter Water Quality Monitoring System

For detailed instructions with graphics, along with important notes, please refer to the **Operation Manual**.

A. Calibration

1. Ensure that the sensor probe is connected.

2. Press the **POWER** key.

3. Wash the sensor in distilled water a few times and put some of the pH 4 standard solution into the calibration beaker to the marked line.

4. Immerse the sensor in the calibration beaker.

5. Press the CAL auto calibration mode key in one of the Measurement modes **pH**, **COND**, **TURB**, **DO**. **AUTO** and **CAL** appear and the instrument enters the **AUTO** calibration mode.

6. Press the **ENT** key to start **AUTO** calibration. Upon completion of the **pH**, **COND**, **TURB**, **DO**, and **DEP** modes, "End" will be displayed on the screen.

7. Press the **MEAS** key to return to the Measurement mode.

B. Measurement

1. Slowly immerse the sensor in the sample.

2. Select the measurement item. Use the **MEAS** key to switch measurement items in the following order: **pH**, **COND**, **TURB**, **DO**, **TEMP**, **DEP**, **SAL**, **TDS**, **σ**, **ORP**, **TIME**, then back to **pH**.

3. After taking the measurement:

   3.1 Turn the power off.

   3.2 Use tap water to completely wash off the sample on the sensor and then wipe water drops.

   3.3 Pour about 20 mL (about 2 cm from the bottom) of distilled water in the probe cap and install it on the sensor probe. Place the rubber cap on the connector and store the instrument in the carrying case.

4. Water quality data should always be recorded to the *Field Data Sheet* while out in the field. To additionally manually store the measurement data (up to 2880 sets) in the instrument for later download:
   4.1 Make sure that **MAN** is displayed as the Measurement mode.

   4.2 Press the **ENT** key. Data storage starts, **DATA IN** and the data set number is displayed on the screen, and the measured value to be stored and the measurement item are displayed in order at approximately 0.5 second intervals. After the data are stored to memory, the screen returns to the original Measurement mode. Note the data set number on the *Field Data Sheet*.

5. Viewing stored data on the Horiba (note that the data cannot be transferred to a PC, only to a Horiba printer):

5.1 Press the **DATA** key in the Measurement mode. The instrument goes into **DATA** mode.

5.2 Press the **DATA** key. The measurement data are displayed. Data you want to call can be displayed by selecting a measurement item and data number.

5.3 Press the **UP/DOWN** keys to switch the measurement item or number that has been selected with the **DATA** key.

5.4 Press the **DATA** key. Use the **UP/DOWN** keys to switch between "Year, Month, Day" and "Hour, Minute, Second".

C. Specifications

Measurement range

Measurement item		Measurement range		Measurement units
		Expanded	Standard	
pH		0.00 to 14.00	0.0 to 14.0	pH
		—	−1999 to 1999	mV in pH measurement
Conductivity (COND)	Range 1	0.90 to 9.99	0.9 to 9.9	S/m
		9.0 to 99.9	9 to 99	mS/cm
	Range 2	0.090 to 0.999	0.09 to 0.99	S/m
		0.90 to 9.99	0.9 to 9.9	mS/cm
	Range 3	0.0 to 99.9	0 to 99	mS/m
		0.000 to 0.999	0.00 to 0.99	mS/cm
Turbidity (TURB) *1		0.0 to 800.0	0 to 800	NTU (nephelometric turbidity units) or mg/L
Dissolved-oxygen (DO)		0.00 to 19.99	0.0 to 19.9	mg/L
		0.0 to 199.9	0 to 199	%
Temperature (TEMP)		0.00 to 55.00	0.0 to 55.0	°C
Water depth (DEP)		0.0 to 100.0	0 to 100	m
		0.0 to 330.0	0 to 330	ft
Salinity (SAL)		0.00 to 4.00	0.0 to 4.0	%
Total dissolved solids	Range 1	5.5 to 65.0	5 to 65	g/L
(TDS) *2	Range 2	0.55 to 6.50	0.5 to 6.5	g/L
	Range 3	0.000 to 0.650	0.00 to 0.65	g/L
Seawater specific gravity (σ_t)		0.0 to 50.0	0 to 50	–
Oxygen-reduction potential (ORP)		—	−1999 to 1999	mV

*1: Depending on the concentration range, the minimum turbidity is displayed as follows:
0 to 100 NTU ... 1 NTU for standard readout, 0.1 NTU for expanded readout.
100 to 800 NTU ... 10 NTU for standard readout, 1 NTU for expanded readout.
*2: The TDS range depends on the TDS factor settings. (Above ranges are given for a TDS coefficient of 0.65.)

Oakton Waterproof pHTestr 2

For detailed instructions with graphics, along with important notes, please refer to the **Operation Manual**.

A. Calibration
   1. Before you begin: Remove electrode cap. To condition electrode, immerse electrode in electrode storage solution, buffer, or tap water for at least 30 minutes. **DO NOT USE DE-IONIZED WATER.**

   2. Calibration: Calibration should be done regularly, typically every day that the *Testr* is used. Calibrate the *pHTestr 2* at three points (pH 4, 7, 10).

      2.1 Press **ON/OFF** button to switch unit on.

      2.2 Dip electrode 1/2" to 1" into chosen buffer (pH 4, 7, or 10).

      2.3 Press **CAL** button to enter Calibrate (CA) mode. 'CA' flashes on the display. Then, a pH value close to the pH buffer value will flash repeatedly.

      2.4 After at least 30 seconds (about 30 flashes) press the **HOLD/CON** button to confirm calibration. The display will show **'CO'** and then switch to the buffer value reading.

      2.5 Repeat with other buffers if necessary (*pHTestr 2* only). Rinse electrode in tap water before dipping into next buffer.

B. Measurement
   1. Remove cap from the electrode and press the **ON/OFF** button to switch *Testr* on.

   2. Dip the electrode 1/2" to 1" into the test solution. Stir once and let the reading stabilize.

   3. Note the pH or press **HOLD/CON** button to freeze the reading. Press **HOLD/CON** again to release the reading.

   4. Press **ON/OFF** to turn off *Testr*. If you do not press a button for 8.5 minutes, the *Testr* will automatically shut off to conserve batteries.

   5. If possible, keep a small piece of paper or sponge in the electrode cap – moistened with clean water or electrode storage solution (**NOT DE-IONIZED WATER**) – and close the cap over the electrode.

C. Specifications

Specifications

	WP pHTestr 1	WP pHTestr 2
Range	–1.0 to 15.0 pH	
Resolution	0.1 pH	
Accuracy	±0.2 pH	±0.1 pH
Calibration	1 point (pH 4.0; 7.0; or 10.0)	3 points (pH 4.0; 7.0 and 10.0)
ATC	No	Yes
Operating Temperature	0 to 50°C (32 to 122°F)	
Functions	ON/OFF; HOLD; CA (Calibrate); CO (Confirm display); auto buffer recognition; auto-shutoff after 8.5 min. of nonuse	
Power	Three 1.5 V batteries (included). 24 hours continuous use (approx. 720 tests per battery set)	
Dimensions	6.5"L x 1.5" dia. (165 x 38 mm dia.)	
Weight	3.25 oz (90 gms)	

Oakton TDSTestr 20

For detailed instructions with graphics, along with important notes, please refer to the **Operation Manual**.

A. Calibration

1. Before you Begin: Remove electrode cap. Switch unit on for 15 minutes to stabilize the batteries. Soak electrodes for a few minutes in alcohol to remove oils. **Caution: Never immerse the electrode above color band as it will damage the instrument electronics.**

2. Calibration: Your tester features push- button calibration at two points (one per range). Select a calibration standard appropriate for each range: low range, between 150 to 1999 µS; high range, between 2.0 to 19.99 mS. It is best to select a standard close to the test solution value, and one that has a similar chemical make-up to the test solution.

   2.1 Rinse the electrode in tap or deionized water, then in a known calibration standard.

   2.2 Switch unit on (ON/OFF button).

   2.3 Dip electrode into calibration standard. **DO NOT immerse above color band!**

   2.4 Press CAL/CON button to enter Calibrate mode. 'CA' flashes on the display. An uncalibrated conductivity value close to the calibration standard value will flash.

   2.5 Wait at least 30 seconds (about 30 flashes) for the reading to stabilize. Press the HOLD/INC button repeatedly to adjust reading to match value of the known calibration standard.

   2.6 Press CAL/CON button to confirm calibration. The display will show 'CO' and then switch to a calibrated conductivity reading.

   2.7 For second range, repeat steps 1-6.

B. Measurement

1. Remove cap from electrode. Switch unit on (ON/OFF button).

2. Rinse the electrode in tap or deionized water, then in a small portion of test solution.

3. Dip the electrode into the test solution. Stir once and let the reading stabilize. **DO NOT immerse electrode above color band!**

4. Allow time for the Automatic Temperature Compensation to correct the readings for solution temperature changes.

5. Note the reading once the display is stable. Press HOLD/CON button to freeze the reading. Press HOLD/CON again to release the reading.

6. Press ON/OFF to turn off Testr. If you do not press a button for 8.5 minutes, the Testr will automatically shut off to conserve batteries.

C. Specifications

Specifications

TDSTestr	10	20
Range	0 to 999 ppm/ 1.00 to 9.99 ppt	0 to 1999 µS/ 2.0 to 19.99 mS
Resolution	1 ppm/ 0.01 ppt	1 µS/ 0.01 mS
Accuracy	±2% full scale	
Calibration	two-point push button slope adjustments (one in each range)	
Calibration Standard	100 to 999 ppm 2.00 to 9.99 ppt	150 to 1999 µS/ 2.0 to 19.99 mS
Operating Temperature	32 to 122°F / 0 to 50°C	
ATC	32 to 122°F / 0 to 50°C (1.11% per °F / 2% per °C)	
Power	Four 1.5 V alkaline batteries (Eveready A76BP; supplied) 20 hrs. continuous use Alternate replacement Model Eveready 303 silver oxide, 70 hrs. continuous use.	
Dimensions	5.9" x 1.7" x 1" (151 x 42 x 24 mm)	
Weight	3.25 oz (90 gms)	

Hanna Instruments HI 98129 Waterproof pH, EC/TDS & Temperature Multimeter

For detailed instructions with graphics, along with important notes, please refer to the **Operation Manual**.

A. Calibration
   1. pH calibration:
      1.1 From measurement mode, press and hold the MODE button until CAL is displayed on the lower LCD. Release the button. The LCD will display pH 7.01 USE or pH 6.86 USE (if you have selected the NIST buffer set). The CAL tag blinks on the LCD.

      1.2 For a single-point pH calibration, place the electrode in any buffer from the selected buffer set (e.g. pH 7.01 or pH 4.01 or pH 10.01). The meter will recognize the buffer value automatically.
         1.2.1 If using pH 4.01 or pH 10.01, the meter will display OK for 1 second and then return to measurement mode.

         1.2.2 If using pH 7.01, after recognition of the buffer the meter will ask for pH 4.01 as second calibration point. Press the MODE button to return to measurement mode or, if desired, proceed with the 2-point calibration as explained below.

      1.3 A two-point pH calibration give better accuracy. For a two-point pH calibration, place the electrode in pH 7.01 (or 6.86 if you have selected the NIST buffer set). The meter will recognize the buffer value and then display pH 4.01 USE.
         1.3.1 Rinse the electrode thoroughly to eliminate cross-contamination.

         1.3.2 Place the electrode in the second buffer value (pH 4.01 or 10.01, or, if using NIST, pH 4.01 or 9.18). When the second buffer is recognized, the LCD will display OK for 1 second and the meter will return to normal measurement mode.

      1.4 The CAL symbol on the LCD means that the meter is calibrated.

   2. EC/TDS calibration:
      2.1 From measurement mode, press and hold the MODE button until CAL is displayed on the lower LCD.

      2.2 Release the button and immerse the probe in the proper calibration solution: HI7031 (1413 µS/cm) for HI98129 and HI7030 (12.88 mS/cm) for HI98130.

      2.3 Once the calibration has been automatically performed, the LCD will display OK for 1 second and the meter will return to normal measurement mode.

      2.4 Since there is a known relationship between EC and TDS readings, it is not necessary to calibrate the meter in TDS

      2.5 The CAL symbol on the LCD means that the meter is calibrated.

B. Measurement

1. pH measurement:

1.1 Select the pH mode with the SET/HOLD button.

1.2 Submerge the electrode in the solution to be tested.

1.3 The measurements should be taken when the stability symbol on the top left of the LCD disappears.

1.4 The pH value automatically compensated for temperature is shown on the primary LCD while the secondary LCD shows the temperature of the sample.

2. EC/TDS measurement:

2.1 Select either EC or TDS mode with the SET/HOLD button.

2.2 Submerge the probe in the solution to be tested. Use plastic beakers to minimize any electromagnetic interferences.

2.3 The measurements should be taken when the stability symbol on the top left of the LCD disappears.

2.4 The EC (or TDS) value automatically compensated for temperature is shown on the primary LCD while the secondary LCD shows the temperature of the sample.

C. Specifications

Range Temperature:	0.0 to 60.0°C or 32.0 to 140.0°F	
HI 98129	pH: 0.00 to 14.00	
	EC: 0 to 3999 µS/cm	
	TDS: 0 to 2000 ppm	
HI 98130	pH: 0.00 to 14.00	
	EC: 0.00 to 20.00 mS/cm	
	TDS: 0.00 to 10.00 ppt	
Resolution	0.1°C or 0.1°F	
HI 98129	0.01 pH; 1 µS/cm ; 1 ppm	
HI 98130	0.01 pH, 0.01 mS/cm ; 0.01 ppt	
Accuracy (@20°C/68°F)	Temperature	±0.5°C or ±1°F
	EC/TDS	±2% f.s.
	pH	±0.01
Typical EMC Deviation	Temperature	±0.5°C or ±1°F
	pH	±0.02 pH
	EC/TDS	±2% f.s.
Temp.Compensation	pH: Automatic	
	EC/TDS: with β=0.0 to 2.4%/°C	
Environment	0 to 50°C (32 to 122°F); RH 100%	
EC/TDS Conversion Factor	0.45 to 1.00 (CONV)	
Calibration	pH: at 1 or 2 points with 2 sets of memorized buffers (pH 4.01/7.01/10.01 or pH 4.01/6.86/9.18)	
	EC/TDS: automatic, at 1 point	
EC/TDS Calibration Solutions		
HI 98129	HI7031 (1413 µS/cm)	
	HI7032 (1382 ppm; CONV=0.5)	
	HI70442 (1500 ppm; CONV=0.7)	
HI 98130	HI7030 (12.88 mS/cm)	
	HI70038 (6.44 ppt; CONV=0.5 or 9.02 ppt; CONV=0.7)	
Electrode	HI 73127 pH electrode (**included**)	
Battery Type/Life	4 x 1.5V with BEPS / typical 100 hours	
Auto-off	After 8 min.	
Dimensions	163 x 40 x 26 mm (6.4 x 1.6 x 1.0")	
Weight	85 g (3.0 oz)	

APPENDIX I:

SWAMP DATA GUIDANCE MANUALS

I1. Field Data Submission Guidance
I2. Chemistry Data Submission Guidance
I3. Toxicity Data Submission Guidance
I4. Taxonomy Data Submission Guidance

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I1. Field Data Submission Guidance

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CEDEN

California Environmental Data Exchange Network

Field Data Submission Guidance Document

January 8, 2019

Table of Contents

List of Acronyms

CEDEN	California Environmental Data Exchange Network
RDC	Regional Data Center
SWAMP	Surface Water Ambient Monitoring Program
QAO	Quality Assurance Officer

List of Terms

Controlled Vocabulary	Controlled vocabulary refers to codes and associated definitions maintained within CEDEN to ensure comparability between and among data sets. Current controlled vocabulary contained within associated lookup lists can be found at: http://ceden.org/CEDEN_checker/Checker/LookUpLists.php. The process for adding new values can be found at: http://ceden.org/vocabulary_request.shtml.
Data Checker	Web-based automated tool that assists data submitters in examining their data sets against the required LookUp lists, formats and business rules.
LookUp Lists	Controlled vocabularies are maintained within the CEDEN database as "LookUp Lists" and are managed through individual RDCs to maintain comparability between RDCs and throughout data sets available through CEDEN.
Primary Key	Uniquely identifies each row in a table and is comprised of a set of columns. No two distinct rows in a table can have the same combination of column values. Required for record uniqueness.
Data Type	Refers to the type of format required for a specific column heading in CEDEN templates. Data type examples include: integer (whole numbers), text, date and time, and decimal.

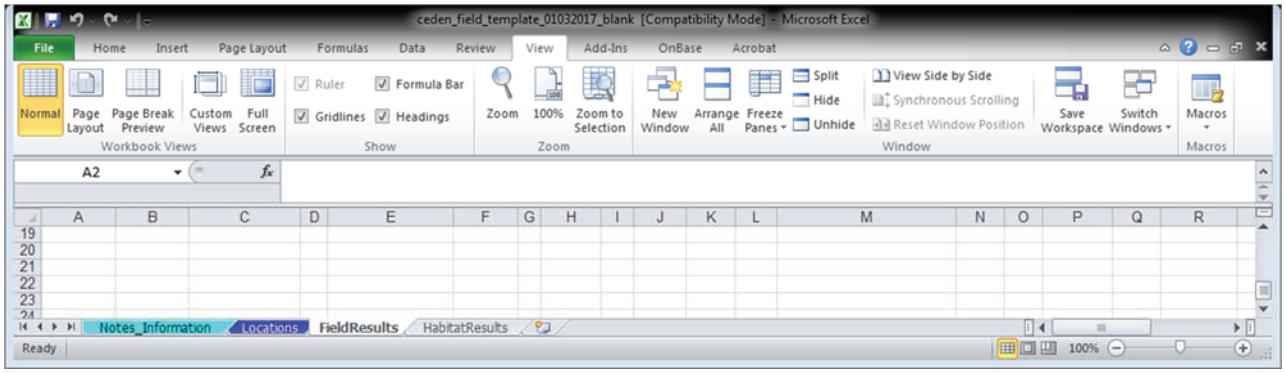
Introduction

This document is designed to provide guidance on reporting requirements for electronic data to be entered in the California Environmental Data Exchange Network (CEDEN) templates. Detailed below are definitions of data elements and rules for formatting field data within the CEDEN field template. Please review the entire Field Data Submission Guidance Document prior to filling out or submitting the CEDEN Field Template. If you have any questions regarding these guidelines, contact your Regional Data Center (RDC) for help.

Regional Data Center (RDC)	Contact	Phone Number	Email
Central Coast RDC	Stacey Swenson	831/771-4114	sswenson@mlml.calstate.edu
Central Valley RDC	Melissa Turner	530/756-5200	mturner@mlj-llc.com
San Francisco RDC	Cristina Grosso	510/746-7371	cristina@sfei.org

Field Data Submission Steps

To submit water quality field data to CEDEN, start with the CEDEN_Field_Template Excel file, which can be found at: http://ceden.org/ceden_datatemplates.shtml. In this template you will find the three data tables (each in a separate worksheet) required for submitting field data. This file can be named at the discretion of the user; however, the Excel sheet tabs **MUST** be named **Locations**, **FieldResults**, and **HabitatResults,** respectively.



CEDEN Field Template Tables

Below describes what is included and submission requirements for each of the 3 tables in the CEDEN Field Template:

1. Locations
    a. Holds information about location sampled
    b. Required only if actual unique latitudes and longitudes were recorded for each sampling event.

2. FieldResults
    a. Used to record field measurement results
    b. Required when submitting field measurement results
3. HabitatResults
    a. Used to record habitat/field observation results
    b. Required when submitting habitat results

The guidelines in the following sections will assist you in getting your data into the CEDEN Field Template tables. However, if at any time you have questions more specific to your data, (e.g. adding new codes to LookUp lists) contact your local RDC.

Once you have placed your data into the CEDEN Field Template tables, visit your RDC's website to check and submit your data. Regional Data Center information can be found at: http://www.ceden.org/data_centers.shtml. The online data submission process includes specific checks on your data to ensure both data integrity and comparability with other data sets. Once your data has passed all of the checks it will be uploaded into the centralized CEDEN database and become available through the CEDEN website (www.ceden.org).

Field Template Data Tables

Locations Table

PURPOSE:

The locations table contains specific information about the locations sampled. Actual latitudes and longitudes are recorded here for each sampling event. In the event that only target latitudes and longitudes were recorded, it is sufficient to rely on the stations and associated details approved during the controlled vocabulary request process.

COLUMN REQUIREMENTS:

Columns within the CEDEN Field Template tables are either considered 1) required, 2) desired or 3) not required. Required columns must be completed in order for data to be accepted by CEDEN. Desired columns are strongly encouraged and should be completed with known values, whenever possible. If the actual value is unknown, then the given default value **must** be used. Not required columns include additional information that aid in data usability. Individual column requirements are listed below:

Required Columns:

StationCode
SampleDate
ProjectCode
CoordinateNumber
ActualLatitude
ActualLongitude
Datum

Desired Columns:

EventCode
ProtocolCode
AgencyCode
LocationCode
CoordinateSource

Not Required Columns:

SampleComments
GeometryShape
Elevation
UnitElevation
StationDetailVerBy
StationDetailVerDate
StationDetailComments

LOCATIONS TABLE STRUCTURE:

* Primary Key, required for record uniqueness.

CHEMISTRY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
StationCode*	Text	**Yes**	25	Station LookUp	A code representing the StationName and site and should be unique within CEDEN. A single waterbody may have multiple stations. StationCodes and station information must be submitted to the CEDEN system via the new vocabulary request process before lab data can be submitted.
SampleDate*	Date/ Time	**Yes**	20		Refers to the date the sample was collected in the field; formatted as dd/mmm/yyyy.
ProjectCode*	Text	**Yes**	25	Project LookUp	References the project that is associated with the sample.
EventCode	Text	**Desired**	20	Event LookUp	Represents the primary reason (e.g. water quality, tissue or bioassessment sampling) of the sampling event at a particular station and date.
ProtocolCode	Text	**Desired**	50	Protocol LookUp	Represents the sampling protocol used, which includes the set of methods, methodology and/or specifications, such as "MPSL-DFG_Field_v1.0." Established protocols may be used or Regions may document their own sampling protocols. Use "Not Recorded" when environmental samples are taken using unknown protocols.
AgencyCode	Text	**Desired**	20	Agency LookUp	Refers to the organization or agency that collected the sample. This should be listed on the Chain of Custody (COC) document that accompanies the samples from the field. Use "Not Recorded" if unknown.
SampleComments	Text	No	255		Comments related to the GIS station information verification.
LocationCode	Text	**Desired**	50	Location LookUp	Describes the physical location in the waterbody where the sample was collected. One sampling event may have a single or multiple locations. Default value equals "Not Recorded" if unknown

CHEMISTRY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
GeometryShape	Text	No	50	Variable Codes LookUp; Geometry-ShapeList	Physical shape of the location. Example values are Line, Point, or Polygon.
CoordinateNumber	Integer	**Yes**			Number of coordinates recorded at a Location; e.g. 1 for Points (target and actual coordinates), 1 and 2 for Lines. Default value equals "1."
ActualLatitude	Decimal	**Yes**			Represents the actual latitude for the sample site in decimal degrees with 5 decimal places.
ActualLongitude	Decimal	**Yes**			Represents the actual longitude for the sample site in decimal degrees with 5 decimal places (must be negative).
Datum	Text	**Yes**	10	Variable Codes LookUp; DatumList	The Datum field records the datum that was used on the GPS Device to record the GPS measurements. Example = NAD83. If the datum is unknown, use "NR."
CoordinateSource	Text	**Desired**	50	Variable Codes LookUp; Coordinate-SourceList	Describes how the coordinate was measured. For example, if measurement was taken from a map or GPS. Use "NR" if unknown.
Elevation	Decimal	No			Elevation at which the sample was taken. Example = 1.
UnitElevation	Text	No	2	Variable Codes LookUp; Unit-Elevation-List	Unit of the Elevation measurement. Example = m
StationDetailVerBy	Text	No	100		Agency or person who performed the verification of the station detail information.
StationDetailVerDate	Date/ Time	No			Date the station detail information was verified; formatted as dd/mmm/yyyy.
StationDetailComments	Text	No	255		Comments related to the station detail information.

Field Results Table

PURPOSE:

The purpose of the field results table is to document field measurement results. Each record represents a result from a particular water quality measurement at a specific station at a specific point in time.

COLUMN REQUIREMENTS:

Columns within the CEDEN Field Template tables are either considered 1) required, 2) desired or 3) not required. Required columns must be completed in order for data to be accepted by CEDEN. Desired columns are strongly encouraged and should be completed with known values, whenever possible. If the actual value is unknown, then the given default value **must** be used. Not required columns include additional information that aid in data usability. Individual column requirements are listed below:

Required Columns:

StationCode
SampleDate
ProjectCode
CollectionTime
CollectionMethodCode
Replicate
CollectionDepth
UnitCollectionDepth
MatrixName
MethodName
AnalyteName
FractionName
UnitName
Result
ResQualCode
QACode

Desired Columns:

EventCode
ProtocolCode
AgencyCode
LocationCode
CollectionDeviceName
PositionWaterColumn
FieldReplicate
ComplianceCode
BatchVerificationCode
CalibrationDate

Not Required Columns:

SampleComments
GeometryShape
FieldCollectionComments
FieldResultComments

FIELD RESULTS TABLE STRUCTURE:

* Primary Key, required for record uniqueness.

FIELD TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
StationCode*	Text	**Yes**	25	Station LookUp	A code representing the StationName and site and should be unique within CEDEN. A single waterbody may have multiple stations. StationCodes and station information must be submitted to the CEDEN system via the new vocabulary request process prior to submitting associated data.
SampleDate*	Date/ Time	**Yes**			Refers to the date the sample was collected in the field. Formatted as dd/mmm/yyyy. Use "01/Jan/1950" if the actual SampleDate is unknown.
ProjectCode	Text	**Yes**	25	Project LookUp	References the project that is associated with the sample.
EventCode	Text	**Desired**	20	Event LookUp	Represents the primary reason (e.g. water quality, tissue or bioassessment sampling) of the sampling event at a particular station and date.
ProtocolCode	Text	**Desired**	50	Protocol LookUp	Represents the sampling protocol used, which includes the set of methods, methodology and/or specifications, such as "MPSL-DFG_Field_v1.0." Established protocols may be used or Regions may document their own sampling protocols. Use "Not Recorded" when environmental samples are taken using unknown protocols.
AgencyCode	Text	**Desired**	20	Agency LookUp	Refers to the organization or agency that collected the sample. This should be listed on the Chain of Custody (COC) document that accompanies the samples from the field. Use "Not Recorded" if unknown.
SampleComments	Text	No	255		The comments field should be used for any notes or comments specifically related to the sample collection.

FIELD TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
LocationCode	Text	**Desired**	50	Location LookUp	Describes the physical location in the waterbody where the sample was collected. One sampling event may have a single or multiple locations. Use "Not Recorded" if unknown.
GeometryShape	Text	No	50	Variable Codes LookUp; Geometry-ShapeList	Physical shape of the location. Example values are Line, Point, or Polygon.
CollectionTime*	Date/ Time	**Yes**	20		Refers to the time when the first sample of a sampling event at a specific station was collected in the field. Format equals hh:mm. Use "00:00" if the time sampling started is unknown.
CollectionMethodCode	Text	**Yes**	50	Collection Method LookUp	Refers to the general method of collection such as Field, Field_Cont or Lentic_CSBP. The default value equals "Field. "
Replicate*	Integer	**Yes**			Used to distinguish between replicates created at a single collection in the field. Default value is "1." Replicate samples are collected at the same station and date. Therefore, samples collected on different dates from the same station should both have a value of 1 for Replicate.
CollectionDeviceName	Text	**Desired**	50	Collection Device LookUp	Name of the CollectionDevice. Use "Not Recorded" if unknown.
CollectionDepth	Decimal	**Yes**			Records the depth or penetration, from the surface in the water or sediment column, at which the sample was collected.
UnitCollectionDepth	Text	**Yes**	50	Variable Codes LookUp; Unit-Collection-DepthList	Refers to the units used in the CollectionDepth including cm (centimeters) and m (meters).

FIELD TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
PositionWaterColumn	Text	**Desired**	20	Variable Codes LookUp; Position-Water-ColumnList	Position in water column where sample was taken. Use “Not Applicable” if unknown.
FieldCollection Comments	Text	No	255		Comments related to the FieldCollection
MatrixName*	Text	**Yes**	50	Matrix LookUp	Refers to the sample matrix, e.g. samplewater. Use “Not Recorded” if unknown.
MethodName*	Text	**Yes**	50	Method LookUp	Refers to the analysis method used to analyze the sample. The default is "FieldMeasure".
AnalyteName*	Text	**Yes**	100	Analyte LookUp	Name of the analyte or parameter for which the analysis is conducted and result is reported. The LookUp list includes the acceptable abbreviation or name of the variable used by the database, enabling consistency across reporting.
FractionName*	Text	**Yes**	50	Fraction LookUp	Specific descriptor of the Analyte. For example, metals are often expressed as total or dissolved and therefore this description should be used within the fraction field.
UnitName*	Text	**Yes**	50	Unit LookUp	Refers to how the chemistry result is measured or expressed.
FieldReplicate*	Integer	**Desired**			The replicate number identifies replicates created in the field. The default value is “1.”
Result	Text	**Yes**	50		Final numeric result of a given analyte, stored as text to retain trailing zeros. The result should be reported with the appropriate number of significant figures. Result may be left blank as long as an appropriate ResQualCode is provided.
ResQualCode	Text	**Yes**	10	ResQual LookUp	Qualifies the analytical result of the sample. Use “=” if unknown.

FIELD TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
QACode*	Text	**Yes**	30	QA LookUp	Applied to the result to describe any special conditions, situations or outliers that occurred during or prior to the analysis to achieve the result. The default code, indicating no special conditions, is "None." Use "NR" if the special conditions are unknown or if it is unknown whether there were special conditions. If more than one code should be applied to a record, the convention is to list them in alphabetical order separated by commas and no spaces.
ComplianceCode	Text	**Desired**		Data Compliance LookUp	Unique code describing the compliance with the associated Quality Assurance Project Plan (QAPP). Use "NR" if the compliance is unknown.
BatchVerificationCode	Text	**Desired**	10	Batch Verification Lookup	Unique code referencing the Verification of a Batch. Use "NR" if unknown.
CalibrationDate	Date/ Time	**Desired**			CalibrationDate refers to the date the collection device was calibrated. Formatted as dd/mmm/yyyy. Use "01/Jan/1950" if the actual date the equipment was calibrated is unknown.
FieldResultComments	Text	No	255		Holds any comments related to the field result or analysis of the sample.

Habitat Results Table

PURPOSE:

The purpose of the habitat results table is to document field observation results. Each record represents a result for a single observation at a specific station at a specific point in time.

COLUMN REQUIREMENTS:

Columns within the CEDEN Field Template tables are either considered 1) required, 2) desired or 3) not required. Required columns must be completed in order for data to be accepted by CEDEN. Desired columns are strongly encouraged and should be completed with known values, whenever possible. If the actual value is unknown, then the given default value **must** be used. Not required columns include additional information that aid in data usability. Individual column requirements are listed below:

Required Columns:

StationCode
SampleDate
ProjectCode
CollectionTime
CollectionMethodCode
Replicate
MatrixName
MethodName
AnalyteName
FractionName
UnitName
VariableResult*
Result*
ResQualCode
QACode

***Conditionally required i.e. VariableResult or Result is required to be populated, but not both.**

Desired Columns:

EventCode
ProtocolCode
AgencyCode
LocationCode
CollectionDeviceName
ComplianceCode
BatchVerificationCode

Not Required Columns:

SampleComments
GeometryShape
HabitatCollectionComments
HabitatResultComments

HABITAT RESULTS TABLE STRUCTURE:

* Primary Key, required for record uniqueness.

FIELD TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
StationCode*	Text	**Yes**	25	Station LookUp	A code representing the StationName and site and should be unique within CEDEN. A single waterbody may have multiple stations. StationCodes and station information must be submitted to the CEDEN system via the new vocabulary request process prior to submitting associated data.
SampleDate*	Date/ Time	**Yes**			Refers to the date the sample was collected in the field. Formatted as dd/mmm/yyyy. Use "01/Jan/1950" if the actual SampleDate is unknown.
ProjectCode	Text	**Yes**	25	Project LookUp	References the project that is associated with the sample.
EventCode	Text	**Desired**	20	Event LookUp	Represents the primary reason (e.g. water quality, tissue or bioassessment sampling) of the sampling event at a particular station and date.
ProtocolCode	Text	**Desired**	50	Protocol LookUp	Represents the sampling protocol used, which includes the set of methods, methodology and/or specifications, such as "MPSL-DFG_Field_v1.0." Established protocols may be used or Regions may document their own sampling protocols. Use "Not Recorded" when environmental samples are taken using unknown protocols. Use "Not Applicable" when LabQA samples are taken with unknown protocols.
AgencyCode	Text	**Desired**	20	Agency LookUp	Refers to the organization or agency that collected the sample. This should be listed on the Chain of Custody (COC) document that accompanies the samples from the field. Use "Not Recorded" if unknown.
SampleComments	Text	No	255		The comments field should be used for any notes or comments specifically related to the sample collection.

FIELD TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
LocationCode	Text	**Desired**	50	Location LookUp	Describes the physical location in the waterbody where the sample was collected. One sampling event may have a single or multiple locations. Use “Not Recorded” when environmental samples are taken at an unknown location.
GeometryShape	Text	No	50	Variable Codes LookUp; Geometry-ShapeList	Physical shape of the location. Example values are Line, Point, or Polygon.
CollectionTime*	Date/ Time	**Yes**	20		Refers to the time when the first sample of a sampling event at a specific station was collected in the field. Format equals hh:mm. Use “00:00” if the time sampling started is unknown.
CollectionMethodCode	Text	**Yes**	50	Collection Method LookUp	Refers to the general method of collection such as "Habitat_Generic", "Habitat_SWAMP", "Habitat_SNARL", "Habitat_EMAP", "Habitat_CSBP", "Bank/Tow" or "Littoral". Default value equals “Not Recorded.”
Replicate*	Integer	**Yes**			Used to distinguish between replicates created at a single collection in the field. Default value is “1.” Replicate samples are collected at the same station and date. Therefore, samples collected on different dates from the same station should both have a value of “1” for Replicate.
CollectionDeviceName	Text	**Desired**	50	Collection Device LookUp	Name of the CollectionDevice. Default value for habitat is "None.”
HabitatCollection Comments	Text	No	255		Comments related to the habitat collection.
MatrixName*	Text	**Yes**	50	Matrix Lookup	Refers to the sample matrix, e.g. samplewater. Use “Not Recorded” if unknown.
MethodName*	Text	**Yes**	50	Method LookUp	Refers to the analysis method used to analyze the sample. Default is "FieldObservations."

FIELD TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
AnalyteName*	Text	**Yes**	100	Analyte LookUp	Name of the analyte or parameter for which the analysis is conducted and result is reported. The LookUp list includes the acceptable abbreviation or name of the variable used by the database, enabling consistency across reporting.
FractionName*	Text	**Yes**	50	Fraction LookUp	Specific descriptor of the Analyte. For field observations use "None."
UnitName*	Text	**Yes**	50	Unit LookUp	Refers to how the result is measured or expressed. For field observations this is "None."
VariableResult	Text	**Yes**	80	FieldObsVar LookUp	Categorical result for field observation. Utilize FieldObsVarCode column within FieldObsVarLookUp. VariableResult may be left blank as long as the Result is populated. If both the VariableResult and Result are blank then an appropriate ResQualCode needs to be provided.
Result	Text	**Yes**	50		Final numeric result of a given analyte, stored as text to retain trailing zeros. The result should be reported with the appropriate number of significant figures. Result may be left blank as long as the VariableResult is populated. If both the VariableResult and Result are blank then an appropriate ResQualCode needs to be provided.
ResQualCode	Text	**Yes**	10	ResQual LookUp	Qualifies the analytical result of the sample. Default value equals “=.”
QACode*	Text	**Yes**	30	QA LookUp	Applied to the result to describe any special conditions, situations or outliers that occurred during or prior to the analysis to achieve the result. The default code, indicating no special conditions, is "None." Use “NR” if the special conditions are unknown or if it is unknown whether there were special conditions. If more than one code should be applied to a record, the convention is to list them in alphabetical order separated by commas and no spaces.

FIELD TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
ComplianceCode	Text	**Desired**		Data Compliance LookUp	Unique code describing the compliance with the associated Quality Assurance Project Plan (QAPP). Use "NR" if the compliance is unknown.
BatchVerificationCode	Text	**Desired**	10	Batch Verification Lookup	Unique code referencing the Verification of a Batch. Use "NR" if the BatchVerificationCode is unknown.
HabitatResultComments	Text	No	255		Comments related to the habitat result.

Appendix A: Field Data Submission Guidance Documentation Amendments

AMENDMENTS

Amendments made to the CEDEN Field Data Submission Guidance Document are documented within Table 1.

Table 1. Amendments made to the Field Data Submission Guidance Document.

Date of Amendment	Document Section	Amendment Summary	Amendment Details
August 23rd 2013	List of Acronyms	Added acronyms.	Added SWAMP and QAO to the List of Acronyms.
August 23rd 2013	Stations Table: Column Requirements	Updated required field designations for Stations Table.	Updated required field designations for Stations Table. Required Columns: Added: StationAgency, SWRCBWatTypeCode. Desired Columns: Added: CoordinateSource Removed: LocalWatershed, LocalWaterbody, Counties_2004_County, SWRCBWatTypeCode, CalWater_2004_RB. Not Required Columns: Added: EventType1, EventType2, EventType3, LocalWaterShed, LocalWaterBody, Counties_2004_COUNTY, CalWater_2004_RB, NHD_PlusCatchmentComID. Removed: CalWater_2004_SWRCBNUM2 HydrologicUnit
August 23rd 2013	Stations Table	Added Additional Resources section to Stations Table.	Added an "Additional Resources" section to the Stations Table after Column Requirements.
August 23rd 2013	Stations Table: Stations Table Structure: StationSource	Updated StationSource LookUp list and definition.	Updated StationSource LookUp List from blank to "AgencyLookUp or ProjectLookUp". Updated Definition from "Agency or project that created the station." to "Agency or project that submitted the station to CEDEN".
August 23rd 2013	Stations Table: Stations Table Structure	Added new fields to the Stations Table.	Added new fields to Stations Table Structure: StationAgency, EventType1, EventType2, EventType3 and NHD_Plus_CatchmentComID.
August 23rd 2013	Stations Table: Stations Table Structure: AddDate	Added format information to AddDate	Added "Format as dd/mmm/yyyy" to the AddDate definition.

Date of Amendment	Document Section	Amendment Summary	Amendment Details
August 23rd 2013	Stations Table: Stations Table Structure	Added default value information to Stations Table definitions.	Added default value information to the description field within the Stations Table for CoordinateNumber, Datum, CoordinateSource, SWRCBWatTypeCode
August 23rd 2013	Stations Table: Stations Table Structure: State	Added LookUp list information to State.	Updated State LookUp List from blank to "VariableCodesLookUp".
August 23rd 2013	Stations Table: Stations Table Structure	Updated Stations Table template header names.	Updated Stations Table template header names: "NHD24K_GNIS_Name" to "NHD_24K_v2_GNIS_Name", "NHD24k_Reachcode" to "NHD_24k_v2_ReachCode", "NHD24k_HUC12" to "NHD_24k_v2_HUC_12" and "NHD24k_Hu_12_Name" to "NHD_24k_v2_Name".
August 23rd 2013	Field Results Table: Column Requirements	Updated required field designations for Field Results Table.	Updated required field designations for Field Results Table: Desired Columns: Added: EventCode, PositionWaterColumn. Not Required Columns: Removed: EventCode, PositionWaterColumn.
August 23rd 2013	Field Results Table: Field Results Table Structure	Added default value information to Field Results Table definitions.	Added default value information to the description field within the Field Results Table for SampleDate, ProtocolCode, AgencyCode, LocationCode, CollectionTime, CollectionMethodCode, CollectionDeviceName, PositionWaterColumn, MatrixName, FieldReplicate, ResQualCode, QACode, ComplianceCode and BatchVerificationCode
August 23rd 2013	Field Results Table: Field Results Table Structure: CollectionMethodCode	Updated CollectionMethodCode definition within the Field Results Table.	Updated the CollectionMethodCode definition from "Refers to the general method of collection such as Sed_Grab, Sed_Core, Water_Grab, Autosampler24h, Autosampler7d." to "Refers to the general method of collection such as Field, Field_Cont or Lentic_CSBP. Default value equals Field."
August 23rd 2013	Field Results Table: Field Results Table Structure: Result	Added information to the Result definition within the Field Results Table.	Added "Result may be left blank as long as an appropriate ResQualCode is provided." to the Result description within the Field Results Table.
August 23rd 2013	Habitat Results Table: Column Requirements	Updated required field designations for Habitat Results Table.	Updated required field designations for Habitat Results Table: Desired Columns: Added: EventCode, BatchVerificationCode. Not Required Columns: Removed: EventCode, BatchVerificationCode.

Date of Amendment	Document Section	Amendment Summary	Amendment Details
August 23rd 2013	Habitat Results Table: Habitat Results Table Structure	Added default value information to Habitat Results Table definitions.	Added default value information to the description field within the Habitat Results Table for SampleDate, ProtocolCode, AgencyCode, LocationCode, CollectionTime, CollectionMethodCode, MatrixName, ResQualCode, QACode, ComplianceCode and BatchVerificationCode.
August 23rd 2013	Habitat Results Table: Habitat Results Table Structure: CollectionMethodCode	Updated CollectionMethodCode definition.	Updated CollecitonMethodCode definition from "Refers to the general method of collection such as Sed_Grab, Sed_Core, Water_Grab, Autosampler24h, Autosampler7d." to "Refers to the general method of collection such as "Habitat_Generic", "Habitat_SWAMP", "Habitat_SNARL", "Habitat_EMAP", "Habitat_CSBP", "Bank/Tow" or "Littoral". Default value equals Not Recorded."
August 23rd 2013	Habitat Results Table: Habitat Results Table Structure: VariableResult	Updated VariableResult LookUp list and added additional information to definition.	Updated VariableResult LookUp list from "VariableCodesLookUp" to "FieldObsVarLookUp". Added the following information to the VariableResult definition: "Utilize FieldObsVarCode column within FieldObsVarLookUp VariableResult may be left blank as long as the Result is populated. If both the VariableResult and Result are blank then an appropriate ResQualCode needs to be provided."
August 23rd 2013	Habitat Results Table: Habitat Results Table Structure: Result	Added additional information to Result definition.	Added the following information to the Result definition: "Result may be left blank as long as the VariableResult is populated. If both the VariableResult and Result are blank then an appropriate ResQualCode needs to be provided."
October 11th 2013	Introduction	Updated Southern California RDC contact information.	Updated Southern California RDC contact information from Shelly Moore to Marlene Hanken contact information.
January 3rd, 2017	Introduction, Station Table, Field Results Table, Habitat Results Tables	Removed references to Stations tab	Removed the Stations section and references to Stations tab, updated effected screen shot, and modified StationCode definition to note that station codes must be established through the new vocabulary request process prior to subittal.
January 3rd, 2017	All	Updated use of quotes	Replaced single quotes with double quotes.
January 3rd, 2017	Locations Table, Field Results Table, and Habitat Results Table	Updated description of "desired" fields	Added reference to using default values when actual values are not know for "desired" fields in the "Column Requirements" paragraph.
January 3rd, 2017	List of Terms	Updated links	Added current links for the LookUp lists and vocabulary request process.

Date of Amendment	Document Section	Amendment Summary	Amendment Details
January 3rd, 2017	Introduction	Updated Central Coast RDC contact information	Updated the Central Coast RDC contact information from Mark Pranger to Stacey Swenson.
January 3rd, 2017	Locations Table, Field Results Table, and Habitat Results Table	Modified use of "default" wording	Changed most instances of "Default equals…if unknown" to "Use…if unknown."
January 3rd, 2017	All	Various edits	Removed double spaces and duplicate words and other small edits.
January 3rd, 2017	Locations Table, Field Results Table, and Habitat Results Table	Updated StationCode definition	Included that StationCode must be unique within CEDEN, not just within the study design, as previously stated.
January 8th, 2019	Introduction	Updated RDCs	Removed SCCWRP as current RDC.
January 8th, 2019	All tables	Variable Code List references	Added references to the appropriate lists in the Lookup List columns for fields that rely on Variable Codes.
January 8th, 2019	Locations Table, Field Results Table, and Habitat Results Table	Updated wording for "desired" (default required) fields	Changed "should" to "must" for "desired" fields in the "Column Requirements" paragraphs.
January 8th, 2019	All tables	Format changes	Changed shading, font, and alignment of tables as needed for consistency.

I2. Chemistry Data Submission Guidance

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CEDEN

California Environmental Data Exchange Network

Chemistry Data Submission Guidance Document

Updated January 8, 2019

Table of Contents

List of Acronyms

CEDEN	California Environmental Data Exchange Network
LABQA	Laboratory Quality Assurance
RDC	Regional Data Center
SWAMP	Surface Water Ambient Monitoring Program
QAO	Quality Assurance Officer

List of Terms

Controlled Vocabulary	Controlled vocabulary refers to codes and associated definitions maintained within CEDEN to ensure comparability between and among data sets. Current controlled vocabulary contained within associated lookup lists can be found at: http://ceden.org/CEDEN_checker/Checker/LookUpLists.php. The process for adding new values can be found at: http://ceden.org/vocabulary_request.shtml.
Data Checker	Web-based automated tool that assists data submitters in examining their data sets against the required LookUp lists, formats and business rules.
LookUp Lists	Controlled vocabularies are maintained within the CEDEN database as "LookUp Lists" and are managed through individual RDCs to maintain comparability between RDCs and throughout data sets available through CEDEN.
Native Sample	Native sample refers to the environmental sample collected and analyzed. The native sample can be compared to field quality assurance samples (e.g. field duplicate, field blank) and laboratory quality assurance samples (e.g. laboratory duplicate, matrix spike).
Primary Key	Uniquely identifies each row in a table and is comprised of a set of columns. No two distinct rows in a table can have the same combination of column values. Required for record uniqueness.
Data Type	Refers to the type of format required for a specific column heading in CEDEN templates. Data type examples include: integer (whole numbers), text, date and time, and decimal.

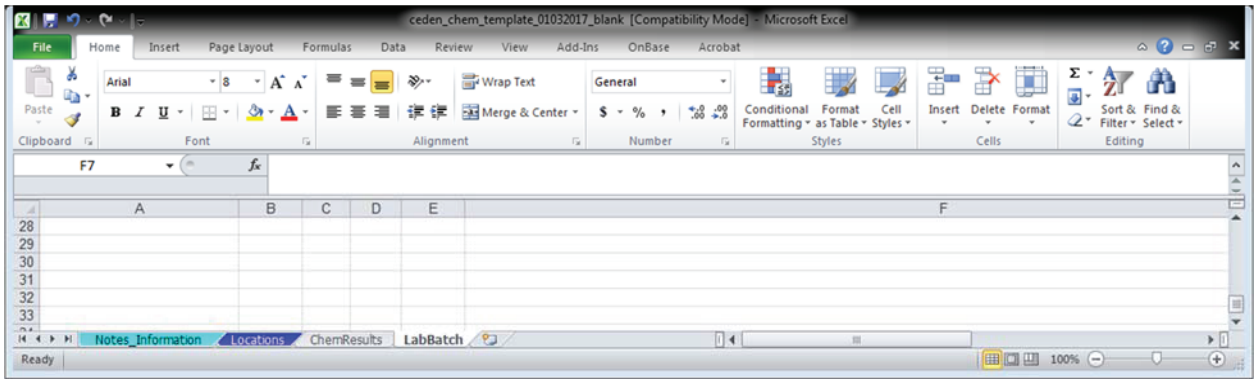
Introduction

This document is designed to provide guidance on reporting requirements for electronic data to be entered in the California Environmental Data Exchange Network (CEDEN) templates. Detailed below are definitions of data elements and rules for formatting chemistry data within the CEDEN chemistry template. For information on entering laboratory QA samples and field generated QA samples see Appendix A. Please review the entire Chemistry Data Submission Guidance Document prior to filling out or submitting the CEDEN Chemistry Template. If you have any questions regarding these guidelines, contact your Regional Data Center (RDC) for help.

Regional Data Center (RDC)	Contact	Phone Number	Email
Central Coast RDC	Stacey Swenson	831/771-4114	sswenson@mlml.calstate.edu
Central Valley RDC	Melissa Turner	530/756-5200	mturner@mlj-llc.com
San Francisco RDC	Cristina Grosso	510/746-7371	cristina@sfei.org

Chemistry Data Submission Steps

To submit water quality chemistry data to CEDEN, start with the CEDEN_Chemistry_Template Excel file, which can be found at: http://ceden.org/ceden_datatemplates.shtml. In this template you will find the three data tables (each in a separate worksheet) required for submitting chemistry data. This file can be named at the discretion of the user; however, the Excel sheet tabs **MUST** be named "**Locations**," **"ChemResults"** and **"LabBatch,"** respectively.



CEDEN Chemistry Template Tables

Below describes what is included and submission requirements for each of the 3 tables in the CEDEN Chemistry Template:

1. Locations
    a. Holds information about location sampled
    b. Required only if actual unique latitudes and longitudes were recorded for each sampling event.

2. ChemResults
    a. Used to record chemistry analysis results
    b. Required and must be submitted with LabBatch table
3. LabBatch
    a. Used to record lab batch information necessary for analyzing the data
    b. Required and must be submitted with ChemResults table.

The guidelines in the following sections will assist you in getting your data into the CEDEN Chemistry Template tables. However, if at any time you have questions more specific to your data, (e.g. adding new codes to LookUp lists) contact your local RDC.

Once you have placed your data into the CEDEN Chemistry Template tables, visit your RDC's website to check and submit your data. Regional Data Center information can be found at: http://www.ceden.org/data_centers.shtml. The online data submission process includes specific checks on your data to ensure both data integrity and comparability with other data sets. Once your data has passed all of the checks it will be uploaded into the centralized CEDEN database and become available through the CEDEN website (www.ceden.org).

Chemistry Template Data Tables

Locations Table

PURPOSE:

The locations table contains specific information about the locations sampled. Actual latitudes and longitudes are recorded here for each sampling event. In the event that only target latitudes and longitudes were recorded, it is sufficient to rely on the stations and associated details approved during the controlled vocabulary request process.

COLUMN REQUIREMENTS:

Columns within the CEDEN Chemistry Template tables are either considered 1) required, 2) desired or 3) not required. Required columns must be completed in order for data to be accepted by CEDEN. Desired columns are strongly encouraged and should be completed with known values, whenever possible. If the actual value is unknown, then the given default value **must** be used. Not required columns include additional information that aid in data usability. Individual column requirements are listed below:

Required Columns:

StationCode
SampleDate
ProjectCode
CoordinateNumber
ActualLatitude
ActualLongitude
Datum

Desired Columns:

EventCode
ProtocolCode
AgencyCode
LocationCode
CoordinateSource

Not Required Columns:

SampleComments
GeometryShape
Elevation
UnitElevation
StationDetailVerBy
StationDetailVerDate
StationDetailComments

LOCATIONS TABLE STRUCTURE:

* Primary Key, required for record uniqueness.

CHEMISTRY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
StationCode*	Text	**Yes**	25	Station LookUp	A code representing the StationName and site and should be unique within CEDEN. A single waterbody may have multiple stations. StationCodes and station information must be submitted to the CEDEN system via the new vocabulary request process before lab data can be submitted.
SampleDate*	Date/ Time	**Yes**	20		Refers to the date the sample was collected in the field; formatted as dd/mmm/yyyy.
ProjectCode*	Text	**Yes**	25	Project LookUp	References the project that is associated with the sample.
EventCode	Text	**Desired**	20	Event LookUp	Represents the primary reason (e.g. water quality, tissue or bioassessment sampling) of the sampling event at a particular station and date.
ProtocolCode	Text	**Desired**	50	Protocol LookUp	Represents the sampling protocol used, which includes the set of methods, methodology and/or specifications, such as "MPSL-DFG_Field_v1.0." Established protocols may be used or Regions may document their own sampling protocols. Use "Not Recorded" when environmental samples are taken using unknown protocols.
AgencyCode	Text	**Desired**	20	Agency LookUp	Refers to the organization or agency that collected the sample. This should be listed on the Chain of Custody (COC) document that accompanies the samples from the field. Use "Not Recorded" if unknown.
SampleComments	Text	No	255		Comments related to the GIS station information verification.
LocationCode	Text	**Desired**	50	Location LookUp	Describes the physical location in the waterbody where the sample was collected. One sampling event may have a single or multiple locations. Use "Not Recorded" if unknown.

CHEMISTRY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
GeometryShape	Text	No	50	Variable Codes LookUp; Geometry-ShapeList	Physical shape of the location. Example values are Line, Point, or Polygon.
CoordinateNumber	Integer	**Yes**			Number of coordinates recorded at a Location; e.g. 1 for Points (target and actual coordinates), 1 and 2 for Lines. Default value equals "1."
ActualLatitude	Decimal	**Yes**			Represents the actual latitude for the sample site in decimal degrees with 5 decimal places.
ActualLongitude	Decimal	**Yes**			Represents the actual longitude for the sample site in decimal degrees with 5 decimal places (must be negative).
Datum	Text	**Yes**	10	Variable Codes LookUp; DatumList	The Datum field records the datum that was used on the GPS Device to record the GPS measurements. Example = NAD83. If the datum is unknown, use "NR."
CoordinateSource	Text	**Desired**	50	Variable Codes LookUp; Coordinate-SourceList	Describes how the coordinate was measured. For example, if measurement was taken from a map or GPS. Use "NR" if unknown.
Elevation	Decimal	No			Elevation at which the sample was taken. Example = 1.
UnitElevation	Text	No	2	Variable Codes LookUp; Unit-Elevation-List	Unit of the Elevation measurement. Example = m
StationDetailVerBy	Text	No	100		Agency or person who performed the verification of the station detail information.
StationDetailVerDate	Date/ Time	No			Date the station detail information was verified; formatted as dd/mmm/yyyy.
StationDetailComments	Text	No	255		Comments related to the station detail information.

Chemistry Results Table

PURPOSE:

The purpose of the chemistry results table is to document the analysis results for water chemistry, bacteria and algae biomass. Note bacteria single species concentrations are stored within the following chemistry result table, whereas abundance bacteria are stored within the taxonomy template. Each record represents a result from a specific analysis for a single analyte in a single sample. This table will also contain all supporting QA sample results.

COLUMN REQUIREMENTS:

Columns within the CEDEN Chemistry Template tables are either considered 1) required, 2) desired or 3) not required. Required columns must be completed in order for data to be accepted by CEDEN. Desired columns are strongly encouraged and should be completed with known values, whenever possible. If the actual value is unknown, then the given default value **must** be used. Not required columns include additional information that aid in data usability. Individual column requirements are listed below:

Required Columns:

StationCode
SampleDate
ProjectCode
CollectionTime
CollectionMethodCode
SampleTypeCode
Replicate
CollectionDepth
UnitCollectionDepth
LabBatch
AnalysisDate
MatrixName
MethodName
AnalyteName
FractionName
UnitName
LabReplicate
Result
ResQualCode
MDL
RL
QACode

Desired Columns:

EventCode
ProtocolCode
AgencyCode
LocationCode
CollectionDeviceName
PositionWaterColumn
ComplianceCode
DilutionFactor
PrepPreservationName
PrepPreservationDate
DigestExtractMethod
DigestExtractDate

Not Required Columns:

SampleComments
GeometryShape
LabCollectionComments
ExpectedValue
SampleID
LabSampleID
LabResultComments

RESULTS TABLE STRUCTURE:

* Primary Key, required for record uniqueness.

CHEMISTRY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
StationCode*	Text	**Yes**	25	Station LookUp	A code representing the StationName and site and should be unique within CEDEN. A single waterbody may have multiple stations. StationCodes and station information must be submitted to the CEDEN system via the new vocabulary request process before lab data can be submitted.
SampleDate*	Date/ Time	**Yes**			Refers to the date the sample was collected in the field. Formatted as dd/mmm/yyyy. Use "01/Jan/1950" if the actual SampleDate is unknown.
ProjectCode	Text	**Yes**	25	Project LookUp	References the project that is associated with the sample.
EventCode	Text	**Desired**	20	Event LookUp	Represents the primary reason (e.g. water quality, tissue or bioassessment sampling) of the sampling event at a particular station and date.
ProtocolCode	Text	**Desired**	50	Protocol LookUp	Represents the sampling protocol used, which includes the set of methods, methodology and/or specifications, such as "MPSL-DFG_Field_v1.0." Established protocols may be used or Regions may document their own sampling protocols. Use "Not Recorded" when environmental samples are taken using unknown protocols. Use "Not Applicable" when LabQA samples are taken with unknown protocols.
AgencyCode	Text	**Desired**	20	Agency LookUp	Refers to the organization or agency that collected the sample. This should be listed on the Chain of Custody (COC) document that accompanies the samples from the field. Use "Not Recorded" if unknown.
SampleComments	Text	No	255		The comments field should be used for any notes or comments specifically related to the sample collection.

CHEMISTRY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
LocationCode	Text	**Desired**	50	Location LookUp	Describes the physical location in the waterbody where the sample was collected. One sampling event may have a single or multiple locations. Use "Not Recorded" when environmental samples are taken at an unknown location. For LabQA samples utilize "Not Applicable."
GeometryShape	Text	No	50	Variable Codes LookUp; Geometry-ShapeList	Physical shape of the location. Example values are Line, Point, or Polygon.
CollectionTime*	Date/ Time	**Yes**	20		Refers to the time when the first sample of a sampling event at a specific station was collected in the field. Format equals hh:mm. Use "00:00" if the time sampling started is unknown.
CollectionMethodCode	Text	**Yes**	50	Collection Method LookUp	Refers to the general method of collection such as Sed_Grab, Sed_Core, Water_Grab, Autosampler24h, Autosampler7d. Use "Not Recorded" when environmental samples are taken using an unknown method. For LabQA samples utilize "Not Applicable."
SampleTypeCode*	Text	**Yes**	20	Sample Type LookUp	Refers to the type of sample collected or analyzed. Use "Not Recorded" if unknown.
Replicate*	Integer	**Yes**			Used to distinguish between replicates created at a single collection in the field. The default value is "1." Replicate samples are collected at the same station and date. Therefore, samples collected on different dates from the same station should both have a Replicate value of "1."
CollectionDeviceName	Text	**Desired**	50	Collection Device Lookup	Name of the CollectionDevice. Use "Not Recorded" if unknown.

CHEMISTRY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
CollectionDepth	Decimal	**Yes**			Records the depth or penetration, from the surface in the water or sediment column, at which the sample was collected.
UnitCollectionDepth	Text	**Yes**	50	Variable Codes LookUp; Unit-Collection-DepthList	Refers to the units used in the CollectionDepth including cm (centimeters) and m (meters).
PositionWaterColumn	Text	**Desired**	20	Variable Codes LookUp; Position-Water-ColumnList	Position in water column where the sample was taken. Use "Not Applicable" if unknown.
LabCollectionComments	Text	No	255		Comments related to the LabCollection
LabBatch*	Text	**Yes**	35		The LabBatch is a unique code, provided by the laboratory, which represents a group of samples processed together. It groups all environmental samples with their supporting QC samples and will be used to verify completeness. This field is the primary key to ensure record uniqueness. To ensure uniqueness in the CEDEN system, the LabAgencyCode may be appended to this value when loaded to CEDEN. Please use a standard format to construct a composite Lab Batch. Format as LabBatch a dash (–) and the AgencyCode. Example: Batch1-SCCWRP. All LabBatch codes used on the ChemResults tab, must be detailed on the LabBatch tab.
AnalysisDate	Date/ Time	**Yes**			Date and time the sample was processed on the analytical instrument. Formatted as dd/mmm/yyyy hh:mm. Use "01/Jan/1950 00:00" if the actual date and time that the analysis was performed is unknown.
MatrixName*	Text	**Yes**	50	Matrix LookUp	Refers to the sample matrix, e.g. samplewater. Use "Not Recorded" if unknown.

CHEMISTRY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
MethodName*	Text	**Yes**	50	Method LookUp	Refers to the analysis method used by the laboratory to analyze the sample. Use "Not Recorded" if the method used is unknown.
AnalyteName*	Text	**Yes**	100	Analyte LookUp	Name of the analyte or parameter for which the analysis is conducted and result is reported. The LookUp list includes the acceptable abbreviation or name of the variable used by the database, enabling consistency across reporting.
FractionName*	Text	**Yes**	50	Fraction LookUp	Specific descriptor of the Analyte. For example, metals are often expressed as total or dissolved and therefore this description should be used within the fraction field.
UnitName*	Text	**Yes**	50	Unit LookUp	Refers to how the chemistry result is measured or expressed.
LabReplicate*	Integer	**Yes**			Used to distinguish between replicates created in the laboratory. It differentiates the original field sample that was analyzed from all subsequent laboratory duplicates. The default is "1."
Result	Text	**Yes**	50		Final numeric result of a given analyte, stored as text to retain trailing zeros. The result should be reported with the appropriate number of significant figures. Result may be left blank as long as an appropriate ResQualCode is provided.
ResQualCode	Text	**Yes**	10	ResQual LookUp	Qualifies the analytical result of the sample. Use "=" if unknown.
MDL	Decimal	**Yes**			The MDL (method detection limit) is the lowest possible calculated detection limit associated with a given method and analyte. The MDL should be reported on the lab summary sheet with the associated measured result. If an MDL is not listed on the lab summary sheet, then the default value should be "-88" with a QACode of "NMDL."

CHEMISTRY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
RL	Decimal	**Yes**			The RL (reporting limit) of the sample analyzed is the minimum value below which data are documented as non-quantifiable, as determined by the laboratory. The default value of "-88" is utilized for analytes such as surrogates or grain size samples.
QACode*	Text	**Yes**	30	QA LookUp	Applied to the result to describe any special conditions, situations or outliers that occurred during or prior to the analysis to achieve the result. The default code, indicating no special conditions, is "None." Use "NR" if the special conditions are unknown or if it is unknown whether there were special conditions. If more than one code should be applied to a record, the convention is to list them in alphabetical order separated by commas and no spaces.
ComplianceCode	Text	**Desired**		Data Compliance LookUp	Unique code describing the compliance with the associated Quality Assurance Project Plan (QAPP). Use "NR" if the compliance is unknown.
DilutionFactor	Decimal	**Desired**			Factor by which a sample was diluted and is reported as a whole number. It is equal to the final volume divided by the initial volume of solution, or DF = Vf ÷ Vi. The default value is "1," meaning no dilution was performed.
ExpectedValue	Decimal	No			Concentration of the analyte in a reference standard, laboratory control sample or matrix spike sample or the value expected to be obtained from analysis of the QC Sample. This consists of the native sample result concentration plus the spike amount. For surrogate samples, the expected value should be 100, representing 100%.

CHEMISTRY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
PrepPreservationName	Text	**Desired**	50	PrepPreservation LookUp	References the preparation or preservation method performed on the samples prior to analysis. Use "Not Recorded" if the preparation or preservation method is unknown. Use "None" if no preparation or preservation was performed.
PrepPreservationDate	Date/ Time	**Desired**			Date and time the preparation or preservation was started. Use "01/Jan/1950 00:00" if the date and time the process started isn't known or if no process was performed.
DigestExtractMethod	Text	**Desired**	50	Digest Extract LookUp	References the digestion or extraction method performed on the sample prior to analysis. Use "Not Recorded" if the preparation or preservation method is unknown. Use "None" if no preparation or preservation was performed.
DigestExtractDate	Date/ Time	**Desired**			Date and time the digestion or extraction was started. Use "01/Jan/1950 00:00" if the date and time the process started isn't known or if no process was performed.
SampleID	Text	No	40		Unique identifier supplied by the organization directing the sampling or sampling agency and is used to track the sample throughout the sampling and analysis processes. This field can be used to tie a result to the sample.
LabSampleID	Text	No	35		Recommended field intended to provide lab specific identification for an analyzed sample.
LabResultComments	Text	No	130		Holds any comments related to the lab result or analysis of the sample.

Chemistry LabBatch Table

PURPOSE:

The chemistry LabBatch table contains information about lab batches. A batch represents a group of samples processed together. It groups all environmental samples with their supporting QA samples. Review method or project specific requirements for specific batch definitions. Each project or method might have different requirements for a batch. An example batch for methods with no digestions or extractions would include all samples (including QA samples) processed by a single lab, within a 24 hour period, using a single preparation and analytical method. An example batch for methods with digestions or extractions would include all samples processed by a single lab, digested or extracted together, using a single preparation and analytical method. In some cases, a batch may include analyses for several analytes (as with most metals); in other cases, only a single analyte is included within a batch (as with Hardness as CaCO3). If your project requires QA samples, these are expected to be submitted with each batch

COLUMN REQUIREMENTS:

Columns within the CEDEN Chemistry Template tables are either considered 1) required, 2) desired or 3) not required. Required columns must be completed in order for data to be accepted by CEDEN. Desired columns are strongly encouraged and should be completed with known values, whenever possible. If the actual value is unknown, then the given default value **must** be used. Not required columns include additional information that aid in data usability. Individual column requirements are listed below:

Required Columns:

LabBatch
LabAgencyCode

Desired Columns:

LabSubmissionCode
BatchVerificationCode

Not Required Columns:

SubmittingAgencyCode
LabBatchComments

LABBATCH TABLE STRUCTURE:

* Primary Key, required for record uniqueness.

CHEMISTRY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
LabBatch*	Text	**Yes**	35		The LabBatch is a unique code, provided by the laboratory, which represents a group of samples processed together. It groups all environmental samples with their supporting QC samples and will be used to verify completeness. This field is the primary key to ensure record uniqueness. To ensure uniqueness in the CEDEN system, the LabAgencyCode may be appended to this value when loaded to CEDEN. Please use a standard format to construct a composite Lab Batch. Format as LabBatch a dash – and the AgencyCode. Example: Batch1-SCCWRP. All LabBatch codes used on the ChemResults tab must be detailed on the LabBatch tab.
LabAgencyCode*	Text	**Yes**	20	Agency LookUp	LabAgencyCode refers to the organization, agency or laboratory that performed the analysis on the sample. Use "Not Recorded" if the agency is unknown.
LabSubmissionCode	Text	**Desired**	10	Lab Submission Lookup	The LabSubmissionCode is a unique batch qualifier code assigned to the LabBatch as a whole that references the quality of the data in the LabBatch. The LabSubmissionCode is assigned by the analyzing laboratory, but should be reviewed by the Project Manager or other appropriate person to ensure that the code has been applied based on project specific data quality objectives and criteria. Use "NR" if the code is unknown.
BatchVerificationCode	Text	**Desired**	10	Batch Verification Lookup	Unique code referencing the Verification of a Batch. Use "NR" if unknown.
SubmittingAgencyCode	Text	No	20	Agency LookUp	Organization or agency that is responsible for submission of the data to the database. This agency may be different from LabAgencyCode if the analytical data were subcontracted to another agency.

CHEMISTRY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
LabBatchComments	Text	No	255		LabBatchComments records any comments relating to the LabBatch as a whole. Comments should explain any irregularities in sample processing.

Appendix A: Specific Entry for Laboratory and Field Generated QA Samples

INTRODUCTION

Appendix A has been created to give additional guidance regarding business rules and formatting of quality assurance data generated in the laboratory or in the field. The following sections on Laboratory QA Samples and Field Generated QA Samples list example values that can be used to ensure comparability with other QA samples generated with different projects. The example values are listed for a subset of the Chemistry Template columns and are associated with descriptions and business rules to further guide the data generator in how to format quality assurance data. The examples only reference a subset of the columns in the Chemistry Template; the Chemistry Data Submission Guidance Document main body should be used as a reference for definitions and associated lookup lists for how to populate the additional columns not addressed in the examples.

1. LABORATORY QA SAMPLES

The sections below provide examples for entering the following types of data into the chemistry templates:

1.1. Samples that are generated or created by a laboratory (LABQA)
1.2. Environmental samples that are modified by a laboratory for QA purposes (e.g. matrix spikes)

1.1 LABORATORY GENERATED QA SAMPLES (LABQA)

All samples generated from within the laboratory, such as a lab blank, laboratory control spike (LCS), or certified reference material (CRM), are entered into the chemistry template according to specific business rules. Table 1 is an example of the values that should be entered for laboratory generated QA (LABQA) samples within the chemistry template columns. Descriptions are included in Table 1 (Description & Business Rules) to further address formatting specifications, give additional details and note business rules. Specific business rules may vary by project and RDC; please check with your RDC to ensure appropriate business rules are being followed and/or any changes are appropriately documented.

Table 1. Example values to be used for laboratory generated QA samples (LABQA) for a subset of chemistry template columns.

Chemistry Template Header	Value	Description & Business Rules
StationCode	LABQA	"LABQA" is used as the station code for any sample generated in the laboratory including lab blanks, LCS and CRMs.
SampleDate		The SampleDate of a LABQA samples reflects the date that the sample was created within the laboratory. SampleDate must be equal to or before AnalysisDate and expressed as dd/mmm/yyyy.
ProjectCode		Populate with the associated project code within Project LookUp or use default value of "Not Applicable."

Chemistry Template Header	Value	Description & Business Rules
EventCode	WQ	For water and sediment chemistry use "WQ." See the EventCode LookUp list for additional EventCodes and associated definitions. The EventCode should be consistent with the environmental samples in the same batch.
ProtocolCode		Populate with applicable ProtocolCode within Protocol LookUp or use default value of "Not Applicable."
AgencyCode		Organization or agency that analyzed the sample. Select from Agency LookUp list or utilize the null value of "Not Recorded."
LocationCode	Not Applicable	LABQA samples are generated in the laboratory and therefore are associated with a LocationCode of "Not Applicable."
GeometryShape		Leave blank
CollectionTime	00:00	LABQA are associated with 00:00 time for collection since they are generated in the laboratory. BR: There are situations within a batch when two identical sample types are used for QA reasons and the only way to differentiate between them is to give them each a different CollectionTime. For example, when more than one CNEG is analyzed in the same batch but are not replicates of each other, one CollectionTime should be 0:00 and the other 0:15, increasing the time by 15 minutes for each additional sample. Adjusting the Replicate to differentiate between samples is also acceptable.
CollectionMethodCode	Not Applicable	LABQA samples are generated in the laboratory and therefore are not associated with a sample LocationCode.
SampleTypeCode	LabBlank, LCS or CRM	Select from SampleTypeLookUp List – LabBlank, LCS and CRM are listed as the most common LABQA sample types.
Replicate	1	BR: There are situations within a batch when two identical sample types are used for QA reasons and the only way to differentiate between them is to give them each a different CollectionTime (See collection time for details) or Replicate.
CollectionDeviceName		Leave blank; there is no CollectionDeviceName associated with LABQA and this field does not need to be populated.
CollectionDepth	-88	"-88" is used as a null value for LABQA samples. This field must be populated with a number and cannot be left blank.
UnitCollectionDepth	m	For water use "m" for meter.
	cm	For sediment use "cm" for centimeter.
PositionWaterColumn	Not Applicable	LABQA samples are generated in the laboratory and therefore there is associated with the PositionWaterColumn value of "Not Applicable."
Matrix	labwater	See Matrix LookUp for definition.
	blankwater	See Matrix LookUp for definition.
	blankmatrix	See Matrix LookUp for definition.
	sediment	See Matrix LookUp for definition.
LabReplicate	1	Use a LabReplicate of "1" for the original LABQA sample.
	2	Use a LabReplicate of "2" for a duplicate LABQA sample.

BR: Business Rule

1.2 LABORATORY MODIFIED QA SAMPLES

There are several types of samples discussed in this section that are generated or modified within the laboratory. The first is a matrix spike, which is a modified, or analyte-spiked, field sample. The second is a laboratory generated duplicate of a field sample. At times, laboratories use samples not generated through the data generator's project to satisfy project specific batch QA requirements. This third type is a non-project sample.

1.2.1 MATRIX SPIKE AND LABORATORY DUPLICATE SAMPLES

For matrix spike samples (collected by the project) and laboratory duplicate samples performed on project sample (native field sample), all fields describing the sample (StationCode, EventCode, ProtocolCode, LocationCode, SampleDate, CollectionTime, CollectionMethodCode, CollectionDepth, UnitCollectionDepth, ProjectCode, AgencyCode) remain the same as the native sample. For matrix spike samples, the only fields that are different than the native field sample are SampleTypeCode and potentially the Replicate. For laboratory generated duplicate samples, the only field that is different than the native field sample is the LabReplicate. Table 2 lists the column headers in the chemistry template that describe the sample and give example values and associated descriptions/business rules to aid the data generator in populating those fields for their own data.

Table 2. Example values to be used for matrix spike and laboratory duplicate samples created from project specific samples (native field sample).

Chemistry Template Header	Value	Description & Business Rules
StationCode		Same as native field sample
SampleDate		Same as native field sample
ProjectCode		Same as native field sample
EventCode		Same as native field sample
ProtocolCode		Same as native field sample
AgencyCode		Same as native field sample
LocationCode		Same as native field sample
GeometryShape		Same as native field sample
CollectionTime		Same as native field sample
CollectionMethodCode		Same as native field sample
SampleTypeCode		For laboratory generated duplicates this is the same SampleTypeCode as the native field sample.
	MS1	Matrix Spike performed on a Grab or Integrated sample
	MS2	Matrix Spike performed on a field duplicate sample (native field sample will have a SampleTypeCode of Grab or Integrated with a Replicate of 2).
	MSBLDup	Matrix Spike performed on a field blind duplicate (FieldBLDup).

Chemistry Template Header	Value	Description & Business Rules
		BR: There are situations when a Matrix Spike was unintentionally performed on a blank sample such as a FieldBlank, TravelBlank, EquipBlank, DIBlank or FilterBlank. A batch may include two or more of these types of native samples where the only difference between them is the environmental sample's SampleTypeCode. The only way to differentiate between them is to give each a different CollectionTime. For example, when a batch contains both a DIBlank and an EquipBlank (both with an original time of 0:00) and a Matrix Spike was performed on the EquipBlank, one CollectionTime should be 0:00 and the other 0:15. Then the associated native sample CollectionTime should correspond to the MS1 sample times. For example, the EquipBlank would have a native sample time of 00:00 and an MS1 time of 00:00 and the DIBlank would have a native sample time of 00:15 (updated from 00:00).
Replicate	1	
CollectionDeviceName		Same as native field sample
CollectionDepth		Same as native field sample
UnitCollectionDepth		Same as native field sample
Matrix		Same as native field sample
LabReplicate	1	Native field sample or Matrix Spike
	2	Laboratory generated duplicate or Matrix Spike duplicate

BR = Business Rule

1.2.1.1 Matrix Spike Samples performed on Field Duplicates

Table 3 describes the way to format matrix spike samples performed on field duplicates (Replicate = 2), field blind duplicates (FieldBLDup), and composite blind duplicates (CompBLDup) in CEDEN as well as coding duplicate samples.

Table 3. Formatting field duplicates and matrix spikes.

	Descriptions	Chemistry Template Header		
		Sample Type Code	Replicate	Lab Replicate
1	**One environmental sample: sampled or split in triplicate**			
	Single environmental sample	Grab	1	1
	Field duplicate of single environmental sample	Grab	2	1
	Second field duplicate of single environmental sample	Grab	3	1
2	**One environmental sample: sampled or split in triplicate and submitted to the laboratory blind (unknown to the laboratory)**			
	Single environmental sample	Grab	1	1

		Chemistry Template Header		
	Descriptions	**Sample Type Code**	**Replicate**	**Lab Replicate**
	Field blind duplicate of single environmental sample	FieldBLDup or CompBLDup	1	1
	Second field blind duplicate of single environmental sample	FieldBLDup or CompBLDup	2	1
3	**One pair of MS/MSD: associated to one grab**			
	Single environmental sample	Grab	1	1
	Matrix spike of single environmental sample	MS1	1	1
	Matrix spike duplicate of single environmental sample	MS1	1	2
4	**One pair of MS/MSD: associated to one grab with field duplicate present**			
	Single environmental sample	Grab	1	1
	Field duplicate of single environmental sample	Grab	2	1
	Matrix spike of single environmental sample	MS1	1	1
	Matrix spike duplicate of single environmental sample	MS1	1	2
5	**One pair of MS/MSD: associated to one field duplicate**			
	Single environmental sample	Grab	1	1
	Field duplicate of single environmental sample	Grab	2	1
	Matrix spike of field duplicate sample	MS2	1	1
	Matrix spike duplicate of field duplicate sample	MS2	1	2
6	**One pair of MS/MSD: associated to one field blind duplicate**			
	Single environmental sample	Grab	1	1
	Field blind duplicate of single environmental sample	FieldBLDup or CompBLDup	1	1
	Matrix spike of field blind duplicate sample	MSBLDup	1	1
	Matrix spike duplicate of field blind duplicate sample	MSBLDup	1	2
7	**Two pairs of MS/MSD: one associated to the grab and one associated to the field duplicate**			
	Single environmental sample	Grab	1	1
	Field duplicate of single environmental sample	Grab	2	1
	Matrix spike of single environmental sample	MS1	1	1
	Matrix spike duplicate of single environmental sample	MS1	1	2
	Matrix spike of field duplicate sample	MS2	1	1
	Matrix spike duplicate of field duplicate sample	MS2	1	2

1.2.2 NON-PROJECT MATRIX SPIKE AND DUPLICATE SAMPLES (000NONPJ)

At times, laboratories use samples not generated through the project to satisfy batch QA requirements. These samples have different formatting rules, which are displayed in Table 4. In most cases, non-project samples have no sample collection information since they are used only to satisfy batch QA requirements. Please contact your RDC if the formatting rules in Table 4 are not applicable to non-project data for your data set.

Table 4. Example values to be used with non-project (000NONPJ) matrix spike and duplicates samples and associated business rules.

Chemistry Template Header	Value	Description & Business Rules
StationCode	000NONPJ	"000NONPJ" is the StationCode associated with an environmental sample that was collected by a different project but used for laboratory quality assurance purposes (i.e. duplicate or matrix spike).
SampleDate		SampleDate must be equal to or before AnalysisDate and expressed as dd/mmm/yyyy. Suggested date would be the earliest date of manipulation.
ProjectCode		Utilize ProjectCode of 000NONPJ sample or default value of "Not Applicable" if not known.
EventCode	WQ	For water and sediment chemistry use "WQ". See the EventCode LookUp list for additional EventCodes and associated definitions. The EventCode should be consistent with the environmental samples in the same batch.
ProtocolCode		Utilize ProtocolCode of 000NONPJ sample or default value of "Not Applicable" if not known.
AgencyCode		Organization or agency that analyzed the sample. Select from Agency LookUp list. Use "Not Recorded" if unknown.
LocationCode		Utilize LocationCode of 000NONPJ sample or null value of "Not Recorded" if not known.
Geometry Shape		Leave blank.
CollectionTime		Utilize CollectionTime of 000NONPJ sample or null value of 00:00 if not known. BR: There are situations within a batch when two identical sample types are used for QA reasons and the only way to differentiate between them is to give them each a different CollectionTime. For example, when more than one LabBlank, CRM, or LCS is digested, extracted, or analyzed in the same batch on the same day but are not replicates of each other, one CollectionTime should be 0:00 and the other 0:15, increasing the time by 15 minutes for each additional sample. Adjusting the Replicate to differentiate between samples is also acceptable.
CollectionMethodCode		Utilize CollectionMethodCode of 000NONPJ sample or null value of "Not Recorded" if not known.

Chemistry Template Header	Value	Description & Business Rules
SampleTypeCode		Select from the SampleTypeCode LookUp list for 000NONPJ laboratory duplicates. Use "Not Recorded" if SampleType is unknown.
	MS1	"MS1" is used for laboratory matrix spikes created with 000NONPJ samples. See *Table 3: Formatting field duplicated and matrix spikes* for additional business rules regarding matrix spikes.
Replicate		Utilize Replicate of 000NONPJ sample or default value of "1" if not known. BR: There are situations within a batch when two identical sample types are used for QA reasons and the only way to differentiate between them is to give them each a different CollectionTime (See *CollectionTime* for details) or Replicate.
CollectionDeviceName		Utilize CollectionDeviceName of 000NONPJ sample or leave blank if not known.
CollectionDepth		Utilize CollectionDepth of 000NONPJ sample or null value of "-88" if not known. This field must be populated with a number and cannot be left blank.
UnitCollectionDepth	m	For water use "m" for meter.
	cm	For sediment use "cm" for centimeter.
PositionWaterColumn		Utilize PositionWaterColumn of 000NONPJ sample or default value of "Not Applicable."
Matrix		Utilize Matrix of 000NONPJ sample. If the actual matrix is not known, use "samplewater" for water samples and "sediment" for sediment samples.
QACode	QAX	"QAX" is associated with 000NONPJ samples when the native sample is not included in the batch reported.
	None	If the batch includes the native 000NONPJ sample result as well as the laboratory quality assurance 000NONPJ sample, "None" or appropriate QACode to indicate recoveries outside criteria or other QA issues (see QACode Lookup list).
Preparation Preservation		Actual preparation or preservation performed. This should be the same as the other samples in the batch.
Preparation Preservation Date		Actual preparation or preservation date and time expressed as dd/mmm/yyyy hh:mm
LabReplicate	1	Original 000NONPJ samples and original 000NONPJ matrix spike samples are associated with a LabReplicate of "1".
	2	Matrix spike duplicates and laboratory duplicates are associated with a LabReplicate of "2".
SampleID		The *LabSampleID* or *Source ID* can be used here as the *SampleID* as an indicator to identify the native sample. This column may be left blank.
LabSampleID		Recommended - provide lab specific identification for an analyzed sample. It is preferable to add -Dup, -MS, -MSD to the end of the Lab ID to help confirm the SampleTypeCode and the LabSampleID of the native sample. This column can be left blank.

BR = Business Rule

2. FIELD GENERATED QA SAMPLES

There are two types of blank samples discussed in this section that are generated as field quality assurance samples. The first is when a field generated QA sample is created at a specific station and that station information is important to record. For example, some projects may allow a certain amount to be detected in the blank provided it is less than five times the native (environmental) sample. For those situations it would be important to have similar sample information between the blank and the native sample to evaluate quality assurance criteria. The second example is when a field generated QA sample is created for a sampling trip or if the station information is not recorded.

Field duplicate samples should be associated with a station and that information should be the same as the native sample such that the sample collection information is identical between the field duplicate and native sample except that the field duplicate is associated with a Replicate of "2." Therefore, the following section is specific to field generated blanks.

2.1 FIELD GENERATED BLANK SAMPLES – STATION SPECIFIC

For analyses that require an EquipBlank, TravelBlank, FieldBlank, or FilterBlank to accompany a sampling event and where it is important to record the station information, the data are entered into CEDEN in the same manner as the native samples collected at that station. Table 5 lists the chemistry template column headers and associated descriptions and business rules for guidance.

Table 5. Example values to be used for field generated blank samples associated with station specific details.

Chemistry Template Header	Value	Description & Business Rules
StationCode		Same as native sample. BR: For EquipBlanks, TravelBlanks or FilterBlanks that may be created at a laboratory or agency prior to sampling, a StationCode may still be applied to the sample if it serves the purpose of the project to associate all field and laboratory QA samples together (i.e. via the same sample entry information).
SampleDate		Same as native sample.
ProjectCode		Same as native sample.
EventCode	WQ	Same as native sample. For water and sediment chemistry use "WQ."
ProtocolCode		Same as native sample.
AgencyCode		Same as native sample.
LocationCode		Same as native sample.
GeometryShape		Same as native sample.
CollectionTime		Time sample was created (same as native sample time) or "00:00."
		There are situations within a batch when two identical sample types are used for QA reasons and the only way to differentiate between them is to give them each a different *CollectionTime*. For example, when more than one EquipBlank, FieldBlank, or FilterBlank is created on the same day but are not replicates of each other, one *CollectionTime* should be 00:00 and the other 00:15, increasing the time by 15 minutes for each additional sample.
CollectionMethodCode	Not Applicable	Field generated blanks are associated with the CollectionMethodCode of "Not Applicable."
SampleTypeCode	EquipBlank, TravelBlank, FieldBlank or FilterBlank	See the SampleTypeCode LookUp list for definitions of the various field generated QA SampleTypeCodes.
Replicate	1	Field generated blanks should have a replicate of "1."
CollectionDeviceName	Not Applicable	Field generated blanks are associated with the CollectionDeviceName of "Not Applicable."
CollectionDepth	-88	Field generated blanks are not generated using environmental water and therefore are associated with a null value (-88) for CollectionDepth.
UnitCollectionDepth	m	For water use "m" for meter.
LabCollection Comments		It is recommended that when an equipment blank (EquipBlank) is generated, a comment is recorded that lists the type of equipment cleaned and location (lab or field). A value is not required for this field and can be left blank.
Matrix	Labwater or blankwater	See Matrix LookUp for definitions.
LabSampleID		Recommended - provide lab specific identification for an analyzed sample.

BR = Business Rule

2.2 FIELD GENERATED BLANK SAMPLES (FIELDQA) – NON STATION SPECIFIC

For analyses that require an EquipBlank, FieldBlank, FilterBlank, TravelBlank or DIBlank to accompany a sampling event and it is not important to record the station information, the data are not associated with specific sample collection information. Table 6 lists example values that are to be used for generic blank samples generated in the field and associated description and business rules that can be used for guidance for data entry.

Table 6. Example of values to be used for field generated blank samples that are not associated with station specific details (FIELDQA).

Chemistry Template Header	Value	Description & Business Rules
StationCode	FIELDQA	Field generated blanks not associated with a specific station are associated with the StationCode "FIELDQA."
SampleDate		Date that the sample was created. BR: TravelBlank should be entered as the date the TravelBlank becomes part of the sample group (i.e., leaves the lab for the sampling event).
ProjectCode		Project associated with the sample.
EventCode	WQ	Same as native sample. For water and sediment chemistry use "WQ."
ProtocolCode		Protocol used or "Not Recorded."
AgencyCode		Organization or agency that created the sample.
LocationCode	Not Applicable	Since the FIELDQA blank sample is not associated with a specific station, the LocationCode is "Not Applicable."
GeometryShape	Not Applicable	Since the FIELDQA blank sample is not associated with a specific station, the GeometryShape is "Not Applicable."
CollectionTime		Time sample was created or "00:00." There are situations within a batch when two identical sample types are used for QA reasons and the only way to differentiate between them is to give them each a different *CollectionTime*. For example, when more than one EquipBlank, FieldBlank, or FilterBlank is created on the same day but are not replicates of each other, one *CollectionTime* should be 00:00 and the other 00:15, increasing the time by 15 minutes for each additional sample.
CollectionMethodCode	Not Applicable	Field generated blanks including FIELDQA are associated with the CollectionMethodCode of "Not Applicable."
SampleTypeCode	EquipBlank, TravelBlank, FieldBlank, FilterBlank or DIBlank	See the SampleTypeCode lookup list for definitions of the various field generated QA SampleTypeCodes.
Replicate	1	Field generated blanks including FIELDQA should have a replicate of "1."

Chemistry Template Header	Value	Description & Business Rules
CollectionDeviceName	Not Applicable	Field generated blanks including FIELDQA are associated with the CollectionDeviceName of "Not Applicable."
CollectionDepth	-88	Field generated blanks including FIELDQA are not generated using environmental water and therefore are associated with a null value (-88) for CollectionDepth.
UnitCollectionDepth	m	For water use "m" for meter.
LabCollection Comments		It is recommended that when an equipment blank (EquipBlank) is generated, a comment is recorded that lists the type of equipment cleaned and location (lab or field).A value is not required for this field and can be left blank.
Matrix	Labwater or blankwater	See MatrixLookup for definitions.
LabSampleID		Recommended - provide lab specific identification for an analyzed sample.

BR = Business Rule

Appendix B: Chemistry Data Submission Guidance Documentation Amendments

AMENDMENTS

Amendments made to the CEDEN Chemistry Data Submission Guidance Document are documented within Table 1.

Table 7. Amendments made to the Chemistry Data Submission Guidance Document.

Date of Amendment	Document Section	Amendment Summary	Amendment Details
August 23rd 2013	List of Acronyms	Added acronyms.	Added SWAMP and QAO to the List of Acronyms.
August 23rd 2013	Stations Table: Column Requirements	Updated required field designations for Stations Table.	Updated required field designations for Stations Table. Required Columns: Added: StationAgency, SWRCBWatTypeCode. Desired Columns: Added: CoordinateSource Removed: LocalWatershed, LocalWaterbody, Counties_2004_County, SWRCBWatTypeCode, CalWater_2004_RB. Not Required Columns: Added:EventType1, EventType2, EventType3, LocalWaterShed, LocalWaterBody, Counties_2004_COUNTY, CalWater_2004_RB, NHD_PlusCatchmentComID. Removed: CalWater_2004_SWRCBNUM2 HydrologicUnit
August 23rd 2013	Stations Table	Added Additional Resources section to Stations Table.	Added an "Additional Resources" section to the Stations Table after Column Requirements.
August 23rd 2013	Stations Table: Stations Table Structure: StationSource	Updated StationSource LookUp list and definition.	Updated StationSource LookUp List from blank to "AgencyLookUp or ProjectLookUp".Updated Definition from "Agency or project that created the station." to "Agency or project that submitted the station to CEDEN".
August 23rd 2013	Stations Table: Stations Table Structure	Added new fields to the Stations Table.	Added new fields to Stations Table Structure: StationAgency, EventType1, EventType2, EventType3 and NHD_Plus_CatchmentComID.
August 23rd 2013	Stations Table: Stations Table Structure: AddDate	Added format information to AddDate	Added "Format as dd/mmm/yyyy" to the AddDate definition.

Date of Amendment	Document Section	Amendment Summary	Amendment Details
August 23rd 2013	Stations Table: Stations Table Structure	Added default value information to Stations Table definitions.	Added default value information to the description field within the Stations Table for CoordinateNumber, Datum, CoordinateSource, SWRCBWatTypeCode
August 23rd 2013	Stations Table: Stations Table Structure: State	Added LookUp list information to State.	Updated State LookUp List from blank to "VariableCodesLookUp".
August 23rd 2013	Stations Table: Stations Table Structure	Updated Stations Table template header names.	Updated Stations Table template header names: "NHD24K_GNIS_Name" to "NHD_24K_v2_GNIS_Name", "NHD24k_Reachcode" to "NHD_24k_v2_ReachCode", "NHD24k_HUC12" to "NHD_24k_v2_HUC_12" and "NHD24k_Hu_12_Name" to "NHD_24k_v2_Name".
August 23rd 2013	Chemistry LabBatch Table: Column Requirements	Updated required field designations for Chemistry LabBatch Table.	Updated required field designations for Chemistry LabBatch Table: Required Columns: Added: LabAgencyCode. Desired Columns: Removed: LabAgencyCode,
August 23rd 2013	Chemistry LabBatch Table: LabBatch Table Structure	Added default value information to LabBatch Table definitions.	Added default value information to the description field within the LabAgencyCode, LabSubmissionCode and BatchVerificationCode.
August 23rd 2013	Chemistry Results Table: Purpose	Updated the Chemistry Results Table purpose section to specify where bacteria results are stored within CEDEN.	Updated Chemistry Results Table purpose language from "The purpose of the chemistry results table is to document the analysis results for water chemistry and algae biomass. Each record represents a result from a specific analysis for a single analyte in a single sample. This table will also contain all supporting QA sample results" to "The purpose of the chemistry results table is to document the analysis results for water chemistry, bacteria and algae biomass. Note bacteria single species concentrations are stored within the following chemistry result table, whereas abundance bacteria are stored within the taxonomy template. Each record represents a result from a specific analysis for a single analyte in a single sample. This table will also contain all supporting QA sample results."

Date of Amendment	Document Section	Amendment Summary	Amendment Details
August 23rd 2013	Chemistry Results Table: Column Requirements	Updated required field designations for Chemistry Results Table.	Updated required field designations for Chemistry Results Table: Desired Columns: Added: EventCode, PositionWaterColumn; Removed: ExpectedValue. Not Required Columns: Added: ExpectedValue; Removed: PositionWaterColumn,
August 23rd 2013	Chemistry Results Table: Stations Table Structure	Added default value information to Results Table definitions.	Added default value information to the description field within the SampleDate, ProtocolCode, AgencyCode, LocationCode, CollectionTime, CollectionMethodCode, SampleTypeCode, CollectionDeviceName, PositionWaterColumn, AnalysisDate, MatrixName, MethodName, ResQualCode, QACode, ComplianceCode, PrepPreservationName, PrePreservationDate, DigestExtractMethod, and DigestExtractDate.
August 23rd 2013	Chemistry Results Table: Stations Table Structure: Result	Added language to Result definition.	Added the following language to the Results field: "Result may be left blank as long as an appropriate ResQualCode is provided."
August 23rd 2013	Chemistry Results Table: Stations Table Structure: DilutionFactor	Updated Data Type for DilutionFactor	Updated DilutionFactor Data Type from Integer to Decimal.
October 11th 2013	Introduction	Updated Southern California RDC contact information.	Updated Southern California RDC contact information from Shelly Moore to Marlene Hanken contact information.
March 17th 2014	Appendix A	Updated Table 1 Matrix Descriptions	Updated Table 1 Matrix descriptions to "See Matrix LookUp for definition."
January 3rd, 2017	Introduction, Station Table, and Chemistry Table	Removed references to Stations tab	Removed the Stations section and references to Stations tab, updated effected screen shot, and modified StationCode definition to note that station codes must be established through the new vocabulary request process prior to subittal.
January 3rd, 2017	All	Updated use of quotes	Replaced single quotes with double quotes.
January 3rd, 2017	Locations Table, Chemistry Results Table, LabBatch Table	Updated description of "desired" fields	Added reference to using default values when actual values are not know for "desired" fields in the "Column Requirements" paragraph.
January 3rd, 2017	List of Terms	Updated links	Added current links for the LookUp lists and vocabulary request process.
January 3rd, 2017	Introduction	Updated Central Coast RDC contact information	Updated the Central Coast RDC contact information from Mark Pranger to Stacey Swenson.
January 3rd, 2017	Chemistry Table and LabBatch Table	Switched order of sections	Moved Chemistry Table to be before LabBatch table to reflect the order in the template.

Date of Amendment	Document Section	Amendment Summary	Amendment Details
January 3rd, 2017	Locations Table, Chemistry Results Table, LabBatch Table	Modified use of "default" wording	Changed most instances of "Default equals…if unknown" to "Use…if unknown."
January 3rd, 2017	All	Various edits	Removed double spaces and duplicate words and other small edits.
January 3rd, 2017	Locations Table and Chemistry Results Table	Updated StationCode definition	Included that StationCode must be unique within CEDEN, not just within the study design, as previously stated.
January 8th, 2019	Introduction	Updated RDCs	Removed SCCWRP as current RDC.
January 8th, 2019	Locations Table, Chemistry Results Table, LabBatch Table	Updated wording for "desired" (default required) fields	Changed "should" to "must" for "desired" fields in the "Column Requirements" paragraphs.
January 8th, 2019	Locations Table and Chemistry Results Table	Variable Code List references	Added references to the appropriate lists in the Lookup List columns for fields that rely on Variable Codes.

I3. Toxicity Data Submission Guidance

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CEDEN

California Environmental Data Exchange Network

Toxicity Data Submission Guidance Document

Updated January 8, 2019

Table of Contents

List of Acronyms

CEDEN	California Environmental Data Exchange Network
CNEG	Laboratory Toxicity Negative Control Sample
LABQA	Laboratory Quality Assurance or Laboratory Generated Quality Assurance Samples
RDC	Regional Data Center
QA	Quality Assurance
SWAMP	Surface Water Ambient Monitoring Program
QAO	Quality Assurance Officer

List of Terms

Controlled Vocabulary	Controlled vocabulary refers to codes and associated definitions maintained within CEDEN to ensure comparability between and among data sets. Current controlled vocabulary contained within associated lookup lists can be found at: http://ceden.org/CEDEN_checker/Checker/LookUpLists.php. The process for adding new values can be found at: http://ceden.org/vocabulary_request.shtml.
Data Checker	Web-based automated tool that assists data submitters in examining their data sets against the required LookUp lists, formats and business rules.
LookUp Lists	Controlled vocabularies are maintained within the CEDEN database as "LookUp Lists" and are managed through individual RDCs to maintain comparability between RDCs and throughout data sets available through CEDEN.
Primary Key	Uniquely identifies each row in a table and is comprised of a set of columns. No two distinct rows in a table can have the same combination of column values. Required for record uniqueness.
Data Type	Refers to the type of format required for a specific column heading in CEDEN templates. Data type examples include: integer (whole numbers), text, date and time, and decimal.

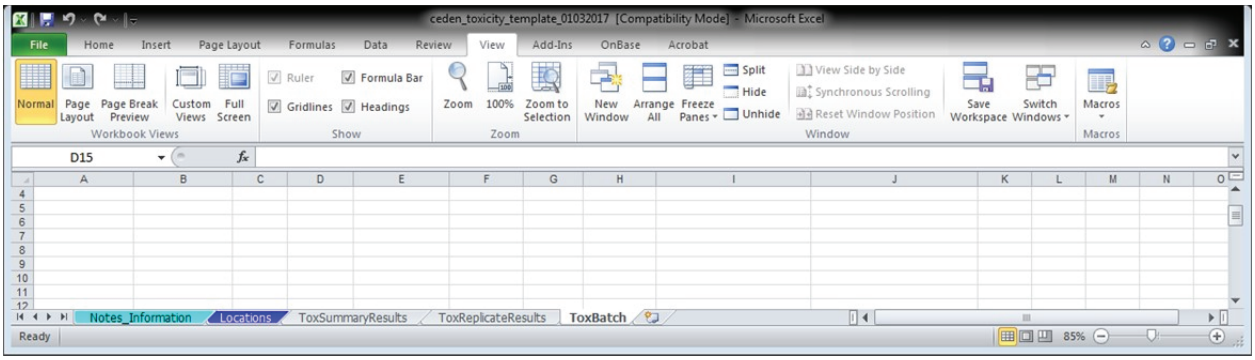
Introduction

This document is designed to provide guidance on reporting requirements for electronic data to be entered in the California Environmental Data Exchange Network (CEDEN) templates. Detailed below are definitions of data elements and rules for formatting toxicity data within the CEDEN toxicity template. For information on entering laboratory QA samples, i.e. negative control samples, see Appendix A. Please review the entire Toxicity Data Submission Guidance Document prior to filling out or submitting the CEDEN Toxicity Template. If you have any questions regarding these guidelines, contact your Regional Data Center (RDC) for help.

Regional Data Center (RDC)	Contact	Phone Number	Email
Central Coast RDC	Stacey Swenson	831/771-4114	sswenson@mlml.calstate.edu
Central Valley RDC	Melissa Turner	530/756-5200	mturner@mlj-llc.com
San Francisco RDC	Cristina Grosso	510/746-7371	cristina@sfei.org

Toxicity Data Submission Steps

To submit water quality toxicity data to CEDEN, start with the CEDEN_Toxicity_Template excel file you received from your Regional Data Center (RDC). In this template you will find the five data tables (each in a separate worksheet) required for submitting toxicity data. This file can be named at the discretion of the user; however, the Excel sheet tabs **MUST** be named **Locations**, **ToxSummaryResults**, **ToxReplicateResults** and **ToxBatch** respectively.



CEDEN Toxicity Template Tables

Below describes what is included and submission requirements for each of the 4 tables in the CEDEN Toxicity Template:

1. Locations
    a. Holds information about location sampled
    b. Required only if actual unique latitudes and longitudes were recorded for each sampling event.
2. ToxSummaryResults
    a. Used to record toxicity summary results
    b. Required to be submitted with the ToxBatch table. It is desired to include both the ToxSummaryResults and ToxReplicateResults tab but it is not required.

3. ToxReplicateResults
    a. Used to record toxicity replicate results
    b. Used to record toxicity in-test water quality measurements as well.
    c. Required to be submitted with the ToxBatch table. It is desired to include both the ToxSummaryResults and ToxReplicateResults tables but it is not required.
4. ToxBatch
    a. Used to record toxicity batch information necessary for analyzing the data
    b. Required and must be submitted with the ToxSummaryResults and/or ToxReplicateResults table.

The guidelines in the following sections will assist you in getting your data into the CEDEN Toxicity Template tables. However, if at any time you have questions more specific to your data, (e.g. adding new codes to LookUp lists) contact your local RDC.

Once you have placed your data into the CEDEN Toxicity Template tables, visit your Regional Data Center's website to check and submit your data. Regional Data Center information can be found at: http://www.ceden.org/data_centers.shtml. The online data submission process includes specific checks on your data to ensure both data integrity and comparability with other data sets. Once your data has passed all of the checks it will be uploaded into the centralized CEDEN database and become available through the CEDEN website (www.ceden.org).

Toxicity Template Data Tables

Locations Table

PURPOSE:

The locations table contains specific information about the locations sampled. Actual latitudes and longitudes are recorded here for each sampling event. In the event that only target latitudes and longitudes were recorded, it is sufficient to fill out the Stations table only.

COLUMN REQUIREMENTS:

Columns within the CEDEN Toxicity Template tables are either considered 1) required, 2) desired or 3) not required. Required columns must be filled out in order for data to be accepted by CEDEN. Desired columns are strongly encouraged and should be completed with known values, whenever possible. If the actual value is unknown, then the given default value **must** be used. Not required columns include additional information that aid in data usability. Individual column requirements are listed below:

Required Columns:

StationCode
SampleDate
ProjectCode
CoordinateNumber
ActualLatitude
ActualLongitude
Datum

Desired Columns:

EventCode
ProtocolCode
AgencyCode
LocationCode
CoordinateSource

Not Required Columns:

SampleComments
GeometryShape
Elevation
UnitElevation
StationDetailVerBy
StationDetailVerDate
StationDetailComments

LOCATIONS TABLE STRUCTURE:

* Primary Key, required for record uniqueness.

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
StationCode*	Text	**Yes**	25	Station LookUp	A code representing the StationName and site and should be unique within CEDEN. A single waterbody may have multiple stations. StationCodes and station information must be submitted to the CEDEN system via the new vocabulary request process before lab data can be submitted.
SampleDate*	Date/ Time	**Yes**	20		Refers to the date the sample was collected in the field; formatted as dd/mmm/yyyy.
ProjectCode*	Text	**Yes**	25	Project LookUp	References the project that is associated with the sample.
EventCode	Text	**Desired**	20	Event LookUp	Represents the primary reason (e.g. water quality, tissue or bioassessment sampling) of the sampling event at a particular station and date.
ProtocolCode	Text	**Desired**	50	Protocol LookUp	Represents the sampling protocol used, which includes the set of methods, methodology and/or specifications, such as "MPSLDFG_Field_v1.0." Established protocols may be used or Regions may document their own sampling protocols. Use "Not Recorded" when environmental samples are taken using unknown protocols.
AgencyCode	Text	**Desired**	20	Agency LookUp	Refers to the organization or agency that collected the sample. This should be listed on the Chain of Custody (COC) document that accompanies the samples from the field. Use "Not Recorded" if unknown.
SampleComments	Text	No	255		Comments related to the GIS station information verification.
LocationCode	Text	**Desired**	50	Location LookUp	Describes the physical location in the waterbody where the sample was collected. One sampling event may have a single or multiple locations. Use "Not Recorded" if unknown.

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
GeometryShape	Text	No	50	Variable Codes LookUp; Geometry-ShapeList	Physical shape of the location. Example values are Line, Point, or Polygon.
CoordinateNumber	Integer	**Yes**			Number of coordinates recorded at a Location; e.g. 1 for Points (target and actual coordinates), 1 and 2 for Lines. Default value equals "1."
ActualLatitude	Decimal	**Yes**			Represents the actual latitude for the sample site in decimal degrees with 5 decimal places.
ActualLongitude	Decimal	**Yes**			Represents the actual longitude for the sample site in decimal degrees with 5 decimal places (must be negative).
Datum	Text	**Yes**	10	Variable Codes LookUp; DatumList	The Datum field records the datum that was used on the GPS Device to record the GPS measurements. Example = NAD83. If the datum is unknown, use "NR."
CoordinateSource	Text	**Desired**	50	Variable Codes LookUp; Coordinate-SourceList	Describes how the coordinate was measured. For example, if measurement was taken from a map or GPS. Use "NR" if unknown.
Elevation	Decimal	No			Elevation at which the sample was taken. Example = 1.
UnitElevation	Text	No	2	Variable Codes LookUp; Unit-Elevation-List	Unit of the Elevation measurement. Example = m
StationDetailVerBy	Text	No	100		Agency or person who performed the verification of the station detail information.
StationDetailVerDate	Date/ Time	No			Date the station detail information was verified; formatted as dd/mmm/yyyy.
StationDetailComments	Text	No	255		Comments related to the station detail information.

ToxBatch Table

PURPOSE:

The ToxBatch table contains information about toxicity batches. A batch groups all environmental samples and supporting QA samples within a unique analysis batch. Batches should only include one species and should not combine test types, i.e. reference toxicants and sample results should not be in the same batch.

COLUMN REQUIREMENTS:

Columns within the CEDEN Toxicity Template tables are either considered 1) required, 2) desired or 3) not required. Required columns must be filled out in order for data to be accepted by CEDEN. Desired columns are strongly encouraged and should be completed with known values, whenever possible. If the actual value is unknown, then the given default value **must** be used. Not required columns include additional information that aid in data usability. Individual column requirements are listed below:

Required Columns:

ToxBatch
StartDate
LabAgencyCode

Desired Columns:

LabSubmissionCode
BatchVerificationCode
RefToxBatch

Not Required Columns:

OrganismAgeAtTestStart
SubmittingAgencyCode
OrganismSupplier
ToxBatchComments

TOXBATCH TABLE STRUCTURE:

* Primary Key, required for record uniqueness.

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
ToxBatch*	Text	**Yes**	50		The ToxBatch is a unique code, provided by the laboratory, which represents a group of samples processed together. It groups all environmental samples with their supporting QC samples and will be used to verify completeness. Batches should only include one species and should not combine test types, i.e. reference toxicants and sample results should not be in the same batch. It is recommended that the species code be included in the ToxBatch. To ensure uniqueness in the CEDEN system, the LabAgencyCode may be appended to this value when loaded to CEDEN. Please use a standard format to construct a composite ToxBatch. Format as ToxBatch a dash – and the AgencyCode. Example: Batch1SCCWRP.
StartDate	Date/ Time	**Yes**			StartDate refers to the date the toxicity test began. Use "01/Jan/1950 00:00" if unknown.
LabAgencyCode*	Text	**Yes**	20	Agency LookUp	LabAgencyCode refers to the organization, agency or laboratory that performed the analysis on the sample. Default value equals Not Recorded.
LabSubmissionCode	Text	**Desired**	10	Lab Submission Lookup	The LabSubmissionCode is a unique batch qualifier code assigned to the ToxBatch as a whole by the analyzing laboratory which references the quality of the data in the ToxBatch. The LabSubmissionCode should be reviewed by the Project Manager or other appropriate person to ensure that the code has been applied based on project specific data quality objectives and criteria. Use "NR" if unknown.

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
BatchVerificationCode	Text	**Desired**	10	Batch Verification Lookup	Unique code referencing the Verification of a Batch. If the Batch Verification used is not found in the lookup list please contact your Regional Data Center for assistance. Use “NR” if unknown..
RefToxBatch	Text	**Desired**	25		RefToxBatch lists the Reference Tox Batch ID run with this batch of samples. Use “NR” if unknown.
OrganismAgeAtTestStart	Text	No	10		OrganismAgeAtTestStart indicates the age or age range (e.g. 7 days or 7-10 days) of the test organisms at the beginning of the test. The age or range is usually recommended by the method.
SubmittingAgencyCode	Text	No	20	Agency LookUp	Organization or agency that is responsible for submission of the data to the database. This agency may be different from LabAgencyCode if the toxicity tests were subcontracted to another agency.
OrganismSupplier	Text	No	75		OrganismSupplier refers to the agency that supplied the test organisms.
ToxBatchComments	Text	No	255		ToxBatchComments records any comments relating to the ToxBatch as a whole. Comments should explain any irregularities in sample processing and/or execution of the testing procedures.

ToxSummaryResults Table

PURPOSE:

The purpose of the toxicity summary table is to hold the core toxicity summary data including the mean, toxicity significance, and percent of effect. Each record represents the mean of a particular organism analyzed by a particular method at a specific station. Both the environmental sample and negative control should be included in this table.

COLUMN REQUIREMENTS:

Columns within the CEDEN Toxicity Template tables are either considered 1) required, 2) desired or 3) not required. Required columns must be filled out in order for data to be accepted by CEDEN. Desired columns are strongly encouraged and should be completed with known values, whenever possible. If the actual value is unknown, then the given default value **must** be used. Not required columns include additional information that aid in data usability. Individual column requirements are listed below:

Required Columns:

StationCode	**TestDuration**	**TimePoint**
SampleDate	**OrganismName**	**RepCount**
ProjectCode	**QAControlID**	**Mean**
CollectionTime	**Treatment**	**StdDev**
CollectionMethodCode	**Concentration**	**StatisticalMethod**
SampleTypeCode	**UnitTreatment**	**AlphaValue**
Replicate	**Dilution**	**CalcValueType**
CollectionDepth	**WQSource**	**CalculatedValue**
UnitCollectionDepth	**ToxPointMethod**	**CriticalValue**
ToxBatch	**AnalyteName**	**PercentEffect**
MatrixName	**FractionName**	**SigEffect**
MethodName	**UnitAnalyte**	**TestQACode**

Desired Columns:

EventCode	**PositionWaterColumn**
ProtocolCode	**TestExposureType**
AgencyCode	**bValue**
LocationCode	**ComplianceCode**
CollectionDeviceName	

Not Required Columns:

SampleComments	MSD
GeometryShape	EvalThreshold
LabCollectionComments	TIENarrative
ToxTestComments	
SampleID	ToxPointSummaryComments
LabSampleID	

TOX SUMMARY RESULTS TABLE STRUCTURE:

* Primary Key, required for record uniqueness.

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
StationCode*	Text	**Yes**	25	Station LookUp	A code representing the StationName and site and should be unique within CEDEN. A single waterbody may have multiple stations. StationCodes and station information must be submitted to the CEDEN system via the new vocabulary request process before lab data can be submitted.
SampleDate*	Date/ Time	**Yes**			Refers to the date the sample was collected in the field. Formatted as dd/mmm/yyyy.
ProjectCode	Text	**Yes**	25	Project LookUp	References the project that is associated with the sample.
EventCode	Text	**Desired**	20	Event LookUp	Represents the primary reason (e.g. water quality, tissue or bioassessment sampling) of the sampling event at a particular station and date.
ProtocolCode	Text	**Desired**	50	Protocol LookUp	Represents the sampling protocol used, which includes the set of methods, methodology and/or specifications, such as "MPSL-DFG_Field_v1.0." Established protocols may be used or Regions may document their own sampling protocols. Use "Not Recorded" when environmental samples are taken using unknown protocols.
AgencyCode	Text	**Desired**	20	Agency LookUp	Refers to the organization or agency that collected the sample. This should be listed on the Chain of Custody (COC) document that accompanies the samples from the field. Use "Not Recorded" if unknown.
SampleComments	Text	No	255		The comments field should be used for any notes or comments specifically related to the sample collection.

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION

LocationCode	Text	**Desired**	50	Location LookUp	Describes the physical location in the waterbody where the sample was collected. One sampling event may have a single or multiple locations. The default value of "Not Recorded" is utilized for environmental samples if unknown. For LabQA samples, utilize "Not Applicable."
GeometryShape	Text	No	50	Variable Codes LookUp; Geometry-ShapeList	Physical shape of the location. Example values are Line, Point, or Polygon.
CollectionTime*	Date/ Time	**Yes**	20		Refers to the time when the first sample of a sampling event at a specific station was collected in the field. Format equals hh:mm. Use "00:00" if the time sampling started is unknown.
CollectionMethodCode	Text	**Yes**	50	Collection Method LookUp	Refers to the general method of collection such as Sed_Grab, Sed_Core, Water_Grab, Autosampler24h, Autosampler7d. Use "Not Recorded" when environmental samples are taken using an unknown method. For LabQA samples utilize "Not Applicable."
SampleTypeCode*	Text	**Yes**	20	Sample Type LookUp	Refers to the type of sample collected or analyzed. Use "Not Recorded" if unknown.
Replicate*	Integer	**Yes**			Used to distinguish between replicates created at a single collection in the field. The default value is 1. Replicate samples are collected at the same station and date. Therefore, samples collected on different dates from the same station should both have a Replicate value of "1."
CollectionDeviceName	Text	**Desired**	50	Collection Device Lookup	Name of the CollectionDevice. Use "Not Recorded" if unknown.
CollectionDepth	Decimal	**Yes**			Records the depth or penetration, from the surface in the water or sediment column, at which the sample was collected.
UnitCollectionDepth	Text	**Yes**	50	Variable Codes LookUp	Refers to the units used in the CollectionDepth including cm (centimeters) and m (meters).

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
PositionWaterColumn	Text	**Desired**	20	Variable Codes LookUp; Position-Water-ColumnList	Position in water column where the sample was taken. Use "Not Applicable" if unknown.
LabCollectionComments	Text	No	255		Comments related to the LabCollection
ToxBatch*	Text	**Yes**	35		The ToxBatch is a unique code, provided by the laboratory, which represents a group of samples processed together. It groups all environmental samples with their supporting QC samples and will be used to verify completeness. Batches should only include one species and should not combine test types, i.e. reference toxicants and sample results should not be in the same batch. It is recommended that the species code be included in the ToxBatch. To ensure uniqueness in the CEDEN system, the LabAgencyCode may be appended to this value when loaded to CEDEN. Please use a standard format to construct a composite ToxBatch. Format as ToxBatch a dash – and the AgencyCode. Example: Batch1-SCCWRP
MatrixName*	Text	**Yes**	50	Matrix LookUp	Refers to the sample matrix, e.g. samplewater. Use "Not Recorded" if unknown.
MethodName*	Text	**Yes**	50	Method LookUp	Refers to the analysis method used by the laboratory to analyze the sample. Use "Not Recorded" if the method used is unknown.
TestDuration	Text	**Yes**	10	ToxTestDur LookUp	ToxTestDurCode indicates the duration of the toxicity test as a number and includes the associated units.
OrganismName	Text	**Yes**	100	Organism LookUp	OrganismName (FinalID) refers to the scientific name of the species used in the toxicity test.

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
TestExposureType	Text	**Desired**		Variable Codes LookUp; Test-Exposure-TypeList	Describes the type of exposure. Toxicity test exposure type based on the test method. Populate field with Acute or Chronic values. Use "Not Recorded" if unknown.
QAControlID	Text	**Yes**			LabSampleID of the control sample used for statistical comparisons
SampleID	Text	No	35		Unique identifier supplied by the organization directing the sampling or sampling agency and is used to track the sample throughout the sampling and analysis processes. This field can be used to tie a result to the sample.
LabSampleID	Text	No	35		Recommended field intended to provide lab specific identification for an analyzed sample.
ToxTestComments	Text	No	255		Holds any comments related to the toxicity test results. Usually provided by the laboratories or QA personnel. Examples include: comments about sample test anomalies, temperature changes, high DO values that may affect all other results, etc.
Treatment	Text	**Yes**	255	Analyte Lookup	Treatment refers to any treatment performed on the sample, such as a pH adjustment. Default value is "None."
Concentration	Integer	**Yes**			Concentration refers to the adjusted final concentration or value of the analyte applied to the toxicity sample, expressed as a number. Default value is "0."
UnitTreatment	Text	**Yes**	50	Unit LookUp	UnitTreatment refers to the units used in the treatment. When the treatment is "None," the default for unit is "None."
Dilution	Integer	**Yes**			Dilution is recorded as a proportion of the original sample. If no dilution is performed, the default value of "100" is used. A sample with 80% sample and 20% blank water has a dilution value of "80."

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
WQSource	Text	**Yes**	50	Matrix LookUp	WQSource differentiates between water quality measurements taken in the overlying water or interstitialwater (pore water). Default value equals "Not Applicable" for toxicity endpoints.
ToxPointMethod	Text	**Yes**		Method LookUp	ToxPointMethod refers to the general method used in obtaining or calculating the result. Toxicity replicate and summary data have a default value of "None" unless a method other than the test MethodName is used for the calculations.
AnalyteName*	Text	**Yes**	100	Analyte LookUp	Name of the analyte or parameter for which the analysis is conducted and result is reported. The LookUp list includes the acceptable abbreviation or name of the variable used by the database, enabling consistency across reporting.
FractionName*	Text	**Yes**	50	Fraction LookUp	Specific descriptor of the Analyte. For example, Ammonia as NH3 are often expressed as total or unionized and therefore this description should be used within the fraction field.
UnitAnalyte*	Text	**Yes**	50	Unit LookUp	UnitAnalyte indicates the units used in the measurement of the AnalyteName.
TimePoint*	Text	**Yes**	10	Time Point LookUp	TimePoint is the code value that represents the point in time during the test at which the measurement was recorded for water quality measurements or the day on which the end points were taken. Example if a test was originally going to last 7 days but the endpoints were taken on the 6th day then the TimePoint would indicate "Day 6."
RepCount	Integer	**Yes**			RepCount is the total number of sample replicates analyzed for the associated toxpoint in the toxicity test i.e. RepCount equals the number of lab replicates used to calculate the mean result.
Mean	Decimal	**Yes**			Mean is the average result calculated from all replicates of a single sample.

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
StdDev	Decimal	**Yes**			StdDev or standard deviation is a statistic that indicates how tightly all the replicates are clustered around the mean in a set of data. This calculation includes all the applicable replicates from a single sample.
StatisticalMethod	Text	**Yes**		Variable Codes LookUp; StatMethod-List	StatisticalMethod is the statistical test or method used to calculate the probability of whether a test is significant or not. Used to determine whether the sample replicates are significantly different from the control. Use "NR" when unknown.
AlphaValue	Decimal	**Yes**			AlphaValue is the predetermined statistical acceptance level that is not calculated, but is chosen by the laboratory when running the statistical method.
bValue	Decimal	**Desired**			bValue represents the threshold for unacceptable toxicity or the Regulatory Management Decision (RMD) associated with hypothesis testing between the control and sample
CalcValueType	Text	**Yes**		Variable Codes LookUp; CalcValue-TypeList	Calculated statistical type. For example Probability or T value.
CalculatedValue	Decimal	**Yes**			Calculated statistic from associated statistical method. Note when utilizing a CalcValueType of Probability ,negative control samples (CNEG) are "0.5."
CriticalValue	Decimal	**Yes**			The derived critical value based on sample size and alpha value of the statistical test. The CriticalValue is compared to the calculated value in the associated statistical test.
PercentEffect	Decimal	**Yes**			Percent difference between the mean of the endpoint and the mean of the control's associated endpoint; ((Mean Control Response – Mean Sample Response) / Mean Control Response) * 100.

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
MSD	Decimal	No			The minimum significant difference (MSD) is a measurement that can be produced for each statistical comparison performed between sample and control, or among multiple concentrations of a sample and control. It represents the smallest significant difference from the control and is unique for each statistical comparison. This number should be reported as a percentage, e.g., "20" = 20%. For the EPA TST method there is no MSD value therefore the MSD field should be left blank.
EvalThreshold	Decimal	No			The evaluation threshold or EvalThreshold is the programmatic level that is used to identify that an environmental sample is biologically significantly different from its associated control sample and is recorded as a percentage. EvalThreshold is compared to the PercentEffect field. In cases where programs use program specific MSDs the EvalThreshold will equal the MSD and will be compared to the PercentEffect. If you are utilizing the TST method this field corresponds to the critical difference in the EPA TST methods.
SigEffect	Text	**Yes**	10	SigEffect Lookup	The toxicity significant effect code or SigEffect indicates whether the sample result is significantly different from the control and can include whether or not it is greater or less than the evaluation threshold. Default value equals NR for environmental samples. Default value equals NA for LABQA with a CriticalValueType of Probability.

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
TestQACode	Text	**Yes**	30	QA LookUp	Applied to the result to describe any special conditions, situations or outliers that occurred during or prior to the analysis to achieve the result. The default code, indicating no special conditions, is "None." If more than one code needs to be applied to a record, the convention is to list them in alphabetical order separated by commas and no spaces. Use "NR" if unknown.
ComplianceCode	Text	**Desired**	25	Data Compliance LookUp	Unique code referencing the Compliance with the associated QAPP. Use "NR" if unknown.
ToxPointSummary Comments	Text	No	130		The SummaryComments field includes any comments necessary to describe special circumstances for the toxicity summary data for the specific record.
TIENarrative	Text	No	64000		Short narrative on the results of the toxicity identification evaluation (TIE).

ToxReplicateResults Table

PURPOSE:

The purpose of the toxicity replicate results table is to hold toxicity replicate data including in-test water quality measurements. This table should complement the toxicity summary results and provide the data that was used to calculate the summary results. This data will allow for external statistical analysis of the toxicity test replicates as well as provide environmental conditions of the samples to account for variability of the results and quality control review. Each record represents a replicate result of a particular organism analyzed by a particular method at a specific station or a particular water quality measurement at a specific point in time. Both the environmental and negative control samples should be included in this table.

COLUMN REQUIREMENTS:

Columns within the CEDEN Toxicity Template tables are either considered 1) required, 2) desired or 3) not required. Required columns must be filled out in order for data to be accepted by CEDEN. Desired columns are strongly encouraged and should be completed with known values, whenever possible. If the actual value is unknown, then the given default value **must** be used. Not required columns include additional information that aid in data usability. Individual column requirements are listed below:

Required Columns:

StationCode	**MatrixName**	**WQSource**
SampleDate	**MethodName**	**ToxPointMethod**
ProjectCode	**TestDuration**	**AnalyteName**
CollectionTime	**OrganismName**	**FractionName**
CollectionMethodCode	**QAControlID**	**UnitAnalyte**
SampleTypeCode	**Treatment**	**TimePoint**
Replicate	**Concentration**	**LabReplicate**
CollectionDepth	**UnitTreatment**	**Result**
UnitCollectionDepth	**Dilution**	**ResQualCode**
ToxBatch		

Desired Columns:

EventCode	**PositionWaterColumn**
ProtocolCode	**TestExposureType**
AgencyCode	**OrganismPerRep**
LocationCode	**ToxResultQACode**
CollectionDeviceName	**ComplianceCode**

Not Required Columns:

SampleComments	LabSampleID
GeometryShape	ToxTestComments
LabCollectionComments	ToxResultComments
SampleID	

TOX REPLICATE RESULTS TABLE STRUCTURE:

* Primary Key, required for record uniqueness.

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
StationCode*	Text	**Yes**	25	Station LookUp	A code representing the StationName and site and should be unique within CEDEN. A single waterbody may have multiple stations. StationCodes and station information must be submitted to the CEDEN system via the new vocabulary request process before lab data can be submitted.
SampleDate*	Date/ Time	**Yes**			Refers to the date the sample was collected in the field. Formatted as dd/mmm/yyyy. Use "01/Jan/1950" if the actual SampleDate is unknown.
ProjectCode	Text	**Yes**	25	Project LookUp	References the project that is associated with the sample.
EventCode	Text	No	20	Event LookUp	Represents the primary reason (e.g. water quality, tissue or bioassessment sampling) of the sampling event at a particular station and date.
ProtocolCode	Text	**Desired**	50	Protocol LookUp	Represents the sampling protocol used, which includes the set of methods, methodology and/or specifications, such as "MPSLDFG_Field_v1.0." Established protocols may be used or Regions may document their own sampling protocols. Use "Not Recorded" when environmental samples are taken using unknown protocols. Use "Not Applicable" when LabQA samples are taken with unknown protocols.
AgencyCode	Text	**Desired**	20	Agency LookUp	Refers to the organization or agency that collected the sample. This should be listed on the Chain of Custody (COC) document that accompanies the samples from the field. Use "Not Recorded" if unknown.
SampleComments	Text	No	255		The comments field should be used for any notes or comments specifically related to the sample collection.

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
LocationCode	Text	**Desired**	50	Location LookUp	Describes the physical location in the waterbody where the sample was collected. One sampling event may have a single or multiple locations. The default value of Not Recorded is utilized for environmental samples if unknown. For LabQA samples, utilize "Not Applicable."
GeometryShape	Text	No	50	Variable Codes LookUp; Geometry-ShapeList	Physical shape of the location. Example values are Line, Point, or Polygon.
CollectionTime*	Date/ Time	**Yes**	20		Refers to the time when the first sample of a sampling event at a specific station was collected in the field. Format equals hh:mm. Use "00:00" if the time sampling started is unknown.
CollectionMethodCode	Text	**Yes**	50	Collection Method LookUp	Refers to the general method of collection such as Sed_Grab, Sed_Core, Water_Grab, Autosampler24h, Autosampler7d. The default value of Not Recorded is utilized for environmental samples if unknown. For LabQA samples utilize "Not Applicable."
SampleTypeCode*	Text	**Yes**	20	Sample Type LookUp	Refers to the type of sample collected or analyzed. Use "Not Recorded" if unknown.
Replicate*	Integer	**Yes**			Used to distinguish between replicates created at a single collection in the field. Default value is 1. Replicate samples are collected at the same station and date. Therefore, samples collected on different dates from the same station should both have a value of 1 for FieldReplicate.
CollectionDeviceName	Text	**Desired**	50	Collection Device LookUp	Name of the CollectionDevice. Use "Not Recorded" if unknown.
CollectionDepth	Decimal	**Yes**			Records the depth and penetration, from the surface in the water or sediment column, at which the sample was collected.

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
UnitCollectionDepth	Text	**Yes**	50	Variable Codes LookUp; Unit-Collection-DepthList	Refers to the units used in the CollectionDepth including cm (centimeters) and m (meters).
PositionWaterColumn	Text	No	20	Variable Codes LookUp; Position-Water-ColumnList	Position in water column where sample was taken. Use "Not Applicable" if unknown.
LabCollection Comments	Text	No	255		Comments related to the LabCollection
ToxBatch*	Text	**Yes**	50		The ToxBatch is a unique code, provided by the laboratory, which represents a group of samples processed together. It groups all environmental samples with their supporting QC samples and will be used to verify completeness. Batches should only include one species and should not combine test types, i.e. reference toxicants and sample results should not be in the same batch. It is recommended that the species code be included in the ToxBatch. To ensure uniqueness in the CEDEN system, the LabAgencyCode may be appended to this value when loaded to CEDEN. Please use a standard format to construct a composite ToxBatch. Format as ToxBatch a dash – and the AgencyCode. Example: Batch1SCCWRP
MatrixName*	Text	**Yes**	50	Matrix LookUp	Refers to the sample matrix, e.g. samplewater. Use "Not Recorded" if unknown.
MethodName*	Text	**Yes**	50	Method LookUp	Refers to the analysis method used by the laboratory to analyze the sample. Use "Not Recorded" if unknown.

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
TestDuration*	Text	**Yes**	10	ToxTestDur LookUp	ToxTestDurCode indicates the duration of the toxicity test as a number and includes the associated units.
OrganismName*	Text	**Yes**	100	Organism LookUp	OrganismName refers to the scientific name of the species used in the toxicity test.
TestExposureType	Text	**Desired**		Variable Codes LookUp; Test-Exposure-List	Describes the type of exposure. Toxicity test exposure type based on the test method. Populate field with "Acute" or "Chronic values." Default value equals Not Recorded if unknown.
QAControlID	Text	**Yes**			LabSampleID of the control sample used for statistical comparisons
SampleID	Text	No	35		Unique identifier supplied by the organization directing the sampling or sampling agency and is used to track the sample throughout the sampling and analysis processes. This field can be used to tie a result to the sample.
LabSampleID	Text	No	35		Recommended field intended to provide lab specific identification for an analyzed sample.
ToxTestComments	Text	No	255		Holds any comments related to the toxicity test results. Usually provided by the laboratories or QA personnel. Examples include: comments about sample test anomalies, temperature changes, high DO values that may affect all other results, etc.
Treatment	Text	**Yes**	255	Analyte Lookup	Treatment refers to any treatment performed on the sample, such as a pH adjustment. Default value is "None."
Concentration	Integer	**Yes**			Concentration refers to the adjusted final concentration or value of the analyte applied to the toxicity sample, expressed as a number. Default value is "0."

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
Unit Treatment	Test	Yes	50	Unit LookUp	UnitTreatment refers to the units used in the treatment. When the treatment is none, the default for unit is "None."
Dilution	Integer	Yes			Dilution is recorded as a proportion of the original sample. If no dilution is performed, the default value of "100" is used. A sample with 80% sample and 20% blankwater has a dilution value of "80."
WQSource	Text	Yes	50	Matrix LookUp	WQSource differentiates between water quality measurements taken in the overlying water as well as in the sediment or interstitial water. Default value equals Not Applicable for toxicity endpoints. Default value equals Not recorded for water quality measurements if unknown.
ToxPointMethod	Text	Yes	50	Method LookUp	ToxPointMethod refers to the general method used in obtaining or calculating the result. Toxicity replicate and summary data have a default value of "None" unless a method other than the test MethodName is used for the calculations. Water quality measurement results have a default value of "ToxWQMeasurement."
AnalyteName*	Text	Yes	100	Analyte LookUp	Name of the analyte or parameter for which the analysis is conducted and result is reported. The LookUp list includes the acceptable abbreviation or name of the variable used by the database, enabling consistency across reporting.
FractionName*	Text	Yes	50	Fraction LookUp	Specific descriptor of the Analyte. For example, metals are often expressed as total or dissolved and therefore this description should be used within the fraction field.
UnitAnalyte*	Text	Yes	50	Unit LookUp	UnitAnalyte indicates the units used in the measurement of the AnalyteName.

TOXICITY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
TimePoint*	Text	**Yes**	10	TimePoint LookUp	TimePoint is the code value that represents the point in time during the test at which the measurement was recorded for water quality measurements or the day on which the end points were taken. Example if a test was originally going to last 7 days but the endpoints were taken on the 6th day then the TimePoint would indicate "Day 6."
LabReplicate*	Integer	**Yes**			The LabReplicate identifies the individual splits of the toxicity sample and is used to identify from which replicate a result originated.
OrganismPerRep	Integer	**Desired**			Number of organisms in each replicate. Default value equals "-88" when unknown. Default value for ToxWQMeasurements equals "0."
Result	Text	**Yes**	10		Numeric result of test, stored as text to retain trailing zeros. Result may be left blank as long as an appropriate ResQualCode is provided.
ResQualCode	Text	**Yes**	10	ResQual LookUp	The Result Qualifier Code or ResultQualCode qualifies the analytical result of the sample. Default value equals "=."
ToxResultQACode	Text	**Desired**	30	ToxResultQA LookUp	A ToxResultQACode is used to further qualify the analytical result of the sample. Default value equals None.
ComplianceCode	Text	**Desired**	25	Data Compliance LookUp	Unique code referencing the compliance with the associated QAPP. Default value equals NR if unknown.
ToxResultComments	Text	No	255		In the ToxResultsComments field note any comments necessary to describe special circumstances for the toxicity results data for the specific record. These could be comments needed to clarify any portion of the analysis which is not described in any other field. Examples include: survival may be low due to lost individuals, questionable hardness due to probe variances, etc.

Appendix A: Specific Entry for Laboratory Generated QA Samples

INTRODUCTION

Appendix A has been created to give additional guidance regarding business rules and formatting of quality assurance data generated in the laboratory. The following sections on Laboratory Quality Assurance (QA) Samples list example values that can be used to ensure comparability with other QA samples generated with different projects. The example values are listed for a subset of the Toxicity Template columns and are associated with descriptions and business rules to further guide the data generator in how to format quality assurance data. Because the examples below only reference a subset of the columns in the Toxicity Template, the Toxicity Data Submission Guidance Document main body should be used as a reference for definitions and associated LookUp lists for how to populate the additional columns not addressed in the examples.

1. LABORATORY QA SAMPLES

The section below provides examples for entering negative controls, i.e. laboratory control samples.

1.1 LABORATORY GENERATED QA SAMPLES (LABQA)

All samples generated from within the laboratory, such as CNEG, should be entered into the Toxicity Template according to specific business rules. Below is an example of the data that should be entered for laboratory-generated QA samples for the specific Toxicity Template columns.

Table 1. Example values to be used for laboratory generated QA samples (LABQA) for a subset of toxicity template columns.

Toxicity Template Column Header	Value	Description & Business Rules
StationCode	LABQA	LABQA is used as the station code for any sample generated in the laboratory including CNEG, CSNL. etc.
SampleDate		SampleDate of LABQA reflects the date that the sample was created within the laboratory. SampleDate must be equal to or before AnalysisDate and expressed as dd/mmm/yyyy.
ProjectCode		Populate with applicable project code within Project LookUp or use default value of "Not Applicable"
EventCode	WQ	For water and sediment toxicity use "WQ." See the EventCode LookUp list for additional EventCodes and associated definitions. The EventCode should be consistent with the environmental samples in the same batch.
ProtocolCode		Populate with applicable ProtocolCode within Protocol LookUp or use default value of "Not Applicable"

Toxicity Template Column Header	Value	Description & Business Rules
AgencyCode		Organization or agency that analyzed the sample. Select from Agency LookUp list. Or utilize null value of "Not Recorded."
LocationCode	Not Applicable	LABQA samples are generated in the laboratory and therefore are associated with a LocationCode of "Not Applicable."
GeometryShape		Leave blank
CollectionTime	00:00	LABQA are associated with 00:00 time for collection since they are generated in the laboratory. BR: There are situations within a batch when two identical sample types are used for QA reasons and the only way to differentiate between them is to give them each a different CollectionTime. For example, when more than one CNEG is analyzed in the same but are not replicates of each other, one CollectionTime should be 0:00 and the other 0:15, increasing the time by 15 minutes for each additional sample. Adjusting the Replicate to differentiate between samples is also acceptable.
CollectionMethodCode	Not Applicable	LABQA samples are generated in the laboratory and therefore are not associated with a sample LocationCode.
SampleTypeCode	CNEG	Select from SampleTypeLookUp List. CNEG is listed as the most common LABQA sample type code for toxicity data.
Replicate	1	BR: There are situations within a batch when two identical sample types are used for QA reasons and the only way to differentiate between them is to give them each a different CollectionTime (See collection time for details) or Replicate.
CollectionDeviceName		Leave blank; there is no CollectionDeviceName associated with LABQA and this field does not need to be populated.
CollectionDepth	-88	"-88" is used as a null value for LABQA samples. This field must be populated with a number and cannot be left blank.
UnitCollectionDepth	m	For water use "m" for meter.
	cm	For sediment use "cm" for centimeter.
PositionWaterColumn	Not Applicable	LABQA samples are generated in the laboratory and therefore are associated with the PositionWaterColumn value of "Not Applicable."
Matrix	labwater	See Matrix LookUp for definition.
	blankwater	See Matrix LookUp for definition.
	blankmatrix	See Matrix LookUp for definition.
	sediment	See Matrix LookUp for definition.
LabReplicate	1	LabReplicate "1" is associated with the original LABQA sample.
	2	LabReplicate "2" is associated with a duplicate LABQA sample.

BR: Business Rule

Appendix B: Toxicity Data Submission Guidance Documentation Amendments

AMENDMENTS

Amendments made to the CEDEN Toxicity Data Submission Guidance Document are documented within Table 1.

Table 2. Amendments made to the Toxicity Data Submission Guidance Document.

Date of Amendment	Document Section	Amendment Summary	Amendment Details
August 23rd 2013	List of Acronyms	Added acronyms.	Added SWAMP and QAO to the List of Acronyms.
August 23rd 2013	Stations Table: Column Requirements	Updated required field designations for Stations Table.	Updated required field designations for Stations Table. Required Columns: Added: StationAgency, SWRCBWatTypeCode. Desired Columns: Added: CoordinateSource Removed: LocalWatershed, LocalWaterbody, Counties_2004_County, SWRCBWatTypeCode, CalWater_2004_RB. Not Required Columns: Added: EventType1, EventType2, EventType3, LocalWaterShed, LocalWaterBody, Counties_2004_COUNTY, CalWater_2004_RB, NHD_PlusCatchmentComID. Removed: CalWater_2004_SWRCBNUM2 HydrologicUnit
August 23rd 2013	Stations Table	Added Additional Resources section to Stations Table.	Added an "Additional Resources" section to the Stations Table after Column Requirements.
August 23rd 2013	Stations Table: Stations Table Structure: StationSource	Updated StationSource LookUp list and definition.	Updated StationSource LookUp List from blank to "AgencyLookUp or ProjectLookUp." Updated Definition from "Agency or project that created the station." to "Agency or project that submitted the station to CEDEN."
August 23rd 2013	Stations Table: Stations Table Structure	Added new fields to the Stations Table.	Added new fields to Stations Table Structure: StationAgency, EventType1, EventType2, EventType3 and NHD_Plus_CatchmentComID.

Date of Amendment	Document Section	Amendment Summary	Amendment Details
August 23rd 2013	Stations Table: Stations Table Structure: AddDate	Added format information to AddDate	Added "Format as dd/mmm/yyyy" to the AddDate definition.
August 23rd 2013	Stations Table: Stations Table Structure	Added default value information to Stations Table definitions.	Added default value information to the description field within the Stations Table for CoordinateNumber, Datum, CoordinateSource, SWRCBWatTypeCode
August 23rd 2013	Stations Table: Stations Table Structure: State	Added LookUp list information to State.	Updated State LookUp List from blank to "VariableCodesLookUp".
August 23rd 2013	Stations Table: Stations Table Structure	Updated Stations Table template header names.	Updated Stations Table template header names: "NHD24K_GNIS_Name" to "NHD_24K_v2_GNIS_Name", "NHD24k_Reachcode" to "NHD_24k_v2_ReachCode", "NHD24k_HUC12" to "NHD_24k_v2_HUC_12" and "NHD24k_Hu_12_Name" to "NHD_24k_v2_Name".
August 23rd 2013	ToxBatch Table: Column Requirements	Updated required field designations for ToxBatch Table.	Updated required field designations for ToxBatch Table. Required Columns: Added: LabAgencyCode. Desired Columns: Removed: LabAgencyCode OrganismAgeAtTestStart; Not Required Columns: Added: OrganismAgeAtTestStart.
August 23rd 2013	ToxBatch Table: ToxBatch Table Structure	Added default value information to ToxBatch Table definitions.	Added default value information to the description field within the ToxBatch Table for LabAgencyCode, LabSubmissionCode, BatchVerificaitonCode and RefToxBatch.
August 23rd 2013	ToxSummaryResults Table: Column Requirements	Updated required field designations for ToxSummaryResults Table.	Updated required field designations for ToxSummaryResults Table: Desired Columns: Added: EventCode, PositionWaterColumn; Removed: QAControlID, MSD, EvalThreshold. Not Required Columns: Added: QAControlID, MSD, EvalThreshold; Removed: PositionWaterColumn.

Date of Amendment	Document Section	Amendment Summary	Amendment Details
August 23rd 2013	ToxSummaryResults Table: ToxSummaryResults Table Structure	Deleted fields within the ToxSummaryResults Table.	Deleted fields within ToxSummaryResults Table Structure: Probability and PercentControl.
August 23rd 2013	ToxSummaryResults Table: ToxSummaryResults Table Structure	Added new fields to the ToxSummaryResults Table.	Added new fields to ToxSummaryResults Table Structure: CalcValueType, CalculatedValue CriticalValue, bValue and TestExposureType.
August 23rd 2013	ToxSummaryResults Table: ToxSummaryResults Table Structure	Added default value information to ToxSummaryResults Table definitions.	Added default value information to the description field within the ToxSummaryResults Table for SampleDate, ProtocolCode, AgencyCode, LocationCode, CollectionTime, CollectionMethodCode, SampleTypeCode, CollectionDeviceName, PositionWaterColumn, MatrixName, MethodName, WQSource, SigEffect, TestQACode and ComplianceCode .
August 23rd 2013	ToxSummaryResults Table: ToxSummaryResults Table Structure: TimePoint	Updated TimePoint definition.	Updated TimePoint definition from "TimePoint refers to the point in time during the test at which the measurement was recorded for water quality measurements" to "TimePoint refers to the point in time during the test at which the measurement was recorded for water quality measurements or the day on which the end points were taken. Example if a test was originally going to last 7 days but the endpoints were taken on the 6th day then the TimePoint would indicate "Day 6"."

Date of Amendment	Document Section	Amendment Summary	Amendment Details
August 23rd 2013	ToxSummaryResults Table: ToxSummaryResults Table Structure: EvalThreshold	Updated EvalThreshold definition.	Updated EvalThreshold definition from "The evaluation threshold or EvalThreshold is the associated level that is used to identify that an environmental sample is biologically significantly different from its associated control sample and is recorded in the same unit as the mean; e.g. 80 or in percent when evaluating against the percent control.In cases where programs use the MSD to evaluate the evaluation threshold, for percentage endpoints (e.g. survival, etc.) EvalThreshold = Mean of Control - MSD and is compared to the Mean of the sample. To calculate the EvalThreshold for non-percentage endpoints (e.g. growth, cell counts, etc.) EvalThreshold = Mean of Control*(100-MSD)/100 and is compared to the Mean of the sample.In cases where programs use the percent control to evaluate the evaluation threshold, EvalThreshold = Control % - MSD% and is compared to the percent control of the sample." to "The evaluation threshold or EvalThreshold is the programmatic level that is used to identify that an environmental sample is biologically significantly different from its associated control sample and is recorded as a percentage. EvalThreshold is compared to the PercentEffect field.In cases where programs use program specific MSDs the EvalThreshold will equal the MSD and will be compared to the PercentEffect. If you are utilizing the TST method this field corresponds to the critical difference in the EPA TST methods."
August 23rd 2013	ToxReplicateResults Table: Column Requirements	Updated required field designations for ToxReplicateResults Table.	Updated required field designations for ToxReplicateResults Table: Required Columns: Added ResQualCode. Desired Columns: Added: EventCode, PositionWaterColumn; Removed: QAControlID, ResQualCode. Not Required Columns: Added: QAControlID; Removed: PositionWaterColumn, EventCode.
August 23rd 2013	ToxReplicateResults Table: ToxReplicateResults Table Structure	Added new fields to the ToxReplicateResults Table.	Added new fields to ToxReplicateResults Table Structure: TestExposureType and OrganismPerRep.

Date of Amendment	Document Section	Amendment Summary	Amendment Details
August 23rd 2013	ToxReplicateResults Table: ToxReplicateResults Table Structure	Added default value information to ToxReplicateResults Table definitions.	Added default value information to the description field within the ToxReplicateResults Table for SampleDate, ProtocolCode, AgencyCode, LocationCode, CollectionTime, CollectionMethodCode, SampleTypeCode, CollectionDeviceName, PositionWaterColumn, MatrixName, MethodName, UnitTreatment, WQSource, ResQualCode, ToxResultQACode and ComplianceCode .
August 23rd 2013	ToxReplicateResults Table: ToxReplicateResults Table Structure: TimePoint	Updated TimePointMethod definition.	Updated TimePointMethod definition from "ToxPointMethod refers to the general method used in obtaining or calculating the result. Toxicity replicate and summary data have a default value of 'None Water quality measurement results have a default value of 'ToxWQMeasurement'." to "ToxPointMethod refers to the general method used in obtaining or calculating the result. Toxicity replicate and summary data have a default value of 'None unless a method other than the test MethodName is used for the calculations. Water quality measurement results have a default value of 'ToxWQMeasurement'."
August 23rd 2013	ToxReplicateResults Table: ToxReplicateResults Table Structure: TimePoint	Updated TimePoint definition.	Updated TimePoint definition from "TimePoint refers to the point in time during the test at which the measurement was recorded for water quality measurements" to "TimePoint refers to the point in time during the test at which the measurement was recorded for water quality measurements or the day on which the end points were taken. Example if a test was originally going to last 7 days but the endpoints were taken on the 6th day then the TimePoint would indicate "Day 6"."
October 11th 2013	Introduction	Updated Southern California RDC contact information.	Updated Southern California RDC contact information from Shelly Moore to Marlene Hanken contact information.
November26th 2013	ToxSummaryResults Table: Purpose	Updated ToxSummary purpose language from percent of control to percent of effect.	Updated language from "The purpose of the toxicity summary table is to hold the core toxicity summary data including the mean, toxicity significance, and percent of control." To "The purpose of the toxicity summary table is to hold the core toxicity summary data including the mean, toxicity significance, and percent of effect."

Date of Amendment	Document Section	Amendment Summary	Amendment Details
March 17th 2014	Appendix A	Updated Table 1 StationCode description	Updated StationCode description from " LABQA is used as the station code for any sample generated in the laboratory including LabBlank, LCS and CRMs" to " LABQA is used as the station code for any sample generated in the laboratory including CNEG, CSNL, etc."
March 17th 2014	Appendix A	Updated Table 1 Matrix Descriptions	Updated Table 1 Matrix descriptions to "See Matrix LookUp for definition."
January 3rd, 2017	Introduction, Station Table, and Chemistry Table	Removed references to Stations tab	Removed the Stations section and references to Stations tab, updated effected screen shot, and modified StationCode definition to note that station codes must be established through the new vocabulary request process prior to subittal.
January 3rd, 2017	All	Updated use of quotes	Replaced single quotes with double quotes.
January 3rd, 2017	All tables	Updated description of "desired" fields	Added reference to using default values when actual values are not know for "desired" fields in the "Column Requirements" paragraph.
January 3rd, 2017	List of Terms	Updated links	Added current links for the LookUp lists and vocabulary request process.
January 3rd, 2017	Introduction	Updated Central Coast RDC contact information	Updated the Central Coast RDC contact information from Mark Pranger to Stacey Swenson.
January 3rd, 2017	All tables	Modified use of "default" wording	Changed most instances of "Default equals…if unknown" to "Use…if unknown."
January 3rd, 2017	All	Various edits	Removed double spaces and duplicate words and other small edits.
January 3rd, 2017	All tables	Updated StationCode definition	Included that StationCode must be unique within CEDEN, not just within the study design, as previously stated.
January 8th, 2019	Introduction	Updated RDCs	Removed SCCWRP as current RDC.
January 8th, 2019	ToxSummary and ToxReplicate Results Tables	Updated status of QAControlID	Chaged QAControlID to a be a required field.
January 8th, 2019	All tables	Variable Code List references	Added references to the appropriate lists in the Lookup List columns for fields that rely on Variable Codes.
January 8th, 2019	All sections	Updated wording for "desired" (default required) fields	Changed "should" to "must" for "desired" fields in the "Column Requirements" paragraphs.
January 8th, 2019	All tables	Format changes	Changed shading, font, and alignment of tables as needed for consistency.

I4. Taxonomy Data Submission Guidance

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CEDEN

California Environmental Data Exchange Network

Taxonomy Data Submission Guidance Document

Updated January 8, 2019

Table of Contents

List of Acronyms

CEDEN	California Environmental Data Exchange Network
RDC	Regional Data Center
SWAMP	Surface Water Ambient Monitoring Program
QAO	Quality Assurance Officer

List of Terms

Controlled Vocabulary	Controlled vocabulary refers to codes and associated definitions maintained within CEDEN to ensure comparability between and among data sets. Current controlled vocabulary contained within associated lookup lists can be found at: http://ceden.org/CEDEN_checker/Checker/LookUpLists.php. The process for adding new values can be found at: http://ceden.org/vocabulary_request.shtml.
Data Checker	Web-based automated tool that assists data submitters in examining their data sets against the required LookUp lists, formats and business rules.
LookUp Lists	Controlled vocabularies are maintained within the CEDEN database as 'LookUp Lists' and are managed through individual RDCs to maintain comparability between RDCs and throughout data sets available through CEDEN.
Primary Key	Uniquely identifies each row in a table and is comprised of a set of columns. No two distinct rows in a table can have the same combination of column values. Required for record uniqueness.
Data Type	Refers to the type of format required for a specific column heading in CEDEN templates. Data type examples include: integer (whole numbers), text, date and time, and decimal.

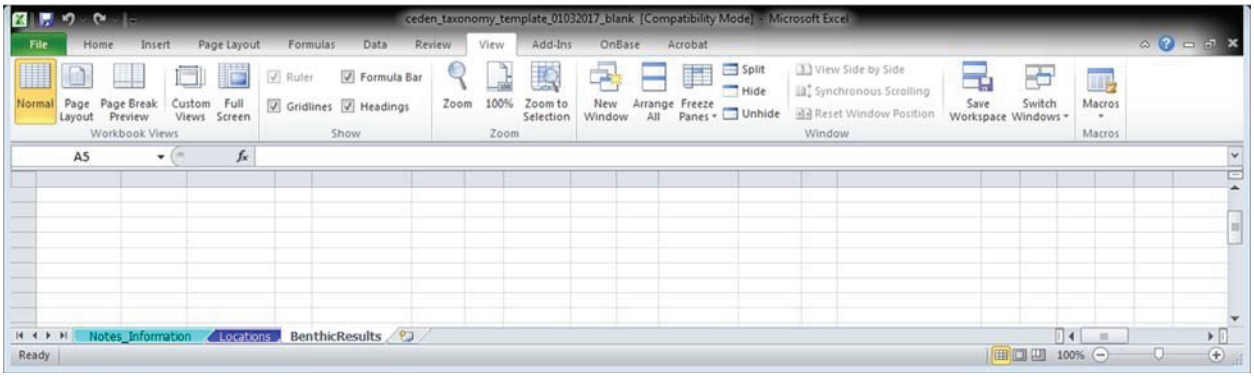
Introduction

This document is designed to provide guidance on reporting requirements for electronic data to be entered in the California Environmental Data Exchange Network (CEDEN) templates. Detailed below are definitions of data elements and rules for formatting taxonomy data within the CEDEN taxonomy template. For information on entering qualitative organism identifications and Colonial organism counts see Appendix A. Please review the entire Taxonomy Data Submission Guidance Document prior to filling out or submitting the CEDEN Taxonomy Template. If you have any questions regarding these guidelines, contact your Regional Data Center (RDC) for help.

Regional Data Center (RDC)	Contact	Phone Number	Email
Central Coast RDC	Stacey Swenson	831/771-4114	sswenson@mlml.calstate.edu
Central Valley RDC	Melissa Turner	530/756-5200	mturner@mlj-llc.com
San Francisco RDC	Cristina Grosso	510/746-7371	cristina@sfei.org

Taxonomy Data Submission Steps

To submit taxonomy data to CEDEN, start with the CEDEN_Taxonomy_Template Excel file which can be found at: http://ceden.org/ceden_datatemplates.shtml. In this template you will find the two data tables (each in a separate worksheet) required for submitting taxonomy data. This file can be named at the discretion of the user; however, the Excel sheet tabs **MUST** be named **Locations**, and **BenthicResults** respectively.



CEDEN Taxonomy Template Tables

Below describes what is included and submission requirements for each of the 2 tables in the CEDEN Taxonomy Template:

1. Locations
    a. Holds information about location sampled

    b. Required only if actual unique latitudes and longitudes were recorded for each sampling event.
2. BenthicResults
    a. Used to record taxonomy results
    b. Required to submit taxonomy results

The guidelines in the following sections will assist you in getting your data into the CEDEN Taxonomy Template tables. However, if at any time you have questions more specific to your data, (e.g. adding new codes to LookUp lists) contact your local DC.

Once you have placed your data into the CEDEN Taxonomy Template tables, visit your RDC's website to check and submit your data. Regional Data Center information can be found at: http://www.ceden.org/data_centers.shtml. The online data submission process includes specific checks on your data to ensure both data integrity and comparability with other data sets. Once your data has passed all of the checks it will be uploaded into the centralized CEDEN database and become available through the CEDEN website (www.ceden.org).

Taxonomy Template Data Tables

Locations Table

PURPOSE:

The locations table contains specific information about the locations sampled. Actual latitudes and longitudes are recorded here for each sampling event. In the event that only target latitudes and longitudes were recorded, it is sufficient to rely on the stations and associated details approved during the controlled vocabulary request process.

COLUMN REQUIREMENTS:

Columns within the CEDEN Taxonomy Template tables are either considered 1) required, 2) desired or 3) not required. Required columns must be completed in order for data to be accepted by CEDEN. Desired columns are strongly encouraged and should be completed with known values, whenever possible. If the actual value is unknown, then the given default value **must** be used. Not required columns include additional information that aid in data usability. Individual column requirements are listed below:

Required Columns:

StationCode
SampleDate
ProjectCode
CoordinateNumber
ActualLatitude
ActualLongitude
Datum

Desired Columns:

EventCode
ProtocolCode
AgencyCode
LocationCode
CoordinateSource

Not Required Columns:

SampleComments
GeometryShape
Elevation
UnitElevation
StationDetailVerBy
StationDetailVerDate
StationDetailComments

LOCATIONS TABLE STRUCTURE:

* Primary Key, required for record uniqueness.

TAXONOMY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
StationCode*	Text	**Yes**	25	Station LookUp	A code representing the StationName and site and should be unique within CEDEN. A single waterbody may have multiple stations. StationCodes and station information must be submitted to the CEDEN system via the new vocabulary request process before lab data can be submitted.
SampleDate*	Date/ Time	**Yes**	20		Refers to the date the sample was collected in the field; formatted as dd/mmm/yyyy.
ProjectCode*	Text	**Yes**	25	Project LookUp	References the project that is associated with the sample.
EventCode	Text	**Desired**	20	Event LookUp	Represents the primary reason (e.g. water quality, tissue or bioassessment sampling) of the sampling event at a particular station and date.
ProtocolCode	Text	**Desired**	50	Protocol LookUp	Represents the sampling protocol used, which includes the set of methods, methodology and/or specifications, such as "MPSL-DFG_Field_v1.0." Established protocols may be used or Regions may document their own sampling protocols. Use "Not Recorded" when environmental samples are taken using unknown protocols.
AgencyCode	Text	**Desired**	20	Agency LookUp	Refers to the organization or agency that collected the sample. This should be listed on the Chain of Custody (COC) document that accompanies the samples from the field. Use "Not Recorded" if unknown.
SampleComments	Text	No	255		Comments related to the GIS station information verification.
LocationCode	Text	**Desired**	50	Location LookUp	Describes the physical location in the waterbody where the sample was collected. One sampling event may have a single or multiple locations. Use "Not Recorded" if unknown.

TAXONOMY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
GeometryShape	Text	No	50	Variable Codes LookUp; Geometry-ShapeList	Physical shape of the location. Example values are Line, Point, or Polygon.
CoordinateNumber	Integer	**Yes**			Number of coordinates recorded at a Location; e.g. 1 for Points (target and actual coordinates), 1 and 2 for Lines. Default value equals "1."
ActualLatitude	Decimal	**Yes**			Represents the actual latitude for the sample site in decimal degrees with 5 decimal places.
ActualLongitude	Decimal	**Yes**			Represents the actual longitude for the sample site in decimal degrees with 5 decimal places (must be negative).
Datum	Text	**Yes**	10	Variable Codes LookUp; DatumList	The Datum field records the datum that was used on the GPS Device to record the GPS measurements. Example = NAD83. If the datum is unknown, use "NR."
CoordinateSource	Text	**Desired**	50	Variable Codes LookUp; Coordinate-SourceList	Describes how the coordinate was measured. For example, if measurement was taken from a map or GPS. Use "NR" if unknown.
Elevation	Decimal	No			Elevation at which the sample was taken. Example = 1.
UnitElevation	Text	No	2	Variable Codes LookUp; Unit-Elevation-List	Unit of the Elevation measurement. Example = m
StationDetailVerBy	Text	No	100		Agency or person who performed the verification of the station detail information.
StationDetailVerDate	Date/ Time	No			Date the station detail information was verified; formatted as dd/mmm/yyyy.
StationDetailComments	Text	No	255		Comments related to the station detail information.

Benthic Results Table

PURPOSE:

The purpose of the benthic results table is to document data collected for marine benthic infauna, freshwater benthic macroinvertebrate (BMI), algae, bacteria and diatom taxonomic analyses. Note bacteria single species concentrations are stored within the chemistry template, whereas abundance bacteria are stored within the following taxonomy results table. Each record represents a result from a specific event location for a single organism in a single sample. This table will also contain all supporting QA sample results.

COLUMN REQUIREMENTS:

Columns within the CEDEN Taxonomy Template tables are either considered 1) required, 2) desired or 3) not required. Required columns must be completed in order for data to be accepted by CEDEN. Desired columns are strongly encouraged and should be completed with known values, whenever possible. If the actual value is unknown, then the given default value **must** be used. Not required columns include additional information that aid in data usability. Individual column requirements are listed below:

Required Columns:

StationCode
SampleDate
ProjectCode
CollectionTime
CollectionMethodCode
SampleTypeCode
Replicate
CollectionDeviceName
FinalID
BAResult*
Result*
UnitName
ResQualCode
QACode

***Conditionally required i.e. BAResult or Result is required to be populated but not both.**

Desired Columns:

EventCode
ProtocolCode
AgencyCode
LocationCode
CollectionDepth
UnitCollectionDepth
SieveSize
GrabSize
UnitGrabSize
AgencyCode_LabEffort
PercentSampleCounted
TotalGrids
GridsAnalyzed
GridsVolumeAnalyzed
TargetOrganismCount
ActualOrganismCount
ExtraOrganismCount
QCOrganismCount
DiscardedOrganismCount
EffortQACode
LifeStageCode
Distinct
ComplianceCode
BatchVerificationCode
TaxonomicQualifier
ExcludedTaxa
PersonnelCode_Result
LabSampleID

Not Required Columns:

SampleComments
GeometryShape
SampleID
BenthicCollectionComments
ReplicateName
ReplicateCollectionDate
NumberJars
BenthicCollectionDetailComments
PersonnelCode_LabEffort
BenthicLabEffortComments
EnterDate
BenthicResultComments

BENTHIC RESULTS TABLE STRUCTURE:

* Primary Key, required for record uniqueness.
+ Conditionally required i.e. BAResult or Result is required to be populated but not both

TAXONOMY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
StationCode*	Text	**Yes**	25	Station LookUp	A code representing the StationName and site and should be unique within CEDEN. A single waterbody may have multiple stations. StationCodes and station information must be submitted to the CEDEN system via the new vocabulary request process before lab data can be submitted.
SampleDate*	Date/ Time	**Yes**			Refers to the date the sample was collected in the field. Formatted as dd/mmm/yyyy. Use "01/Jan/1950" if the actual SampleDate is unknown.
ProjectCode	Text	**Yes**	25	Project LookUp	References the project that is associated with the sample.
EventCode	Text	**Desired**	20	Event LookUp	Represents the primary reason (e.g. water quality, tissue or bioassessment sampling) of the sampling event at a particular station and date.
ProtocolCode	Text	**Desired**	50	Protocol LookUp	Represents the sampling protocol used, which includes the set of methods, methodology and/or specifications, such as "MPSL-DFG_Field_v1.0." Established protocols may be used or Regions may document their own sampling protocols. Use "Not Recorded" when environmental samples are taken using unknown protocols. Use "Not Applicable" when LabQA samples are taken with unknown protocols.
AgencyCode	Text	**Desired**	20	Agency LookUp	Refers to the organization or agency that collected the sample. This should be listed on the Chain of Custody (COC) document that accompanies the samples from the field. Use "Not Recorded" if unknown.
SampleComments	Text	No	255		The comments field should be used for any notes or comments specifically related to the sample collection.

TAXONOMY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
LocationCode	Text	**Desired**	50	Location LookUp	Describes the physical location in the waterbody where the sample was collected. One sampling event may have a single or multiple locations. Use "Not Recorded" when environmental samples are taken at an unknown location.
GeometryShape	Text	No	50	Variable Codes LookUp; Geometry-ShapeList	Physical shape of the location. Example values are Line, Point, or Polygon.
CollectionTime*	Date/ Time	**Yes**	20		Refers to the time when the first sample of a sampling event at a specific station was collected in the field. Format equals hh:mm. Use "00:00" if the time sampling started is unknown.
CollectionMethodCode	Text	**Yes**	50	Collection Method LookUp	Refers to the general method of collection such as Sed_Grab, Sed_Core, Water_Grab, Autosampler24h, Autosampler7d. Use "Not Recorded" when environmental samples are taken using an unknown method.
SampleTypeCode*	Text	**Yes**	20	Sample Type LookUp	Refers to the type of sample collected or analyzed. Use "Not Recorded" if unknown.
Replicate*	Integer	**Yes**			Used to distinguish between replicates created at a single collection in the field. The default value is "1." Replicate samples are collected at the same station and date. Therefore, samples collected on different dates from the same station should both have a Replicate value of "1."
CollectionDeviceName	Text	**Yes**	50	Collection Device Lookup	Name of the CollectionDevice. Use "Not Recorded" if unknown.
CollectionDepth	Decimal	**Desired**			Records the depth or penetration, from the surface in the water or sediment column, at which the sample was collected.

TAXONOMY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
UnitCollectionDepth	Text	**Desired**	50	Variable Codes LookUp; Unit-Collection-List	Refers to the units used in the CollectionDepth including cm (centimeters) and m (meters).
SieveSize	Text	**Desired**	50	Variable Codes LookUp; SieveSize-List	Size of the sieve the sample was passed through; e.g. 0.5mm, none.
SampleID	Text	No	40		Unique identifier supplied by the organization directing the sampling or sampling agency and is used to track the sample throughout the sampling and analysis processes. This field can be used to tie a result to the sample.
BenthicCollection Comments	Text	No	255		Comments related to the benthic collection.
GrabSize	Decimal	**Desired**			Represents the total area of substrate collected for the sample, regardless of CollectionDevice area size. This is determined by the sampling device area and, if applicable, the number of transects or grabs sampled.
UnitGrabSize	Text	**Desired**	10	Variable Codes LookUp; UnitGrab-SizeList	Refers to the units used for GrabSize e.g. m2 or cm2.
ReplicateName	Text	No	20		Name of the Replicate Number if applicable; e.g. Transect 1 or T-1. This field was used previously in the CalEDAS database to identify if replicate samples were collected.
ReplicateCollectionDate	Date/ Time	No			Represents the date of the ReplicateCollection; format as dd/mmm/yyyy. Default value equals 01/Jan/1950.
NumberJars	Integer	No			Number of jars into which the sample fit for transport to the analytical lab
BenthicCollectionDetail Comments	Text	No	255		Comments related to the BenthicCollectionDetail

TAXONOMY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
AgencyCode_LabEffort	Text	**Desired**	20	Agency LookUp	Agency that sorted or processed the taxonomic sample. Default value equals Not Recorded if unknown.
PersonnelCode_LabEffort	Text	No	50	Personnel LookUp	Name of the person initially identifying/sorting the taxon.
PercentSampleCounted	Decimal	**Desired**			Refers to the percent of the sample that was counted.
TotalGrids	Integer	**Desired**			Represents the total number of grids onto which the sample was spread for subsampling.
GridsAnalyzed	Integer	**Desired**			Represents the number of grids of material pulled from to achieve the TargetOrganismCount.
GridsVolumeAnalyzed	Decimal	**Desired**			Volume of grids included in the analysis required to achieve the TargetOrganismCount; i.e. if 0.25 from each of 3 grids were analyzed, GridsVolumeAnalyzed would be 0.75. Units are in grids.
TargetOrganismCount	Integer	**Desired**			Number of organisms at which subsampling will cease.
ActualOrganismCount	Integer	**Desired**			Total number of organisms recovered by lab sorter in all grids analyzed, including the count above and beyond the target total for the subsample.
ExtraOrganismCount	Integer	**Desired**			Number of organisms subsampled beyond the target count.
QCOrganismCount	Integer	**Desired**			Refers to the number of organisms in the subsample counted during the quality control (QC) check. It refers to cases where a sample is re-sorted and more organisms are found. If the original sort found 500 organisms and then it was re-sorted by a different person who found 3 organisms, the QCOrganismCount would be 3 rather than 503.
DiscardedOrganismCount	Integer	**Desired**			Number of organisms in the subsample determined to be unsuitable for identification.

TAXONOMY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
EffortQACode	Text	**Desired**	30	QA LookUp	Unique code applied to the result which describes any special conditions, situations or outliers occurring during or prior to lab sorting. Default value equals NR if unknown.
BenthicLabEffort Comments	Text	No	255		Comments related to lab sorting or sample processing.
FinalID*	Text	**Yes**	100	Organism LookUp	Refers to the lowest taxon level identified for the organism.
LifeStageCode	Text	**Desired**	5	LifeStage LookUp	Unique code referencing the stage of life of the organism; e.g. adult, juvenile, larvae. Utilize 'NR' for not recorded if unknown.
Distinct	Integer	**Desired**			An indicator whether or not this record represents a unique taxon in the sample. Use >=1 for distinct or 0 for non-distinct. Utilize null value of '-88' if unknown.
BAResult	Integer	**Yes**[+]			Represents the number of individuals of a given FinalID and stage that were identified within a sample replicate. This is for unadjusted (raw) counts and is to be used for cases where a TargetOrganismCount is used. Either BAResult or Result should be populated (unless QACodes and ResQualCodes other than the defaults are used), but NOT both fields.
Result	Integer	**Yes**[+]			Represents the final numeric result of a given FinalID and stage scaled up to grab size. Result is for counts adjusted to the area sampled and for biovolumes and it may represent raw counts if the full sample is sorted. Either BAResult or Result should be populated (unless QACodes and ResQualCodes other than the defaults are used), but NOT both fields.
UnitName	Text	**Yes**		Unit LookUp	Refers to how the taxonomic result is measured or expressed. Taxonomic units are indicated by count or volume/area, e.g. um3/cm2

TAXONOMY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
ResQualCode	Text	**Yes**	10	ResQual LookUp	Qualifies the analytical result of the sample. Default value equals "=".
QACode*	Text	**Yes**	30	QA LookUp	Applied to the result to describe any special conditions, situations or outliers that occurred during or prior to the analysis to achieve the result. The default code, indicating no special conditions, is "None." Use "NR" if the special conditions are unknown or if it is unknown whether there were special conditions. If more than one code should be applied to a record, the convention is to list them in alphabetical order separated by commas and no spaces.
ComplianceCode	Text	**Desired**		Data Compliance LookUp	Unique code describing the compliance with the associated Quality Assurance Project Plan (QAPP). Use "NR" if the compliance is unknown.
BatchVerificationCode	Text	**Desired**	10	Batch Verification Lookup	Unique code referencing the Verification of a Batch. Use "NR" if unknown.
TaxonomicQualifier	Text	**Desired**	50	Variable Codes LookUp; Taxonomic-Qualifier-List	These codes are used to indicate reasons why terminal identification was not achieved for a particular taxon. Default value equals None if unknown.
ExcludedTaxa	Text	**Desired**	50	Variable Codes LookUp; Excluded-Qualifier-List	Code representing the taxonomist's justification for excluding a specimen from analysis.
PersonnelCode_Result	Text	**Desired**	50	Personnel LookUp	Name of the person making the FinalID. May or may not be the same person indicated in PersonnelCode_LabEffort.
LabSampleID	Text	**Desired**	35		Recommended field intended to provide lab specific identification for an analyzed sample.

TAXONOMY TEMPLATE HEADER	DATA TYPE	REQUIRED	SIZE	LOOKUP LIST	DEFINITION
EnterDate	Date/ Time	No			Date the data were entered into the template; formatted as dd/mmm/yyyy. Default value equals 01/Jan/1950.
BenthicResult Comments	Text	No	130		Comments related to the BenthicResult or individual taxa count.

Appendix A: Specific Entry for Qualitative Organism Identifications and Colonial Organism Counts

INTRODUCTION

Appendix A has been created to give additional guidance regarding business rules and formatting for qualitative organism identifications and colonial organism counts. The following sections list example values that can be used to ensure comparability between samples and projects. The example values are listed for a subset of the Taxonomy Template columns and are associated with descriptions and business rules to further guide the data generator in formatting data for these different situations. The examples only reference a subset of the columns in the Taxonomy Template; the Taxonomy Data Submission Guidance Document main body should be used as a reference for definitions and associated lookup lists for how to populate the additional columns not addressed in the examples.

1. QUALITATIVE ORGANISM IDENTIFICATIONS

Qualitative organism identifications refer to samples where the field personnel note the presence of algae in the stream without noting the abundance of the taxon. See Table 1 for recommended coding in these situations.

Table 1. Example values to be used for qualitative organism identifications

Taxonomy Template Header	Value	Description & Business Rules
SampleTypeCode	Qualitative	For qualitative organism identifications a SampleTypeCode of 'Qualitative' is utilized.
BAResult		Leave BAResult column blank
Result		Leave result column blank
ResQualCode	P	For qualitative organism identifications a ResQualCode of 'P' for present is utilized.
UnitName	count	For qualitative organism identifications a UnitName of 'count' is utilized.

2. COLONIAL ORGANISM COUNTS

Colonial organism counts refer to samples where the objective is to obtain a count for a taxon but a colonial organism is found. Laboratories should not provide a count in these cases due to the difficulty in obtaining a count for certain organism types (e.g. a sponge or hydroid). If a biovolume or biomass is the objective, then record the result and appropriate unit. See Table 2 for recommended coding in these situations.

Table 2. Example values to be used for colonial organism counts

Taxonomy Template Header	Value	Description & Business Rules
SampleTypeCode	Epiphyte	For epiphyte colonial organism identifications a SampleTypeCode of 'Epiphyte' is utilized.
	Macroalgae	For Macroalgae colonial organism identifications a SampleTypeCode of 'Macroalgae' is utilized.
	Microalgae	For Microalgae colonial organism identifications a SampleTypeCode of 'Microalgae' is utilized.
BAResult		Leave BAResult column blank
Result		Leave result column blank
ResQualCode	COL	For qualitative organism identifications a ResQualCode of 'COL' for colonial is utilized.
UnitName	count	For qualitative organism identifications a UnitName of 'count' is utilized.

Appendix B: Taxonomy Data Submission Guidance Documentation Amendments

AMENDMENTS

Amendments made to the CEDEN Taxonomy Data Submission Guidance Document are documented within Table 1.

Table 3. Amendments made to the Taxonomy Data Submission Guidance Document.

Date of Amendment	Document Section	Amendment Summary	Amendment Details
August 23rd 2013	List of Acronyms	Added acronyms.	Added SWAMP and QAO to the List of Acronyms.
August 23rd 2013	Stations Table: Column Requirements	Updated required field designations for Stations Table.	Updated required field designations for Stations Table. Required Columns: Added: StationAgency, SWRCBWatTypeCode. Desired Columns: Added: CoordinateSource Removed: LocalWatershed, LocalWaterbody, Counties_2004_County, SWRCBWatTypeCode, CalWater_2004_RB. Not Required Columns: Added: EventType1, EventType2, EventType3, LocalWaterShed, LocalWaterBody, Counties_2004_COUNTY, CalWater_2004_RB, NHD_PlusCatchmentComID. Removed: CalWater_2004_SWRCBNUM2 HydrologicUnit
August 23rd 2013	Stations Table	Added Additional Resources section to Stations Table.	Added an "Additional Resources" section to the Stations Table after Column Requirements.
August 23rd 2013	Stations Table: Stations Table Structure: StationSource	Updated StationSource LookUp list and definition.	Updated StationSource LookUp List from blank to "AgencyLookUp or ProjectLookUp". Updated Definition from "Agency or project that created the station." to "Agency or project that submitted the station to CEDEN".
August 23rd 2013	Stations Table: Stations Table Structure	Added new fields to the Stations Table.	Added new fields to Stations Table Structure: StationAgency, EventType1, EventType2, EventType3 and NHD_Plus_CatchmentComID.
August 23rd 2013	Stations Table: Stations Table Structure: AddDate	Added format information to AddDate	Added "Format as dd/mmm/yyyy" to the AddDate definition.

Date of Amendment	Document Section	Amendment Summary	Amendment Details
August 23rd 2013	Stations Table: Stations Table Structure	Added default value information to Stations Table definitions.	Added default value information to the description field within the Stations Table for CoordinateNumber, Datum, CoordinateSource, SWRCBWatTypeCode
August 23rd 2013	Stations Table: Stations Table Structure: State	Added LookUp list information to State.	Updated State LookUp List from blank to "VariableCodesLookUp".
August 23rd 2013	Stations Table: Stations Table Structure	Updated Stations Table template header names.	Updated Stations Table template header names: "NHD24K_GNIS_Name" to "NHD_24K_v2_GNIS_Name", "NHD24k_Reachcode" to "NHD_24k_v2_ReachCode", "NHD24k_HUC12" to "NHD_24k_v2_HUC_12" and "NHD24k_Hu_12_Name" to "NHD_24k_v2_Name".
August 23rd 2013	Taxonomy Results Table: Purpose	Updated the Taxonomy Results Table purpose section to specify where bacteria results are stored within CEDEN.	Updated Taxonomy Results Table purpose language from "The purpose of the taxonomy results table is to document data collected for marine benthic infauna, freshwater benthic macroinvertebrate (BMI), algae and diatom taxonomic analyses. Each record represents a result from a specific event location for a single organism in a single sample. This table will also contain all supporting QA sample results." to " The purpose of the taxonomy results table is to document data collected for marine benthic infauna, freshwater benthic macroinvertebrate (BMI), algae, bacteria and diatom taxonomic analyses. Note bacteria single species concentrations are stored within the chemistry template, whereas abundance bacteria are stored within the following taxonomy results table. Each record represents a result from a specific event location for a single organism in a single sample. This table will also contain all supporting QA sample results."
August 23rd 2013	Taxonomy Table: Column Requirements	Updated required field designations for Taxonomy Results Table.	Updated required field designations for Taxonomy Results Table: Desired Columns: Added EventCode.
August 23rd 2013	Taxonomy Results Table: Benthic Results Table Structure	Added default value information to Benthic Results Table definitions.	Added default value information to the description field within the Benthic Results Table for SampleDate, ProtocolCode, AgencyCode, LocationCode, CollectionTime, CollectionMethodCode, SampleTypeCode, CollectionDeviceName, ReplicateCollectionDate, AgencyCode_LabEffort, EffortQACode, ResQualCode, QACode, ComplianceCode, BatchVerificationCode, TaxonomicQualifier and EnterDate.

Date of Amendment	Document Section	Amendment Summary	Amendment Details
October 11th 2013	Introduction	Updated Southern California RDC contact information.	Updated Southern California RDC contact information from Shelly Moore to Marlene Hanken contact information.
January 3rd, 2017	Introduction, Station Table, and Benthic Results Table	Removed references to Stations tab	Removed the Stations section and references to Stations tab, updated effected screen shot, and modified StationCode definition to note that station codes must be established through the new vocabulary request process prior to subittal.
January 3rd, 2017	All	Updated use of quotes	Replaced single quotes with double quotes.
January 3rd, 2017	Locations Table, Benthic Results Table	Updated description of "desired" fields	Added reference to using default values when actual values are not know for "desired" fields in the "Column Requirements" paragraph.
January 3rd, 2017	List of Terms	Updated links	Added current links for the LookUp lists and vocabulary request process.
January 3rd, 2017	Introduction	Updated Central Coast RDC contact information	Updated the Central Coast RDC contact information from Mark Pranger to Stacey Swenson.
January 3rd, 2017	Locations Table and Benthic Results Table	Modified use of "default" wording	Changed most instances of "Default equals…if unknown" to "Use…if unknown."
January 3rd, 2017	All	Various edits	Removed double spaces and duplicate words and other small edits.
January 3rd, 2017	Locations Table and Benthic Results Table	Updated StationCode definition	Included that StationCode must be unique within CEDEN, not just within the study design, as previously stated.
January 8th, 2019	Introduction	Updated RDCs	Removed SCCWRP as current RDC.
January 8th, 2019	Benthic Results Table	Changed reference to Benthic Results Table	Changed refence from Taxonomy Results Table to Benthic Results Table to be consistent with template.
January 8th, 2019	Locations Table and Benthic Results Table	Variable Code List references	Added references to the appropriate lists in the Lookup List columns for fields that rely on Variable Codes.
January 8th, 2019	Locations Table and Benthic Results Table	Updated wording for "desired" (default required) fields	Changed "should" to "must" for "desired" fields in the "Column Requirements" paragraphs.
January 8th, 2019	All tables	Format changes	Changed shading, font, and alignment of tables as needed for consistency.

APPENDIX J:

HEALTH AND SAFETY PROCEDURES

It is the Policy of the District that the safety of its employees and the people it serves is of the highest priority. All District employees shall comply with all the of the safety directives outlined in the District's Safety and Operation Manual (SOM), available to staff from the District's internal intranet site. Managers are responsible for ensuring that employees in their Divisions comply with all of the safety directives outlined in the Safety and Operations Manual (SOM 1 thru SOM 30). Supervisors are directly responsible for the safety of their employees and must ensure that their staff is trained and in compliance with the procedures outlined in the SOM. Employees are to inform the District's Safety Consultant, their Supervisor or management of any perceived safety hazards. Suggestions for improving the Safety Program are encouraged and will be given full consideration.

SOM 30 specifically references the Watershed Protection Division Field Safety Manual. The Manual is a living document reviewed and updated as necessary. The purpose of this Manual is to assist District staff in identifying potential hazards associated with their unique field activities and to assist them in following the District's safety policies. It is also intended as a training tool for all new employees and a document to be reviewed by each employee before undertaking field assignments involving WPD tasks. It includes references to the District's SOMs that are standard and applicable to all field operations, such as communication, vehicle operation, and adequate preparation for anticipated weather conditions.

The guide is not intended to be a technical handbook outlining step-by-step procedures for performing specific tasks, or a comprehensive discussion of every possible activity that may be undertaken by an employee. Ultimately, each employee is personally responsible for knowing and learning the proper procedures to avoid injuries.

Safety of the sampling team is paramount. The field vehicle should start out with a full tank of gas and be in good repair. Extra care must be taken when driving at night or in the rain. If the sampling location is unsafe, make note of the unsafe situation and either do not collect a sample or come back after the hazardous situation has ceased.

Medical Referral for Treatment of Work-related Injuries or Illnesses

The treatment of work-related injuries or illnesses is handled through the County of Riverside Human Resources Department, Workers' Compensation Division.

The following website will locate the closest medical provider. The Medical Provider Network (MPN) includes the Kaiser Occupational Clinics in Riverside and Fontana. Upon clicking the link below, the MPN search page will load. Simply type in the name of the provider or choose a specialty option and click "Find Providers". An option to adjust the range of the search is also provided by utilizing the “within miles” tool.

http://www.compcaremed.com/riverside/

Questions regarding the MPN program may be answered by contacting the following:

CorVel Corporation, MPN Department	800-966-5307
Riverside County Workers' Compensation Division (HR Dept)	951-955-3530

APPENDIX K:

NPDES CONTACTS

NPDES Watershed Program Contacts

Riverside County Flood Control and Water Conservation District
1995 Market Street
Riverside, CA 92501

Watershed Protection Division Chief
Richard Boon
Ph: 951.955.1273
rboon@rivco.org

Water Quality Compliance 1 Section:

NPDES Program Manager
Amy McNeill
Ph: 951.955.1330
ammcneil@rivco.org

Santa Ana Region
Andrea Macias
Ph: 951.955.1372
almacias@rivco.org
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Whitewater River Region
Graciela Torres
Ph: 951.955.0836
graciela@rivco.org

IC/ID Officer:
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Ph: 951.955.4390
djortega@rivco.org

Water Quality Compliance 2 Section:

NPDES Program Manager
Matt Yeager
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Santa Margarita Region
Aldo Licitra
Ph: 951.955.0842
alicitra@rivco.org

Watershed Monitoring Section:

Monitoring Programs Manager
Rebekah Guill
Ph: 951.955.2901
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Other County Contacts

Riverside County Executive Office

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Fax: 951.955.1105
SBruckner@RIVCO.ORG ~~abarrera@rivco.org~~

Riverside County Department of Environmental Health

Keith Jones
3880 Lemon Street, 2nd Floor
Riverside, CA 92501
Ph: 951.358.5055
kjones@rivco.org

Riverside County Facilities Management

Cliff Smith ~~John Alfred or~~
3403 10th Street, Suite 500
Riverside, CA 92501
Ph: 951.955.4884
CliffSmith@rivcoeda.org ~~Jalfred@rivcoeda.org or~~

Riverside County Transportation Land and Management Agency (TLMA)

Jan Bulinski
4080 Lemon Street, 8th Floor
Riverside, CA 92501
Ph: 951.955.6859
Fax: 951.955.6721
jbulinki@rivco.org

Code Enforcement Contacts

County Code Enforcement Manager
Brian Black
Ph: 951.955.6180
bblack@rivco.org

Supervisor

District 1 and District 2
(West County Office)
Jamison Cole
Ph: 951.791.3914
jcole@rivco.org

District 3 and District 5
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Marr Christian
Ph: 951.600.6252
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District 4
East County Office
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NPDES Coordinators, Santa Ana Region

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City of Cathedral City
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Coachella Valley Water District (CVWD)
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Fire Department Contacts

The County of Riverside contracts with the following cities for emergency response services. For hazardous materials incidents within these cities, or within unincorporated Riverside County, contact County Environmental Health at 951.358.5055

Banning	Beaumont	Calimesa	Canyon Lake
Cathedral City	Coachella	Desert Hot Springs	Indian Wells
Indio	La Quinta	Lake Elsinore	Moreno Valley
Murrieta	Norco	Palm Desert	Palm Springs
Perris	Rancho Mirage	Rubidoux	San Jacinto
Temecula			

The following cities have their own hazardous material management program:

City of Riverside
Fire Station No. 2
9449 Andrew St.
Riverside, CA 92503
Ph: 951.351.6102

City of Corona
Call 9-1-1

City of Hemet
Hemet Fire Department
510 E. Florida Ave.
Hemet, CA 92543
Ph: 951.765.2450 during business hours
Ph: 951.765.2400 outside of business hours

APPENDIX L:

CHARACTERISTICS OF CONTAMINANTS COMMONLY ASSOCIATED WITH VARIOUS FACILITIES AND ACTIVITIES

Table 4.[1] Typical Chemical and Physical properties of Industrial Non-Stormwater Discharges.

Industrial Categories Major Classifications SIC Group Numbers	Odor	Color	Turbidity	Floatables	Debris and Stains	Structural Damage	Vegetation	pH	TDS
Primary Industries									
20 Food and Kindred Products									
201 Meat Products	Spoiled Meats, Rotten Eggs and Flesh	Brown to Reddish-Brown	High	Animal Fats, Byproducts, Pieces of Processed Meats	Brown to Black	High	Flourish	Normal	High
202 Dairy Products	Spoiled Milk, Rancid Butter	Grey to White	High	Animal Fats, Spoiled Milk Products	Grey to Light Brown	High	Flourish	Acidic	High
203 Canned and Preserved Fruits and Vegetables	Decaying Products Compost Pile	Various	High	Seeds, Skins, Cores, Leaves	Brown	Low	Normal	Wide Range	High
204 Grain Mill Products	Slightly Sweet & Musty, Grainy	Brown to Reddish Brown	High	Grain Hulls and Skins, Straw & Plant Fragments	Light Brown	Low	Normal	Normal	High
205 Bakery Products	Sweet and/or Spoiled	Brown to Black	High	Cooking Oils, Lard, Flour, Sugar	Grey to Light Brown	Low	Normal	Normal	High
206 Sugar and Confectionary Products	NA	NA	Low	Low Potential	White Crystals	Low	Normal	Normal	High
207 Fats and Oils	Spoiled Meats, Lard or Grease	Brown to Black	High	Animal Fats, Lard	Grey to Light Brown	Low	Normal	Normal	High
208 Beverages	Flat Soda, Beer or Wine, Alcohol, Yeast	Various	Moderate	Grains & Hops, Broken Glass, Discarded Canning Items	Light Brown	High	Inhibited	Wide Range	High
21 Tobacco Manufactures	Dried Tobacco, Cigars, Cigarettes	Brown to Black	Low	Leaves, Papers and Fillers	Brown	Low	Normal	Normal	Low
22 Textile Mill Products	Wet Burlap, Bleach, Soap, Detergents	Various	High	Fibers, Oils, Grease	Grey to Black	Low	Inhibited	Basic	High
23 Apparel and Other Finished Products	NA	Various	Low	Some Fabric Particles	NA	Low	Normal	Normal	Low

[1] Dr. Robert Pitt of the University of Alabama developed a table of chemical and physical properties of Industrial Non-Stormwater Discharges. This provides an aid to identifying potential sources of illicit discharges when no other evidence is available.

Table 4.[1] Typical Chemical and Physical properties of Industrial Non-Stormwater Discharges.

Industrial Categories Major Classifications SIC Group Numbers	Odor	Color	Turbidity	Floatables	Debris and Stains	Structural Damage	Vegetation	pH	TDS
Material Manufacture									
24 Lumber & Wood Products	NA	NA	Low	Some Sawdust	Light Brown	Low	Normal	Normal	Low
25 Furniture & Fixtures	Various	Various	Low	Some Sawdust,Solvents	Light Brown	Low	Normal	Normal	Low
26 Paper & Allied Products	Bleach, Various Chemicals	Various	Moderate	Sawdust, Pulp Paper, Waxes, Oils	Light Brown	Low	Normal	Wide Range	Low
27 Printing, Publishing, and Allied Industries	Ink, Solvents	Brown to Black	Moderate	Paper Dust, Solvents	Grey to Light Brown	Low	Inhibited	Normal	High
31 Leather & Leather Products	Leather, Bleach, Rotten Eggs or Flesh	Various	High	Animal Flesh & Hair, Oils, Grease	Grey to Black, Salt Crystals	High	Highly Inhibited	Wide Range	High
33 Primary Metal Industries	Various	Brown to Black	Moderate	Ore, Coke, Oils, Limestone, Millscale	Grey to Black	High	Inhibited	Acidic	High
34 Fabricated Metal Products	Detergents, Rotten Eggs	Brown to Black	High	Dirt, Grease, Oils, Sand, Clay Dust	Grey to Black	Low	Inhibited	Wide Range	High
32 Stone, Clay, Glass, and Concrete Products	Wet Clay, Mud, Detergents	Brown to Reddish-Brown	Moderate	Glass Particles Dust from Clay or Stone	Grey to Light Brown	Low	Normal	Basic	Low
Chemical Manufacture									
28 Chemicals & Allied Products									
2812 Alkalies and Chlorine	Strong Halogen or Chlorine, Pungent, Burning	Alkalies - NA Chlorine - Yellow to Green	Low	NA	Alkalies – White Carbonate Scale Chlorine - NA	High	Highly Inhibited	Basic	High
2816 Inorganic Pigments	NA	Various	High	Low Potential	Various	Low	Highly Inhibited	Wide Range	High
282 Plastic Materials and Synthetics	Pungent, Fishy	Various	High	Plastic Fragments, Pieces of Synthetic Products	Various	Low	Inhibited	Wide Range	High

Table 4.[1] Typical Chemical and Physical properties of Industrial Non-Stormwater Discharges.

Industrial Categories Major Classifications SIC Group Numbers	Odor	Color	Turbidity	Floatables	Debris and Stains	Structural Damage	Vegetation	pH	TDS
283 Drugs	NA	Various	High	Gelatin Byproducts for Capsulating Drugs	Various	Low	Highly Inhibited	Normal	High
284 Soap, Detergents & Cleaning Preparations	Sweet or Flowery	Various	High	Oils, Grease	Grey to Black	Low	Inhibited	Basic	High
285 Paints, Varnishes, Lacquers, Enamels and Allied Products (SB - Solvent Base)	Latex - Ammonia SB – Dependent Upon Solvent (Paint Thinner, Mineral Spirits)	Various	High	Latex - NA SB - All Solvents	Grey to Black	Low	Inhibited	Latex-Basic SB-Normal	High
286 Indust. Organic Chemicals									
2861 Gum and Wood Chemicals	Pine Spirits	Brown to Black	High	Rosins and Pine Tars	Grey to Black	Low	Inhibited	Acidic	High
2865 Cyclic Crudes, & Cyclic Intermediates Dyes, & Organic Pigments	Sweet Organic Smell	NA	Low	Translucent Sheen	NA	Low	Highly Inhibited	Normal	Low
287 Agricultural Chemicals									
2873 Nitrogenous Fertilizers	NA	NA	Low	NA	White Crystalline Powder	High	Inhibited	Acidic	High
2874 Phosphatic Fertilizers	Pungent Sweet	Milky White	High	NA	White Amorphous Powder	High	Inhibited	Acidic	High
2875 Fertilizers, Mixing Only	Various	Brown to Black	High	Pelletized Fertilizers	Brown Amorphous Powder	Low	Normal	Normal	High
29 Petroleum Refining and Related Industries									
291 Petroleum Refining	Rotten Eggs, Kerosene, Gasoline	Brown to Black	High	Any Crude or Processed Fuel	Black Salt Crystals	Low	Inhibited	Wide Range	High

Table 4.[1] Typical Chemical and Physical properties of Industrial Non-Stormwater Discharges.

Industrial Categories Major Classifications SIC Group Numbers	Odor	Color	Turbidity	Floatables	Debris and Stains	Structural Damage	Vegetation	pH	TDS
30 Rubber & Miscellaneous Plastic Products	Rotten Eggs, Chlorine, Peroxide	Brown to Black	Moderate	Shredded Rubber Pieces of Fabric or Metal	Grey to Black	Low	Inhibited	Wide Range	High
Transportation & Construction									
15 Building Construction	Various	Brown to Black	High	Oils, Grease, Fuels	Grey to Black	Low	Normal	Normal	High
16 Heavy Construction	Various	Brown to Black	High	Oils, Grease, Fuels, Diluted Asphalt or Cement	Grey to Black	Low	Normal	Normal	High
Retail									
52 Building Materials, Hardware, Garden Supply, and Mobil Home Dealers	NA	Brown to Black	Low	Some Seeds, Plant Parts, Dirt, Sawdust, or Oil	Light Brown	Low	Normal	Normal	Low
53 Gen. Merchandise Stores	NA	NA	NA	NA	NA	Low	Normal	Normal	Low
54 Food Stores	Spoiled Produce, Rancid, Sour	Various	Low	Fragments of Food, Decaying Produce	Light Brown	Low	Flourish	Normal	Low
55 Automotive Dealers & Gasoline Service Stations	Oil or Gasoline	Brown to Black	Moderate	Oil or Gasoline	Brown	Low	Inhibited	Normal	Low
56 Apparel & Accessory Stores	NA	NA	Low	NA	NA	Low	Normal	Normal	Low
57 Home Furniture, Furnishings, & Equip. Stores	NA	NA	Low	NA	NA	Low	Normal	Normal	Low
58 Eating & Drinking Places	Spoiled Foods Oil & Grease	Brown to Black	Low	Spoiled or Leftover Foods	Brown	Low	Normal	Normal	Low
Miscellaneous									
Coal Steam Electric Power	NA	Brown to Black	High	Coal Dust	Black Amorphous Powder	Low	Normal	Slightly Acidic	Low
Nuclear Steam Electric Power	NA	Light Brown	Low	Oils, Lubricants	Light Brown	Low	Normal	Normal	Low

Table 5.[2] Contaminants Commonly Associated With Selected Facilities and Activities.

POTENTIAL SOURCE	CONTAMINANT
Commercial / Industrial	
Above-ground storage tanks	Arsenic, Barium, Benzene, Cadmium, 1,4-Dichlorobenzene or P-Dichlorobenzene, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Lead, Trichloroethylene (TCE), Tetrachloroethylene or Perchlorethylene (Perc)
Automobile, Body Shops/Repair Shops	Arsenic, Barium, Benzene, Cadmium, Chlorobenzene, Copper, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, 1,4-Dichlorobenzene or P-Dichlorobenzene, Lead, Fluoride, 1,1,1-Trichloroethane or Methyl Chloroform, Dichloromethane or Methylene Chloride, Tetrachloroethylene or Perchlorethylene (Perc), Trichloroethylene (TCE), Xylene (Mixed Isomers)
Boat Repair/Refinishing/Marinas	Benzene, Cadmium, cis 1,2-Dichloroethylene, Coliform, Cryptosporidium, Dichloromethane or Methylene Chloride, Giardia Lambia, Lead, Mercury, Nitrate, Nitrite, trans 1,2-Dichloroethylene, Tetrachloroethylene or Perchlorethylene (Perc), Trichloroethylene (TCE), Vinyl Chloride, Viruses
Cement/Concrete Plants	Barium, Benzene, Dichloromethane or Methylene Chloride, Ethylbenzene, Lead, Styrene, Tetrachloroethylene or Perchlorethylene (Perc), Toluene, Xylene (Mixed Isomers)
Chemical/Petroleum Processing	Acrylamide, Arsenic, Atrazine, Alachlor, Aluminum (Fume or Dust), Barium, Benzene, Cadmium, Carbofuran, Carbon Tetrachloride, Chlorobenzene, Copper, Cyanide, 2,4-D, 1,2-Dibromoethane or Ethylene Dibromide (EDB), 1,2-Dichlorobenzene or O-Dichlorobenzene, 1,4-Dichlorobenzene or P-Dichlorobenzene, 1,1-Dichloroethylene or Vinylidene Chloride, cis 1,2 Dichloroethylene, Dichloromethane or Methylene Chloride, Di(2-ethylhexyl) adipate, Di(2-ethylhexyl) phthlate, 1,2-Dichloroethane or Ethylene Dichloride, Dioxin, Endrin, Epichlorohydrin, Ethylbenzene, Hexachlorobenzene, Hexachlorocyclopentadiene, Lead, Mercury, Methoxychlor,Polychlorinated Biphenyls, Selenium, Styrene, Sulfate, Tetrachloroethylene or Perchlorethylene (Perc), Toluene, 1,2,4-Trichlorobenzene, 1,1,1-Trichloroethane or Methyl Chloroform, Trichloroethylene (TCE), Vinyl Chloride, Xylene (Mixed Isomers), Zinc (Fume or Dust)
Construction/Demolition	Arsenic, Asbestos, Benzene, Cadmium, Chloride, Copper,Cyanide, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Fluorides, Lead, Selenium, Tetrachloroethylene or Perchlorethylene (Perc), 1,1,1-Trichloroethane or Methyl Chloroform, Trichloroethylene (TCE), Turbidity, Xylene (Mixed Isomers), Zinc (Fume or Dust)
Dry Cleaners/Dry Cleaning	Tetrachloroethylene or Perchlorethylene (Perc), 1,1,1-Trichloroethane or Methyl Chloroform, 1,1,2-Trichloroethane

[2] EPA maintains a chart that lists some potential facilities and activities where one might find the contaminants referred to as primary and secondary drinking water standards. The listing of a contaminant does not mean that it will always occur at the associated source, nor does it encompass all contaminants that may be present. This list is intended as a resource guide for creating an inventory list. A state or local community may have different sources of concern from the list below, based on local variability such as existing industrial activity, and known contaminant occurrence information.

Table 5.[2] Contaminants Commonly Associated With Selected Facilities and Activities.

POTENTIAL SOURCE	CONTAMINANT
Dry Goods Manufacturing	Barium, Benzene, Cadmium, Copper, Dichloromethane or Methylene Chloride, Di(2-ethylhexyl) phthlate, Lead, 1,1,1-Trichloroethane or Methyl Chloroform, Polychlorinated Biphenyls, Tetrachloroethylene or Perchlorethylene (Perc), Toluene, Trichloroethylene (TCE), Xylene (Mixed Isomers)
Electrical/Electronic Manufacturing	Aluminum (Fume or Dust), Antimony, Arsenic, Barium, Benzene, Cadmium, Chlorobenzene, Copper, Cyanide, Carbon Tetrachloride, 1,2-Dichlorobenzene or O-Dichlorobenzene, 1,2-Dichloroethane or Ethylene Dichloride, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Di(2-ethylhexyl) phthlate, Ethylbenzene, Lead, Mercury, Polychlorinated Biphenyls, Selenium, Styrene, Sulfate, Tetrachloroethylene or Perchlorethylene (Perc), 1,1,1-Trichloroethane or Methyl Chloroform, 1,1,2-Trichloroethane, Trichloroethylene (TCE), Thallium, Toluene, Vinyl Chloride, Xylene (Mixed Isomers), Zinc (Fume or Dust)
Fleet/Trucking/ Bus Terminals	Arsenic, Acrylamide, Barium, Benzene, Benzo(a)pyrene, Cadmium, Chlorobenzene, Cyanide, Carbon Tetrachloride, 2,4-D, 1,2-Dichlorobenzene or O-Dichlorobenzene, 1,4-Dichlorobenzene or P-Dichlorobenzene, 1,2-Dichloroethane or Ethylene Dichloride, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Di(2-ethylhexyl) phthlate, Epichlorohydrin, Heptachlor (and Epoxide), Lead, Mercury, Methoxychlor, Pentachlorophenol, Propylene Dichloride or 1,2-Dichloropropane, Selenium, Styrene, Toxaphene, Tetrachloroethylene or Perchlorethylene (Perc), Toluene, 1,1,1-Trichloroethane or Methyl Chloroform, Trichloroethylene (TCE), Vinyl Chloride, Xylene (Mixed Isomers)
Food Processing	Arsenic, Benzene, Cadmium, Copper, Carbon Tetrachloride, Dichloromethane or Methylene Chloride, Lead, Mercury, Picloram, Tetrachloroethylene or Perchlorethylene (Perc), Toluene, 1,1,1-Trichloroethane or Methyl Chloroform, Trichloroethylene (TCE), Xylene (Mixed Isomers)
Funeral Services/Taxidermy	Glyphosate, Dichloromethane or Methylene Chloride, Nitrate, Nitrite, Total Coliforms, Viruses
Furniture Repair/Manufacturing	Barium, 1,2-Dichloroethane or Ethylene Dichloride, Dichloromethane or Methylene Chloride, Ethylbenzene, Lead, Mercury, Selenium, Trichloroethylene (TCE)
Gas Stations (see also above ground/underground storage tanks, motor-vehicle drainage wells)	cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Tetrachloroethylene or Perchlorethylene (Perc), Trichloroethylene (TCE)
Graveyards/Cemetaries	Dalapon, Lindane, Nitrate, Nitrite, Total Coliforms, Viruses.
Hardware/Lumber/Parts Stores	Aluminum (Fume or Dust), Barium, Benzene, Cadmium, Chlorobenzene, Copper, Dichloromethane or Methylene Chloride, Di(2-ethylhexyl)adipate, Di(2-ethylhexyl) phthlate, 1,4-Dichlorobenzene or P-Dichlorobenzene, Ethylbenzene, Lead, Mercury, Tetrachloroethylene or Perchlorethylene (Perc), 1,1,1-Trichloroethane or Methyl Chloroform, Trichloroethylene (TCE), Toluene, Xylene (Mixed Isomers)
Historic Waste Dumps/Landfills	Atrazine, Alachlor, Carbofuran, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Diquat, Dalapon, Glyphosate, Dichloromethane or Methylene Chloride, Nitrate, Nitrite, Oxamyl (Vydate), Sulfate, Simazine, Tetrachloroethylene or Perchlorethylene (Perc), Trichloroethylene(TCE)

Table 5.[2] Contaminants Commonly Associated With Selected Facilities and Activities.

POTENTIAL SOURCE	CONTAMINANT
Home Manufacturing	Arsenic, Barium, Benzene, Cadmium, Chlorobenzene, Copper, Carbon Tetrachloride, 1,2-Dichlorobenzene or O-Dichlorobenzene, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Di(2-ethylhexyl) phthlate, Ethylbenzene, Lead, Mercury, Selenium, Styrene, Tetrachloroethylene or Perchlorethylene (Perc), 1,1,1-Trichloroethane or Methyl Chloroform, Trichloroethylene (TCE), Toluene, Turbidity, Xylene (Mixed Isomers)
Industrial Waste Disposal Wells (see UIC for more information on concerns, and locations)	Acrylamide, Arsenic, Atrazine, Alachlor, Aluminum (Fume or Dust), Ammonia, Barium, Benzene, Cadmium, Carbofuran, Carbon Tetrachloride, Chlorobenzene, Copper, Cyanide, 2,4-D, 1,2-Dibromoethane or Ethylene Dibromide (EDB), 1,2-Dichlorobenzene or O-Dichlorobenzene, 1,4-Dichlorobenzene or p-Dichlorobenzene, 1,1-Dichloroethylene or Vinylidene Chloride, cis 1,2 Dichloroethylene, Dichloromethane or Methylene Chloride, Di(2-ethylhexyl) adipate, Di(2-ethylhexyl) phthlate, 1,2-Dichloroethane or Ethylene Dichloride, Dioxin, Endrin, Epichlorohydrin, Hexachlorobenzene, Hexachlorocyclopentadiene, Lead, Mercury, Methoxychlor, Oxamyl (Vydate), Polychlorinated Biphenyls, Selenium, Styrene, Sulfate, Tetrachloroethylene or Perchlorethylene (Perc), Toluene, 1,2,4-Trichlorobenzene, 1,1,1-Trichloroethane or Methyl Chloroform, Trichloroethylene (TCE), Vinyl Chloride, Xylene (Mixed Isomers), Zinc (Fume or Dust)
Junk/Scrap/Salvage Yards	Barium, Benzene, Copper, Dalapon, cis 1,2-Dichloroethylene, Diquat, Glyphosate, Lead, Polychlorinated Biphenyls, Sulfate, Simazine, Trichloroethylene (TCE), Tetrachloroethylene or Perchlorethylene (Perc)
Machine Shops	Arsenic, Aluminum (Fume or Dust), Barium, Benzene, Boric Acid, Cadmium, Chlorobenzene, Copper, Cyanide, Carbon Tetrachloride 2,4-D, 1,4-Dichlorobenzene or P-Dichlorobenzene, 1,2-Dichloroethane or Ethylene Dichloride, 1,1-Dichloroethylene or Vinylidene Chloride, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Di(2-ethylhexyl) phthlate, Ethylbenzene, Fluoride, Hexachlorobenzene, Lead, Mercury, Polychlorinated Biphenyls, Pentachlorophenol, Selenium, Styrene, Tetrachloroethylene or Perchlorethylene (Perc), Toluene, 1,1,1-Trichloroethane or Methyl Chloroform, 1,1,2-Trichloroethane, Trichloroethylene (TCE), Xylene (Mixed Isomers), Zinc (Fume or Dust)
Medical/Vet Offices	Arsenic, Acrylamide, Barium, Benzene, Cadmium, Copper, Cyanide, Carbon Tetrachloride, Dichloromethane or Methylene Chloride, 1,2-Dichloroethane or Ethylene Dichloride, Lead, Mercury, Methoxychlor, 1,1,1-Trichloroethane or Methyl Chloroform, Radionuclides, Selenium, Silver, Tetrachloroethylene or Perchlorethylene (Perc), 2,4,5-TP (Silvex), Thallium, Xylene (Mixed Isomers)
Metal Plating/Finishing/Fabricating	Antimony, Aluminum (Fume or Dust), Arsenic, Barium, Benzene, Cadmium, Carbon Tetrachloride, Chlorobenzene, Chromium, Copper, Cyanide, 1,4-Dichlorobenzene or P-Dichlorobenzene, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Di(2-ethylhexyl) adipate, Ethylbenzene,Lead, Mercury, Polychlorinated Biphenyls, Pentachlorophenol, Selenium, Styrene, Sulfate, Tetrachloroethylene or Perchlorethylene (Perc), , Thallium, Toluene, 1,1,1-Trichloroethane or Methyl Chloroform, 1,1,2-Trichloroethane, Trichloroethylene(TCE), Vinyl Chloride, Xylene (Mixed Isomers), Zinc (Fume or Dust)
Military Installations	Arsenic, Barium, Benzene, Cadmium, Chlorobenzene, 1,2-Dichlorobenzene or O-Dichlorobenzene, 1,2-Dichloroethane or Ethylene Dichloride, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Hexachlorobenzene, Lead, Mercury, Methoxychlor, 1,1,1-Trichloroethane or Methyl Chloroform, Radionuclides, Selenium, Tetrachloroethylene or Perchlorethylene (Perc), , Toluene, Trichloroethylene (TCE)

Table 5.[2] Contaminants Commonly Associated With Selected Facilities and Activities.

POTENTIAL SOURCE	CONTAMINANT
Mines/Gravel Pits	Lead, Selenium, Sulfate, Tetrachloroethylene or Perchlorethylene (Perc), 1,1,1-Trichloroethane or Methyl Chloroform, Turbidity
Motor Pools	cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride,
Motor Vehicle Waste Disposal Wells (gas stations, repair shops) See UIC for more on concerns for these sources http://www.epa.gov/safewater/uic/cv-fs.html	Arsenic, Barium, Benzene, Cadmium, Chlorobenzene, Copper, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, 1,4-Dichlorobenzene or P-Dichlorobenzene, Lead, Fluoride, 1,1,1-Trichloroethane or Methyl Chloroform, Dichloromethane or Methylene Chloride, Tetrachloroethylene or Perchlorethylene (Perc), Trichloroethylene (TCE), Xylene (Mixed Isomers)
Office Building/Complex	Barium, Benzene, Cadmium, Copper, 2,4-D, Diazinon, 1,2-Dichlorobenzene or O-Dichlorobenzene, Dichloromethane or Methylene Chloride, Diquat, 1,2-Dichloroethane or Ethylene Dichloride, Ethylbenzene, Glyphosate, Lead, Mercury, Selenium, Simazine, Tetrachloroethylene or Perchlorethylene (Perc), 1,1,1-Trichloroethane or Methyl Chloroform, Trichloroethylene (TCE), Vinyl Chloride, Xylene (Mixed Isomers)
Photo Processing/Printing	Acrylamide, Aluminum (Fume or Dust), Arsenic, Barium, Benzene, Cadmium, Carbon Tetrachloride, Chlorobenzene, Copper, Cyanide, 1,1-Dichloroethylene or Vinylidene Chloride, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Di(2-ethylhexyl) phthlate, 1,2-Dichlorobenzene or O-Dichlorobenzene, 1,4-Dichlorobenzene or P-Dichlorobenzene, 1,2-Dichloroethane or Ethylene Dichloride, 1,2-Dibromoethane or Ethylene Dibromide (EDB), Heptachlor epoxide, Hexachlorobenzene, Lead, Lindane, Mercury, Methoxychlor, Propylene Dichloride or 1,2-Dichloropropane, Selenium, Styrene, Tetrachloroethylene or Perchlorethylene (Perc), 1,1,1-Trichloroethane or Methyl Chloroform, Toluene, 1,1,2-Trichloroethane, Trichloroethylene(TCE), Vinyl Chloride, Xylene (Mixed Isomers), Zinc (Fume or Dust)
Synthetic / Plastics Production	Antimony, Arsenic, Barium, Benzene, Cadmium, Carbon Tetrachloride, Chlorobenzene, Copper, Cyanide, 1,2-Dichlorobenzene or O-Dichlorobenzene, 1,4-Dichlorobenzene or P-Dichlorobenzene, 1,2-Dichloroethane or Ethylene Dichloride, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Di(2-ethylhexyl) adipate, Di(2-ethylhexyl) phthlate, Ethylbenzene, Hexachlorobenzene, Lead, Mercury, Methyl Chloroform or 1,1,1-Trichloroethane, Pentachlorophenol, Selenium, Styrene, Tetrachloroethylene or Perchlorethylene (Perk), Toluene, Trichloroethylene (TCE), Vinyl Chloride, Xylene (Mixed Isomers), Zinc (Fume or Dust)
RV/Mini Storage	Arsenic, Barium, Cyanide, 2,4-D, Endrin, Lead, Methoxychlor
Railroad Yards/Maintenance/Fueling Areas	Atrazine, Barium, Benzene, Cadmium, Dalapon, 1,4-Dichlorobenzene or P-Dichlorobenzene, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Lead, Mercury, Tetrachloroethylene or Perchlorethylene (Perc), Trichloroethylene (TCE).
Research Laboratories	Arsenic, Barium, Benzene, Beryllium Powder, Cadmium, Carbon Tetrachloride, Chlorobenzene, Cyanide, 1,2-Dichloroethane or Ethylene Dichloride, 1,1-Dichloroethylene or Vinylidene Chloride, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Endrin, Lead, Mercury, Polychlorinated Biphenyls, Selenium, Tetrachloroethylene or Perchlorethylene (Perc), Thallium, Thiosulfates, Toluene, 1,1,1-Trichloroethane or Methyl Chloroform, Trichloroethylene (TCE), Vinyl Chloride, Xylene (Mixed Isomers)
Retail Operations	Arsenic, Barium, Benzene, Cadmium, 2,4-D, 1,2-Dichloroethane or Ethylene Dichloride, Lead, Mercury, Styrene, Tetrachloroethylene or Perchlorethylene (Perc), Toluene, 1,1,1-Trichloroethane, Vinyl Chloride

Table 5.[2] Contaminants Commonly Associated With Selected Facilities and Activities.

POTENTIAL SOURCE	CONTAMINANT
Underground Storage Tanks	Arsenic, Barium, Benzene, Cadmium, 1,4-Dichlorobenzene or P-Dichlorobenzene, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Lead, Tetrachloroethylene or Perchlorethylene (Perc), Trichloroethylene (TCE).
Wood Preserving/Treating	cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Lead, Sulfate
Wood/Pulp/Paper Processing	Arsenic, Barium, Benzene, Cadmium, Carbon Tetrachloride, Copper, Dichloromethane or Methylene Chloride, Dioxin, 1,2-Dichloroethane or Ethylene Dichloride, Ethylbenzene, Lead, Mercury, Polychlorinated Biphenyls, Selenium, Styrene, Tetrachloroethylene or Perchlorethylene (Perc), Trichloroethylene (TCE), Toluene, 1,1,1-Trichloroethane or Methyl Chloroform, Xylene (Mixed Isomers)
Residential / Municipal	
Airports (Maintenance/Fueling Areas)	Arsenic, Barium, Benzene, Cadmium, Carbon Tetrachloride, cis 1,2- Dichloroethylene, Dichloromethane or Methylene Chloride, Ethylbenzene, Lead, Mercury, Selenium, Tetrachloroethylene or Perchlorethylene (Perc), 1,1,1-Trichloroethane or Methyl Chloroform, Trichloroethylene (TCE), Xylene (Mixed Isomers)
Apartments and Condominiums	Atrazine, Alachlor, Coliform, Cryptosporidium, Dalapon, Diquat, Giardia Lambia, Glyphosate, Nitrate, Nitrite, Picloram,Sulfate,Simazine, Vinyl Chloride, Viruses
Camp Grounds/RV Parks	Benomyl, Coliform, Cryptosporidium, Diquat, Dalapon, Giardia Lambia, Glyphosate, Isopropanol, Nitrate, Nitrite, Picloram,Sulfate,Simazine, Turbidity, Vinyl Chloride, Viruses
Cesspools - Large Capacity (see UIC for more information)	Atrazine, Alachlor, Carbofuran, Coliform, Cryptosporidium, Diquat, Dalapon, Giardia Lambia, Glyphosate, Nitrate, Nitrite, Oxamyl (Vydate), Picloram,Sulfate,Simazine, Vinyl Chloride, Viruses
Drinking Water Treatment Facilities	Atrazine, Benzene, Cadmium, Cyanide, Fluoride, Lead, Polychlorinated Biphenyls, Toluene, Total Trihalomethanes, 1,1,1-Trichloroethane or Methyl Chloroform
Gas Pipelines	cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Tetrachloroethylene or Perchlorethylene (Perc), Trichloroethylene or TCE
Golf Courses and Urban Parks	Arsenic, Atrazine, Benzene, Chlorobenzene, Carbofuran, 2,4-D, Diquat, Dalapon, Glyphosate, Lead, Methoxychlor, Nitrate, Nitrite, Picloram, Simazine, Turbidity
Housing developments	Atrazine, Alachlor, Coliform, Cryptosporidium, Carbofuran, Diquat, Dalapon, Giardia Lambia, Glyphosate, Dichloromethane or Methylene Chloride, Nitrate, Nitrite, Picloram, Simazine, Trichloroethylene (TCE), Turbidity, Vinyl Chloride, Viruses
Landfills/Dumps	Arsenic, Atrazine, Alachlor, Barium, Benzene, Cadmium, Carbofuran, cis 1,2 Dichloroethylene, Diquat, Glyphosate, Lead, Lindane, Mercury, 1,1,1-Trichloroethane or Methyl Chloroform, Dichloromethane or Methylene Chloride, Nitrate, Nitrite, Picloram, Selenium, Simazine, Trichloroethylene (TCE)
Public Buildings (e.g., schools, town halls, fire stations, police stations) and Civic Organizations	Arsenic, Acrylamide, Barium, Benzene, Beryllium Powder, Cadmium, Carbon Tetrachloride, Chlorobenzene, Cyanide, 2,4-D, 1,2-Dichlorobenzene or O-Dichlorobenzene, 1,4-Dichlorobenzene or P-Dichlorobenzene, Dichloromethane or Methylene Chloride, Di(2-ethylhexyl) phthlate, 1,2-Dichloroethane or Ethylene Dichloride, Endothall, Endrin, 1,2-Dibromoethane or Ethylene Dibromide (EDB), Lead, Lindane, Mercury, Methoxychlor, Selenium, Toluene, 1,1,1-Trichloroethane or Methyl Chloroform, Trichloroethylene (TCE), Vinyl Chloride, Xylene (Mixed Isomers)

Table 5.[2] Contaminants Commonly Associated With Selected Facilities and Activities.

POTENTIAL SOURCE	CONTAMINANT
Septic Systems	Atrazine, Alachlor, Carbofuran, Coliform, Cryptosporidium, Diquat, Dalapon, Giardia Lambia, Glyphosate, Nitrate, Nitrite, Oxamyl (Vydate), Picloram, Sulfate, Simazine, Vinyl Chloride, Viruses
Sewer Lines	Coliform, Cryptosporidium, Diquat, Dalapon, Giardia Lambia, Glyphosate, Nitrate, Nitrite, Oxamyl (Vydate), Picloram,Sulfate,Simazine, Vinyl Chloride, Viruses
Stormwater infiltration basins/injection into wells (UIC Class V), runoff zones	Atrazine, Alachlor, Coliform, Cryptosporidium, Carbofuran, Chlorine, Diquat, Dalapon, Giardia Lambia, Glyphosate, Dichloromethane or Methylene Chloride, Nitrate, Nitrite, Nitrosamine, Oxamyl (Vydate), Phosphates, Picloram, Simazine, Trichloroethylene(TCE), Turbidity, Vinyl Chloride, Viruses
Transportation Corridors (e.g., Roads, railroads)	Dalapon, Picloram, Simazine, Sodium, Sodium Chloride, Turbidity
Utility Stations	Arsenic, Barium, Benzene, Cadmium, Chlorobenzene, Cyanide, 2,4-D, 1,4-Dichlorobenzene or P-Dichlorobenzene, 1,2-Dichloroethane or Ethylene Dichloride, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Lead, Mercury, Picloram, Toluene, 1,1,2,2- Tetrachloroethane, Tetrachloroethylene or Perchlorethylene (Perc), Trichloroethylene (TCE), Xylene (Mixed Isomers)
Waste Transfer /Recycling	Coliform, Cryptosporidium, Giardia Lambia, Nitrate, Nitrite, Vinyl Chloride, Viruses
Wastewater Treatment Facilities/Discharge locations (incl. land disposal and underground injection of sludge)	Cadmium, Coliform, Cryptosporidium, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Dichloromethane or Methylene Chloride, Fluoride, Giardia Lambia, Lead, Mercury, Nitrate, Nitrite, Tetrachloroethylene or Perchlorethylene (Perc) Selenium, sulfate,Trichloroethylene (TCE), Vinyl Chloride, Viruses
Agricultural / Rural	
Auction Lots/Boarding Stables	Coliform, Cryptosporidium, Giardia Lambia, Nitrate, Nitrite,Sulfate,Viruses
Animal Feeding Operations/ Confined Animal Feeding Operations	Coliform, Cryptosporidium, Giardia Lambia, Nitrate, Nitrite, Sulfate, Turbidity, Viruses
Bird Rookeries/Wildlife feeding /migration zones	Coliform, Cryptosporidium, Giardia Lambia, Nitrate , Nitrite , Sulfate, Turbidity, Viruses
Crops - Irrigated + Non-irrigated	Benzene, 2,4-D, Dalapon, Dinoseb, Diquat, Glyphosate, Lindane, Lead, Nitrate, Nitrite , Picloram, Simazine, Turbidity
Dairy operations	Coliform, Cryptosporidium, Giardia Lambia, Nitrate , Nitrite,Sulfate,Turbidity, Viruses
Drainage Wells, Lagoons and Liquid Waste Disposal - Agricultural	Atrazine, Alachlor, Coliform, Cryptosporidium, Carbofuran, Diquat, Dalapon, Giardia Lambia, Glyphosate, Nitrate, Nitrite, Oxamyl (Vydate), Picloram,Sulfate,Simazine, Vinyl Chloride, Viruses
Managed Forests/Grass Lands	Atrazine, Diquat, Glyphosate, Picloram, Simazine, Turbidity
Pesticide/Fertilizer Storage Facilities	Atrazine, Alachlor, Carbofuran, Chlordane, 2,4-D, Diquat, Dalapon, 1,2-Dibromo-3-Chloropropane or DBCP, Glyphosate, Nitrate, Nitrite, Oxamyl (Vydate), Picloram, Simazine, 2,4,5-TP (Silvex)
Rangeland/Grazing lands	Coliform, Cryptosporidium, Giardia Lambia, Nitrate, Nitrite, Sulfate, Turbidity, Viruses
Residential Wastewater lagoons	Atrazine, Alachlor, Carbofuran, Coliform, Cryptosporidium, Diquat, Dalapon, Giardia Lambia, Glyphosate, Nitrate, Nitrite, Oxamyl (Vydate), Picloram,Sulfate,Simazine, Vinyl Chloride, Viruses

Table 5.[2] Contaminants Commonly Associated With Selected Facilities and Activities.

POTENTIAL SOURCE	CONTAMINANT
Rural Homesteads	Atrazine, Alachlor, Carbofuran, Coliform, Cryptosporidium, cis 1,2-Dichloroethylene, trans 1,2-Dichloroethylene, Diquat, Dalapon, Giardia Lambia, Glyphosate, Nitrate, Nitrite,Oxamyl (Vydate), Picloram, Sulfate, Simazine, Vinyl Chloride, Viruses

MISCELLANEOUS SOURCES	
Abandoned drinking water wells (conduits for contamination)	Atrazine, Alachlor, Coliform, Cryptosporidium, Carbofuran, Diquat, Dalapon, Giardia Lambia, Glyphosate, Dichloromethane or Methylene Chloride, Nitrate, Nitrite, Oxamyl (Vydate), Picloram, Simazine, Trichloroethylene (TCE), Turbidity, Vinyl Chloride, Viruses
Naturally Occurring	Arsenic, Asbestos, Barium, Cadmium, Chromium, Coliform, Copper, Cryptosporidium, Fluoride, Giardia Lambia, Iron, Lead, Manganese, Mercury, Nitrate, Nitrite, Radionuclides, Selenium, Silver, Sulfate, Viruses, Zinc (Fume or Dust)
Underground Injection Control (UIC) Wells CLASS I - deep injection of hazardous and non-hazardous wastes into aquifers separated from underground sources of drinking water	see UIC
UIC Wells CLASS II deep injection wells of fluids associated with oil/gas production (for more detailed list of sites click here)	see UIC
UIC Wells CLASS III re-injection of water/steam into mineral formations for mineral extraction	see UIC
UIC Wells CLASS IV - officially banned. Inject hazardous or radioactive waste into or above underground sources of drinking water	see UIC

Table 6.[3] Possible Contaminating Activities (PCAs).

Risk	Activities			
	Commercial/Industrial	**Residential/Municipal**	**Agricultural/Rural**	**Other**
Very High (VH)	-Gas stations -Chemical/petroleum processing/storage -Dry cleaners -Metal plating/ finishing/fabricating -Plastics/synthetics producers	-Airports – maintenance/fueling areas -Landfills/dumps -*Septic systems - High density (>1/acre) (for groundwater sources otherwise M) -*Wastewater Treatment Plants	-* Animal Feeding Operations -* Concentrated Aquatic Animal Production Facilities -* Managed Forests (VH for surface water otherwise H)	-Underground injection of commercial/ industrial discharges -Historic gas stations -Historic waste dumps/landfills -Injection wells/dry wells/ sumps -Known contaminant plumes -Military installations -Historic Mining operations -Active Mining operations -Confirmed leaking underground storage tanks
High (H)	-Auto Body shops -Auto Repair shops -Boat services/repair/ refinishing -Chemical/petroleum pipelines -Electrical/electronic manufacturing -Fleet/trucking/bus terminals -Furniture repair/ manufacturing -Home manufacturing -Junk/scrap/salvage yards -Machine shops -Photo processing/ printing -Research laboratories -Wood preserving/ treating -Lumber processing and manufacturing -Wood/pulp/paper processing and mills -*Sewer collection systems	-Railroad yards/ maintenance/fueling areas -*Sewer collection systems -Utility stations - maintenance areas -*Wastewater Treatment Plants	-* Grazing (> 5 animals/ acre) -* Animal Feeding Operations -* Other animal operations -Concentrated Aquatic Animal Production Facilities -Other aquatic animal operations -Farm chemical distributor/ application service -Farm machinery repair -*Septic systems- low density (<1/acre) -*Lagoons/liquid wastes -Machine shops -Pesticide/fertilizer/ petroleum storage and transfer areas -Managed Forests (VH for surface water otherwise H) -Agricultural Drainage and Irrigation Wells	-Industrial discharges -Illegal activities/unauthorized dumping -Mining - Sand/Gravel -Wells- Oil, Gas, Geothermal -Salt water intrusion -*Recreational area - surface water source -Non-regulated Underground storage tanks (tanks smaller than regulatory limit) -Not yet upgraded or registered Underground storage tanks -Snow Ski Areas -Recent (< 10 years) Burn Areas -Dredging

[3] The Navy Environmental Health Center (NEHC) has prepared tables based on EPA's State Source Water Assessment And Protection Programs Guidance, identifying Possible Contaminating Activities (PCAs) associated with various potential risks for drinking water contamination. The concept is largely applicable to stormwater, as activities with the runoff potential to contaminate drinking water are also likely to impact stormwater. In addition, rising contaminated groundwater could enter an MS4. This table is taken from the NEHC's efforts. It identifies PCAs divided by land use type and risk to drinking/receiving water. The risk rankings are based on the general nature of activities and the contaminants associated with them. An asterisk (*) indicates PCAs that may be associated with microbiological contamination.

Table 6.[3] Possible Contaminating Activities (PCAs).

Risk	Activities			
	Commercial/Industrial	**Residential/Municipal**	**Agricultural/Rural**	**Other**
Moderate (M)	-Car washes -Parking lots/malls (>50 spaces) -Cement/concrete plants -*Food processing -Funeral services/ graveyards -Hardware/lumber/parts stores	-*Septic systems - High density (>1/acre) -Drinking water treatment plants -Golf courses -Housing – High density (>1 house/0.5 acres) -Motor pools -Parks -Waste transfer/ recycling stations	-* Other animal operations -Other aquatic animal operations (H in Zones for surface water, otherwise M) -Crops, irrigated (berries, hops, mint, orchards, sod, greenhouses, vineyards, nurseries, vegetables) NOTE: Drip-irrigated crops are considered Low risks. -*Sewage sludge (biosolids) land application -Fertilizer, pesticide/ herbicide application -Managed Forests (M for ground water) -Agricultural Drainage	-Above ground storage tanks -Wells - water supply -Construction/demolition staging areas -Contractor or government agency equipment storage yards -Managed forests -Freeways/state highways -Railroads -Historic railroad right-of-ways -Road right-of-ways (herbicide use areas) -Hospitals -Storm drain discharge points -Storm water detention facilities -Artificial recharge projects – nonpotable water (includes recycled, storm, and untreated imported water) -Injection wells -Spreading basins -Snow Ski Areas (H in Zones for surface water, otherwise M) -Recent (< 10 years) Burn Areas (H in Zones for surface water, otherwise M) -Dredging (H in Zones for surface water, otherwise M)
Low (L)	-*Sewer collection systems -Appliance/Electronic repair -Office buildings/ complexes -Rental yards -RV/mini storage	-*Sewer collection systems -Apartments and condominiums -Campgrounds/ Recreational areas -Fire stations -RV parks -Schools -Hotels, Motels	-Crops, non-irrigated (e.g. Christmas trees, grains, grass seeds, hay) (or drip-irrigated crops) -* Septic systems - low density (<1/acre)	-Decommissioned underground storage tanks – inactive -Upgraded and/or registered underground storage tanks – active -Roads/Streets -Artificial recharge projects – potable water-Injection wells -Artificial recharge projects – potable water -Spreading basins -Medical/dental offices/clinics -Veterinary offices/clinics -*Surface water - streams/lakes/ rivers -Wells - Monitoring, test holes, borings

APPENDIX M:

KISTERS DATA ENTRY PROCEDURES

KiWQM Data Entry Procedures

In 2017 the District began the process of replacing its existing water quality database with a more advanced software program. The prior database technology was Kisters Hydstra Water Quality Module purchased in the 1990's. This database will remain at the District to maintain the hydrologic data (rainfall, stage, flow) within it's Time Series Module. The Water Quality Module has become outdated with limitations on the type of data and number of parameters certain fields can hold. As MS4 permits expand to include requirements of habitat data and field observations such as vegetation cover, floatables, and water color, software that can manage these narrative results is now essential. This older module also requires more technical support from the company to write individual computer programs to make any customizations or format changes to graphs and reports. This module is being replaced by Kisters Water Quality Module (KiWQM). This new program automates quality control checks such as completeness of data, meeting target reporting limits, and identifying any analyses that were incorrectly reported by the laboratory. This database has the capabilities necessary to hold, filter, and export narrative field conditions with the associated laboratory numeric results. Staff also have the ability to create standard reports and graphs within the database to ensure consistency throughout the MS4 compliance program. Specific constituent lists with approved laboratory methods and SWAMP recommended reporting limits can be tailored to each of the water quality programmatic elements. By using these more rigid lists staff can be alerted as to when the laboratory was not able to meet a requested reporting limit or used an unexpected analysis method.

The following is a general step-wise procedure for importing data, creating field data sheets, and conducting quality control checks on both the field and laboratory reported data.

General Procedures for Import Workflow and QC Process

Importing a New Sampling:

1. Field staff will collect and submit surveys to the ESRI website.
2. Run download script from KiDSM
3. Open excel that was created to review columns and edit as needed
    a. If Wet Event must manually fill in storm start/storm stop/ precipitation total, OR can add information to 'Additional attributes' tab once imported.
    b. All dates/times must be in the following format mm/dd/yyyyy hh:mm
4. To Import select 'File', 'import', 'samplings'. Ensure the appropriate 'Configuration' for the type of data is selected. A different configuration for events classified as Visited-Not-Sampled (VNS).
    a. Survey123 = KiDSM created csv file 'data'
    b. VNS = KiDSM created csv file 'vns'
5. Select the desired csv file from 'Import' tab
6. Click 'Read file'
7. Review and fix any errors encountered
8. Click 'Import data' Note: only valid data will be imported, if there are errors then that line will not be imported into the system.
9. Navigate to appropriate 'sampling' to see that Status is automatically set as 'Incomplete' (if chemistry data) or 'Unconfirmed' (if field data).
10. Edit 'Additional attributes' tab(s):
    a. Fix any spelling/grammatical errors from survey
    b. Delete any unused fields (i.e., circular flow rate)
    c. If multiple samples within sampling, keep all attributes in primary grab sample, delete out majority of attributes, leave fields for type and number of bottles.

Creating Field Data Sheet:

11. Run 'FDS' report and confirm all data is populating correctly and matches the survey123 data.
    a. Select 'Report View' button or under 'Tools' tab select 'Report View'
    b. Expand 'Measuring Program' folders and 'Field Data Sheet' folder to select appropriate measuring program. Right click to select 'Open'
    c. Use drop downs to select specific site and event.
    d. Click 'Finish'
    e. Click 'Execute'
    f. If it is a composite sample then manually add times/flow/percentages as appropriate
12. Save FDS as a pdf in data folder ("Print to PDF")
13. Save .jpeg photo files into event data folder and also pdf any photos as a 1-page 8x10, and add to FDS pdf.
    a. Photos are located here parsed into site and event folders
        i. \\HYDSTRA\kidsm\Photos
14. Add FDS to 'Assigned documents' tab of sampling
    a. Right click, chose 'Add'
    b. Click 'Select' button
    c. Navigate to FDS and double click to select
    d. Select 'No' when asked 'Save in the database' (documents take up lots of space, only add the link to destination file so they can be opened within KiWQM but saved in the original data folders).

Importing Chemical Analytical Data:

15. To import the chemistry file (after survey/field data).
    a. Navigate to input folder
        i. \\HYDSTRA\kidsm\input\ChemEDD
    b. Drag and drop laboratory EDD from event folder into 'download' folder.
    c. Kisters' script will parse and incorporate appropriate fields and create a csv for import in the 'CSV' folder.
16. Select 'File', 'import', 'samplings'. Ensure the appropriate 'Configuration' for the type of data is selected.
    a. ChemEDD = Kisters created csv file
17. Select correct csv file from 'Import' tab
18. Click 'Read file'
19. Review and fix any errors encountered
20. Click 'Import data' Note: only valid data will be imported, if there are errors that line will not be imported into the system.
21. If parameter is expected and analyzed by expected method it will import into previously created row and will show status as 'Unconfirmed'. If analyzed by different method will show in newly created row and the 'Incomplete' row will need to be deleted and parameter lists updated as necessary.
22. Import any other analytical data, manual entry if required (e.g., toxicity, ethylene glycol, carbamates). If analyzed by a separate lab (sub-out from Babcock):
    a. In 'Sample Fractions' tab, right click to 'Add'
    b. Fill out yellow required fields
        i. 'Fraction number' next progressive numerical (if Babcock is 1, then the next lab would be 2, and the next lab 3, etc.)

ii. 'Laboratory' select appropriate lab from drop down.

c. In 'Sample Results' double click parameter row that you are manually entering and enter required data (e.g., Value, Fraction [lab in previous step], Detection limit, status, lab sample ID, Batch No., Dilution Factor, Reporting limit, and any lab qualifiers) as appropriate.

How to run a QC Check:

23. Run QC Report in KiWQM, save to event folder in WQ Data with suffix or FAIL or PASS.
24. If errors are identified return chemistry report to laboratory as needed for amendments. This could include missing or unnecessary qualifiers, missing or unnecessary results, sample ID, COC errors.
25. Redo steps 14-23 until all QC issues are resolved.
26. Once QC report has passed then go to appropriate sample table to bulk edit status of data to 'Confirmed' and remove UC- prefix from all lab reports in event data file:
    a. Select appropriate sample table to include just the samplings you want to confirm,
    b. Check the 'Show value columns' box,
    c. Right click and select "Edit quality of samples and sample results…",
    d. Check the 'Allow bulk changes' box, and
    e. Click in 'S' box to select appropriate status to change all results to *confirmed*.
27. Save all links to documents (not in the database) including FDS with Photos and all pdf lab reports.

~~In 2017 the District updating the Districts water quality database with newer technology that will allow staff to be more efficient and create better products in house. The prior database technology was Kisters Hydstra Water Quality Module purchased in the early 1990's. This database will remain at the District to maintain the Hydrologic data (rainfall, stage, flow) within it's Time Series Module. The Water Quality Module has become outdated with limitations on the amount of parameters certain fields can hold. This module also requires more support from the company to write individual computer programs to make any customizations. This module is being replaced by Kisters Water Quality Module (KiWQM). The migration of all historical data, import and Q/C procedures are being developed at the time of this CMP update. The following is a general procedure for importing data which may be further refined as this database becomes fully integrated.~~

~~1. Receive Analytical Data from Laboratory~~
~~2. Import Laboratory and Field Data Into Hydstra~~
~~E.S. Babcock Lab will send "edds" – electronic data excel files, periodically via email. The excel files will be attachments to the email.~~
~~2.1 Within KiWQM Explorer mode, select File, Import, Others, Samplings~~
~~2.2 Within Configuration tab select correct importer for type of data (**Survey 123 data must be imported first as sampling event will be created from this**.)~~
~~2.3 Click on Import tab and select data file to be uploaded by selecting the box with '…'~~
~~2.4 Click 'Read file' button~~
~~2.5 Address any errors identified by importer~~
~~2.6 Click 'Import data' button to import into KiWQM~~
~~3. Run report to check reporting limits and parameter lists.~~
~~4. If report identified any errors, send back to Babcock Labs for correction.~~
~~5. Input any toxicity data manually to appropriate Sampling event.~~
~~6. Run plausibility checks to change status of data to 'Confirmed'.~~

Hydstra WQ Module Data Entry Procedures

1. Receive Analytical Data from Laboratory

2. Import Laboratory and Field Data Into Hydstra

   E.S. Babcock Lab will send "edds" – electronic data text files, periodically via email. The text files will be attachments to the email. A sample data file name is given for this example and will be different for each file sent by the lab.

   2.1 Match the paper copy of the lab results with the text file from the email. The paper copy of the lab results will accompany the invoices from the lab.

   2.2 Open up the text file and review its format. It should read similar to:

   "A5D1827-01 813 BacT Sampling 04/22/2005 14:30 David Ortega 04/22/2005 16:35 Fecal Streptococcus 40 MPN/100 mL 20 SM 9230B 04/22/2005 SAMP"

   2.2.1 The first item (**A5D1827-01**) is the lab number.

   2.2.2 The Hydstra station number (**813**) is next. This number should match the Sample ID on the *Chain of Custody* form.

   2.2.3 The project name (**BACTEE Sampling**) should match the Project Name on the *Chain of Custody* form.

   2.2.4 The date (**4/22/05**) should match the sample date on the *Chain of Custody* form.

   2.2.5 The time (**14:30**) should match the sample time on the *Chain of Custody* form.

   2.2.6 The name (**David Ortega**) should match the name under Sampler Information on the *Chain of Custody* form.

   2.2.7 The next date (**4/22/05**) is the date that the samples were received by the lab, and should match the *Chain of Custody* form.

   2.2.8 The next time (**16:35**) is the time that the lab received the samples, and should match the *Chain of Custody* form.

   2.2.9 **Fecal Streptococcus** refers to the type of lab analysis performed by the lab.

   2.2.10 **MPN/100 mL** refers to the reporting units of the lab results.

   2.2.11 **SM 9230B** refers to the analytical method use by the lab.

   2.3 If there is a discrepancy or difference between the paper copy of the lab report and the electronic lab data, please contact Rebekah Guill (951-955-2901) and/or Abigail Suter Penny Nanney (951-955-1734 1325) at the District and Kayelani Deener (951-653-3351) at the lab.

   2.4 Open **Q:\NPDES\LABORATORY REPORTS\Babcock Data 04-05** (the reporting year at the end of the filename may be different).

   2.5 If there are no discrepancies between the paper copy of the lab report and the electronic lab data, then copy the text file and paste to the file **Babcock Data 04-05** in **Q:\NPDES\LABORATORY REPORTS.** Make a note of the entire text file name, *e.g.*: **A5D1827 FINAL SIMPLE 27 Apr 05 10481.txt**

   2.6 Log on to the Hydstra database, double click on file: **"Programs by Function"**, double click on file: **"Hydstra/WQ – Water Quality"**, double click on **"RFCWQIN – Import WQ Samples from lab"**. Wait for Window labeled **"RFCWQIN – Import WQ Samples from lab"** appears. Click **"Program"** tab, click **"Previous run F8"**. Insert Data File Name: **Q:\NPDES\LABORATORY REPORTS\Babcock Data 04-05**\.: **A5D1827 FINAL SIMPLE 27 Apr 05 10481.txt**, Insert Work file name: **A5D1827**, Insert Date Format: **B** (for Babcock), click **RUN**.

2.7 Successful import will produce a page on the HYEXPLORE window. The page will read: **Perl -- opening input file [Q:\NPDES\LABORATORY REPORTS\Babcock Data 04-05\.: A5D1827]**. The next line will read: **Perl -- Preprocessor read** a number **lines, wrote** same number **lines**. The following line will read: **Summary for Samples**.

2.8 Double click on **WQWRK -- WQ Samples and Results Management**.

2.9 Click on work file: **A5D1827** to highlight it, then click on **OK**.

2.10 Click on the **Toggle browse/form view** tab for each site number listed in the work file. Check the site number, sample number, collection date and time. Match this information to the *Chain of Custody* form, *Field Data Sheet* and the lab results. Perform a check off procedure as you match the information.

2.11 The Lab Sample number should match the Sample number on this page for Dry Weather or Wet Weather sampling (WWR, SMR and SAR). For TMDL samples, the sample number will begin with an S (example: S010205O5A).

2.12 To manually enter in the Field Data, click on **RESULTS -- Water Quality Results (work area)** while in WQWRK Manage.

2.13 Click on the green plus symbol button at the top left to **"Add a New Record"**.

2.14 Enter in a three or four digit numerical variable from *Field Data Sheet*:

- 2.14.1 **262: CFS, Discharge (Flow) Q**
- 2.14.2 **1690: Turbidity (NTU)**
- 2.14.3 **1200: Conductivity (µS/cm or mS/cm)**
- 2.14.4 **1435: Dissolved Oxygen, Field Concentration (mg/L)**
- 2.14.5 **1515: ORP (Redox Potential) Field (mV)**
- 2.14.6 **1655: Temperature Field (ºC)**
- 2.14.7 **1660: Temperature Field (ºF)**
- 2.14.8 **1705: pH, Field**
- 2.14.9 **8998: IC/ID sample; Value: 1 = Yes; 0 = No**
- 2.14.10 **8999: Visited not Sampled; Value: 1 = Yes; 0 = No**
- 2.14.11 **9000: Visited (Sampled); Value: 1 = Wet weather; 0 = Dry weather**

2.15 Enter in value and enter in a comment (if needed).

2.16 Double click on **WQ Manage -- WQ Archive Management**

2.17 Highlight a site number that matches with the work file, then click **SAMPLES -- Water Quality Samples**.

2.18 Click the **Options** button at the top.

2.19 Click on **Import a WQ workfile**.

2.20 Click on the Workfile number to import into **Archive**.

2.21 Successful Archiving will allow you to go to the site number(s) and check the sample number and results as a double check against the *Chain of Custody* form, *Field Data Sheets* and the paper copy of the lab results.

APPENDIX N:

IC/ID AND IDDE FORMS

(In general, the example forms in this appendix are included for reference purposes and may be used as appropriate. Procedures and exact forms as used by the individual jurisdictions, or region-specific programs, may vary. Individual Permittees are recommended to refer to their local guidance as described in their individual JRMP's or LIP's. In place of individual forms, a digital application may also be used to record incidents and/or investigations.)

IC/ID Incident Reporting Form Instructions

A. Reporting Party
   1. *Self-explanatory.*
   2. *If the person does not want to give out their name, try to get at least their last name. If the caller hesitates in giving out a phone number, ask for a callback number. Be sure to also fill in the "Received by" information in the box above.*

B. Incident Location
   1. *Mostly self-explanatory.*
   2. *Get detailed directions to the incident location, including cross streets and Thomas Bros. map page, especially if it is in an out-of-the-way location.*
   3. *Ask the complainant if evidence of the incident is still present. If the incident occurred more than two days prior to the complaint, inform the caller that if there is no evidence of the incident nothing may be able to be done this time and request that the caller call sooner next time.*
   4. *Get as detailed a description of the incident as possible, including whether the complainant has taken photos or video. This information may be needed if formal enforcement actions will be taken.*
   5. *Let the caller know that if a District facility is not involved, you will be referring their complaint to the local jurisdiction. Thank the person for the call and tell him/her that you appreciate their helping to prevent pollution.*

C. Substance Involved
   1. *Mostly self-explanatory.*
   2. *Find out if the substance discharged has any known risks, such as toxic, respiratory irritant, etc.*
   3. *Get the names and agencies of other people the complainant contacted, if available.*
      a. *The complainant may have already notified several other people, and may feel they are getting the runaround or that their complaint is not being taken seriously. If you have to refer the complainant to another person, let the complainant know and try to get them a specific person to call.*
      b. *If another County or City employee referred the complainant to you and the referral was not appropriate, help the complainant and notify the municipal coordinator.*
      c. *The complainant may have contacted someone from a state or federal agency.*
      d. *If someone on the County Board of Supervisors is involved, the priority of response may need to be elevated, even if it is a minor issue.*

D. Containment – *Self-explanatory.*

E. Alleged Responsible Party
   1. *Mostly self-explanatory.*
   2. *Note if any precautions will be needed in approaching the alleged responsible party. If anyone at the incident site behaves in a threatening manner, leave the site and contact your supervisor for further instruction.*

F. Action Needed – *Self-explanatory.*

IC/ID Incident Reporting Form

Riverside County Flood Control & Water Conservation District

Illicit Connection / Illegal Discharge Incident Reporting Form

Received by: _____
Date: _____ Time Received: _____
Complaint Routed to: _____

Reporting Party

Name: _____ ☐Anon. Agency: _____
Address: _____ City: _____ Zip Code: _____
Phone: _____ Ext.: _____ Pager/Cell: _____ e-mail: _____

Incident Location

Incident Address: _____ City: _____ Zip Code: _____
Incident Location or Business Name: _____ Thos. Bros. Page _____ Zone: ____
Incident Date: _____ Time (24-hr clock): _____ Discharge Currently Occurring: ☐Yes ☐No
Incident Description (attach add'l sheets as needed): _____
_____
_____
_____
_____ Photos Available: ☐Yes ☐No

Substance Involved

Substance Description/Chemical Name: _____
Quantity: ☐Less than ☐Greater than Amount: _____ Units: _____
Color: _____ Odor: _____ Duration of Discharge: _____
Other Details: _____
_____
Special Precautions Needed: ☐No ☐Yes _____
Other parties contacted: ☐HazMat Team ☐County Env. Health ☐County Exec. ☐City of _____
by Reporting Party ☐RWQCB ____ ☐OES – Control #_____ ☐Other _____

Containment

_____% Contained Containment Measure Used: _____
Waterbody or MS4 Involved: _____
Cleaned Up: ☐No ☐Yes, by whom _____ on Date _____ Time (24-hr) _____

Alleged Responsibility Party/Parties (If Known)

Name: _____ Business: _____
Address: _____ City: _____ Zip Code: _____
Phone: _____ Vehicle License No.: _____ Make: _____ Model: _____
Precautions Needed: ☐No ☐Yes _____

Action Needed

Investigation Required: ☐No ☐Yes Details: _____
_____
Investigation Team: Name: _____ Agency: _____ Phone No. _____
Name: _____ Agency: _____ Phone No. _____
Name: _____ Agency: _____ Phone No. _____
Name: _____ Agency: _____ Phone No. _____
Copy sent to: ☐City of _____ via ☐Mail ☐Fax ☐e-mail ☐_____

IC/ID Incident Investigation Report Instructions

Fill out this form as completely as possible. All of the information is required for the Annual Reports.

A. Responsible Party
   1. *Self-explanatory.*
   2. *Ensure that the "Received by" information in the box above is filled out.*

B. Outreach
   1. *Self-explanatory.*
   2. *If no outreach materials are distributed, explain why.*

C. Follow-up Visit – *Self-explanatory.*

D. Investigation – *Self-explanatory.*

E. Enforcement
   1. *Self-explanatory.*
   2. *If no enforcement action is taken, explain why.*

IC/ID Incident Investigation Report

Riverside County Flood Control & Water Conservation District

Illicit Connection / Illegal Discharge

Incident Investigation Report

Response Time: 1-6 hrs 12 hrs 24 hrs 48 hrs Other: _____

Responsible Party

Name: _____ Business: _____
Address: _____ City: _____ Zip Code: _____
Phone: _____ Ext.: _____ Pager/Cell: _____ e-mail: _____
Responsible Party Notified: ☐No ☐Yes, via ☐Mail ☐Fax _____ ☐e-mail ☐_____
Repeat Violation: ☐Yes ☐No Discharge Stopped: ☐Yes ☐No ☐Industrial ☐Commercial ☐Residential
Corrective Action Required: ☐No ☐Yes, describe _____
_____

Outreach

Outreach Material Distributed:
☐None ☐Door Hanger ☐Business Card ☐Supplement "A" ☐Brochure _____
Other: _____

Follow-up Visit

Date: _____ Time (24-hr): _____ Investigator's Name: _____
Discharge Stopped: ☐Yes ☐No Proper Cleanup Action Taken: ☐Yes ☐No
Explain "No" answer: _____
_____
Further Action Required: ☐No ☐Yes _____
Additional Follow-up Visit(s) Required: ☐Yes ☐No
Details: _____
_____
_____

Investigation

Description of Discharge and Analyses Made: ☐Attach Field Data Sheet for Additional Details
Date/Time Discharge Started: _____ Date/Time Discharge Ceased: _____ Total Amount: _____
Incident Occurred: ☐On Land ☐In Water ☐In Air Waterbody/MS4 Involved: ☐No ☐Yes _____
Substance(s) Involved: ☐ Oil & Grease ☐Soil/Sediment ☐Sewage ☐Reclaimed Water ☐Petroleum (Gas/Diesel/Jet Fuel)
☐ Chemicals _____ ☐Other _____
Photos Taken: ☐Yes (attach) ☐No Field Testing: ☐Yes ☐No Samples Collected: ☐Yes ☐No
Attach pages as needed for investigation details, photos, analyses, phone logs, meeting notes, etc.
Other parties contacted: ☐HazMat Team ☐County Env. Health ☐County Exec. ☐City of _____
☐RWQCB ____ ☐OES – Control #_____ ☐Other _____
Reason for Investigation: ☐Discharge/Spill Response ☐Citizen Complaint ☐Sewage Spill
☐Visual Monitoring ☐Construction Concern ☐Industrial Concern

Enforcement

Enforcement: ☐None ☐Verbal Warning ☐Door Hanger ☐Written Warning (attach copy)
☐Cease and Desist Order: ☐Verbal ☐Written ☐Stop Work Order
Other Enforcement Actions: _____
_____
Investigator's Name: _____ Agency: _____ Phone No. _____
Signature: _____ Date: _____

Rev 7/2008 ABC

APPENDIX O:

MONITORING CONSULTANT APPROVAL AND RESPONSIBILITIES FORMS

Monitoring Contractor Approval and Responsibilities Form

Riverside County Quality Assurance Project Plan for Water Quality Monitoring

Contractor Name:
Weston Solutions

Address: **5817 Dryden Place, Suite 101** **Carlesbad, CA 92008**	
County Monitoring Project Name and Elements	General Monitoring Program Support Services
District Agreement Number and Approval Date	FCARC-92561-0058-0621 6/12/2018
Project Manager	Sheri Dister
Signature	
Phone Number	(760) 795-6996
E-mail	Sheri.Dister@westonsolutions.com
Quality Assurance Officer	Andrea Crumpacker
Signature	
Phone Number	(760) 795-6987
E-mail	Andrea.Crumpacker@WestonSolutions.com

The Contractor's Project Manager is responsible for implementing monitoring activities and data management in accordance with the requirements of this Quality Assurance Project Plan (QAPP) and the corresponding elements of the watershed-specific Monitoring Plans. The Contractor's Quality Assurance (QA) Officer is responsible for quality assurance and quality control procedures for sampling and data management procedures in this QAPP. The Contractor's QA officer will review and assess procedures during the project against QAPP requirements. The Contractor's Project Manager will report all findings to the District's Watershed Monitoring Section Manager and/or designated District's Project Contact (may vary by watershed/assignment), including all requests for corrective action. The District may stop monitoring activities, if there are significant deviations from required practices or if there is evidence of a systematic failure.

The Contractor will be responsible for ensuring QAPP/Monitoring Plan compliance by subcontractors hired on single or various elements of the Monitoring Project named above.

Monitoring Contractor Approval and Responsibilities Form

Riverside County Quality Assurance Project Plan for Water Quality Monitoring

Contractor Name:
NV5

Address: **2110 South Coast Hwy, Suite B** **Oceanside, CA 92554**	
County Monitoring Project Name and Elements	General Monitoring Program Support Services
District Agreement Number and Approval Date	FCARC-92561-0017-0622 6/12/2018
Project Manager	Garth Engelhorn
Signature	
Phone Number	(760) 237-2703
E-mail	Garth.Engelhorn@nv5.com
Quality Assurance Officer	David Renfrew
Signature	
Phone Number	(760) 237-2702
E-mail	david.renfrew@nv5.com

The Contractor's Project Manager is responsible for implementing monitoring activities and data management in accordance with the requirements of this Quality Assurance Project Plan (QAPP) and the corresponding elements of the watershed-specific Monitoring Plans. The Contractor's Quality Assurance (QA) Officer is responsible for quality assurance and quality control procedures for sampling and data management procedures in this QAPP. The Contractor's QA officer will review and assess procedures during the project against QAPP requirements. The Contractor's Project Manager will report all findings to the District's Watershed Monitoring Section Manager and/or designated District's Project Contact (may vary by watershed/assignment), including all requests for corrective action. The District may stop monitoring activities, if there are significant deviations from required practices or if there is evidence of a systematic failure.

The Contractor will be responsible for ensuring QAPP/Monitoring Plan compliance by subcontractors hired on single or various elements of the Monitoring Project named above.

Monitoring Contractor Approval and Responsibilities Form

Riverside County Quality Assurance Project Plan for Water Quality Monitoring

Contractor Name:
Babcock Laboratories, Inc.

Address: **6100 Quail Valley Ct.** **Riverside, CA 92507**	
County Monitoring Project Name and Elements	General Analytical Laboratory Support Services
District Agreement Number and Approval Date	FCARC-92561-0022-0622 6/12/2018
Project Manager	Angela Brown
Signature	Angela Brown
Phone Number	(951) 653-3351
E-mail	abrown@babcocklabs.com
Quality Assurance Officer	Stacey Fry
Signature	Stacey Fry Digitally signed by: Stacey Fry DN: CN = Stacey Fry email = sfry@babcocklabs.com C = US O = Babcock Labs OU = QA Department Date: 2020.10.08 13:27:18 -07'00'
Phone Number	(951) 653-3351
E-mail	sfry@babcocklabs.com

The Contractor's Project Manager is responsible for implementing monitoring activities and data management in accordance with the requirements of this Quality Assurance Project Plan (QAPP) and the corresponding elements of the watershed-specific Monitoring Plans. The Contractor's Quality Assurance (QA) Officer is responsible for quality assurance and quality control procedures for sampling and data management procedures in this QAPP. The Contractor's QA officer will review and assess procedures during the project against QAPP requirements. The Contractor's Project Manager will report all findings to the District's Watershed Monitoring Section Manager and/or designated District's Project Contact (may vary by watershed/assignment), including all requests for corrective action. The District may stop monitoring activities, if there are significant deviations from required practices or if there is evidence of a systematic failure.

The Contractor will be responsible for ensuring QAPP/Monitoring Plan compliance by subcontractors hired on single or various elements of the Monitoring Project named above.

Monitoring Contractor Approval and Responsibilities Form

Riverside County Quality Assurance Project Plan for Water Quality Monitoring

Contractor Name:
Wood Environmental

Address: **9177 Sky Park Court** **San Diego, CA 92123**	
County Monitoring Project Name and Elements	General Monitoring Program Support Services
District Agreement Number and Approval Date	FCARC-92561-0018-0622 6/12/2018
Project Manager	Brenda Stevens
Signature	Brenda.Stevens Digitally signed by Brenda.Stevens DN: cn=Brenda.Stevens Date: 2020.10.08 14:06:12 -07'00'
Phone Number	(858) 514-7729
E-mail	brenda.stevens@woodplc.com
Quality Assurance Officer	Matt Rich
Signature	Matt.Rich Digitally signed by Matt.Rich Date: 2020.10.08 14:12:36 -07'00'
Phone Number	(858) 514-6478
E-mail	matt.rich@woodplc.com

The Contractor's Project Manager is responsible for implementing monitoring activities and data management in accordance with the requirements of this Quality Assurance Project Plan (QAPP) and the corresponding elements of the watershed-specific Monitoring Plans. The Contractor's Quality Assurance (QA) Officer is responsible for quality assurance and quality control procedures for sampling and data management procedures in this QAPP. The Contractor's QA officer will review and assess procedures during the project against QAPP requirements. The Contractor's Project Manager will report all findings to the District's Watershed Monitoring Section Manager and/or designated District's Project Contact (may vary by watershed/assignment), including all requests for corrective action. The District may stop monitoring activities, if there are significant deviations from required practices or if there is evidence of a systematic failure.

The Contractor will be responsible for ensuring QAPP/Monitoring Plan compliance by subcontractors hired on single or various elements of the Monitoring Project named above.

APPENDIX P:

CALIFORNIA RAPID ASSESSMENT METHOD (CRAM)

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California Rapid Assessment Method for Wetlands

User's Manual

Version 6.1

April 2013

This report should be cited as:

California Wetlands Monitoring Workgroup (CWMW). 2013. California Rapid Assessment Method (CRAM) for Wetlands, Version 6.1 pp. 67

Funding for initial CRAM development was provided to the San Francisco Estuary Institute, the Southern California Coastal Water Research Project, and the California Coastal Commission through USEPA contracts CD-96911101-0, CD-96911201-0, and CD-96911301-1, respectively. The contents of this document do not necessarily reflect the views and policies of the EPA nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

Cover Photograph: Ash Creek Wildlife Area by Kevin O'Connor, Central Coast Wetlands Group

California Rapid Assessment Method (CRAM) For Wetlands

User's Manual

Version 6.1
April 2013

A Product of the

Level 2-Rapid Assessment Committee

of the

California Wetlands Monitoring Workgroup

Edited by Kevin O'Connor
Central Coast Wetlands Group at Moss Landing Marine Labs

L2 Rapid Assessment Committee of the California Wetlands Monitoring Workgroup	
Name	**Organization**
Lindsey Tunis	AECOM
Kevin Lunde	Bay Area Regional Water Quality Control Board
Rebecca Payne	California Department of Transportation
Glenn Sibbald	CDFW-Aquatic Bioassessment Laboratory
Cara Clark	Central Coast Wetlands Group at Moss Landing Marine Labs
Kevin O'Connor	Central Coast Wetlands Group at Moss Landing Marine Labs
Ross Clark	Central Coast Wetlands Group at Moss Landing Marine Labs
Ayzik Solomesheh	Consultant
Carol Witham	Consultant
Marie Denn	National Park Service
Chad Roberts	Roberts Environmental and Conservation Planning
Michelle Stevens	Sacramento State University
Cristina Grosso	San Francisco Estuary Institute
Josh Collins	San Francisco Estuary Institute
Sarah Pearce	San Francisco Estuary Institute
Chris Solek	Southern California Coastal Water Research Project
Eric Stein	Southern California Coastal Water Research Project
Cliff Harvey (Chair)	State Water Resources Control Board
Dave Weixelman	U.S. Forest Service
Paul Jones	USEPA Region 9
Melissa Scianni	USEPA Region 9

Version History of CRAM Methodology

Version 6.1 released April 2013
Changes in this version:

- Changed Manual cover image and layout
- Updated list of Level 2 Committee member names
- Updated Chapter 3: Procedures for using CRAM, Step 2: Classify the Wetland According to the CRAM typology. The definitions and references were updated to reflect more current information.
- Updated Figure 3.2 with revised wetland names
- Re-inserted Chapter 4: Definition and Rationale for CRAM Attributes and Metrics. This chapter contains general information about each metric and submetric. All rating tables are still maintained in the individual field books.
- Re-inserted Chapter 5: Guidelines to Complete Stressor Checklists.
- Updated the Acronym List
- Removed Appendix I: Protocol for Project Assessment Based on CRAM. This information is now maintained in the CRAM Technical Bulletin (CWMW, 2009).
- Removed Appendix II: Flow Chart to determine plant dominance. This information is maintained in all of the individual field books.
- Removed Appendix 5: Invasive Plant Species List. Please refer to the California Invasive Plant Council website for this information.
- Fixed typos, website addresses, and table of contents

Version 6.0 released March 2012
Changes in this version:

- Removed all of the tables and worksheets from Chapter 4: Guidelines for Scoring CRAM Metrics. This information is now maintained in individual field books.
- Removed some text from Chapter 3: Procedures for Using CRAM. This information is now maintained in individual field books.
- Removed Appendix VI. This information is now maintained in the Vernal Pools field books.
- Updated Appendix III with additional definitions
- Updated References section with additional citations
- Changed authorship, removed original Core and Regional Team information, added L2 Committee members
- Revised several figures and tables
- Replaced Seasonal Estuarine wetland sub-type with Bar-built estuarine wetland sub-type
- Revised wording through out the document to be consistent with recent developments in CRAM and wetland assessment in California.
- Fixed typos; updated heading and table of contents

Version 5.0.2 released 9/30/08
Changes in this version:

- Added section on version history of CRAM methodology and fixed typos

- Added paragraph in Section 2.3.1 to explain separation of assessments of condition and stress
- Added note to Section 3.2.2.2 that the depressional module was primarily based on perennial depressional wetlands and caution should be applied in the interpretation of scores in seasonal depressional wetlands
- Corrected text in various Sections to eliminate inconsistencies in terminology
- Updated figures in Chapter 3
- Revised the ratings for scoring Structural Patch Richness for Estuarine wetlands

Version 5.0.1 released 10/17/07
Changes in this version:

- Minor wording changes for clarification

Version 5.0.0 released 9/18/07
Changes in this version:

- Version numbering changed from 4.6 to 5.0—no other changes

Version 4.6 released 9/10/07
Changes in this version:

- Substantial changes in nearly all areas
- Changes to metrics included:
  - Wording changes for clarification
  - Added a second "B" rating for scoring Landscape Connectivity for Riverine wetlands
  - Revised the "C" and "D" ratings for scoring Number of Plant Layers Present for Slope and Confined Riverine wetlands

Versions 4.3 - 4.5

- Internal development versions

Version 4.2.3 released 11/1/06
Changes in this version:

- Reorganized volume 2 into three sections: Assessment Forms, Narratives, Tables & Figures; typos fixed

Version 4.2.2 released 8/17/06
Changes in this version:

- Added citation to title page and fixed typos

Version 4.2.1 released 8/10/06
Changes in this version:

- Vol 1, p. 15: Table 2.2, added new metric name Plant Community and bulleted its four component submetrics
- Vol 1, p. 36: Added language prescribing the calculation of mean submetric score in order to arrive at Plant Community metric value; in Table 3.8, changed expected maximum value of Biotic Structure attribute from 84 to 36 for Playas and Vernal Pools and 48 for all other wetland classes

- Vol 1, pp. 68-71: Changed "metric" to "submetric" for discussion of the four submetrics of the Plant Community metric
- Vol 2, pp.145-6: removed wrackline or organic debris in channel or on floodplain from worksheet 2 since this patch type is not expected in playas
- Vol 2, p. 55: Revised "D" narrative for number of plants layers present from "No layers are present" to "0-1 layer is present"
- Vol 2, pp. 133, 149, 166: Removed shading from scoring sheet for Interspersion and Zonation since this metric is assessed for vernal pools and playas
- Vol 2: Revised scoring forms to incorporate Plant Community metric

Version 4.2.0 released 8/4/06
Changes in this version:

- Split into two volumes: main manual and assessment forms
- Created separate volume for assessment forms - all supporting documents included with each class
- Updated entrenchment ratio and hydrologic connectivity metric bins
- Revised bins for percent co-dominant species that are non-native
- Added confined v. unconfined diagram
- Revised scoring to a 1-12 scale for all metrics

Version 4.1 released 7/11/06
Changes in this version:

- Separated estuarine class into two sub-classes: saline and non-saline

Version 4.0 released 5/25/06

Acknowledgments

The authors would like to credit the Washington State Wetland Rating System, the Ohio Rapid Assessment Method for Wetlands, and the Hydrogeomorphic (HGM) Functional Assessment Method for providing a foundation upon which to create the California Rapid Assessment Method for Wetlands (CRAM).

CRAM could not have been developed without the championship of Paul Jones (USEPA Region 9) and Richard Sumner (USEPA Office of Research and Development), technical guidance from Mary Kentula (USEPA Office of Research and Development), the inspirational successes of John Mack (Ohio EPA) and M. Siobhan Fennessy (Kenyon College), plus the abundant advice and review provided by the original CRAM Core Team and Regional Teams.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Large amounts of public funds and human resources are being invested in the protection, restoration, creation, and enhancement of wetlands in California. The State needs to be able to track the extent and condition of these habitats to evaluate the investments in them now and into the future. The community of wetland scientists, managers, and regulators needs to be able to answer the questions: where are the wetland areas and how are they doing? This need is clearly indicated by the California State Wetlands Conservation Policy.

A consortium of local, state and federal authorities has been developing tools to increase the State's capacity to monitor its wetlands. The effort is guided by the three-level framework for surface water monitoring and assessment issued to the state by the USEPA (USEPA 2006). Level 1 consists of habitat inventories and landscape profiles based on the statewide wetland inventory as mandated by California Assembly Bill 2286, the California Aquatic Resources Inventory, the statewide riparian inventory as planned by the Riparian Habitat Joint Venture, and EcoAtlas of the Regional Data Centers (RDC) being developed by the State Water Resources Control Board and others as part of the California Environmental Data Exchange Network (CEDEN). Level 2 consists of rapid assessment of wetland condition in relation to the broadest suite possible of ecological and social services and beneficial uses. Level 3 consists of standardized protocols for intensive-quantitative assessment of selected services and to validate and explain Level 1 and Level 2 methods and results. All three levels are to be supported by data management systems that enable the State to compile local and regional Level 1-3 data into statewide summary reports. Level 1 and Level 2 methods are supported by open-source, web-based information systems (www.ecoatlas.org and www.cramwetlands.org) that are consistent with existing state and federal environmental databases. Level 3 protocols and results will be added to these information systems as they are developed.

This manual focuses on the California Rapid Assessment Method. CRAM has beendeveloped as a cost-effective and scientifically defensible Level 2 method for monitoring the conditions of wetlands throughout California. The CRAM web site (www.cramwetlands.org) provides access to an electronic version of this manual, training materials, eCRAM and the CRAM database. CRAM results can be uploaded to the database, viewed, and retrieved via the CRAM website using eCRAM. CRAM, eCRAM, and the supporting web sites are public and non-proprietary.

Initial CRAM development had focused on the wetlands of coastal watersheds from Mexico to Oregon. These watersheds in aggregate encompass almost as much variation in climate, geology, and land use as the State as a whole. A special effort was made, however, to involve environmental scientists and managers who are familiar with inland arid montane environments that are not well represented in the coastal watersheds. Seasoned staff from natural resource management and regulatory agencies, NGO science institutions, the private sector, and academia worked together through four coastal Regional Teams and a statewide Core Team to provide the breadth and depth of technical and administrative experience necessary to help assure statewide applicability of CRAM. Since then the ongoing development process has moved inland to include the Central Valley, Inland Empire and Tahoe regions.

CRAM development has incorporated aspects of other approaches to habitat assessment used in California and elsewhere, including the Washington State Wetland Rating System (WADOE

1993), MRAM (Burglund 1999), and ORAM (Mack 2001). CRAM also draws on concepts from stream bio-assessment and wildlife assessment procedures of the California Department of Fish and Wildlife, the different wetland compliance assessment methods of the San Francisco Bay Regional Water Quality Control Board and the Los Angeles Regional Water Quality Control Board, the Releve Method of the California Native Plant Society, and various HGM guidebooks that have been developed in California.

In essence, CRAM enables two or more trained practitioners working together in the field for one half day or less to assess the overall health of a wetland by choosing the best-fit set of narrative descriptions of observable conditions ranging from the worst commonly observed to the best achievable for the type of wetland being assessed. There are four alternative descriptions of condition for each metric of condition. Metrics are organized into four main attributes: (landscape context and buffer, hydrology, physical structure, and biotic structure) for each of six major types of wetlands recognized by CRAM (riverine wetlands, lacustrine wetlands, depressional wetlands, slope wetlands, playas, and estuarine wetlands). To the extent possible, CRAM has been standardized across all these wetland types, and the differences in metrics and narrative descriptions between wetland types have been minimized.

CRAM yields an overall score for each assessed area based on the component scores for the attributes and their metrics. The alternative narrative description for each metric has a fixed numerical value. An attribute score is calculated by combining (methods vary by attribute type) the values of the chosen narrative descriptions for the attribute's component metrics, and then converting the result into a percentage of the maximum possible score for the attribute. The overall score for an area is calculated by averaging the four final attribute scores . The maximum possible score represents the best condition that is likely to be achieved for the type of wetland being assessed. The overall score for a wetland therefore indicates how it is doing relative to the best achievable conditions for that wetland type in the state. Local conditions can be constrained by unavoidable land uses that should be considered when comparing wetlands from different land use settings.

CRAM also provides guidelines for identifying stressors that might account for low scores. Evident stressors are characterized as present or present and having a significant negative effect on an attribute score. The stressor checklist allows researchers and managers to explore possible relationships between condition and stress, and to identify actions to counter stressor effects.

CRAM is a cost-effective ambient monitoring and assessment tool that can be used to assess condition on a variety of scales, ranging from individual wetlands to watersheds and larger regions. Applications could include preliminary assessments to determine the need for more intensive analysis; supplementing information during the evaluation of wetland condition to aid in regulatory review under Section 401 and 404 of the Clean Water Act or other wetland regulations; and assisting in the assessment of restoration or mitigation projects by providing a rapid means of checking progress along a particular restoration trajectory. CRAM is not intended to replace any existing tools or approaches to monitoring or assessment, and will be used at the discretion of each individual agency to complement preferred approaches. Quality assurance and control practices have been developed to ensure that CRAM is appropriately applied in ambient and regulatory applications (California Wetland Monitoring Workgroup 2009).

CHAPTER 1: NEED, GOAL, STRATEGIC CONTEXT, INTENDED USES, AND GEOGRAPHIC SCOPE

1.0 Introduction

This document is the User's Manual for the California Rapid Assessment Method (CRAM) for Wetlands and Riparian Areas. Chapter 1 presents the rationale for CRAM, including why it's needed, its primary goal, its strategic context, intended uses, and the geographic scope of its applicability. Chapter 2 covers key terms, the conceptual framework for CRAM, and its development process. Chapter 3 describes the basic steps of the methodology. Chapter 4 provides background information and rationale for each of the metrics and attributes. Chapter 5 describes the guidelines to completing the stressor checklist.

1.1 Statement of Need

Large amounts of public and private funds are being invested in policies, programs, and projects to protect, restore, and manage wetlands in California. Most of these investments cannot be evaluated, however, because the ambient conditions of wetlands are not being monitored, the methods to monitor individual wetland areas are inconsistent, and there is little assurance of data quality. Furthermore, the results of monitoring are not readily available to analysts and decision makers. CRAM is a new approach that can provide consistent, scientifically defensible, affordable information about wetland conditions throughout California.

1.2 Justification for Rapid Assessment

The three most significant obstacles to developing adequate information about the conditions of California wetlands are (1) the lack of regional or statewide inventories of wetlands and related projects; (2) the high costs of conventional assessment methods; and (3) the lack of an information management system to support regional or statewide wetland assessments. The USEPA has developed a 3-tiered framework for comprehensive assessment and monitoring of surface waters that can guide efforts to overcome these obstacles (USEPA 2006).

> Level 1. Level 1 is a series of tools for landscape-level analysis of the State's aquatic resources. The toolbox consists of a Geographic Information System (GIS)-based inventory of aquatic resources (streams, wetlands, and riparian areas), data visualization, and landscape summary tools. The California Aquatic Resource Inventory, or CARI, is a standardized and comprehensive map of the State's aquatic resources and is essential for identifying their absence or presence and describing their geographic distribution and abundance. While there are various efforts to map wetlands on regional, county, and local levels, CARI is the primary wetland inventory for the State [http://www.sfei.org/it/gis/cari]. CARI is compatible with the National Wetlands Inventory (NWI) of the USFWS and the National Hydrography Dataset (NHD) of the USGS and also meets the needs of regional scientists, managers, and regulators. In addition to CARI, the State is continuing to track wetland restoration, enhancement, and mitigation projects that can be used to assess the cumulative effect of these projects on the extent and overall ambient condition of wetlands. EcoAtlas, an on-line visualization tool, houses these important aquatic resource inventories and allows

for dynamic querying and summarizing of information (www.ecoatlas.org). The landscape profile tool within EcoAtlas allows users to select a geographic area of interest and summarize various data layers within that area to produce a report of the following information: acreage of aquatic resources (existing and historical), CRAM scores, wetland projects, land cover, and census.

The Level 1 toolbox, aquatic resource inventory, project tracking, data visualization, and data analysis tools will aid wetland conservation planning by displaying aquatic resources in the context of other data layers. They will also serve as sample frames for objective, probabilistic surveys of the ambient condition of wetlands and for assessing the effects of projects and other management actions on the ambient wetland condition at various scales ranging from local watersheds to the State as a whole. Through CARI and EcoAtlas, the State can overcome the obstacle of not having an adequate inventory of wetlands and related projects to track changes in their extent and condition or the ability to holistically show and dynamically analyze information that contribute to the health and condition of wetlands.

Level 2. Level 2 methods assess the existing condition of a wetland relative to its broadest suite of suitable functions, services, and beneficial uses, such as flood control, groundwater recharge, pollution control, and wildlife support, based on the consensus of best professional judgment. In this regard, a level 2 assessment represents the overall functional capacity of a wetland. To be valid, rapid assessments must be strongly correlated to Level 3 measures of actual functions or services. Once validated, Level 2 assessments can be used where Level 3 data are lacking or too expensive to collect. Level 2 assessments can thus lessen the amount and kinds of data needed to monitor wetlands across large areas over long periods. CRAM is the most completely developed and tested Level 2 method for California at this time.

Level 3. Level 3 provides quantitative data about selected functions, services, or beneficial uses of wetlands. Such data are needed to develop indicators, to develop standard techniques of data collection and analysis, to explore mechanisms that account for observed conditions, to validate Level 1 and 2 methods, and to assess conditions when the results of Level 1 and Level 2 efforts are too general to meet the needs of wetland planners, managers, or regulators.

CRAM is based on a growing body of scientific literature and practical experience in the rapid assessment of environmental conditions. Several authors have reviewed methods of wetland assessment (Margules and Usher 1981, Westman 1985, Lonard and Clairain 1986, Jain *et al.* 1993, Stein and Ambrose 1998, Bartoldus 1999, Carletti *et al.* 2004, Fennessy *et al.* 2004). Most methods differ more in the details of data collection than in overall approach. In general, the most useful approaches focus on the visible, physical and/or biological structure of wetlands, and they rank or categorize wetlands along one or more stressor gradients (Stevenson and Hauer 2002). The indicators of condition are derived from intensive Level 3 studies that show relationships between the indicators, high-priority functions or ecological services of wetlands, and anthropogenic stress, such that the indicators can be used to assess the effects of management actions on wetland condition.

Existing methods have been used to assess wetlands at a variety of spatial scales, from habitat patches within local projects, to watersheds and regions of various sizes. Methods that are designed to assess large areas, such as the Synoptic Approach (Leibowitz *et al.* 1992), typically produce coarser and more general results than site-specific methods, such as the Hydrogeomorphic Method (HGM; Smith *et al.* 1995, Smith 2000) or the Index of Biotic Integrity (IBI; Karr 1981). Each scale of wetland assessment provides different information. Furthermore, assessments at different scales can be used for cross-validation, thereby increasing confidence in the approach being used. A comprehensive wetland monitoring program might include a variety of methods for assessing wetlands at different scales.

Existing methods also differ in the amount of effort and expertise they require. Methods such as the Wetland Rapid Assessment Procedure (WRAP; Miller and Gunsalus 1997) and the Descriptive Approach (USACOE 1995), are extremely rapid, whereas the Habitat Evaluation Procedure (HEP; USFWS 1980), the New Jersey Watershed Method (Zampella *et al.* 1994), and the Bay Area Watersheds Science Approach (WSA version 3.0, Collins *et al.* 1998), are much more demanding of time and expertise.

None of the existing methods other than CRAM can be applied equally well to all kinds of wetlands in California. The HGM and the IBI are the most widely applied approaches in the U.S. While they are intended to be rapid, they require more time and resources than are usually available, and both have a somewhat limited range of applicability. For example, IBIs are developed separately for different ecological components of wetland ecosystems, such as vegetation and fish, and for different types of wetlands, such as wadeable streams and lakes. HGM guidebooks are similarly restricted to one type of habitat, such as vernal pools or riverine wetlands, and they are typically restricted to a narrowly defined bioregion. Some guidebooks are restricted to individual watersheds. Trial applications of rapid assessment methods developed for other states, including the Florida WRAP and the Ohio Rapid Assessment Method (ORAM; Mack 2001) in California coastal watersheds indicated that significant modifications of these methods would be required for their use in California, and lead to developing CRAM.

1.3 Goal and Intended Use

The overall goal of CRAM is to:

> *Provide rapid, scientifically defensible, standardized, cost-effective assessments of the status and trends in the condition of wetlands and the performance of related policies, programs and projects throughout California.*

CRAM has beendeveloped as a rapid assessment tool to provide information about the condition of a wetland and the stressors that affect that wetland. CRAM is intended for cost-effective ambient monitoring and assessment that can be performed on different scales, ranging from an individual wetland, to a watershed or a larger region. It can be used to develop a picture of reference condition for a particular wetland type or to create a landscape-level profile of the conditions of different wetlands within a region of interest. This information can then be used in planning wetland protection and restoration activities. Additional applications could include:

- *preliminary* assessments to determine the need for more traditional intensive analysis or monitoring;

- providing *supplemental* information during the evaluation of wetland condition to aid in regulatory review under Section 401 and 404 of the Clean Water Act, the Coastal Zone Management Act, Section 1600 of the Fish and Game code, or local government wetland regulations; and
- *assisting* in the monitoring and assessment of restoration or mitigation projects by providing a rapid means of checking progress along restoration trajectories.

CRAM is *not* intended to replace any existing tools or approaches to monitoring or assessment, and will be used at the discretion of each individual agency to complement preferred approaches. Wetland impact analysis and compensatory mitigation planning and monitoring for larger wetland areas that exhibit more complex physical and biological functions will typically require more information than CRAM will be able to provide.

1.4 Related Rapid Assessment Efforts in California and Other States

Development of CRAM has incorporated concepts and methods from other wetland assessment programs in California and elsewhere, including the Washington State Wetland Rating System (WADOE 1993), MRAM (Burglund 1999), and ORAM (Mack 2001). CRAM also draws on concepts from stream bio-assessment and wildlife assessment procedures of the California Department of Fish and Wildlife, the different wetland compliance assessment methods of the San Francisco Bay Regional Water Quality Control Board and the Los Angeles Regional Water Quality Control Board, the Releve Method of the California Native Plant Society, and various HGM guidebooks that are being used in California.

1.5 Geographic Scope

CRAM is intended for application to all kinds of wetlands throughout California. Although centered on coastal watersheds through much of the initial development process, it has now spread inland to the Central Valley, Inland Empire and Tahoe regions. CRAM development to date has involved scientists and managers from other regions to account for the variability in wetland type, form, and function that occurs with physiographic setting, latitude, altitude, and distance inland from the coast. Validation efforts have indicated that CRAM is broadly applicable throughout the range of conditions commonly encountered. However, since CRAM emphasizes the functional benefits of structural complexity, it may yield artificially low scores for wetlands that do not naturally appear to be structurally complex. CRAM should therefore be used with caution in such wetlands. This can include riverine wetlands in the headwater reaches of very arid watersheds, montane depressional wetlands above timberline, and vernal pools on exposed bedrock. Future refinements of CRAM will be used to adjust CRAM metrics as needed to remove any systematic bias against any particular kinds of wetlands or their settings[1].

1.6 Supporting Information Systems

Information management is an essential part of a successful program of environmental monitoring and assessment. CRAM is supported by a public web site (www.cramwetlands.org) that provides downloadable versions of this User's Manual, training materials, and access to an

[1] The riverine and module of CRAM will be revised based on additional field work during FY 2012-14 to better accommodate assessment of arid headwater and other types of aridland streams.

open-source database that allows registered CRAM practitioners to upload, view, and download CRAM results (eCRAM). The CRAM website and database are being developed in the context of a broad initiative in California to improve data and information sharing throughout the community of environmental scientists, managers, and the concerned public. The California Wetlands Monitoring Workgroup (CWMW) has developed the California Wetlands Portal (waterboards.ca.gov/mywaterquality/eco_health/wetlands/) as a mechanism to improve communication with the public about the extent and condition of California's wetland resources.

1.7 Organization and Coordination to Develop CRAM

An organization was created to foster collaboration and coordination among the regional CRAM developers. USEPA awarded Wetland Program Development Grants through Section 104b(3) of the US Clean Water Act to the Southern California Coastal Water Research Project (SCCWRP), to a partnership of the Association of Bay Area Governments (ABAG) and the San Francisco Estuary Institute (SFEI), to a partnership of the Central Coast District of the California Coastal Commission (CCC) and the Moss Landing Marine Laboratories (MLML), and to the North Coast Region of the California Department of Fish and Wildlife (CDFW) to develop and begin implementing Level 1-3 methods, with an emphasis on Level 2 (CRAM) and information management. The Principal Investigators (PIs) worked with sponsoring agencies to form a statewide Core Team and Regional Teams that have provided the breadth and depth of technical and administrative experience necessary to develop and begin implementing CRAM.

1.7.1 Core Team

The Core Team fostered collaboration and coordination among the regions to produce a rapid assessment method that is consistent for all kinds of wetlands throughout California. The Core Team consists of the PIs plus technical experts in government agencies, non-governmental organizations, and academia. Core Team members are listed in the acknowledgments at the front of this document. The Core Team set the direction for the PIs and the Regional Teams, reviewed their products, and promoted CRAM to potential user groups.

1.7.2 Regional Teams

The Regional Teams advised and reviewed the work of the PIs to ensure that CRAM addressed regional differences in wetland form, structure, and ecological service. Members of the Regional Teams assisted in the verification and validation of CRAM, and provided feedback through the PIs to the Core Team about the utility of CRAM in the context of regional wetland regulation and management. Each Regional Team consisted of the PIs, local and regional wetland experts having experience with assessment methodologies, Core Team members who work within the region, and technical representatives from potential user groups.

1.7.3 Institutional Support

In 2010, the California Water Quality Monitoring Council (Kehoe 2006) directed the California Wetland Monitoring Workgroup (CWMW) to create a Level 2 Committee to coordinate the review, development and implementation of CRAM and other rapid assessment methods for all state agencies. CRAM is a core methodology of the Wetland and Riparian Area Monitoirng Plan (WRAMP), a statewide strategy developed by the CWMW to coordinate ongoing wetland monitoring and assessment efforts that consists of standardized methods to monitor the distribution, abundance, and condition of wetlands and riparian areas throughout California.

CRAM is also proposed as a key element of the State Water Board's emerging Wetland and Riparian Area Protection Policy (State Water Board Resolution No. 2008-0026) and is currently being tested by many other state and federal agencies for application to various regulatory and non-regulatory programs.

CHAPTER 2:
KEY TERMS, CONCEPTS, ASSUMPTIONS, AND DEVELOPMENTAL PROCESS

2.0 Overview

CRAM uses standardized definitions for key terms, including "wetland," "disturbance," "stress," and "condition." CRAM is based on basic assumptions about functional relationships between condition and function or ecological service, and about the spatial relationships between stress and condition, as explained below. Please see Appendix I for a complete Glossary of terms.

2.1 Key Terms

Assessment Area (AA). An AA is the portion of a wetland that is the subject of a CRAM assessment. Multiple AAs might be needed to assess large wetlands. Rules for delineating an AA are presented in Section 3.5.

Stress. Stress is the consequence of anthropogenic events or actions that measurably affect conditions in the field. The key stressors tend to reduce the amount of wetlands, or they significantly decrease the quantity and/or quality of sediment supplies and/or water supplies upon which the wetlands depend. Gradients of stress result from spatial variations in the magnitude, intensity, or frequency of the stressors.

Disturbance. Disturbance is the consequence of natural phenomena, such as landslides, droughts, floods, wildfires, and endemic diseases that measurably affect conditions in the field.

Condition. The condition of a wetland is the state of its physical and biological structure and form relative to their best achievable states.

Buffer. For the purposes of CRAM, the buffer is the area outside the assessment area, including adjoining uplands and other wetland areas that can reduce the effects of stressors on the wetland's condition.

Landscape Context. The landscape context of a wetland consists of the lands, waters, and associated natural processes and human uses that directly affect the condition of the wetland or its buffer.

Ecological Services or Beneficial Uses. These are the benefits to society that are afforded by the conditions and functions of a wetland. Key ecological services for many types of wetlands in California include flood control, shoreline and stream bank protection, groundwater recharge, water filtration, conservation of cultural and aesthetic values, and support of endemic biological diversity.

Attribute. Attributes are categories of metrics used to assess condition of the wetland as well as its buffer and landscape context. There are four CRAM attributes: Buffer and Landscape Context, Hydrology, Physical Structure, and Biotic Structure.

Metric. A metric is a measurable component of an attribute. Each metric should be field-based (Fennessy *et al.* 2004), ecologically meaningful, and have a dose-dependent response to stress that can be distinguished from natural variation across a stressor gradient (Barbour *et al.* 1995).

Narrative Descriptions of Alternative States. For each type of wetland, the narrative descriptions of alternative states represent the full range of possible condition from the worst conditions that are commonly observed to the best achievable conditions, for each metric of each attribute in CRAM.

Indicators. These are visible clues or evidence about field conditions used to select the best-fit narrative description of alternative states for CRAM metrics.

Metric Score. The score for a CRAM metric is the numerical value associated with the narrative description of an alternative state that is chosen because it best-fits the condition observed at the time of the assessment.

Attribute Score. An attribute score is the percent of the maximum possible combination of the metric scores for the attribute.

CRAM Index Score or Overall Score. A CRAM Indx score or Overall score indicates the overall condition of an Assessment Area. It is calculated as the average of the four final attribute scores for the Assessment Area.

2.2 Conceptual Framework

CRAM was developed according to a set of underlying conceptual models and assumptions about the meaning and utility of rapid assessment, the best framework for managing wetlands, the driving forces that account for their condition, and the spatial relationships among the driving forces. These models and assumptions are explicitly stated in this section to help guide the interpretation of CRAM scores.

2.2.1 Management Framework

The management framework for CRAM is the Pressure-State-Response model (PSR) of adaptive management (Holling 1978, Bormann *et al.* 1994, Pinter *et al.* 1999). The PSR model states that human operations, such as agriculture, urbanization, recreation, and the commercial harvest of natural resources can be sources of stress or *pressure* affecting the condition or *state* of natural resources. The human *responses* to these changes include any organized behavior that aims to reduce, prevent or mitigate undesirable stresses or state changes. Natural resource protection depends on monitoring and assessment to understand the relationships between stress, state, and management responses. The managers' concerns guide the monitoring efforts, and the results of the monitoring should influence the managers' actions and concerns.

Assessment approaches vary in that they may evaluate any or all aspects of the pressure-state-response model. Pressure indicators describe the variables that directly cause (or may cause) wetland problems, such as discharges of fill or urban encroachment. State indicators evaluate the current condition of the wetland, such as plant diversity or concentration of a particular contaminant in the water. Response indicators demonstrate the efforts of managers to address the wetland problem, such as the implementation of best management practices. The approach used by CRAM is to focus on *condition* or *state*. A separate stressor checklist is then used to note

which, if any, stressors appear to be exerting *pressure* affecting condition. It is assumed that managers with knowledge of pressures and states will exact more effective *responses*.

The PSR framework is a simple construct that can help organize the monitoring components of adaptive management. It can be elaborated to better represent complex systems involving interactions and nonlinear relations among stressors, states and management responses (e.g., Rissik *et al.* 2005) For the purposes of CRAM, the PSR model is simply used to clarify that CRAM is mainly intended to described state conditions of wetlands.

2.2.2 Rapid Assessment

CRAM embodies the basic assumption of most other rapid assessment methods that ecological conditions vary predictably along gradients of stress, and that the conditions can be evaluated based on a fixed set of observable indicators. CRAM metrics were built on this basic assumption according to the following three criteria common to most wetland rapid assessment methods (Fennessy *et al.* 2004):

1. *the method should assess existing conditions* (see Section 2.1 above), without regard for past, planned, or anticipated future conditions;
2. *the method should be truly rapid,* meaning that it requires two people no more than one half day of fieldwork plus one half day of subsequent data analysis to complete; and
3. *the method is a site assessment* based on field conditions and does not depend largely on inference from Level 1 data, existing reports, opinions of site managers, etc.

2.2.3 Forcing Functions, Stress, Buffer, and Condition

The condition of a wetland is determined by interactions among internal and external hydrologic, biologic (biotic), and physical (abiotic) processes (Brinson, 1993). CRAM is based on a series of assumptions about how these processes interact through space and over time. First, CRAM assumes that the condition of a wetland is mainly determined by the quantities and qualities of water and sediment (both mineral and organic) that are either processed on-site or that are exchanged between the site and its immediate surroundings. Second, the supplies of water and sediment are ultimately controlled by climate, geology, and land use. Third, geology and climate govern natural disturbance, whereas land use accounts for anthropogenic stress. Fourth, biota (especially vegetation) tend to mediate the effects of climate, geology, and land use on the quantity and quality of water and sediment (Figure 2.1). For example, vegetation can stabilize stream banks and hillsides, entrap sediment, filter pollutants, provide shade that lowers temperatures, reduce winds, etc. Fifth, stress usually originates outside the wetland, in the surrounding landscape or encompassing watershed. Sixth, buffers around the wetland can intercept and otherwise mediate stress (Figure 2.2).

2.2.4 Condition, Ecological Service, and CRAM Scores

Three major assumptions govern how wetlands are scored using CRAM. First, it is assumed that the societal value of a wetland (i.e., its ecological services) matters more than whatever intrinsic value it might have in the absence of people. This assumption does not preclude the fact that the support of biological diversity is a service to society. Second, it is assumed that the value depends more on the diversity of services than the level of any one service. Third, it is assumed

that the diversity of services increases with structural complexity and size. CRAM therefore favors large, structurally complex examples of each type of wetland.

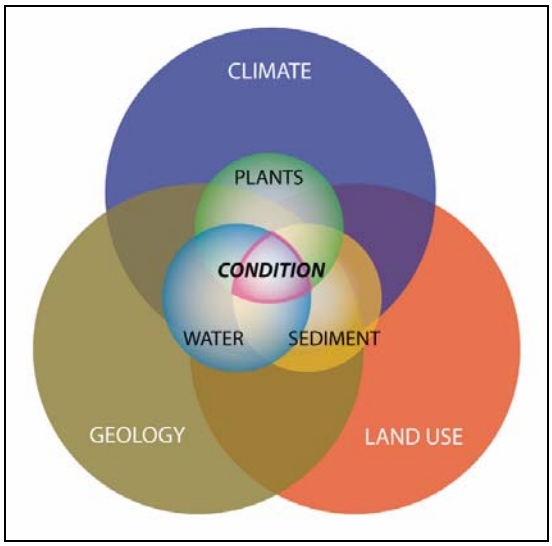


Figure 2.1: Spatial hierarchy of factors that control wetland conditions, which are ultimately controlled by climate, geology, and land use.

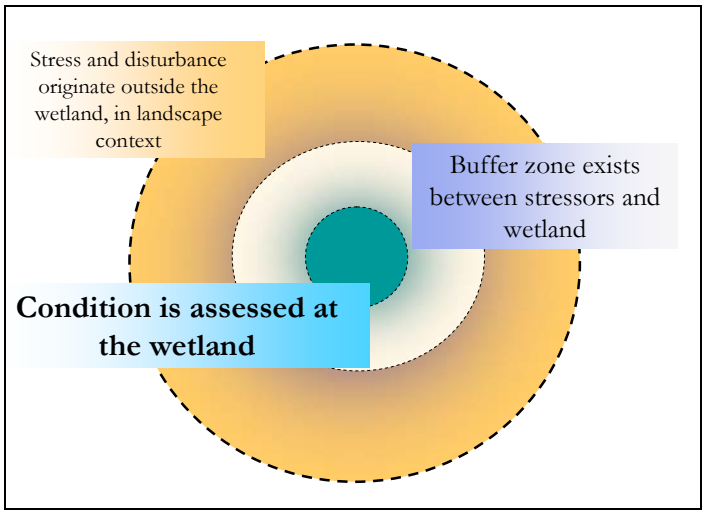


Figure 2.2: Spatial hierarchy of stressors, buffers, and wetland condition. Most stressors originate outside the wetland. The buffer exists between the wetland and the sources of stress, and serves to mediate the stress

2.3 Developmental Framework

The CRAM developmental process consisted of nine steps with distinct products organized into three phases: basic design, calibration, and validation (Table 2.1).

Table 2.1: Basic outline of CRAM development.

Core Team	Basic Design Phase	Develop conceptual models of wetland form and function
		Identify universal Attributes of wetland condition
		Nominate Metrics of the Attributes
		Nominate descriptions of alternative states for each Metric
Core and Regional Teams	Calibration Phase	Clarify and revise the Metrics and narrative descriptions of alternative states based on regional team input and inter- and intra-team comparisons
		Develop a checklist to identify stressors
		Test and select methods of scaling and weighting Attributes and Metrics
		Test and select formulas for calculating Attribute scores and AA scores
	Validation Phase	Validate Metrics and Attributes using Level 3 data
		Conduct independent peer review
		Provide outreach and training

2.3.1 Basic Design

This phase of CRAM development involved creating conceptual models of wetland form and function, defining key terms, developing the wetland typology, identifying the attributes, and formulating metrics that describe each attribute. The basic design work was done primarily through initial field-testing and feedback by Regional Teams and the Core Team. Version 2.0 of CRAM marked the completion of the basic design phase.

Each CRAM attribute is represented by a set of metrics (Table 2.2 below), and each metric is represented by a set of mutually exclusive narrative descriptions of alternative states. In aggregate, the alternative states of all the metrics for any type of wetland represent its full range of visible form and structure.

An effort was made to separate assessments of condition from assessments of stress. This was done to explore correlations between stress and condition. For example, CRAM AAs can be grouped according to their associated stressors, and the groups can be compared based on their CRAM scores. The separation has been difficult to achieve, however. For example, the Plant Community metric of the Biotic Structure attribute includes a sub-metric about the relative abundance of non-native plant species, although biological invasion is usually considered a significant stressor. Some autocorrelation can therefore be expected between stress and condition as assessed using the current version of CRAM

2.3.2 Verification

The verification phase was used to determine if the draft wetland classification scheme, the attributes, the metrics, and the narrative descriptions of alternative states were (1) clear and understandable; (2) comprehensive and appropriate; (3) sensitive to obvious variations in condition; (4) able to produce similar scores for areas subject to similar levels of the same kinds of stress; and (5) tended to foster repeatable results among different practitioners. The verification phase was also used to test and select methods of calculating, scaling, and weighting scores for metrics, attributes, and AAs.

Verification involved iterative adjustments to the classification system and the metrics during multiple field tests by each Regional Team. The amount of revision has declined steadily, but minor changes are expected to continue as the number of CRAM users and the amount of its use increases. For the CRAM version used in the Validation Phase, all the regional teams were able to meet the targeted within-team and between-team QAQC standards of 10% and 20%, respectively, for each metric.

Table 2.2: CRAM Attributes, Metrics, and submetrics

Attributes		Metrics and Submetrics
Buffer and Landscape Context		Aquatic Area Abundance or Steam Corridor Continuity
		Stream Corridor Continuity (Bar-built estuaries only)
		Aquatic Area in Adjacent Landscape (Bar-built estuaries only)
		Marine Connectivity (Bar-built estuaries only)
		Buffer:
		Percent of AA with Buffer
		Average Buffer Width
		Buffer Condition
Hydrology		Water Source
		Hydroperiod or Channel Stability
		Hydrologic Connectivity
Structure	Physical	Structural Patch Richness
		Topographic Complexity
	Biotic	Plant Community:
		Number of Plant Layers Present or Endemic Species Richness (vernal pools only)
		Number of Co-dominant Species
		Percent Invasion
		Horizontal Interspersion
		Vertical Biotic Structure

2.3.3 Validation

The purpose of the validation phase was to assess the overall performance of CRAM by regressing metric scores and attribute scores on Level 3 data representing expected relationships between condition and function or service (Table 2.3). The same models were used to guide alternative approaches for weighting and combining scores. CRAM performed best using the simplest combination rules without any weighting. The level of performance was adequate for the functions and services represented by the selected Level 3 data. The validation phase for estuarine wetlands and riverine/riparian systems was completed with CRAM version 4.0. The other types of wetlands will be validated as CRAM is implemented. The current status of development of each of the CRAM wetland modules is available on the CRAM website (www.cramwetlands.org).

Table 2.3: Expected relationships among CRAM attributes, metrics, and key services.

KEY SERVICES	**Buffer and Landscape Context**	**Hydrology**			**Physical Structure**		**Biotic Structure**				
	Buffer and Landscape Connectivity Metrics	Water Source	Hydroperiod or Channel Stability	Hydrologic Connectivity	Structural Patch Richness	Topographic Complexity	Number of Plant Layers	Number of Co-dominant Species and Endemic Species Richness	Percent Invasion	Horizontal Interspersion and Zonation	Vertical Biotic Structure
Short- or long-term surface water storage	X		X	X	X	X				X	X
Subsurface water storage		X	X	X		X					
Moderation of groundwater flow or discharge	X	X									
Dissipation of energy					X	X	X			X	X
Cycling of nutrients	X		X	X	X	X	X	X	X		X
Removal of elements and compounds	X		X	X		X	X			X	
Retention of particulates			X	X	X	X	X	X		X	
Export of organic carbon			X	X			X		X	X	X
Maintenance of plant and animal communities	X		X	X	X	X	X	X	X	X	X

CHAPTER 3:
PROCEDURES FOR USING CRAM

3.0 Summary

The general procedure for using CRAM consists of eight (8) steps (Table 3.1).

Table 3.1: Steps for using CRAM.

Step 1	Assemble background information about the management of the wetland.
Step 2	Classify the wetland using the CRAM typology and this manual (see Section 3.2 and Figure 3.2).
Step 3	Verify the appropriate season and other timing aspects of the field assessment.
Step 4	Estimate the boundary of the AA in the office (subject to field verification).
Step 5	Conduct the office assessment of stressors and on-site conditions of the AA.
Step 6	Conduct the field assessment of stressors and on-site conditions of the AA.
Step 7	Complete CRAM assessment scores and QA/QC Procedures.
Step 8	Upload CRAM results into statewide information data management system.

3.1 Step 1: Assemble Background Information

CRAM assessments are aided by background information about the management objectives, history, known or expected stressors, and general ecological character of the wetland to be assessed. Background materials may include the following (Table 3.2).

Table 3.2: Example of background materials.

- USGS topographic quadrangles, National Wetlands Inventory (NWI), State Wetlands Inventory, road maps, and other maps of geology, soils, vegetation, land uses, etc.
- Air photos and other imagery, preferably geo-rectified with 1-3 m. pixel resolution.
- California Natural Diversity Database (CNDDB) search results.
- Relevant reports on geology, geotechnical conditions, hydrology, soils, environmental impacts, cultural history, land use, restoration and mitigation projects, management plans, etc., from water districts, flood control districts, open space districts, state and federal agencies, etc.

3.2 Step 2: Classify the Wetland according to the CRAM typology

Wetland classification requires the application of a standard wetland definition followed by the application of a standard typology or classification system.

3.2.1 General Definitions of Wetlands and Riparian Areas

CRAM employs the following wetland definition recommended by the Technical Advisory Team (TAT) to the SWRCB Policy Development Team for the California Wetland and Riparian Area Protection Policy (WRAPP):

> *An area is **wetland** if, under normal circumstances, (1) the area has continuous or recurrent saturation of the upper substrate caused by groundwater or shallow surface water or both; (2) the duration of such saturation is sufficient to cause anaerobic conditions in the upper substrate; and; (3) the area either lacks vegetation or the vegetation is dominated by hydrophytes (SFEI-ASC 2009).*

This definition reflects current scientific understanding of the formation and functioning of wetlands (Lewis *et al.* 1995, Mitsch and Gosselink 2007) and uses field indicators of hydrology, substrate condition, and plant community composition to distinguish wetland areas from other areas of a landscape. This is commonly regarded as the "three-criterion approach" to defining, identifying, and delineating wetland areas in the field (Tiner 1999). Hydrology is the dominant factor in wetland formation because it controls the development of anaerobic chemical conditions, and thus strongly influences the abundance of plant species tolerant of such conditions (Voesenek *et al.* 2003) or indicative of them (Reed 1988).

This wetland definition recognizes that all three criteria might not be evident or present in some areas that provide wetland functions, beneficial uses, or ecological services at some times of the year or in some years (especially during prolonged dry periods), and that some of these areas lack vegetation and therefore may satisfy only two criteria (i.e., wetland hydrology and hydric substrates). The vegetation criterion in this definition requires dominance by hydrophytes only when the wetland is vegetated. That is, non-vegetated areas that satisfy the hydrology and substrate criteria, such as some tidal flats, playas, and shallow non-vegetated ponds, are still considered wetlands. The definition also includes wetland creation, restoration, enhancement, and mitigation sites that have not yet been colonized by vegetation.

CRAM is intended to assess "condition" in wetland areas that satisfy the criteria according to the above definition. However, because CRAM was originally designed to assess vegetated wetlands, meaning wetlands that support at least 5% cover of vegetation during the peak growing season, CRAM may have limited applicability in non-vegetated wetlands (e.g. tidal flats, mudflats) or any wetlands with less than 5% cover of vegetation. While the current version of CRAM can be used in these systems, this must be appropriately annotated in the comments section of the CRAM Basic Information page and the Plant Community metric so that the results of these assessments can be tracked and, if necessary, additional metrics or modules can be proposed.

For the purposes of CRAM, an assessable wetland is further defined as the portion of a discrete area of wetland habitat (as defined by the Draft SWRCB Policy) that is large enough to contain one or more CRAM Assessment Areas (AAs). An assessable wetland may be the same size as an AA or larger than multiple AAs, but it is never smaller than an AA (see AA delineation guidelines in Section 3.5 and AA size recommendations in Table 3.7 below). This modification is necessary to convert a Level 1 wetland inventory based on the TAT definition into a sample frame for ambient surveys of wetland condition using CRAM. A sample frame is a list or map of every wetland or potential CRAM AA within the population of wetlands to be surveyed (Särndal *et al.* 1992).

CRAM recognizes that all wetlands have some amount of adjacent riparian area that reflect various ecological and/or physical processes and local management. For this reason, CRAM employs the riparian definition provided by the US National Research Council (NRC):

> *"**Riparian Areas** are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes and biota. They are areas through which surface and subsurface hydrology connect water bodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems. Riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes and estuarine-marine shorelines" (National Research Council 2002).*

The same functions typically associated with wetlands are, to varying degree, also associated with its accompanying riparian areas (National Research Council 2002). The riparian areas adjacent to rivers and stream corridors are particularly connected through various ecological and hydrological processes. Although the term "riparian" has traditionally been synonymous with "woody" vegetation occurring at the edge or margin of a wetland, many wetlands often contain a woody riparian vegetation component within the boundary of the wetland itself. In other instances, riparian areas only occur outside the wetland boundary, where they may function at various distances from the wetland edges to "buffer" wetland conditions. Some wetlands may lack a woody vegetation component entirely. Individual CRAM AAs for some wetland types (such as riverine) may always include the portions of the adjacent riparian area. For other types of wetlands (such as depressional or estuarine), AAs may occur near the edge of the wetland and include riparian areas, or in the interior of a wetland and lack riparian areas.

The boundaries of a wetland can be determined on the basis of a jurisdictional delineation (JD; this requires compliance with established standards in approved regulatory reference documents; e.g., the 1987 USACE Manual and the two Regional Supplements, pursuant to the federal Clean Water Act), and may be approximated from mapping such as the National Wetland Inventory (NWI). A JD is especially useful for determining the boundaries of a wetland when assessing impacted sites or mitigation sites as defined under Section 404 of the Clean Water Act (CWA). Identifying wetlands under the Draft SWRCB Wetland Policy (2013) is based on similar wetland identification criteria to those used by the US Army Corps of Engineers (USACE) and US Environmental Protection Agency (USEPA) under Section 404 of the CWA, and delineation is proposed to be based on the same references as for the federal program.

If the wetland cannot be identified from an existing inventory or a JD, then its boundaries should be sketched on the base imagery for the CRAM assessment, using Best Professional Judgement and the general guidelines in Table 3.3 and Figure 3.1 below. A sketch map based on these guidelines cannot replace results from a JD,or the NWI. Although a JD is helpful in identifying the boundaries of a wetland where a CRAM assessment is to be conducted, it is NOT a prerequisite for conducting CRAM. CRAM can still be conducted on wetlands that do not have an associated JD. In most cases, however, wetland and "riparian" boundaries are based on features that can only be identified with certainty during field evaluations

Table 3.3: Guidelines to delineate a wetland for the purpose of CRAM.

Delineating Feature	Description of Features
Backshore	The backshore of a wetland is the boundary between the wetland and the adjoining upland, where the upland is at least 5m wide. The high-water contour of the wetland is a good proxy for its backshore boundary.
Foreshore	The foreshore of a wetland is the boundary between the vegetated wetland and any adjoining semi-aquatic, non-wetland area, such as an intertidal flat or a non-vegetated riverine channel bar, or a fully aquatic area such as the open water area of a lake or estuary that is at least 30m wide.
Adjoining Wetland	Any wetland that is mostly less than 5m distant from the wetland being assessed is an adjoining wetland.

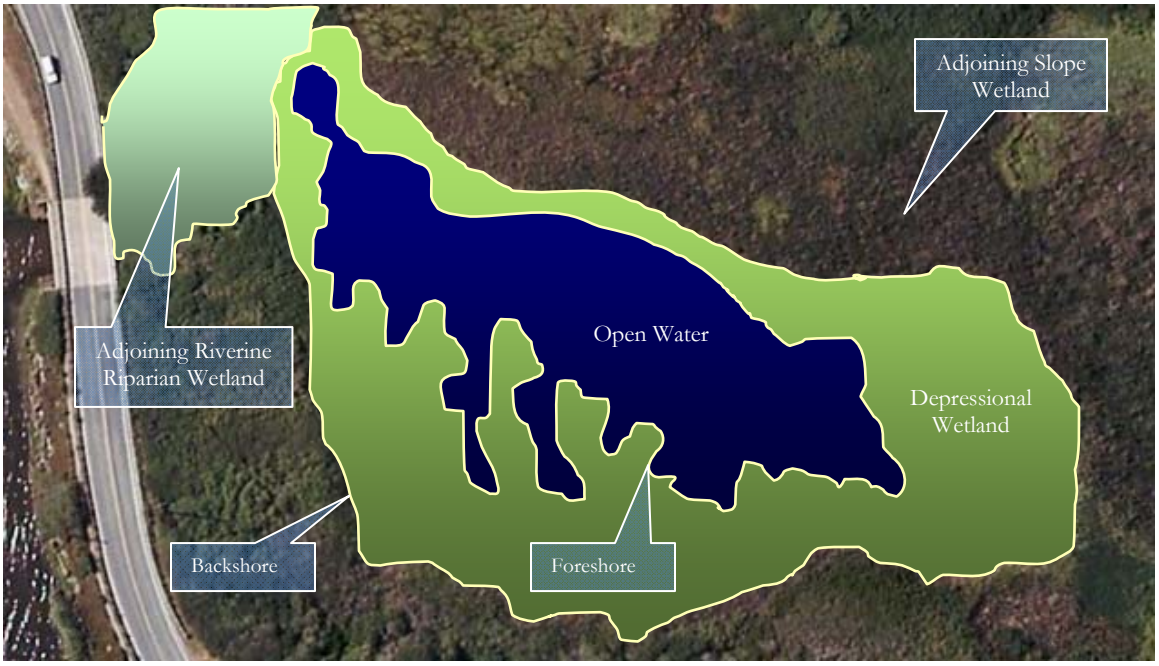


Figure 3.1: Using the backshores, foreshores, and the boundaries between wetland types to delineate a wetland.

3.2.2 Wetland Typology

CRAM provides excellent support for aquatic resource condition assessment in California. Its typology is based on a functional classification approach similar to HGM (Brinson 1993) that uses geomorphic setting, water source, and hydrology to infer function and ecology. CRAM "modules" were developed in direct response to California's assessment and policy needs, and includes many rare wetland types for California, such as vernal pools. CRAM typology supports the Wetland and Riparian Area Monitoring Plan (WRAMP) of the California Wetlands Monitoring Workgroup (CWMW; CWMW 2010). Furthermore, CRAM typology can be cross-walked to other classification systems as needed and allows for seamless integration between Level 1 mapping and Level 2 condition assessment in California.

At this time, CRAM modules have been developed for six major aquatic resource types, four of which have sub-types (Table 3.4 and Figure 3.2). These modules are not comprehensive, modification and refinement are ongoing, and new modules will be created with time.

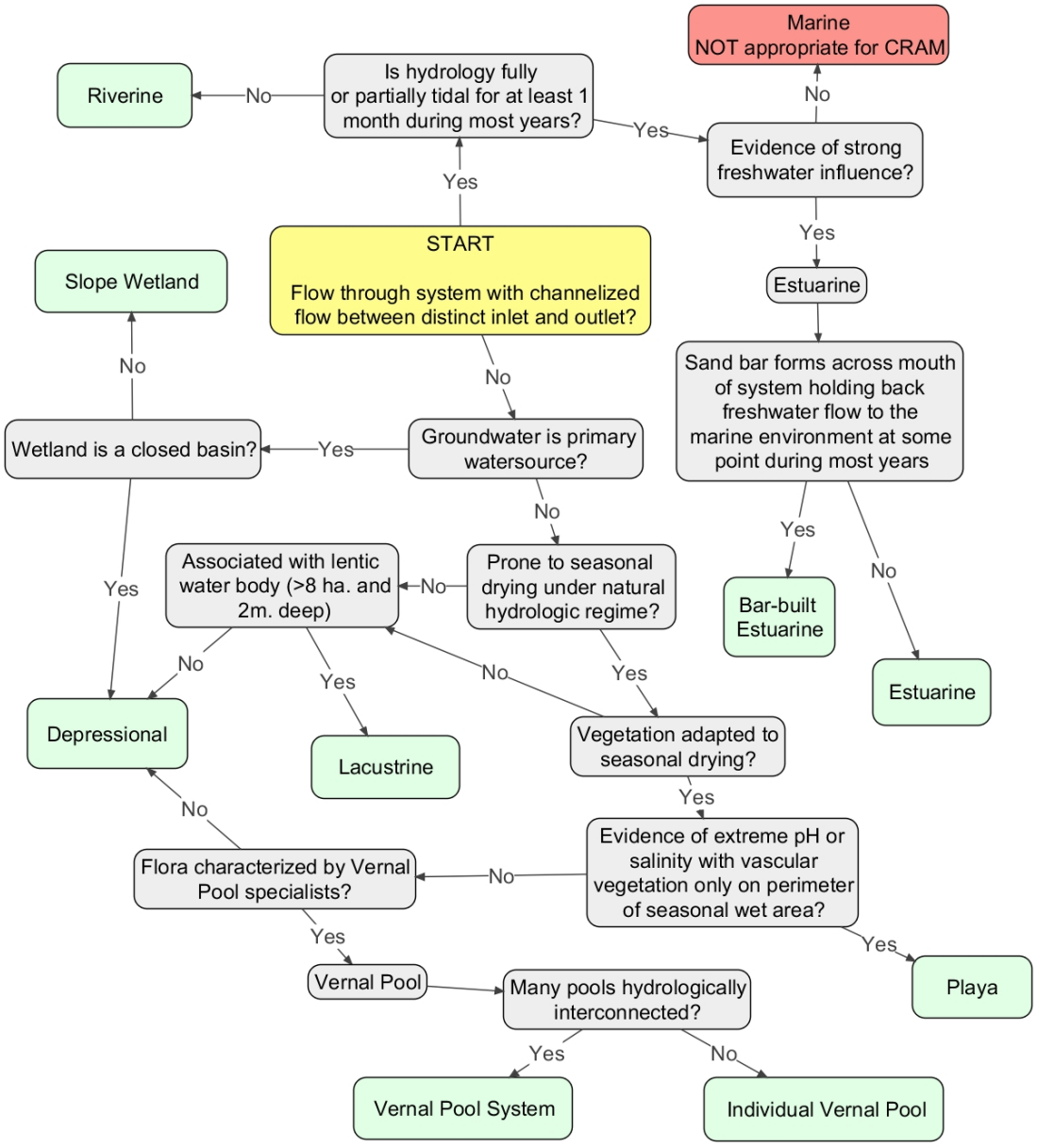
Table 3.4: The CRAM Wetland Typology.

CRAM Wetland Types	CRAM Sub-types
Riverine	Confined Riverine
	Non-confined Riverine
Depressional	Individual Vernal Pools
	Vernal Pool Systems
	Depressional
Playas	no sub-types
Estuarine	Perennial Saline Estuarine
	Perennial Non-saline Estuarine
	Bar-Built Estuarine
Lacustrine	no sub-types
Slope	Seeps and Springs
	Forested Slope
	Wet Meadows

Some wetlands will have undergone a conversion from one type to another due to either natural or anthropogenic events. For example, a channel avulsion may capture a depressional wetland and convert it to a riverine system, or construction of a dam may impound a stream and convert it to a lacustrine system. In any case, the wetland should be evaluated according to its current type and condition. Metric scores should be assigned using the ratings for the current state of the wetland, without regard for what the wetland might have been in the past, or what it might become in the future.

However, for converted wetlands, the historical type (if identifiable) as well as the existing type should be noted. The stressor checklist enables the user to document whether the wetland is currently being stressed by the conversion (i.e., if the process of conversion is continuing and a significant source of stress).

Figure 3.2: Flowchart to determine wetland type and sub-type.



3.2.2.1 Riverine (Including Closely Associated Riparian Areas)

A riverine wetland consists of the riverine channel and its active floodplain, plus any portions of the adjacent riparian areas that are likely to be strongly linked to the channel and immediate floodplain through bank stabilization and allochthonous organic material (productivity) inputs. An active floodplain is defined as the relatively level area that is periodically flooded, as evidenced by deposits of fine sediment, wrack lines, vertical zonation of plant communities, etc. The water level that corresponds to incipient flooding can vary depending on flow regulation and whether the channel is in equilibrium with water and sediment supplies. Under equilibrium conditions, the usual high water contour that marks the inboard margin of the floodplain (i.e., the margin nearest the center of the channel) corresponds to the height of bankfull flow, which

typically has a recurrence interval of about 1.5 to 2.0 years under mesic climate conditions (see Special Notes below for a definition of bankfull). The active floodplain can include broad areas of vegetated and non-vegetated bars and low benches among the distributaries of deltas and braided channel systems. The active floodplain does not include terraces that are geomorphically disconnected from channel-forming processes, although riparian areas along sloping terrace margins may be included as part of the AA since they can affect the floodplain by contributing material and providing shading. Vegetated wetlands can develop along the channel bottoms of intermittent and ephemeral streams during the dry season. Dry season assessment in these systems therefore includes the channel beds. However, the channel bed is excluded from the assessment when it contains non-wadeable flow. To help standardize the assessment of riverine wetlands, the assessments should be restricted to the dry season. Based on the proposed California state wetland definition, vegetated and non-vegetated wetlands can develop within riverine channels and their associated riparian areas. Unless otherwise determined, CRAM assumes that all riverine channels satisfy the proposed state wetland definition.

There may be a limit to the applicability of this module in low order (i.e., headwater) streams, in very arid environments, and in desert streams that tend not to support species-rich plant communities with complex horizontal and vertical structure. CRAM may be systematically biased against such naturally simple riverine systems. In addition, this module has limited application in river reaches with extremely broad floodplains, such as those which occur where large rivers occupy valleys with very low channel slopes, or near coastal embayments or the ocean, unless the extent of the floodplain included in the Assessment Area is limited to an area less than about two times bankfull width on each side of the channel (see below). There is ongoing research and development of CRAM modules for both arid streams and large rivers, which will be made available as they are completed. In the interim, caution should be used when interpreting results from these types of streams.

Riverine wetlands are further classified as confined or non-confined, based on the ratio of valley width to channel bankfull width (see Figure 3.3 below). A channel can be considered confined by artificial levees and urban development if the average distance across the channel at bankfull stage is more than half the distance between the levees or more than half the width of the non-urbanized lands that border the stream course. This assumes that the channel would not be allowed to migrate past the levees or into the urban development, or that levee breaches will be promptly repaired. Confined or non-confined channels can also be entrenched, based on the ratio of flood prone width to bankfull width (Figure 3.3 below). Entrenchment is separate from channel confinement, and strongly affects the hydrologic connectivity between riverine wetlands and their surrounding landscapes.

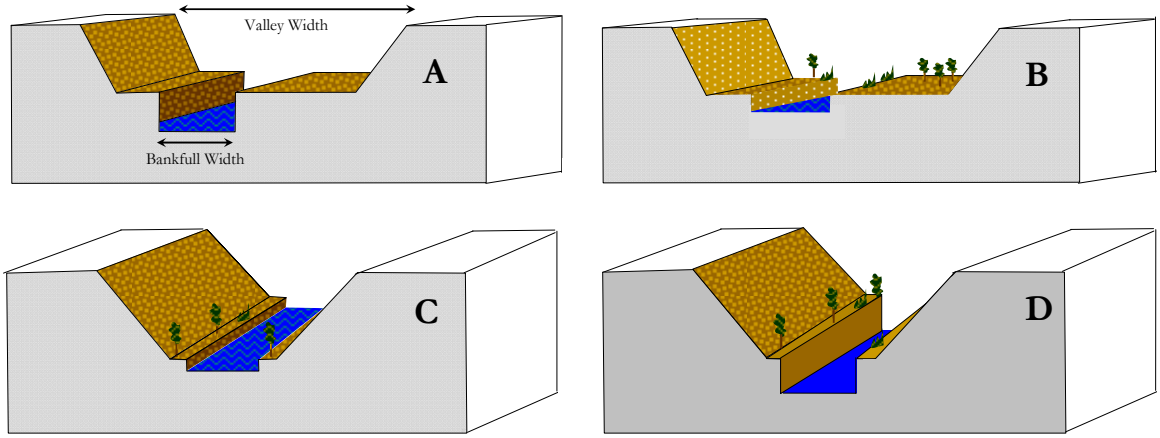


Figure 3.3: Illustrations of riverine confinement and entrenchment. (A) non-confined entrenched, (B) non-confined not entrenched, (C) confined not entrenched, and (D) confined entrenched riverine sub-types.

3.2.2.1.1 Non-confined Riverine Sub-type

In non-confined riverine systems, the width of the valley across which the system can migrate without encountering a hillside, terrace, or other feature that is likely to prevent further migration **is at least twice** the average bankfull width of the channel. Non-confined riverine systems typically occur on alluvial fans and plains, in low gradient landscapes, and along broad valleys.

3.2.2.1.2 Confined Riverine Sub-type

In confined riverine systems, the width of the valley across which the system can migrate without encountering a hillside, terrace, man-made levee, or urban development **is less than twice** the average bankfull width of the channel. Confined riverine systems are typically found in the lower order, higher gradient upper reaches of watersheds, or in constrained urban systems.

3.2.2.2 Depressional Wetlands

Depressional wetlands occur in topographic lows (i.e., closed elevation contours) that allow the accumulation of surface water and, in some cases, groundwater. These systems can be natural or artificial in origin and can occur on the landscape as isolated basins with distinct boundaries, or as a complex of shallows and seasonally wet depressions created by the slight topographic relief with indistinct boundaries, or as a large complex of interconnected basins. The margins of distinct depressional wetlands are relatively easy to discern in aerial photos and in the field. Ponds on fault traces (e.g. sag ponds, snow melt ponds), valley bottoms (e.g. cutoff ox-bows on floodplains), landslide impoundments, and on broad saddles along ridges (e.g. kettle-holes in moraines) are examples of naturally occurring depressional wetlands. Stormwater treatment ponds, wildlife habitat enhancements (e.g., duck ponds), stock ponds, and water hazards on golf courses are examples of artificially constructed depressional wetlands.

Depressional wetlands often lack a direct hydrologic connection to surface waters, and their hydrologic regime may be determined by groundwater discharge, overland runoff, and precipitation. However, many depressional wetlands (e.g., stockponds, constructed wetlands, or oxbows) are directly connected to surface waters and. Depressional wetlands can be perennial

(perennially/permanently flooded) or seasonal (seasonally or temporarily flooded), and may lack surface ponding or saturated conditions during dry years[1]. As defined by CRAM, perennially flooded depressional wetlands have some amount of surface ponding for at least 9 months during most years (i.e. in greater than 5 out of 10 years). Seasonally flooded depressional wetlands are defined as supporting surface ponding for between 4 and 9 months of the year, and temporarily flooded depressional wetlands possess surface water between 2 weeks and 4 months of the year.

CRAM recognizes that all wetlands have some amount of adjacent riparian area, as defined by the US National Research Council (see glossary). For the purposes of CRAM, the riparian areas adjacent to depressional wetlands are considered part of the wetland and are included in the Assessment Area.

3.2.2.2.1 Artificial Depressional Wetlands

A large variety of types and configurations exist for artificially constructed depressional wetlands. In the more urbanized areas of California, many depressional wetlands have been constructed and/or engineered primarily to treat urban runoff for water quality improvement or to store flood flows. In some areas of the state, such as the Central Valley, the majority of depressional wetlands are intensively managed and artificially flooded to promote a variety of benefits to many species of wildlife, especially waterfowl (vegetation for food and cover, adequate water quality, breeding and resting sites).

3.2.2.2.2 Vernal Pool Wetlands

Vernal pools are ephemeral wetlands that form in shallow depressions underlain by bedrock or by an impervious, near-surface soil horizon. These depressions fill with rainwater and runoff during the winter and may remain inundated until spring or early summer, sometimes filling and emptying repeatedly during the wet season. Vernal pools undergo four distinct annual phases: (1) the wetting phase with the onset of the first rains; (2) the aquatic phase when the peak rainfall and inundation occurs; (3) the drying phase when many plants flower and produce seed and many animals disperse; and finally (4) the drought phase when the soil dries and cracks, and the plants succumb to extreme dry conditions. Vernal pools typically support a minimum of 30% cover of native plant species during the aquatic or drying phase. Vernal pools in disturbed areas or subjected to abnormal rainfall patterns might not meet this criterion due to invasion by non-native plants. If the wetland is mostly characteristic of a vernal pool but also has characteristics of other kinds of wetlands, such that its classification as a vernal pool is not completely certain, then it should be considered a vernal pool.

3.2.2.2.3 Vernal Pool Systems

Vernal pools often occur together and with vernal swales as vernal pool systems. These can have many pools of various sizes and shapes, varying floral and faunal composition, and various hydroperiods. Water can move between adjacent pools and swales through the thin soils above

[1] There may be a limit to the applicability of CRAM in extremely seasonal depressional wetlands (inundated less than 1-2 months/year) that tend not to support species-rich plant communities with complex horizontal and vertical structure. CRAM may be systematically biased against such naturally simple depressional systems. Therefore, while the current version of the CRAM depressional module can be used in these systems, the results are being tracked carefully.

the underlying impervious substrate. The lack of surface flow between pools does not necessarily indicate that they are not hydrologically inter-connected.

3.2.2.2.4 Other Depressional Systems

Depressional wetlands other than vernal pools can be seasonal[1] or perennial, but their flora and fauna are mostly not characteristic of vernal pools, and they lack the impervious substrate that controls vernal pool hydrology. They differ from lacustrine wetlands by lacking an adjacent area of open water (at least 2 m deep and 8 ha total area). They differ from playas by lacking an adjacent area larger than the wetland of either alkaline or saline open water less than 2 m deep or non-vegetated, fine-grain sediments. Unlike slope wetlands (i.e., springs and seeps), depressional wetlands depend more on precipitation than groundwater as their water source.

3.2.2.3 Playa Wetlands

The central feature of a playa is a seasonal or perennial body of very sodic (i.e., strongly alkaline) or saline water less than 2m deep that is larger than the adjacent, fringing wetland. The benthic sediments of a playa are mostly very fine-grain clays and silts. The fringing wetlands are characterized by grasses and herbaceous plants tolerant of the soluble salts that accumulate along the margins of the playas (Gustavson *et al.* 1994, Rocchio 2006). Playas differ from vernal pools by having little or no vascular vegetation within the area that is seasonally saturated or inundated. Vernal pools are generally much smaller than playas. And, unlike vernal pools, playas are more dependent on runoff than direct precipitation. The condition of a playa can be strongly influenced by the condition of its watershed (Keate 2005). The shallowness of playas and their high salinity or alkalinity distinguishes them from lacustrine systems.

3.2.2.4 Estuarine Wetlands

An estuary consists of aquatic (i.e., sub-tidal) and semi-aquatic (i.e., intertidal) environments that are strongly influenced by mixtures of ocean water and upland runoff due to tidal processes operating through an ocean inlet. Estuaries are mostly enclosed by land. Their inlets may be natural or unnatural. Typical sources of freshwater include rivers, streams, lakes and reservoirs, point discharges (e.g., effluent from sewage treatment facilities), and storm drains.

An estuarine wetland consists of the vegetated marsh plain, its pannes, potholes, hummocks, and other habitat elements of the plain, as well as the natural levees, shell beds, submerged plant beds, and other habitat elements created or supported by tidal processes and associated with tidal channels that tend to dewater at low tide or that are less than 30m wide. Tidal channels that do not tend to dewater at low tide or that are wider than 30m are not considered to be part of the wetland and can serve to separate one estuarine wetland from another.

[1] There may be a limit to the applicability of CRAM in seasonal depressional wetlands that tend not to support species-rich plant communities with complex horizontal and vertical structure. CRAM may be systematically biased against such naturally simple depressional systems. Therefore, while the current version of CRAM depressional module can be used in these systems, the results are being tracked carefully. The depressional wetlands CRAM module will be revised based on additional field work during FY 2012-03.

3.2.2.4.1 Perennial Saline Estuarine Wetland Sub-type

For the purposes of CRAM, saline estuarine wetlands are distinguished from non-saline estuarine wetlands by the obvious dominance of salt-tolerant species of emergent vascular vegetation, such as cordgrass (*Spartina* spp.), pickleweed (*Salicornia* spp.), and salt grass (*Distichlis* spp.) along the foreshore of the wetland and along the immediate banks of the larger tidal channels that tend to dewater at low tide.

3.2.2.4.2 Perennial Non-saline Estuarine Wetland Sub-type

In non-saline wetlands (i.e., brackish or freshwater estuarine wetlands), the plant community along the foreshore of the wetland and along the immediate banks of the larger tidal channels that tend to dewater at low tide is dominated by species that don't tolerate high salinities, such as cattails (*Typha* spp.), rushes (*Scirpus species),* and willows (*Salix* spp.).

3.2.2.4.3 Bar-Built Esturaine Sub-type

Bar-built estuaries are the reaches of coastal rivers and streams that are ecologically influenced by seasonal closures of their tidal inlets. The frequency and duration of inlet closure can be natural or managed. The tidal regime can be muted or not (i.e., the tidal range can be the same or less than that of the adjacent marine or estuarine system when the tidal inlet is open). The salinity regime of a bar-built estuary can be highly variable. It can be fresh throughout very wet years or hypersaline during extended droughts. Bar-built estuaries are often referred to as "lagoons;" geomorphologically this term refers to any coastal water feature behind a bay-mouth bar.

This module is not used for large coastal lagoons, such as Big Lagoon and Stone Lagoon in Humboldt County and Lake Earl/Tolowa in Del Norte County, even though these lagoons are intermittently tidal. These lagoons are not associated with significant fluvial sediment sources from streams or rivers, and their hydrodynamics differ from the bar-built estuaries covered by this module. These large lagoons are covered, in part, by the Lacustrine Module, and additional development work in appropriate elements of other modules is in progress.

It should be noted that tidal influences on streamflow dynamics may extend many meters above the upstream limit of estuarine mixing when estuaries are open to full tidal exchanges, but this module does not apply to tidal but non-estuarine reaches of rivers or streams. Additionally, if a system has been altered such that hardened structures at its mouth prevent the formation of a sand bar that would close off the system to marine influence, this is considered a type change to a perennially saline estuary and is not covered by this module.

3.2.2.5 Lacustrine Wetlands

Lacustrine systems are lentic water bodies that usually exceed 8 hectares in total area during the dry season and that usually have a maximum dry season depth of at least 2m. They are deeper and larger than depressional wetlands or vernal pools or playas. Some lacustrine systems are separated from estuarine or marine systems by barrier beaches, dunes, or other natural or artificial barriers that are occasionally but irregularly breached. Some of these coastal lacustrine systems are locally referred to as lagoons. Here they are regarded as lacustrine systems because they resemble other lacustrine systems based on CRAM attributes and metrics.

3.2.2.6 Slope Wetlands

Slope Wetland is a broad category of groundwater-dominated wetlands inclusive of wet meadows, forested slopes, seeps and springs sub-types. In these wetlands groundwater may emerge into the root zone or across the ground surface seasonally or perennially, but mainly has unidirectional flow. The term "slope" refers to the uni-directional flow of ground and surface water within the wetland, rather than to a geomorphic feature (e.g. hillslope, toe-slope).

3.2.2.6.1 Seeps and Springs

These wetlands occur on hillsides or at the base of dunes, hills, alluvial fans, levees, etc. Springs are indicated by groundwater emerging and flowing across the ground surface and sometimes through indistinct or very small rivulets, runnels, and other features that are too small to be called a creek or riverine system. They often lack the features of riverine channels, such as a thalweg or floodplain. Seeps are similar to springs but lack a single-dominant origin of surface flow. Most of the flow is confined to the root zone and is not evident on the ground surface. Seeps and Springs may have, or may lack woody vegetation; no distinction is made in CRAM.

3.2.2.6.2 Wet Meadows

Wet meadows include bogs, fens, and alpine meadows where the hydrology is controlled mainly by fluctuations in ground water levels. They are associated with broad, gentle topographic gradients along which the near-surface ground water moves advectively, albeit slowly, in one dominant direction. If the hydroperiod of a wetland that looks like a wet meadow mainly depends on direct precipitation, then it is a depressional wetland (see Sections 3.2.2.2 and 3.2.2.3 above). Some wet meadows are associated with fluvial riverine channels, while others do not contain any distinct channel and have only sub-surface flow or surface sheet flow. Because the meadows with channels often have unique features that are not found in those without channels, this classification splits wet meadows into two types: Channeled Meadows and Non-channeled Meadows.

3.2.2.6.3 Forested Slopes

Forested slope wetlands are separated from wet meadows, by the percent coverage of trees. Forested Slope Wetlands are slope wetlands larger than 0.5 acres (0.2 ha) that form due to a seasonal or perennial emergence of groundwater into the root zone and in some cases onto the ground surface, and that support more than 30% cover of tall woody vegetation, as evidenced in aerial imagery, a LiDAR-derived tree height hillshade, or other sources of plant height information (Cayce et al., 2012). These wetlands can adjoin non-forested slope wetlands (i.e., wet meadows). They can include wetland areas with less than 30% woody cover (i.e., non-forested slope wetlands) that are not larger than 0.5 acres (0.2 ha).

3.4 Step 4: Verify the Appropriate Assessment Window

The Assessment Window is the period of time each year when assessments of wetland condition based on CRAM should be conducted. One Assessment Window exists for all attributes and metrics of each wetland type, but different types of wetlands can have different Assessment Windows. For example, the window is not the same for vernal pools and estuarine wetlands.

In general, the CRAM Assessment Window falls within the *growing season for the characteristic plant community of the wetland type to be assessed*. For wetlands that are not subject to snowfall and that are

non-tidal, the main growing season usually extends from March through September, although it may begin earlier at lower latitudes and altitudes. The growing season tends to start earlier and last longer in tidal wetlands than adjoining non-tidal wetlands due to the seasonal variations in tidal inundation. For wetlands subject to snowfall, the start of the growing season is retarded by the spring thaw, which at very high elevations may not happen until late May or early June, depending on the depth of the snow pack. For seasonal wetlands (e.g., vernal pools, playas, and some seeps), the growing season will generally be March through June, although it can be much shorter for vernal pools.

Since the timing of the growing season varies with altitude and latitude, the Assessment Window might vary within and between regions, and local or regional cues may be needed to determine when the window opens and closes each year. The best cues will be the early evidence of new growth of plants, and the subsequent senescence of the plants, for any given wetland types. For example, the assessment of seasonal depressional wetlands might begin after the start of the growing season (the window is opening) but before summertime desiccation of the wetland soils (the window is closing). Some experts can reconstruct conditions for the Assessment Window after it closes based on forensic botany and other field techniques. It should be clearly noted on the CRAM data sheets, however, if an assessment is being done outside the designated Assessment Window.

Note that the assessment of estuarine wetlands should occur at low tide, when most of the smaller intertidal channels of the wetland are dewatered and associated benthic indicators of conditions are visible.

Also note that riverine wetlands should not be assessed during high water, not only because some important indicators of channel condition might be concealed, but also because of the dangers presented by high flows. Riverine wetlands should be assessed late in the growing season, near the onset of base flow.

3.5 Step 5: Establish the Assessment Area (AA)

The Assessment Area (AA) is the portion of the Wetland that is assessed using CRAM. An AA might include a small wetland in its entirety. But, in most cases the wetland will be larger than the AA. Rules are therefore needed to delineate the AA.

Establishing a proper AA is a critical step in correctly performing a rapid assessment using CRAM. As explained below, the use of an incorrect AA can yield results that are not reproducible, and that are not likely to relate to stressors or management actions. The delineation of the boundary of an AA must adhere to the following guidelines.

It is assumed that different wetlands, even neighboring wetlands of the same type, can be managed differently, or for different purposes, and can be subject to different stressors. Therefore, each AA must not encompass or involve more than one wetland, as defined in the Level 1 inventory.

Since CRAM metrics vary between wetland types, each AA must only represent one type of wetland. Different types of wetlands can be contiguous with each other, or even nested one within the other, but each AA must only represent one wetland type.

The wetland AA must be classified using the typology provided in Section 3.2.2 and it must be assessed using the metrics designed for its wetland type. Misclassification of wetlands can lead to using the wrong CRAM module, which in turn will lead to spurious assessments.

Each of the additional considerations outlined below, if applied alone, could lead to defining a different AA for the same wetland. The delineation of an AA is therefore an optimization among these considerations. Experience has shown, however, that for the purpose of standardizing the AAs for any wetland type, the overriding considerations are hydro-geomorphic integrity and size.

3.5.1 Hydro-geomorphic Integrity

Wetland managers need to be able to distinguish between the effects of management actions and the natural variability within and among wetlands of any given type based on CRAM scores. In effect, the AA should help maximize the CRAM signal-to-noise ratio.

Each AA must therefore encompass most if not all of the natural spatial variability in the visible form and structure of its encompassing wetland, and the AA should also encompass most of the internal workings of the wetland that account for its homeostasis – its tendency to maintain a certain overall condition or return to it during or after significant stress or disturbance.

For an AA to have this desired level of integrity, it should be bounded by obvious physical changes in topography, hydrology, or infrastructure that significantly control the sources, volumes, rates, or general composition of sediment supplies or water supplies within the AA at the time of the field assessment. In essence, the boundaries of an AA should not extend beyond any features that represent or cause a major spatial change in water source or sediment source.

One way to visualize the AA is to identify the spatial scale at which the structure and form of the wetland seem to repeat themselves (i.e., the scale at which self-similarity becomes evident). This is assumed to be the scale at which the internal workings of the wetland yield the least variability in form and structure. For example, the s-shaped curve created by two consecutive river bends tends to have a wave length equal to 10x the average width of the river through the bends (Leopold 1994). Also, large estuarine wetlands tend to consist of a number of drainage networks of very similar length and drainage area for any given drainage order (Collins *et al.* 1987, Collins and Grossinger 2004). Shorelines can be characterized by alternating reaches of erosion and deposition that repeat themselves at certain spatial scales relating to wave fetch and shoreline geology (e.g., Philips 1986). Observing the patterns of self-similarity for a given wetland type can help identify the dimensions of the appropriate AA.

3.5.2 AA Size

For any given wetland type, larger AAs might tend to yield higher CRAM scores. This is because CRAM is especially sensitive to wetland structural complexity, and larger AAs can afford more opportunity to encounter variability in structure. For any given wetland type, having AAs of very different sizes can introduce variability into CRAM scores.

As stated above, one of the primary considerations for delineating an AA is its hydro-geomorphic integrity. The boundaries of the AA should be established based on clear breaks in

surface hydrology, sediment supply, or geomorphology (see Tables 3.5 and 3.6 below). Experience has shown, however, that most of the AAs of each wetland type that are delineated according to indicators of hydro-geomorphic integrity fall within a narrow range of size, although their shapes are more variable. This suggests that size guidelines can be applied to the process of establishing an AA without necessarily violating the criterion for the hydro-geomorphic integrity of the AA.

Furthermore, in some cases the self-similar, self-organizing, integral area of a wetland is not clearly evident. For example, some wet meadows, brackish estuarine wetlands, large riverine systems, and fringing wetlands of playas and lacustrine systems lack obvious hydrological breaks or other features that clearly demarcate changes in water supplies or sediment supplies. In these cases, overall size may be the dominant criterion for delineating the AA.

The preferred AA size is generally greater for types of wetlands that tend to have broad, level planes than for wetlands fringing steep terrain. The size-frequency distribution of wetlands for each wetland type (a Level 1 analysis) was also considered when the recommendations for AA sizes were being developed.

Examples of features that should be used to delineate an AA, and other features that should not be used, are listed in Tables 3.5 and 3.6 below. The preferred and minimum AA sizes for each wetland type are presented below in Table 3.7.

To the degree possible, the delineation of an AA should first be based on the hydro-geomorphic considerations presented in Tables 3.5 and 3.6. But, if these considerations are not applicable, or if the resulting AA is more than about 25% larger than the preferred size presented in Table 3.7, then the AA delineation should rely only on the size guidelines. The number of AAs per wetland will depend on the purpose of the assessment, as outlined in Table 3.8.

In addition to the guidance below, there are special considerations for establishing a AA for each wetland type located in the field books of each CRAM module.

Table 3.5: Examples of features that should be used to delineate AA boundaries. A more complete list is presented in the field books for each wetland type.

Flow-Through Wetlands	**Non Flow-Though Wetlands**	
Riverine, Estuarine and Slope Wetlands	**Lacustrine, Wet Meadows, Depressional, and Playa Wetlands**	**Vernal Pools and Vernal Pool Systems**
• diversion ditches • end-of-pipe large discharges • grade control or water height control structures • major changes in riverine entrenchment, confinement, degradation, aggradation, slope, or bed form • major channel confluences • water falls • open water areas more than 30 m wide on average or broader than the wetland • transitions between wetland types • foreshores, backshores and uplands at least 5 m wide • weirs, culverts, dams, levees, and other flow control structures	• above-grade roads and fills • berms and levees • jetties and wave deflectors • major point sources or outflows of water • open water areas more than 30 m wide on average or broader than the wetland • foreshores, backshores and uplands at least 5 m wide • weirs and other flow control structures	• above-grade roads and fills • major point sources of water inflows or outflows • weirs, berms, levees and other flow control structures

Table 3.6: Examples of features that should not be used to delineate any AAs. A more complete list is presented in the field books for each wetland type.

- at-grade, unpaved, single-lane, infrequently used roadways or crossings
- bike paths and jogging trails at grade
- bare ground within what would otherwise be the AA boundary
- equestrian trails
- fences (unless designed to obstruct the movement of wildlife)
- property boundaries
- riffle (or rapid) – glide – pool transitions in a riverine wetland
- spatial changes in land cover or land use along the wetland border
- state and federal jurisdictional boundaries

Table 3.7: Preferred and minimum AA sizes for each wetland type. Wetlands smaller than the preferred AA sizes can be assessed in their entirety.

Wetland Type	Recommended AA Size
Slope	
Spring or Seep	Preferred size is 0.50 ha (about 75m x 75m, but shape can vary); there is no minimum size (least examples can be mapped as dots).
Wet Meadow	Preferred size is 1.0 ha (about 140m x 140m, but shape can vary); Maximum size is 2.0 ha; minimum size is 0.1 ha (about 30m x 30m).
Depressional	
Vernal Pool	There are no size limits.
Vernal Pool System	Preferred size is <10 ha (about 300m x 300m; shape can vary); there is no minimum size so long as there are between 3 and 6 pools. If the system has between 3 and 6 pools, assess all of them. If there are more than 6 pools, select 6 that represent the range in size of pools present on the site.
Other Depressional	Preferred size is 1.0 ha (a 56 m radius circle or about 100m x 100m, but shape can vary); Maximum size is 2.0 ha (an 80 m radius circle or about 140m x 140m, but shape can vary); There is no minimum size.
Riverine	
Confined and Non-confined	Recommended length is 10x average bankfull channel width; maximum length is 200 m; minimum length is 100 m. AA should extend laterally (landward) from the bankfull contour to encompass all the vegetation (trees, shrubs vines, etc.) that probably provide woody debris, leaves, insects, etc. to the channel and its immediate floodplain; minimum width is 2 m.
Lacustrine	Preferred size is 2.0 ha (about 140m x 140m, but shape can vary); Minimum size is 0.5 ha (about 75m x 75m).
Playa	Preferred size is 2.0 ha (about 140m x 140m, but shape can vary); Minimum size is 0.5 ha (about 75m x 75m).
Estuarine	
Perennial Saline	Preferred size and shape for estuarine wetlands is a 1.0 ha circle (radius about 55m), but the shape can be non-circular if necessary to fit the wetland and to meet hydro-geomorphic and other criteria. The minimum size is 0.1 ha (about 30m x 30m).
Perennial Non-saline	
Bar-Built	Maximum size is 2.25 ha (about 150 m x 150 m, but shape can vary), The minimum size is 0.1 ha (about 30m x 30m).

3.5.3 Assessment Purpose

There are two primary purposes for using CRAM. It is used to assess the ambient condition of a population of wetlands or to assess the condition of an individual wetland or wetland project. The same guidelines for delineating AAs (see Tables 3.5 through 3.7 above) pertain to project assessments and ambient assessments using CRAM.

However, the number of AAs per wetland can vary between ambient surveys and individual wetland assessments. Multiple AAs might be required to assess the average condition of a wetland project that is many times larger than one AA, whereas just one AA would be required in the same wetland if it were only being assessed as part of an ambient survey (see Table 3.8).

Table 3.8: Guidelines for determining the number of AAs per wetland.

	Assessment Scenario
Single AA	If the size of the wetland is within the size limits given in Table 3.7, then the entire wetland constitutes the AA, regardless of the purpose of the assessment. Or If the wetland is one in a population of wetlands to be assessed as part of an ambient survey, then delineate one AA around each point randomly selected within the wetland as part of the sample draw from the ambient sample frame. For more information about ambient sampling design go to http://epa.gov/nheerl/arm/designing/design_intro.htm.
Multiple AAs	If the wetland is about twice as large as the preferred size AA from Table 3.7, and if the purpose is to assess the average condition of the wetland, then assess the second AA and report the results for both AAs. Or If the wetland is at least thrice as large as the preferred size AA from Table 3.7, and if the purpose is to assess the average condition of the wetland, then randomly select and assess three AAs from the array of all possible AAs for the wetland. If the overall score for the third AA differs from the average of the first two scores by more than 15%, then assess a randomly selected fourth AA; if its score differs from the average of the first three by more than 15%, then assess a randomly selected fifth AA. Repeat this procedure until the overall score for the latest AA is no more than 15% different than the average of all previous scores, or until the array of possible AAs is exhausted. For more detailed instructions on assessing multiple AAs per wetland, see the CRAM Technical Bulletin).
Reporting	The final boundaries of all the AAs of a wetland should be mapped using either the eCRAM software mapping tool or by drawing a heavy pencil line on a hardcopy of the site imagery. Hardcopy maps will need to be digitized using the online version of eCRAM as part of the process of entering CRAM results into the online CRAM database.

3.5.3 Special Considerations for Post-assessment Analysis

For CRAM scores to be comparable they must be standardized in terms of time (i.e., scores should represent comparable amounts of assessment effort during comparable years and times of year), and in terms of space (i.e., for any given wetland type, the scores should represent comparable amounts of wetlands, and these should have hydrological and ecological integrity; see Section 3.5.2 above).

For a variety of reasons, scores that do not meet these standards cannot be compared and cannot be combined into datasets. For example, assessments that take longer or that involve larger areas are likely to encounter more structural complexity and therefore yield higher scores.

The use of Assessment Windows (see Section 3.4 above), fixed assessment times (i.e., no assessment should take longer than one half day in the field), recommended AA sizes, and guidelines for assembling data of varying vintage will achieve more consistent assessment results.

To achieve the spatial standards, each AA for each wetland type should fall within a standard size range that is large enough to incorporate the natural processes of homeostasis that characterize the wetland (see discussion of AA integrity in Section 3.5.2), but small enough to meet the time constraints (see Table 3.7).

An additional spatial consideration for ambient surveys is that the probability of any wetland within a given area being selected for assessment increases with its size, and weighting CRAM scores for the inclusion probabilities of their associated AAs depends on having a standard AA size range for each wetland type. For more information about ambient sampling design go to http://epa.gov/nheerl/arm/designing/design_intro.htm.

Standardizing the shape of AAs (e.g., having all AAs be circles or squares of fixed size) may increase the ease with which they are delineated, but may also lead to a disregard of features such as water control structures that affect AA integrity. Standardizing the shapes of AAs is less important than standardizing their sizes.

3.5.4 Special Considerations for Assessing Projects

For the purposes of CRAM, a "project" includes any on-the-ground activity which results in a physical change in the area or condition of an aquatic resource[1]. Projects can be associated with a regulatory or funding decision. Such projects are often at least partly delimited by property lines or other administrative or legal boundaries. Wetland restoration projects, mitigation projects, mitigation banks, and wetlands that are targeted for development (i.e., impacted wetlands) are often delimited by property lines. However, for the purposes of CRAM, the definition of *project* is independent of any regulatory or administrative definition under the Clean Water Act, Porter Cologne, Section 1600 of the State's Fish and Game Code, Coastal Zone Management Act, CEQA, or NEPA.

Property lines, jurisdictional limits, and other administrative or legal boundaries should not automatically be used to delineate AAs, except for the assessment of a project, in which case the

[1] Projects can include the acquisition or placement of a wetland, riparian area, or other aquatic habitat in a conservation easement (or other permanent protection).

wetland and its AA(s) are confined to the project boundaries. A formal wetland Jurisdictional Delineations (JD) in good standing for a project can be used in the absence of any other wetland map to define the wetland and to help delimit the AA(s). If the project is much larger than one AA, then the process outlined in the CRAM Technical Bulletin should be used to assess multiple AAs.

The best achievable condition of a project might be unavoidably constrained by adjacent or nearby land uses. In these situations, the expected or target level of performance of a project might be adjusted for the land use constraints. In other words, although a project is assessed relative to the best achievable conditions for its wetland type throughout the State, what is expected or deemed acceptable for any particular project might reflect its land use setting. For example, stream restoration projects in urban landscapes need not be held to the same standards of high performance as projects in rural or non-developed landscapes. As CRAM scores accumulate throughout the State, their relationship to land use setting can be analyzed to guide local adjustments in project performance criteria that are based on CRAM.

3.6 Step 6: Conduct Initial Office Assessment of Condition Metrics and Stressors

For each CRAM assessment, there is initial office work to acquire the site imagery, plan logistics for the site visit, and to assemble information about the management of the site and its possible stressors. Preliminary scores can be developed for some metrics, based on existing documentation (e.g., aerial photography, reports, etc.), prior to conducting any fieldwork. Such preliminary scoring is not necessary, however, and any preliminary scores must be verified during the site visit. The initial office work is itemized in Table 3.10 below.

Table 3.10: CRAM metrics suitable for pre-site visit draft assessment.

Background Information to Assemble Prior to the Site Visit			
• 1m-3m pixel resolution digital geo-rectified site imagery • Site-specific and neighboring reports on hydrology, ecology, chemistry, etc. • Access permission if needed • Preliminary map of the Assessment Area • Maps to the site, access points, and other logistical information			
Metrics/Submetrics Suitable for Preliminary Scoring Prior to Site Visit			
Attributes		Metrics/Submetrics	Suitable?
Buffer and Landscape Context		Aquatic Area Abundance	Yes
		Stream Corridor Continuity(riverine, BBE)	Yes
		Aquatic Area in Adjacent Landscape (BBE)	Yes
		Marine Connectivity (BBE)	Yes
		Percent of AA with Buffer	Yes
		Average Buffer Width	Yes
		Buffer Condition	No
Hydrology		Water Source	Yes
		Hydroperiod or Channel Stability	No
		Hydrologic Connectivity	No
Structure	Physical	Structural Patch Richness	No
		Topographic Complexity	No
	Biotic	Number of Plant Layers Present	No
		Number of Co-dominant Species	No
		Endemic Plant Species Richness (vernal pools)	No
		Percent Invasion	No
		Horizontal Interspersion and Zonation	No
		Vertical Biotic Structure	No

For air photos and other imagery, the minimum pixel resolution is 3m (i.e., each pixel in the digital image of a site should represent no more than about $9m^2$ of area). National Agriculture Imagery Program (NAIP; http://www.fsa.usda.gov) aerial imagery with a spatial resolution of 1m is available for the entire state (years 2005, 2009, and 2010) as either Digital Orthogonal Quarterly Quadrangle (DOQQ) tiles or as compressed county mosaics (CCMs) from the Cal-Atlas website (atlas.ca.gov). Older, lower resolution (3m) imagery in DOQQ format is also available.

3.7 Step 7: Conduct Field Assessment of Condition Metrics and Stressors

After assembling the background information about the wetland to be assessed, the next step is to conduct an assessment of the wetland in the field. A complete description of CRAM metrics and the Stressor Checklist is provided in the individual field books for each CRAM module. Fieldwork for CRAM consists of finding and confirming the boundaries of the AA, and scoring

the AA based on the condition metrics and stressor checklist. Any field-based modifications of the preliminary AA boundary must be recorded on the site imagery.

3.8 Step 8: Complete CRAM Scores and Basic QA/QC Procedures

3.8.1 Calculating CRAM Scores

Scores for CRAM are easily calculated. There is no weighting of any metrics or attributes. Weightings are not supported by theory or the validation exercises. Letter scores for each metric (A, B, C, D) are simply converted into whole integer scores (12, 9, 6, 3, respectively; see Step 1 in Table 3.11).

For the Hydrology and Physical Structure attributes, the attribute scores are simply calculated as the sum of the component metric scores (see Step 2 in Table 3.11).

For the Buffer and Landscape Context attribute, the submetric scores relating to buffer are combined into an overall buffer score that is added to the score for the Landscape Connectivity metric, using the formula in Step 2 in Table 3.11.

For the Biotic Structure attribute, the Plant Community metric consists of three submetrics (Number of Plant Layers Present; Number of Co-dominant Species; and Percent Invasion). Prior to calculating the Biotic Structure attribute score, the values for these submetrics must be averaged. Then the Biotic Structure attribute score can be calculated as described in Table 3.11.

Each raw attribute score is then converted into a percentage of the maximum possible score (see Step 3 in Table 3.11). This eliminates any weighting of one attribute relative to another due to their differences in numbers of component metrics and numbers of alternative states of the metrics.

An overall AA score is calculated by averaging the attribute scores. All scores are rounded to the nearest whole percentage value (see Step 4 in Table 3.11).

Different wetlands are likely to have different functions and ecological services due to differences in wetland form, structure, geomorphic setting, climatic regime, evolutionary stage, stressor regime, etc. It is therefore unlikely that the same CRAM score represents the same level of function or even the same set of functions for different wetlands. CRAM scores cannot be used to infer wetland function except in the context of correlations between CRAM scores and actual functional levels, as measured using Level 3 methods. Validation efforts to date indicate that CRAM scores are strongly correlated to a variety of wetland functions and services.

It is expected that the same scores for different wetlands of the same type probably represent the same overall condition and functional capacity. CRAM can therefore be used to track the progress of restoration efforts over time, to compare impacted sites to their in-kind mitigation sites, or to compare an individual wetland to the status and trends in ambient condition of its wetland type.

CRAM scores can also be used to compare the status and trends of different types of wetlands. This is because all wetlands are assessed relative to their best achievable condition. For example, separate ambient surveys of lacustrine and estuarine wetlands might reveal that one type is doing better than the other, relative to their particular overall best achievable conditions.

Table 3.11: Steps to calculate attribute scores and AA scores for most wetland types.

Step 1: Calculate Metric Score	For each Metric, convert the letter score into the corresponding numeric score: A=12, B=9, C=6 and D=3.
Step 2: Calculate raw Attribute Score	For each Attribute, calculate the Raw Attribute Score as the sum of the numeric scores of the component Metrics, except in the following cases: • For Attribute 1 (Buffer and Landscape Context), the submetric scores relating to buffer are combined into an overall buffer score that is added to the score for the Aquatic Area Abundance, using the following formula: $\left(\text{Buffer Condition} \times \left(\text{\% AA with Buffer} \times \text{Average Buffer Width}\right)^{1/2}\right)^{1/2} + \text{Aquatic Area Abundance}$ • For Attribute 4 (Biotic Structure) Prior to calculating the Raw Attribute Score, average the three Plant Community sub-metrics. Then sum this result with the other two Biotic Structure metrics. • Do not round the Raw Attribute scores to the nearest integer.
Step 3: Calculate final Attribute Score	For each Attribute, divide its Raw Attribute Score by its maximum possible score, which is 24 for Buffer and Landscape Context, 36 for Hydrology, 24 for Physical Structure, and 36 for Biotic Structure. Do not round the final Attribute scores to the nearest integer before calculating the AA Index Score. You may round the final Attribute score to the nearest integer for reporting purposes.
Step 4: Calculate the AA Index Score	Calculate the AA Index Score by averaging the Final Attribute Scores. Round this average to the nearest whole number (integer) to get the AA Index Score (0.5 or greater rounds up, less than 0.5 rounds down).

There are many possible ways to graphically present CRAM scores. The choice should depend on the information to be conveyed and the intended audience. It will not usually be necessary to present metric scores except in the context of validation efforts and to explain attribute scores. The metric scores can be presented effectively, however, as a circular graph that depicts the contribution of each metric to the overall score (e.g., Figure 3.4A). Site-specific and ambient scores can be compared in bar charts (Figure 3.4B). The progress of a restoration or mitigation project can be shown as the change in average overall score relative to performance standards (Figure 3.4C). The ambient conditions of two different types of wetlands can be compared based on the frequency distributions of the overall scores (Figure 3.4D). The ambient condition of any given wetland type can be displayed as the cumulative frequency of overall scores (Figure 3.4E). The graphs pertaining to ambient condition or to any population of wetlands can be produced for a variety of spatial scales, from watersheds or regions to the State as a whole.

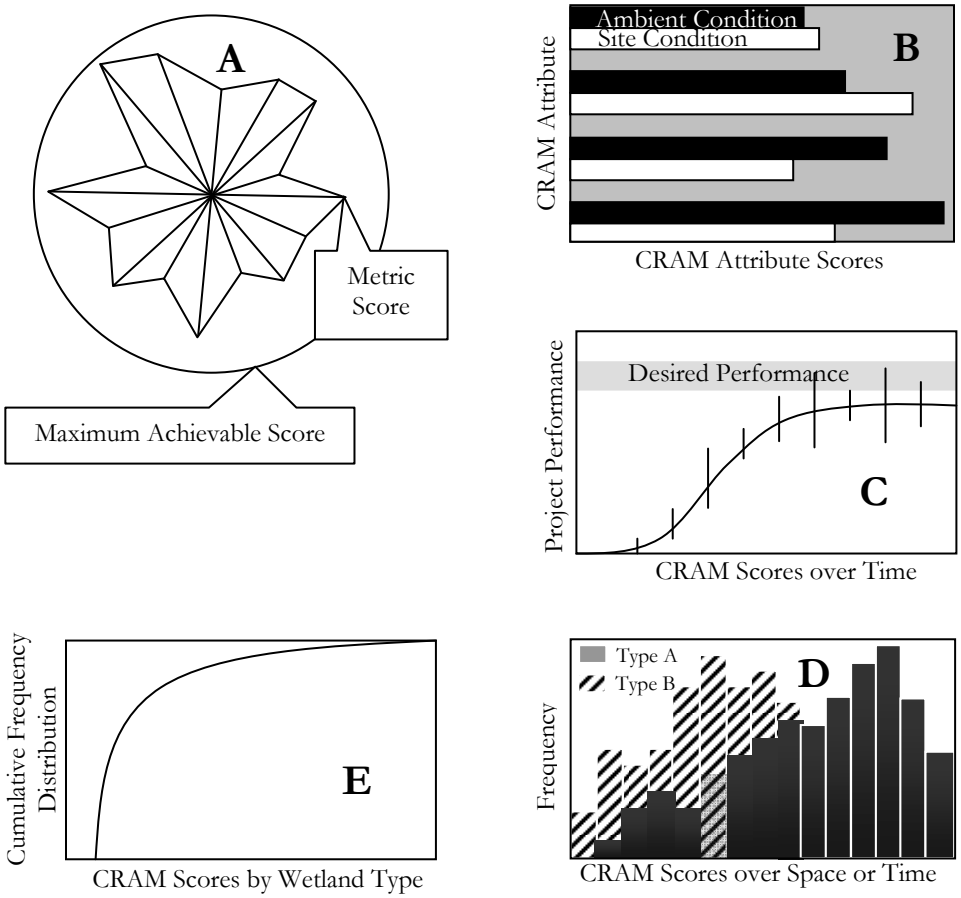


Figure 3.4: Example graphs for displaying CRAM results.

Figure shows (A) "spider plot" of metric scores for one or more AAs (multiple areas would be represented by average scores) (see Ambrose *et al.* 2006); (B) site-specific attribute scores compared to ambinet conditions or reference conditions; (C) changes in AA scores over time for a wetland an project; (D) comparison of two different populations of wetlands based on the frequency distribution of their AA scores; and (E) cummulative frequency distribution of scores for one population of wetlands.

3.8.2 Initial QA/QC Procedures for Data Collectors

Part of the value of CRAM is its ability to yield reproducible results for wetlands of similar condition, regardless of the data collector. Quality control procedures should be employed to assure that the data collectors or assessors are using the same approach and are obtaining information accurately when conducting CRAM assessments. For large wetland projects having numerous AAs and for ambient assessments involving multiple wetlands, it is recommended that at least 10% of the AAs be revisited by an independent CRAM assessment team and compared to the original assessments for the same AAs. The replicate scores should be within 10% of the original scores for each attribute.

In addition to taking on or more CRAM training courses, all CRAM practitioners are advised to carefully read and understand the most recent version of the CRAM User's Manual before they begin conducting assessments. The User's Manual and CRAM training materials are available at the CRAM web site (www.cramwetlands.org). Supporting materials include a photo-glossary with picture examples of many of the terms and wetland characteristics described or referenced in the User's Manual. These materials are intended to help users develop an understanding of the complete range of conditions for each metric, and arrive at consistent conclusions about wetland condition.

The initial quality control procedures for any assessment involve a basic review of the AA map and the summary scoring sheet. The recommended topics for the initial quality control are listed in Table 3.12 below.

Table 3.12: Recommended topics of initial QA/QC.

Recommended Topics of Initial QA/QC for CRAM Results
• *AA map quality:* hardcopy maps must be clear enough to be readily digitized. AA maps must be on geo-rectified imagery with minimum pixel resolution of 3 m (i.e., each pixel should represent no more than 9 m^2). • *Summary data sheet:* make sure all fields of information for site name, wetland type, date of assessment, personnel making the assessment, etc. are complete and legible. • *Summary score sheet*: make sure that every metric and attribute has a correct score, and that the overall site score is also correct. • *Summary stressor sheet:* make sure the stressor checklist has been completed.

3.8.3 Initial Quality Control Procedures for Data Managers

The main objective of data management is to assure that the data are accurately collected and verified for analysis and interpretation by CRAM practitioners and resource managers. Procedures described in this User's Manual are designed to help assure the accuracy and consistency of data collection and processing. Since metric scores are combined into more complex attribute and overall CRAM site scores, any errors in data collection can be compounded if quality control measures are not followed.

Data management involves maintaining various types of data and information, including hardcopy and electronic imaging and other background information for sites to be assessed using CRAM, as well as completed field data sheets. Routine backups of the computing systems and databases should be performed daily, along with measures to assure network and computer security. Backup files containing CRAM data should be stored in fireproof facilities. In addition, hardcopies of the data should be maintained and, if the data are only in electronic form, printouts of these data should be stored separately from the electronic versions.

These basic criteria for secure data management are currently met through administration of the CRAM web site and supporting database at the San Francisco Estuary Institute as a regional Information Center of CEDEN. The eCRAM interface, the CRAM database, and its supporting

web sites are open source. No aspect of CRAM programming is proprietary. The CRAM database incorporates numerous measures to assure accurate data entry and processing, including the following.

- Each database field that requires a value is checked for null or missing values.
- Standard codes are provided in look-up lists for populating the data table fields.
- The entry of duplicate records is prevented, based on a unique combination of fields that define the primary key.
- If one record set is related to another, it is checked for orphan records (parent records have child records and child records have parent records).
- Users are prompted to complete data fields as data are being uploaded into the database via the CRAM web site.
- Data entry and editing are password-protected; data authors can only access and edit their own data.
- All data are time-stamped and automatically assigned to a unique site code.
- Database users are automatically prompted to download new versions of CRAM if the version they have is outdated.

3.9 Step 9: Upload Assessment Data and Results

No CRAM assessment is complete until the results are uploaded into the CRAM database. The database is accessible at www.cramwetlands.org/dataentry. Anyone who wants to enter data into the database must register on the CRAM website to obtain a database log-in name and password. Results for hardcopy versions of CRAM must be transcribed into the electronic version on the web site. The database is only accessible to registered users, and they can only access and edit their own data. All results marked as "public" when entered into eCRAM can be viewed by the public through interactive maps at the CRAM web site.

CHAPTER 4: DEFINITION AND RATIONALE FOR CRAM ATTRIBUTES AND METRICS

4.0 Summary

This chapter contains background information for each metric of CRAM. Each metric is supported by a definition, rationale, and an indication of the metric's sensitivity to seasonal variability in wetland condition.

A field book describing the standard operating procedures for each wetland type is provided on the CRAM website (www.cramwetlands.org) along with datasheets for conducting CRAM assessments.

4.1 Attribute 1: Buffer and Landscape Context

For the purposes of CRAM, a buffer is a zone of transition between the immediate margins of a wetland and its surrounding environment that is likely to help protect the wetland from anthropogenic stress (see Figure 2.2). Areas adjoining wetlands that probably do not provide protection are not considered buffers.

Buffers can protect wetlands by filtering pollutants, providing refuge for wetland wildlife during times of high water levels, acting as barriers to disruptive incursions by people and pets into wetlands, and moderating predation by ground-dwelling terrestrial predators. Buffers can also reduce the risk of invasion by non-native plants and animals, by either obstructing terrestrial corridors of invasion or by helping to maintain the integrity and therefore the resistance of wetland communities to invasions.

Because regulation and protection of wetlands historically did not extend to adjacent uplands, these areas in some cases have been converted to recreational, agricultural, or other human land uses and might no longer provide their critical buffer functions for wetlands.

CRAM includes two metrics to assess the Buffer and Landscape Context attribute of wetlands: the Aquatic Area Abundance metric and the Buffer metric. The buffer metric is composed of three submetrics: (1) percentage of the AA perimeter that has a buffer; (2) the average buffer width; and (3) the condition or quality of the buffer.

4.1.1 Metric 1: Aquatic Area Abundance (Stream Corridor Continuity)

A. Definition: The aquatic area abundance of an Assessment Area is assessed in terms of its spatial association with other areas of aquatic resources, such as other wetlands, lakes, streams, etc. It is assumed that wetlands close to each other have a greater potential to interact ecologically and hydrologically, and that such interactions are generally beneficial.

B. Rationale: Wetlands are often important components of local mosaics of multiple types of habitat. The components of such mosaics tend to be inter-connected by the flow of water and movements of wildlife, such that they have additive influences on the timing and extent of many landscape-level processes, including flooding, filtration of pesticides and other contaminants, and wildlife support. In turn, these processes can strongly influence the form and function of

wetlands. The functional capacity of a wetland is therefore determined not only by its intrinsic properties, but by its relationship to other habitats across the landscape. For example, Frissell *et al.* (1986) concluded that the structure and dynamics of stream habitats are determined by the surrounding watershed. Several researchers have concluded that landscape-scale variables are often better predictors of stream and wetland integrity than localized variables (Roth *et al.* 1996; Scott *et al.* 2002). Wetlands that are close together without hydrological or ecological barriers between them are better able to provide refuge and alternative habitat patches for meta-populations of wildlife, to support transient or migratory wildlife species, and to function as sources of colonists for primary or secondary succession of newly created or restored wetlands. In general, good landscape connectivity exists only where neighboring wetlands or other habitats do not have intervening obstructions that could inhibit the movements of wildlife.

For the purposes of CRAM, 500 m has been surmised as the maximum distance between wetlands and other water-dependent habitats that does not by itself function as a barrier to the easy regular movements of small mammals, birds, amphibians, or reptiles. Greater distances between the wetland of interest and neighboring habitats are considered breaks in landscape connectivity.

C. Seasonality: This metric is not sensitive to seasonality.

4.1.2 Metric 2: Buffer

The buffer is the area adjoining the AA that is in a natural or semi-natural state and currently not dedicated to anthropogenic uses that would severely detract from its ability to entrap contaminants, discourage visitation into the AA by people and non-native predators, or otherwise protect the AA from stress and disturbance.

4.1.2.1 Submetric A: Percent of AA with Buffer

A. Definition: This submetric is based on the relationship between the extent of buffer and the functions provided by aquatic areas. Areas with more buffer typically provide more habitat values, better water quality and other valuable functions.

B. Rationale: The ability of buffers to protect a wetland increases with buffer extent along the wetland perimeter. For some kinds of stress, such as predation by feral pets or disruption of plant communities by cattle, small breaks in buffers may be adequate to nullify the benefits of an existing buffer. However, for most stressors, small breaks in buffers caused by such features as trails and small, unpaved roadways probably do not significantly disrupt the buffer functions.

C. Seasonality: This metric is not sensitive to seasonality.

4.1.1.2 Submetric B: Average Buffer Width

A. Definition: The average width of the buffer adjoining the AA is estimated by averaging the lengths of straight lines drawn at regular intervals around the AA from its perimeter outward to the nearest non-buffer land cover, or to a maximum distance of 250 m, whichever is first encountered. The maximum buffer width is 250 m. The minimum buffer width is 5 m, and the minimum buffer length along the AA perimeter is also 5 m. Any area that is less than 5 m wide and 5 m long is assumed to be too small to provide buffer functions.

B. Rationale: A wider buffer has a greater capacity to serve as habitat for wetland edge-dependent species, to reduce the inputs of non-point source contaminants, to control erosion, and to generally protect the wetland from human activities.

C. Seasonality: This metric is not sensitive to seasonality.

4.1.1.3 Submetric C: Buffer Condition

A. Definition: The condition of a buffer is assessed according to the extent and quality of its vegetation cover, the overall condition of its substrate, and the amount of human visitation. Buffer conditions are assessed only for the portion of the wetland border that has already been identified as buffer. Thus, evidence of direct impacts (parking lots, buildings, etc.) by people are excluded from this metric, because these features are not included as buffer land covers; instead these impacts are included in the Stressor Checklist.

B. Rationale: The condition or composition of the buffer, in addition to its width and extent around a wetland, determines the overall capacity of the buffer to perform its critical functions.

C. Seasonality: This metric is not sensitive to seasonality.

4.2 Attribute 2: Hydrology

Hydrology includes the sources, quantities, and movements of water, plus the quantities, transport, and fates of water-borne materials, particularly sediment as bed load and suspended load. Hydrology is the most important direct determinant of wetland functions (Mitsch and Gosselink 2007). The physical structure of a wetland is largely determined by the magnitude, duration, and intensity of water movement. For example, substrate grain size, depth of wetland sediments, and total organic carbon in sediments tend to be inversely correlated to duration of inundation in a lacustrine wetland. The hydrology of a wetland directly affects many physical processes, including nutrient cycling, sediment entrapment, and pollution filtration. For example, Odum and Heywood (1978) found that leaves in freshwater depressional wetlands decomposed more rapidly when submerged. The hydrology of a wetland constitutes a dynamic habitat template for wetland plants and animals. For example, Richards *et al.* 2002 concluded that meandering and braiding in riverine systems control habitat patch dynamics and ecosystem turnover. Additionally, the spatial distribution of plants and animals in a tidal marsh closely correspond to patterns of tidal inundation or exposure (Sanderson *et al.* 2000).

4.2.1 Metric 1: Water Source

A. Definition: Water Sources directly affect the extent, duration, and frequency of saturated or ponded conditions within an Assessment Area. Water Sources include direct inputs of water into the AA as well as any diversions of water from the AA. Diversions are considered a water source because they affect the ability of the AA to function as a source of water for other habitats while also directly affecting the hydrology of the AA. Direct inputs of water affecting conditions during the dry season are especially important because they strongly influence the structure and composition of wetland plant and animal communities. The Water Source metric therefore focuses on conditions that affect dry season hydrology.

Direct, natural water sources include precipitation, ground water discharge, and flooding of the AA due to high tides or naturally high riverine flows. Examples of direct, unnatural sources include stormdrains that empty into the AA or into an immediately adjacent area. For seeps and springs that occur at the toes of earthen dams, the reservoirs behind the dams are water sources. Indirect sources that should not be considered in this metric include large regional dams that have ubiquitous effects on broad geographic areas of which the AA is a small part. For example,

although the salinity regimes of some estuarine wetlands in San Francisco Bay are indirectly affected by dams in the Sierra Nevada, others are directly affected by nearby discharges from sewage treatment facilities. However, the effects of urbanization on hydrological dynamics in the immediate watershed containing the AA ("hydromodification") are considered in this metric; because hydromodification both increases the volume and intensity of runoff during and immediately after rain events and reduces infiltration that supports base flow discharges during the drier seasons later in the year. Engineered hydrological controls, such as pumps, weirs, and tide gates can serve to demarcate the boundary of an AA, but they are not considered water sources.

B. Rationale: Wetlands depend on constant or recurrent, shallow inundation or saturation at or near the surface of the substrate (National Research Council 2001). Consistent, natural inflows of water to a wetland are important to their ability to perform and maintain most of their intrinsic ecological, hydrological, and societal functions and services. The flow of water into a wetland also affects its sedimentary processes, geo-chemistry, and basic physical structure. Sudol and Ambrose (2002) found that one of the greatest causes of failed wetland mitigation or restoration projects is inadequate or inappropriate hydrology.

C. Seasonality: Water source should be evaluated during the dry season.

4.2.2 Metric 2: Hydroperiod or Channel Stability

A. Definition: Hydroperiod is the characteristic frequency and duration of inundation or saturation of a wetland during a typical year. The natural hydroperiod for estuarine wetlands is governed by the tides, and includes predictable variations in inundation regimes over days, weeks, months, and seasons. Depressional, lacustrine, playas, and riverine wetlands typically have daily variations in water height that are governed by diurnal increases in evapotranspiration and seasonal cycles that are governed by rainfall and runoff. Seeps and springs that depend on groundwater may have relatively slight seasonal variations in hydroperiod.

Channel stability only pertains to riverine wetlands. It is assessed as the degree of channel aggradation (i.e., net accumulation of sediment on the channel bed causing it to rise over time), or degradation (i.e., net loss of sediment from the bed causing it to be lower over time). There is much interest in channel entrenchment (i.e., the inability of flows in a channel to exceed the channel banks) and this is addressed in the Hydrologic Connectivity metric.

B. Rationale: For all wetlands except riverine wetlands, hydroperiod is the dominant aspect of hydrology. The pattern and balance of inflows and outflows is a major determinant of wetland functions Mitch and Gosselink (1993). The patterns of import, storage, and export of sediment and other water-borne materials are functions of the hydroperiod. In most wetlands, plant recruitment and maintenance are dependent on hydroperiod. The interactions of hydroperiod and topography are major determinants of the distribution and abundance of native wetland plants and animals. Natural hydroperiods are key attributes of successful wetland projects (National Research Council 2001).

For riverine systems, the patterns of increasing and decreasing flows that are associated with storms, releases of water from dams, seasonal variations in rainfall, or longer term trends in peak flow, base flow, and average flow are more important than hydroperiod. The patterns of flow, in

conjunction with the kinds and amounts of sediment that the flow carries or deposits, largely determine the form of riverine systems, including their floodplains, and thus also control their ecological functions. Under natural conditions, the opposing tendencies for sediment to stop moving and for flow to move the sediment tend toward a dynamic equilibrium, such that the form of the channel in cross-section, plan view, and longitudinal profile remains relatively constant over time (Leopold 1994). Large and persistent changes in either the flow regime or the sediment regime tend to destabilize the channel and cause it to change form. Such regime changes are associated with upstream land use changes, alterations of the drainage network, and climatic changes. A riverine channel is an almost infinitely adjustable complex of interrelations between flow, width, depth, bed resistance, sediment transport, and riparian vegetation. Change in any of these factors will be countered by adjustments in the others. The degree of channel stability can be assessed based on field indicators.

This metric evaluates recent changes in the hydroperiod, flow regime, or sediment regime of a wetland and the degree to which these changes affect the structure and composition of the wetland plant community or, in the case of riverine wetlands, the stability of the riverine channel.

C. Seasonality: For all wetland types other than depressional wetlands, vernal pools, and playas, hydroperiod should be evaluated during the dry season. For depressional wetlands and playas, hydroperiod should be assessed during the latter part of the wet season (i.e., June and July, in most years). The assessment window for vernal pools can be relatively short, and varies from one year to the next. As a general rule, however, hydroperiod for vernal pools should be assessed near the end of their growing season, when botanical indicators of successional change in hydroperiod are evident (i.e., April or May in most years).

4.2.3 Metric 3: Hydrologic Connectivity

A. Definition: Hydrologic Connectivity describes the ability of water to flow into or out of the wetland, or to accommodate rising flood waters without persistent changes in water level that can result in stress to wetland plants and animals.

B. Rationale: Hydrologic connectivity between wetlands and adjacent uplands promotes the exchange of water, sediment, nutrients, and organic carbon. Inputs of organic carbon are of great importance to ecosystem function. Litter and allochthanous input from adjacent uplands provides energy that subsidizes the aquatic food web (Roth *et al.* 1996). Connection with adjacent water bodies promotes the import and export of water-borne materials, including nutrients. Hydrologic connections with shallow aquifers and hyporheic zones influence most wetland functions. Plant diversity tends to be positively correlated with connectivity between wetlands and natural uplands, and negatively correlated with increasing inter-wetland distances (Lopez *et al.* 2002). Amphibian diversity is directly correlated with connectivity between streams and their floodplains (Amoros and Bornette 2002). Linkages between aquatic and terrestrial habitats allow wetland-dependent species to move between habitats to complete life cycle requirements. For estuarine wetlands, the function of upland transitions as refuge for intertidal wildlife during extreme high tides is especially important

For all wetland types except riverine, this metric is scored by assessing the degree to which the lateral movement of rising tides or flood waters are restricted by features such as levees, dikes,

sea walls, or road grades in the AA, its encompassing wetland and the associated upland transition zone.

For riverine wetlands, Hydrologic Connectivity is assessed based on the degree of channel entrenchment (Leopold *et al.* 1964, Rosgen 1996, Montgomery and MacDonald 2002). Entrenchment is calculated as the flood-prone width divided by the bankfull width. The flood-prone width is measured at the elevation equal to twice the maximum bankfull depth; maximum bankfull depth is the height of bankfull flow above the thalweg.

C. Seasonality: This metric is not sensitive to seasonality.

4.3 Attribute 3: Physical Structure

Physical structure is defined as the spatial organization of living and non-living surfaces that provide habitat for biota (Maddock 1999). For example, the distribution and abundance of organisms in riverine systems are largely controlled by physical processes and the resulting physical characteristics of habitats (e.g., Frissell *et al.* 1986). Metrics of the Physical Structure attribute in CRAM therefore focus on physical conditions that are indicative of the capacity of a wetland to support characteristic flora and fauna.

4.3.1 Metric 1: Structural Patch Richness

A. Definition: Patch richness is the number of different obvious types of physical surfaces or features that may provide habitat for aquatic, wetland, or riparian species. This metric is different from topographic complexity in that it addresses the number of different patch types, whereas topographic complexity evaluates the spatial arrangement and interspersion of the types. Physical patches can be natural or unnatural.

B. Rationale: The richness of physical, structural surfaces and features in a wetland reflects the diversity of physical processes, such as energy dissipation, water storage, and groundwater exchange, which strongly affect the potential ecological complexity of the wetland. The basic assumption is that natural physical complexity promotes natural ecological complexity, which in turn generally increases ecological functions, beneficial uses, and the overall condition of a wetland. For each wetland type, there are visible patches of physical structure that typically occur at multiple points along the hydrologic/moisture gradient. But not all patch types will occur in all wetland types. Therefore, the rating is based on the total number of expected patch types present in an AA for a given type of wetland.

C. Seasonality: This metric is not sensitive to seasonality.

4.3.2 Metric 2: Topographic Complexity

A. Definition: Topographic complexity refers to the micro- and macro-topographic relief within a wetland due to abiotic features and elevations gradients.

B. Rationale: Topographic complexity promotes variable hydroperiods and concomitant moisture gradients that, in turn, promote ecological complexity by increasing the spatial and temporal variability in energy dissipation, surface water storage, groundwater recharge, particulate matter detention, cycling of elements and compounds, and habitat dynamics. Areas that are aerated due to flow across complex surfaces may promote volatilization of compounds, or re-suspension and export of water-borne material.

Topographic complexity is assessed by noting the overall variability in physical patches and topographic features. Care must be taken to distinguish indicators of topographic complexity or habitat features within a wetland. For each type of wetland, topographic complexity can be evaluated by observing the number of elevational features that affect moisture gradients or that influence the path of water flow along a transect across the AA, and the amount of micro-topographic relief along the gradients or flow paths. Topographic gradients may be indicated by plant assemblages with different inundation/saturation or salinity tolerances.

C. Seasonality: This metric is not sensitive to seasonality.

4.4 Attribute 4: Biotic Structure

The biotic structure of a wetland includes all of its organic matter that contributes to its material structure and architecture. Living vegetation and coarse detritus are examples of biotic structure. Plants strongly influence the quantity, quality, and spatial distribution of water and sediment within wetlands. For example, in many wetlands, including bogs and tidal marshes, much of the sediment pile is organic. Vascular plants in estuarine and riverine wetlands entrap suspended sediment. Plants reduce wave energies and decrease the velocity of water flowing through wetlands. Plant detritus is a main source of essential nutrients, while vascular plants and large patches of macroalgae function as habitat for wetland wildlife.

4.4.1 Metric 1: Plant Community

A. Definition: The Plant Community Metric is composed of three submetrics for each wetland type. Two of these sub-metrics, Number of Co-dominant Plants and Percent Invasion, are common to all wetland types. For all wetlands except Vernal Pools and Vernal Pool Systems, the Number of Plant Layers as defined for CRAM is also assessed. For Vernal Pools and Pool Systems, the Number of Plant layers submetric is replaced by the Endemic Species Richness submetric. A thorough reconnaissance of an AA is required to assess its condition using these submetrics. The assessment for each submetric is guided by a set of a set of rules (Figure 4.1) and the Plant Community Worksheets. The Plant Community metric is calculated based on these worksheets.

A "plant" is defined as an individual of any vascular macrophyte species of tree, shrub, herb/forb, or fern, whether submerged, floating, emergent, prostrate, decumbent, or erect, including non-native (exotic) plant species. Mosses and algae are not included among the species identified in the assessment of the plant community. For the purposes of CRAM, a plant "layer" is a stratum of vegetation indicated by a discreet canopy at a specified height that comprises at least 5% of the area of the AA *where the layer is expected.*

Non-native species owe their occurrence in California to the actions of people since shortly before Euroamerican contact. Many non-native species are now *naturalized* in California, and may be widespread in occurrence. "Invasive" species are non-native species that "(1) are not native to, yet can spread into, wildland ecosystems, and that also (2) displace native species, hybridize with native species, alter biological communities, or alter ecosystem processes" (CalIPC 2012). CRAM uses the California Invasive Plant Council (CalIPC) list to determine the invasive status of plants, *with augmentation by regional experts.*

B. Rationale: The functions of whole-wetland systems are optimized when a rich native flora dominates the plant community, and when the botanical structure of the wetland is complex in 3-dimensional space, due to species diversity and recruitment, and resulting in suitable habitat for multiple animal species. Much of the natural microbial, invertebrate, and vertebrate communities of wetlands are adjusted to the architectural forms, phenologies, detrital materials, and chemistry of the native vegetation. Furthermore, the physical form of wetlands is partly the result of interactions between plants and physical processes, especially hydrology. A sudden change in the dominant species, such as results from plant invasions, can have cascading effects on whole-system form, structure, and function.

The Plant Community Metric is assessed in terms of the similarity between the dominant species composition of the plant community and what is expected based on CRAM verification and validation studies, regional botanical surveys, and historical resources. This metric requires the ability to recognize the most common and abundant plants species of wetlands. When a CRAM field team lacks the necessary botanical expertise, photographs and/or voucher specimens will need to be collected using standard plant presses and site documentation. This can greatly increase the time required to complete a CRAM assessment.

C. Seasonality: This suite of metrics is ideally assessed during the latter third of the growing season, when all plant layers have developed to their full extent.

4.4.1.1 Submetric A: Number of Plant Layers Present

The first submetric of the Plant Community Metric is the Number of Plant Layers Present in the AA. This submetric does not pertain to Vernal Pools or Playas. Plant layers play a large role in the assessment of the biotic structure attribute. They are distinguished from one another by the differences in average maximum heights of their co-dominant plant species. To be counted in CRAM, a layer must cover at least 5% of *the portion of the AA that is suitable for the layer*. This would be the littoral zone of lakes and depressional wetlands for the one aquatic layer, called "floating." The "short," "medium," and "tall" layers might be found throughout the non-aquatic areas of each wetland class, except in areas of exposed bedrock, mudflat, beaches, active point bars, etc. The "very tall" layer is usually expected to occur along the backshore, except in forested wetlands.

It is essential that the layers be identified by the actual plant heights (i.e., the approximate maximum heights) of plant species in the AA, regardless of the growth potential of the species. For example, in a riverine system a young sapling redwood between 0.5 m and 1.5 m tall would belong to the "medium" layer, even though in the future the same individual redwood might belong to the "very tall" layer. Some species might belong to multiple plant layers. For example, groves of red alders of all different ages and heights might collectively represent all four non-aquatic layers in a riverine AA. Riparian vines, such as wild grape, might also dominate all of the non-aquatic layers.

Standing (upright) dead or senescent vegetation from the previous growing season can be used in addition to live vegetation to assess the number of plant layers present. However, the lengths of prostrate stems or shoots are disregarded. In other words, fallen vegetation should not be "held up" to determine the plant layer to which it belongs. The number of plant layers must be determined based on the way the vegetation presents itself in the field.

4.4.1.2 Submetric B: Number of Co-dominant Species

The second submetric, Number of Co-dominant Species, deals directly with dominant plant species richness in each plant layer and for the AA as a whole. For each plant layer in the AA, all species represented by living vegetation that comprises at least 10% relative cover within the layer are considered to be dominant. Only living vegetation in growth position is considered in this metric. Dead or senescent vegetation is disregarded.

The investigator lists the names of all co-dominant plant species in each layer. The list is used to determine the total number of co-dominant species for all the layers that are represented in the AA. Some species, such as wild grapes and poison oak, can dominate multiple layers. Even though such plants provide have functional differences between layers, they should only be counted once when calculating the Number of Co-dominant Species for the AA. No matter how many layers a given species dominates, it should only be counted once as a co-dominant.

4.4.1.3 Submetric C: Percent Invasion

For the third submetric, Percent Invasion, the number of invasive co-dominant species for all plant layers combined is assessed as a percentage of the total number of co-dominants, based on the results of the Number of Co-dominant Species sub-metric. The invasive status for many California wetland and riparian plant species is based on the Cal-IPC list. However, the best professional judgment of local experts may be used instead to determine whether or not a co-dominant species is invasive. If the status cannot be determined in the field, then a voucher specimen and field photographs of the plants in question should be used in conjunction with the Jepson Manual (Baldwin, et al. 2012) or in consultation with appropriate experts to determine invasive status.

4.4.1.4 Submetric C (vernal pools): Endemic Species Richness

This submetric only applies to Vernal Pools and Vernal Pool Systems. These wetlands are distinguished from all other wetland types by a unique endemic flora. This submetric is based on the total number of endemic plant species that appear in the AA as listed in the CRAM Vernal Pools Plant List.

4.4.2 Metric 2: Horizontal Interspersion

A. Definition: Horizontal biotic structure refers to the variety and interspersion of plant "zones." Plant zones are plant monocultures or obvious multi-species associations that are arrayed along gradients of elevation, moisture, or other environmental factors that seem to affect the plant community organization in plan view. Interspersion is essentially a measure of the number of distinct plant zones and the amount of edge between them.

B. Rationale: The existence of multiple horizontal plant zones indicates a well-developed plant community and predictable sedimentary and bio-chemical processes. The amount of interspersion among these plant zones is indicative of the spatial heterogeneity of these processes. Richer native communities of plants and animals tend to be associated with greater zonation and more interspersion of the plant zones.

C. Seasonality: This metric is not sensitive to seasonality.

4.4.3 Metric 3: Vertical Biotic Structure

A. Definition: The vertical component of biotic structure assesses the degree of overlap among plant layers. The same plant layers used to assess the Plant Community Composition metrics are used to assess Vertical Biotic Structure. To be counted in CRAM, a layer must cover at least 5% of the portion of the AA that is suitable for the layer. This metric does not pertain to Vernal Pools, Vernal Pool Systems, or Playas.

B. Rationale: The overall ecological diversity of a wetland tends to correlate with the vertical complexity of the wetland's vegetation. For many types of wetlands in California, overlapping layers of vegetation above or below the water surface contribute to vertical gradients in light and temperature that result in greater species diversity of macroinvertebrates, fishes, amphibians, and birds. In riparian areas, the species richness of birds and small mammals tends to increase with the density and number of well-developed, overlapping plant layers. Many species of birds that nest near the ground or water surface in wetlands commonly require a cover of vegetation at their nest sites. Multiple layers of vegetation also enhance hydrological functions, including rainfall interception, reduced evaporation from soils, and enhanced filtration of floodwaters.

In many depressional wetlands and some wet meadows, the detritus of above-ground growth of low and medium layers of herbaceous plants and emergent monocots tends to get entrained within the layers as an internal canopy below the maximum height of the upper plant layer. These "entrained canopies" serve as cover for many wildlife species.

In estuarine wetlands, the entrained canopies entrap debris including coarse plant litter that is lifted into the canopies by rising tides. As the tide goes out, the material is left hanging in the plant cover. Over time, these entrained canopies can gain enough density and thickness to provide important shelter for many species of birds and small mammals that inhabit estuarine wetlands. Most passerine birds and rails that nest in estuarine wetlands choose to nest below an entrained canopy because it protects them from avian predators, including owls and harriers.

C. Seasonality: This metric should be assessed late during the growing season.

CHAPTER 5:
GUIDELINES TO COMPLETE STRESSOR CHECKLISTS

A. Definition: For the purposes of CRAM, a stressor is an anthropogenic perturbation within a wetland or its setting that is likely to negatively impact the functional capacity of a CRAM Assessment Area (AA). In contrast, disturbances are distinctly defined as natural phenomena, although they might have similar impacts as stressors.

B. Rationale: Physical and biological processes connect wetlands to their environmental settings and thus help shape wetland conditions, which are therefore influenced by land use practices within the settings (Frissell *et al.* 1986, Roth *et al.* 1996, Scott *et al.* 2002). Wetland conditions can also be affected by stressors operating directly within the wetlands, although these tend to be less abundant than stressors originating in the surrounding landscape.

The purpose of the Stressor Checklist is to identify stressors within a CRAM Assessment Area (AA) or its immediate vicinity that might help account for any low CRAM scores. In some cases, a single stressor might be the primary cause for low-scoring conditions, but conditions are usually due to interactions among multiple stressors (USEPA 2002).

There are four underlying assumptions of the Stressor Checklist: (1) stressors can help explain CRAM scores; (2) wetland condition declines as the number of stressors acting on the wetland increases (there is no assumption that the decline is additive (linear), non-linear, or multiplicative); (3) increasing the intensity or the proximity of the stressor results in a greater decline in condition; and (4) continuous or chronic stress increases the decline in condition.

C. Seasonality: The Stressor Checklist is not sensitive to seasonality.

D. Office and Field Indicators: The process to identify stressors is the same for all wetland types. For each CRAM attribute, a variety of possible stressors are listed. Their presence and likelihood of significantly affecting the AA are recorded in the Stressor Checklist Worksheet. For the Hydrology, Physical Structure, and Biotic Structure attributes, the focus is on stressors operating within the AA or within 50 m of the AA. For the Buffer and Landscape Context attribute, the focus is on stressors operating within 500 m of the AA. More distant stressors that have obvious, direct, controlling influences on the AA can also be noted.

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APPENDIX I: GLOSSARY

aggradation – filling and raising of the level of the bed of a stream by deposition of sediment; the opposite of degradation

algal mat- macroalgae occurring on the water surface of a wetland.

allochthonous – external source of energy (carbon) for a stream (e.g., dead leaves, branches, and dead trees that fall into the river)

alluvial – refers to natural, channelized runoff from terrestrial terrain and the material borne or deposited by such runoff

anthropogenic – arising from human activity

aquatic area abundance- for the purposes of CRAM, a measure an aquatic area's spatial association with other areas of aquatic resources, such as other wetlands, lakes, streams, etc. For riverine systems, this metric is scored as the continuity of the riparian corridor over a prescribed distance upstream and downstream of the CRAM Assessment Area (AA).

arcuate- shaped or bent like an arc or bow (i.e. broadly curving)

assessment area – the portion of a wetland or riverine system that is the subject of the CRAM evaluation

assessment window – the period of time when assessments of wetland condition should be conducted. In general, it is during the growing season for the characteristic plant community of the wetland type to be assessed.

attribute – attributes constitute the obvious, universal aspects of wetland condition; CRAM recognizes a total of four attributes of condition within a wetland: (1) buffer and landscape context; (2) hydrology; (3) physical structure; and (4) biotic structure.

avulsion – sudden shift or movement of fluvial flow entirely or in part from one channel to another, less sinuous and steeper channel. Avulsions are typically formed during large storm events when high discharge erodes a new channel in the floodplain. Avulsions are more common in braided or aggrading stream channels.

backshore- the boundary between the wetland and the adjoining upland, where the upland is at least 5m wide. The high-water contour of the wetland is a good proxy for its backshore boundary.

bankfull – height of fluvial flow corresponding to the floodplain. This is the stage when water in the channel just begins to flow onto the floodplain.

bank slump- a portion of a bank that has broken free from the rest of the bank but has not eroded away

bar – a transient sedimentary feature within an intertidal and fluvial channel that is often exposed during low-water periods. Bars direct flows and form along the inside of a meander bend (point-bar) or in the middle of straight channel reach (in-channel bar). They are convex in profile and are comprised of alluvial or tidal deposits of sand, gravel, cobble, or other material. Their surface material varies in size from small on top to larger along their lower margins and they sometimes support vegetation.

barrier beach – a natural area of sand or gravel along a lacustrine, marine or estuarine shore that blocks the landward action of tides or waves

benthic – pertaining to the sea bed, river bed, or lake floor

berm- A flat strip of land, raised bank, or terrace bordering a wetland. Berms can be natural or artificial in origin.

borrow ditch-a ditch dug along a roadway to furnish fill and provide drainage

boulder- a size category of rock having a long axis greater than 25 cm

braided – a stream that forms an interlacing network of branching and recombining channels separated by floodplains, channel bars, or islands

buffer – for the purposes of CRAM, the area extending from the immediate edge of the AA that is in a natural, or semi-natural, state and protects the AA from stressors

catchment – synonymous with watershed. An area of land, bounded by a drainage divide, which drains to a fluvial channel or water body.

channel- a feature in tidal and fluvial systems consisting of a bed, its opposing banks, plus its floodplain, that confines and conveys surface water flow. The system of diverging and converging channels that characterize braided and anastomosing fluvial systems usually consist of one or more main (primary) channels plus secondary channels.

channel stability- a measure of the degree of channel aggradation (i.e. net accumulation of sediment on the channel bed causing it to rise over time) or degradation (i.e. net loss of sediment from the bed causing it to be lower over time).

coarse woody debris- a single piece of woody material, greater than 30 cm in diameter and greater than 3 m long

cobble-a size category of rock having a long axis from about 6 cm to about 25 cm

condition – condition is defined as the ability of a wetland to maintain its complexity and capacity for self-organization with respect to species composition, physio-chemical characteristics, and functional processes, relative to healthy wetlands of the same type. There are three primary aspects of condition: location, form, and structure.

confinement – the degree to which levee, terraces, or hillsides prevent the lateral migration of a fluvial channel

crenulated- having a margin that is very finely indented, notched, or with rounded (scalloped), projections, as in a crenulated foreshore of a wetland.

culvert- a drain or covered channel that crosses under a road, railway, etc.

debris jam – an accumulation of material, organic or inorganic, floating or submerged, that has been lodged into place by the action of a flowing water. Debris jams partially or completely obstruct surface water flow and sediment causing a change in the course of flow.

deciduous – plants (trees and shrubs) that shed all of their leaves annually, such that there is a time each year at which individuals of the species are essentially devoid of leaves

deposition – the settlement of materials out of moving water and onto the bed, banks, or floodplain of a wetland or riverine channel.

degradation – the long-term lowering of a fluvial channel due to erosion of its bed

detritus – deposition of newly dead or decaying organic matter

disturbance – the consequence of natural changes in forcing functions, or controlling factors, through space and over time; disturbance is natural, regardless of its frequency, persistence, or magnitude

drop structure- an artificial structure, typically small and built on streams with steep gradients, to pass water to a lower elevation while controlling the energy and velocity of the water as it passes over.

dryland farming-a system of growing crops in arid or semiarid regions without artificial irrigation, by reducing evaporation and by special methods of tillage.

duff – a spongy layer of decaying leaves, branches, and other organic materials along a wetland shore or in a riverine riparian area

ecological services – the services, or beneficial uses, for which a wetland can be managed; key ecological services for many types of wetland include flood control, groundwater recharge, water filtration, conservation of cultural values, aesthetics, and the support of special-status species.

emergent vegetation - plant species typically growing on saturated soils or on soils covered with water for most of the growing season; the leaves of emergent aquatic species are partly or entirely borne above the water surface; examples of such species include *Rorippa nasturtium-aquaticum* (watercress) and *Schoeneoplectus californicus* (tule, bulrush).

entrenchment – the inability of flows in a channel to exceed the channel banks (i.e. the vertical containment of stream); a measure of the degree to which fluvial flood flows are contained within channel banks without access to the effective valley. Entrenchment as a field measurement is calculated as the flood-prone width divided by the bankfull width.

effective valley width – the portion of a valley within which its fluvial channel is able to migrate without cutting into hill slopes, terraces, man-made levees, etc.

floodplain – the bench or broader flat area of a fluvial channel that corresponds to the height of the bankfull flow. It is a relatively flat depositional area that is periodically flooded, as evidenced by deposits of fine sediment, wrack lines, vertical zonation of plant communities, etc.

flood prone - land susceptible to inundation by extreme flood events. The height of the flood prone area approximately corresponds to twice bankfull height.

fluvial – of, relating to, or happening in, a river or stream

forb – a plant with a soft, rather than permanent, woody stem that is not a grass or grass-like

foreshore- the boundary between the vegetated wetland and any adjoining semi-aquatic, non-wetland area, such as an intertidal flat or a non-vegetated riverine channel bar, or a fully aquatic area such as the open water area of a lake or estuary that is at least 30m wide.

free-floating – plants that float at or just beneath the water surface without attachment to the substrate; free-floating aquatic species are transported freely by wind and water currents

function – for the purposes of Level 2 assessment, a function is something that a wetland stream or riparian area does. For example, groundwater recharge, flood-stage desynchronization, pollution filtration, wildlife support, and recreation are wetland functions. In this context, functions are identified separately from the processes that cause them to happen. In most cases, Level 3 tools are needed to assess the processes that account for functions.

herbaceous – a plant having stems that are not secondarily thickened and that die down annually

headcut- an erosional feature of some streams where an abrupt vertical drop in the stream bed occurs. The process of headcutting involves the initiation of channel incision at a nick point as the stream channel bed elevation adjusts to a natural or human induced disturbance. In flowing streams, head cuts resemble a small waterfall. A small plunge pool may be present

at the base of the head cut due to the high energy of falling water. When not flowing, the head cut will resemble a very short cliff or bluff in the stream channel.

hummock – a mound composed of organic materials (typically less than 1m high) along the banks and floodplains of fluvial systems created by the collection of sediment and biotic material around wetland plants such as sedges.

hydrologic connectivity- a measure of the ability of water to flow into or out of the wetland, or to accommodate rising flood waters without persistent changes in water level that can result in stress to wetland plants and animals

hydroperiod- the characteristic frequency and duration of inundation or saturation of a wetland during a typical year

hyporheic – saturated zone under a river or stream, comprising substrate with the interstices filled with water

knick point – an abrupt change of gradient in the profile of a stream or river, typically due to a change in the rate of erosion. This is the point where the stream is actively eroding the streambed to a new base level; nick points tend to migrate upstream. See definition for *headcut*.

in-channel bar- a transient sedimentary feature within an intertidal or fluvial channel that forms in the middle of straight channel reach.

interfluve – the region of higher land between two fluvial channels or swales on a floodplain or in a braided channel system

interspersion-a measure of the number of distinct patches (as in plant zones) and the amount of edge between them.

invasive – species that have been introduced from other regions by the actions of people and that exhibit a tendency to significantly displace native species, hybridize with native species, alter biological communities, or alter ecosystem processes.

litter- a layer of organic matter (partly decomposed leaves, twigs, etc) on the ground.

littoral zone – the nearshore area of a water body, where it is sufficiently shallow to allow light to penetrate to the bottom and reach rooted vegetation; corresponds with the limit of submerged aquatic vegetation

meander – the curves of a fluvial or tidal channel as viewed from above; a meander cutoff is a new, shorter channel across the narrow neck of a meander

metric – a measurable component of a CRAM attribute

muted- pertaining to an estuarine tidal regime in which the fluctuation of the water level is lower in amplitude than would be expected due to levees, culverts, tide gates, or other artificial devices which inhibit the exchange of water between the site and the tidal body. These obstructions reduce the range of tides but still allow frequent inundation and exposure.

natural levee – a low ridge landward of the active floodplain of a channel that forms by deposition during flood events.

nonpoint source discharge- any discharge to a wetland resulting from diffuse sources (e.g. land runoff, precipitation, atmospheric deposition, drainage, seepage, or hydrologic modification). Includes any type of discharge that does not meet the legal definition of "point source" (see definition below)

organic – pertaining to, or derived from, living organisms, or to compounds containing carbon as an essential component

panne – a shallow topographic basin that forms on a fluvial floodplain or tidal marsh plain. Pannes lack vegetation but exist on a well-vegetated wetland plain and fill with water at least seasonally due to overland flow.

patch – a spatially distinct structural element of a wetland system large enough to serve as habitat for wildlife, or to serve as an indicator of spatial variations in hydrological or edaphic (soil) conditions within a wetland

planar bed- a reach of a stream characterized by long, relatively straight channel of uniform depth

periphyton – benthic algae that grow attached to surfaces such as rocks or larger plants

point-bar- a transient sedimentary feature within an intertidal and fluvial channel that form along the inside of a meander bend

point-source discharge- any discernible confined and discrete conveyance (e.g. a pipe, ditch, channel, or conduit) from which pollutants are or may be discharged into a waterway. This term does not include agricultural storm water discharges and return flows from irrigated agriculture.

pool (on floodplain)- a shallow topographic basin on a fluvial floodplain or tidal marsh plain that has been inundated by water.

pool (in channel)- a depression within a fluvial or tidal channel that is much deeper than the average depth of the channel. Pools tend to retain water longer than other areas of the channel during periods of low or no surface flow.

POTW-publicly-owned treatment work; a term used in the United States for a sewage treatment plant that is owned, and usually operated, by a local government agency. They are usually designed to treat domestic sewage and not industrial wastewater.

primary channel-a channel in fluvial and tidal systems that conveys the majority of the surface water flow

rating – for a CRAM metric, a rating represents its state relative to the full range of possible states, from worst possible state to best

reach – a length of stream, lacustrine shore, or estuarine shore that has generally consistent physical and biological characteristics

riffle or rapid – a submerged, topographical high area in a fluvial channel created by the accumulation of relatively coarse-grained sediment (gravel, cobble, or boulders) causing turbulent surface flow and indicated by standing waves

riparian – a transitional area between terrestrial and aquatic ecosystems, distinguished by gradients in biophysical conditions, ecological processes and biota; areas through which surface and subsurface hydrology connect water bodies with their adjacent uplands, including those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems; riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes and estuarine-marine shorelines (National Research Council 2002).

riprap- broken stones loosely deposited in water or on a soft bottom to provide a foundation and protect a riverbed or river banks from scour: used for revetments, embankments, breakwaters, etc.

run – a reach of straight, smooth, fast-moving fluvial flow between riffles; also called a glide

scour – concentrated erosive action of flowing water in streams that removes and carries away material from the bed and banks

secondary channel-a channel in fluvial and tidal systems that conveys flood flows, but not the majority of the flow

sediment – organic or inorganic material that has been transported and/or deposited by wind or water action. Sediment can be coarse (i.e., gravel or larger) or fine (i.e. clay, silt, sand). A fresh splay of sediment is one that has been deposited during the current or previous season's runoff event.

sediment mound- a depositional feature (typically less than 1m high) along the banks and floodplains of fluvial systems formed from repeated flood flows depositing sediment on the floodplain. Sediment mounds lack plant cover.

slough – a large tidal channel, or a large fluvial channel lacking an obvious terminal water body, can also refer to an abandoned fluvial channel within the effective valley

snag – a standing, dead tree or shrub at least 3 m (10 feet) tall

sorting-a measure of the spread of particle size in the substrate. Well-sorted particles are made up of similarly sized particles. Poorly sorted particles are made up of a wide variety of different particle sizes.

stress – the consequence of unnatural, anthropogenic changes in forcing functions or controlling factors; key stressors are anthropogenic actions that tend to modify the quantity and/or quality of physical or biological habitat, sediment supplies, and/or water supplies upon which the desired functions of the wetland depend

stressor – an agent that inflicts stress on a wetland

submerged or submergent vegetation - plant species that are adapted to spending their lifespan, from germination to fruiting, completely or nearly completely under water. Submerged vegetation consists of aquatic macrophytes such as *Elodea canadensis* (common elodea)*, Ruppia cirrhosa* (ditchgrass), and *Zannichellia palustris* (horned pondweed) that are rooted in the sub-aqueous substrate but do not usually grow high enough in the overlying water column to intercept the water surface.

swale –broad, elongated, vegetated, shallow depressions that can sometimes help to convey flood flows to and from vegetated marsh plains or floodplains. However, they lack obvious banks, regularly spaced deeps and shallows, or other characteristics of channels. Swales can entrap water after flood flows recede. They can act as localized recharge zones and they can sometimes receive emergent groundwater.

thalweg – the line connecting the lowest or deepest points along the riverbed

thatch- a matted layer of partly decayed leaves, stems, etc. between growing vegetation and the soil.

tide gate- an opening through which water may flow freely when the tide sets in one direction, but which closes automatically and prevents the water from flowing in the other direction.

transportation corridor- a linear pathway for a particular mode of transportation (highway, road, rail, canal, etc.)

tributary- a type of secondary channel that originates in the wetland and only conveys flow between the wetland and the primary channel. Short tributaries that are entirely contained within the CRAM Assessment Area (AA) are regarded as secondary channels.

undercutting- the removal of material at the base of a streambank or shoreline of a wetland by the erosive action of flowing water

unnatural levee- an artificially raised embankment along a wetland that constrains water flows. Their primary purpose is to provide hurricane, storm, and flood protection relating to seasonal high water, storm surges, precipitation, and other weather events.

variegated- having variety in form. As viewed from above, a variegated shoreline resembles a meandering pathway. Variegated shorelines provide greater contact between water and land.

island- an area of land above the usual high water level and, at least at times, surrounded by water. Islands differ from hummocks and other mounds by being large enough to support trees or large shrubs.

vegetation management-the practice of manipulating vegetation within a prescribed management area. Includes prescribed burning, grazing, chemical applications, timber harvesting, and any other economically feasible methods of enhancing, retarding, or removing the above-ground parts of plants.

wetlands – lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water; wetlands must have one or more of the following attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardin *et al.* 1979).

wier- a small overflow barrier used to alter the flow characteristics of a river or stream. Weirs are commonly used to prevent flooding, measure discharge, and to help render a river navigable.

wrack or wrackline – an accumulation of natural floating debris (kelp, plastic debris, wood, and similar material) left along the shore of a river, lake, tidal marsh, or other water body by high water levels

xeric – characterized by an extremely dry habitat

zonation – distribution of plants or animals arranged in zones or bands, caused by gradations of abiotic and/or biotic factors

APPENDIX II: ACRONYM LIST

AA	Assessment Area
Cal-IPC	California Invasive Plant Council
CDFW	California Department of Fish and Wildlife
CEDEN	California Environmental Data Exchange Network
CNDDB	California Natural Diversity Database
CRAM	California Rapid Assessment Method for Wetlands
CWMW	California Wetland Monitoring Workgroup
DOQQ	Digital Orthogonal Quarterly Quadrangles
eCRAM	A web-based data submission tool for CRAM
GIS	Geographic Information System
HEP	Habitat Evaluation Procedure
HGM	Hydrogeomorphic Functional Assessment Method
IBI	Index of Biotic Integrity
JD	Jurisdictional Delineation
NAIP	National Agriculture Imagery Program
NGO	Non-governmental Organization
NHD	National Hydrography Dataset
NRC	National Research Council
NWI	National Wetlands Inventory
ORAM	Ohio Rapid Assessment Method
PI	Principal Investigator
PSR	Pressure-State-Response Model
QA/QC	Quality Assurance/Quality Control
RDC	Regional Data Center
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WADOE	Washington State Department of Ecology

WRAMP	Wetland and Riparian Area Monitoring Plan
WRAP	Wetland Rapid Assessment Procedure
WRAPP	Wetland and Riparian Area Protection Policy