Santa Ana River Watershed Bacteria Monitoring Program

Quality Assurance Project Plan

Prepared by

CDM Smith

On Behalf of
Santa Ana Watershed Project Authority

Version 1.0

June 2017

CDM Smith

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Group A: Project Management

1. Title and Approval Sheet

Table 1-1. Quality Assurance Project Plan (QAPP) approval sheet (Table 1-1 shall be updated as needed to remain current**)**

Role[1]	Position[2]	Agency/Entity[3]	Name	Signature	Date
Monitoring Plan & QAPP Regulatory Oversight	Project Director	Santa Ana Watershed Project Authority	Rick Whetsel		
Monitoring Plan & QAPP Regulatory Oversight	Project Manager	Santa Ana Regional Water Quality Control Board	Ken Theisen		
Monitoring Plan & QAPP Regulatory Oversight	QA Officer	State Water Resources Control Board	Renee Spears		
Responsible Agency	Project Manager/ Project QA Officer	Agriculture/Dairy Representative	Pat Boldt		
Responsible Agency	Project Manager	City of Claremont	Loretta Mustafa		
Responsible Agency	Project QA Officer	City of Claremont	Kimberly Colbert		
Responsible Agency	Project Manager	City of Pomona	Julie Carver		
Responsible Agency	Project QA Officer	City of Pomona	Rae Beimer		
Responsible Agency	Project Manager	Orange County Watersheds (Orange County Public Works)	Jian Peng		
Responsible Agency	Project QA Officer	Orange County Watersheds (Orange County Public Works)	Kurt Zach		
Responsible Agency	Project Manager/ Project QA Officer	Riverside County Flood Control & Water Conservation District	Stuart McKibbin		

Table 1-1. Quality Assurance Project Plan (QAPP) approval sheet (Table 1-1 shall be updated as needed to remain current**)**

Role[1]	Position[2]	Agency/Entity[3]	Name	Signature	Date
Responsible Agency	Project Manager/ Project QA Officer	San Bernardino County Flood Control District	Arlene Chun		
Responsible Agency (Designee)	Project Manager	CDM Smith	Richard Meyerhoff		
Responsible Agency (Designee)	Project QA Officer	CDM Smith	Barbara Wells		
Responsible Agency (Designee)	Project Manager	CWE	Vik Bapna		
Responsible Agency (Designee)	Project QA Officer	CWE	Cindy Rivers		
Contract Laboratory	Laboratory Manager/Director/ QA Officer	Orange County Public Health Laboratory	Joseph Guzman		
Contract Laboratory	Laboratory Manager/Director	Orange County Water District	Donald Phipps		
Contract Laboratory	Laboratory QA Officer	Orange County Water District	Menu Leddy		
Contract Laboratory	Laboratory Manager/Director	Enthalpy Analytical	Cam Pham		
Contract Laboratory	Laboratory QA Officer	Enthalpy Analytical	Cliff Baldridge		
Contract Laboratory	Laboratory Manager/Director	Weck Laboratories	Kim Tu		
Contract Laboratory	Laboratory QA Officer	Weck Laboratories	Alan Ching		
Contract Laboratory	Laboratory Manager/Director	Weston Solutions Laboratory	Alex Schriewer		

Table 1-1. Quality Assurance Project Plan (QAPP) approval sheet (Table 1-1 shall be updated as needed to remain current**)**

Role[1]	Position[2]	Agency/Entity[3]	Name	Signature	Date
Contract Laboratory	Laboratory QA Officer	Weston Solutions Laboratory	Satomi Yonemasu		
Contract Laboratory	Laboratory Manager/Director	Babcock Laboratories, Inc.	Amanda Porter		
Contract Laboratory	Laboratory QA Officer	Babcock Laboratories, Inc.	Stacey Fry		
Contract Laboratory	Laboratory Manager/Director	Clinical Laboratory of San Bernardino, Inc.	Bob Glaubig		
Contract Laboratory	Laboratory QA Officer	Clinical Laboratory of San Bernardino, Inc.	Roberto Cabrera		
Contract Laboratory	Laboratory Manager/Director	Source Molecular	Mauricio Larenas		
Contract Laboratory	Laboratory QA Officer	Source Molecular	Tania Madi		

[1] **Role**: Monitoring Plan & QAPP Regulatory Oversight; Responsible Agency (or designee); or Contract Laboratory

[2] **Position**: For example, Project Director, Santa Ana Water Board, Project Manager, Project QA Officer, Monitoring Manager, Data Manager, Sampling Personnel, Laboratory Personnel

[3] **Agency/Entity**: Name of the organization where the signatory is employed

[4] **Title**: Job title within the organization that the signatory is employed

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F. Enthalpy Analytical (formerly Associated Laboratories), Standard Operating Procedures
G. Weston Solutions Laboratory, Standard Operating Procedures
H. Source Molecular, Standard Operating Procedures

Acronym List

AgSEP	Agricultural Source Evaluation Plan
AgSEMP	Agricultural Source Evaluation Monitoring Program
Basin Plan	Water Quality Control Plan for the Santa Ana River Basin
BASMP	Bacteria Indicator Agriculture Source Evaluation Plan
BMP	best management practice
BPA	Basin Plan amendment
°C	degrees Celsius
CBRP	Comprehensive Bacteria Reduction Plan
CEDEN	California Environmental Data Exchange Network
cfs	cubic feet per second
cfu	colony forming unit
COC	chain of custody
DPD	N,N-Diethylparaphenylenediamine
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency
ft	feet
Los Angeles Water Board	Los Angeles Regional Water Quality Control Board
MBAS	Methylene blue active substances
mL	milliliters
mg/L	Milligram/liter
mg/mL	milligrams/milliliter
MP	Monitoring Plan
MPN	most probable number
mS/cm	millisiemens/centimeter
MS4	Municipal Separate Storm Sewer System
MSAR	Middle Santa Ana River
MSAR Bacteria TMDL	MSAR Bacterial Indicator TMDL
MSAR TMDL Task Force	MSAR Watershed TMDL Task Force
NTU	Nephelometric Turbidity Unit
OCC	Orange County Coastkeeper
OCWD	Orange County Water District
PPE	Personal protection equipment
Project ID	Project Identification Number
Q	flow
QA	quality assurance
QA/QC	quality assurance/quality control

QAPP	Quality Assurance Project Plan
qPCR	
REC1	water contact recreation
REC2	non-contact water recreation
RMP	Regional Monitoring Program
Sample ID	Sample Identification Number
SAR Bacteria Monitoring Plan	Santa Ana River Watershed Bacteria Monitoring Plan
SAR Bacteria Monitoring Program	Santa Ana River Watershed Bacteria Monitoring Program
Santa Ana Water Board	Santa Ana Regional Water Quality Control Board
SAR	Santa Ana River
SAWPA	Santa Ana Watershed Protection Authority
Site ID	Site Identification Number
SM	Standard Method
State Water Board	State Water Resources Control Board
SWAMP	Surface Water Ambient Monitoring Program
t	Time (seconds)
TMDL	Total Maximum Daily Load
TSS	total suspended solids
UAA	use attainability analysis
USEP	Urban Source Evaluation Plan

3. Distribution List

Table 3-1 identifies the entities that shall receive a copy of a final approved QAPP. These same entities shall participate in revisions to this document. It will be up to each entity or agency to distribute copies of the QAPP within their organizations, where needed.

Table 3-1. QAPP distribution list[1]

Role	Entity/Agency	Position	Contact Name, Tel. No., Email	QAPP Code
Monitoring Plan & QAPP Oversight	Santa Ana Watershed Project Authority (SAWPA)	Project Director	Rick Whetsel, 951-354-4222, rwhetsel@sawpa.org	SAR BACT Monitoring
	Santa Ana Regional Water Quality Control Board (Santa Ana Water Board)	Project Manager	Ken Theisen, 951-320-2028, ktheisen@waterboards.ca.gov	SAR BACT Monitoring
	State Water Resources Control Board	QA Officer	Renee Spears, 916-341-5583, renee.spears@waterboards.ca.gov	SAR BACT Monitoring
Responsible Agencies or Designee	Agriculture/Dairy Representative	Project Manager	Pat Boldt, 951-808-8631, mpboldt@aol.com	SAR BACT Monitoring
		Project QA Officer		SAR BACT Monitoring
	City of Claremont	Project Manager	Loretta Mustafa, 909-399-5475, lmustafa@ci.claremont.ca.us	SAR BACT Monitoring
		Project QA Officer	Kimberly Colbert, 310-729-8031, Kimberly@ColbertGroup.com	SAR BACT Monitoring
	City of Pomona	Project Manager	Julie Carver, 909-620-3628, Julie_carver@ci.pomona.ca.us	SAR BACT Monitoring
		Project QA Officer	Rae Beimer, 714-788-6936, raebeimer@caaprofessionals.com	SAR BACT Monitoring
	Orange County Watersheds (Orange County Public Works)	Project Manager[2]	Jian Peng, 714-955-0650, jian.peng@ocpw.ocgov.com	SAR BACT Monitoring
		Project QA Officer	Kurt Zach, 714-955-0681, kurt.zach@ocpw.ocgov.com	SAR BACT Monitoring
	Riverside County Flood Control & Water Conservation District	Project Manager[2]	Stuart McKibbin, 951-955-1273, smckibbi@rcflood.org	SAR BACT Monitoring
		Project QA Officer		SAR BACT Monitoring
	San Bernardino County Flood Control District	Project Manager[2]	Arlene Chun, 909-387-8109, arlene.chun@dpw.sbcounty.gov	SAR BACT Monitoring
		Project QA Officer		SAR BACT Monitoring
	CDM Smith (Designee)	Project Manager[2]	Richard Meyerhoff, 303-345-3083, meyerhoffrd@cdmsmith.com	SAR BACT Monitoring
		Project QA Officer	Barbara Wells, 816-412-3112, wellsbl@cdmsmith.com	SAR BACT Monitoring
	CWE (Designee)	Project Manager[2]	Vik Bapna, 714-526-7500, VBapna@cwecorp.com	SAR BACT Monitoring
		Project QA Officer	Cindy Rivers, 714-526-7500, CRivers@cwecorp.com	SAR BACT Monitoring
Contract Laboratory	Orange County Public Health Laboratory	Laboratory Manager/Director[3]	Joseph Guzman, 949-219-0424, jguzman@ocha.com	SAR BACT Monitoring
		Laboratory QA Officer		SAR BACT Monitoring

Table 3-1. QAPP distribution list[1]

Role	Entity/Agency	Position	Contact Name, Tel. No., Email	QAPP Code
	Orange County Water District	Laboratory Manager/Director[3]	Donald Phipps, 714-378-3200, dphipps@ocwd.com	SAR BACT Monitoring
		Laboratory QA Officer	Menu Leddy, 714-378-3313, mleddy@ocwd.com	SAR BACT Monitoring
	Enthalpy Analytical (formerly Associated Laboratories)	Laboratory Manager/Director[3]	Cam Pham, 714-771-6900, cam.pham@enthalpy.com	SAR BACT Monitoring
		Laboratory QA Officer	Cliff Baldridge, 714-771-6900, cliff.badridge@enthalpy.com	SAR BACT Monitoring
Contract Laboratory	Weck Laboratories, Inc.	Laboratory Manager/Director[3]	Kim Tu, 626-336-2139 x118, *Kim.Tu@wecklabs.com*	SAR BACT Monitoring
		Laboratory QA Officer	Alan Ching, 626-336-2139 x116, *Alan.Ching@wecklabs.com*	SAR BACT Monitoring
	Weston Solutions Laboratory	Laboratory Manager/Director[3]	Alex Schriewer, 760-795-6957, Alexander.Schriewer@WestonSolutions.com	SAR BACT Monitoring
		Laboratory QA Officer	Satomi Yonemasu, 760-795-6900, satomi.yonemasu@westonsolutions.com	SAR BACT Monitoring
	Babcock Laboratories, Inc.	Laboratory Manager/Director[3]	Amanda Porter, 951-653-3351, x249, aporter@babcocklabs.com	SAR BACT Monitoring
		Laboratory QA Officer	Stacey Fry, 951-653-3351, sfry@babcocklabs.com	SAR BACT Monitoring
	Clinical Laboratory of San Bernardino, Inc.	Laboratory Manager/Director[3]	Bob Glaubig, 909-825-7693, glaubig@clinical-lab.com	SAR BACT Monitoring
		Laboratory QA Officer	Roberto Cabrera, 909-825-7693, cabrera@clinical-lab.com	SAR BACT Monitoring
	Source Molecular	Laboratory Manager/Director[3]	Mauricio Larenas, 786-416-6010, mlarenas@sourcemolecular.com	SAR BACT Monitoring
		Laboratory QA Officer	Tania Madi, 786-220-0379, tmadi@sourcemolecular.com	SAR BACT Monitoring

[1] Table information will be periodically reviewed and updated to reflect program changes.
[2] Project Manager or Project QA Officer within a Responsible Agency or its designee is responsible for distributing QAPP to other project participants including the Monitoring and Data Managers and Sampling Personnel (see Figure 4-1).
[3] Laboratory Manager is responsible for ensuring laboratory staff are provided a copy of the QAPP.

4. Project/Task Organization

4.1 Overview

Figure 4-1 provides the organizational structure for implementation of the Santa Ana River (SAR) Watershed Bacteria Monitoring Program ("SAR Bacteria Monitoring Program"). The SAR Watershed Bacteria Monitoring Plan ("SAR Bacteria Monitoring Plan") will be implemented by a number of Responsible Agencies under the direction of a Project Director and the Santa Ana Water Board, which provide oversight of the SAR Bacteria Monitoring Plan and QAPP. Within each Responsible Agency specific positions are shown; however, each agency may combine positions if more efficient for implementation.

Figure 4-1 illustrates the organizational structure for implementation of the SAR Bacteria Monitoring Program. The following subsections describe the responsibilities associated with various roles and positions shown in Figure 4-1. While the Project Director and Responsible Agencies are ultimately responsible for collection of water quality data and preparation of annual reports to fulfill the requirements of the SAR Bacteria Monitoring Plan and QAPP, some of the specific roles and responsibilities described below may be fulfilled through the use of contractors.

4.2 Monitoring Plan and QAPP Oversight

Two positions have been established to provide oversight to implementation of the SAR Bacteria Monitoring Plan and QAPP.

4.2.1 Project Director

The Project Director for the SAR Bacteria Monitoring Program is SAWPA. Table 4-1 summarizes Project Director's overall responsibilities. While SAWPA will manage the overall program, SAWPA may contract portions of the work assigned to the Project Director position, e.g., preparation of the Annual Report.

4.2.2 Santa Ana Water Board

The Santa Ana Water Board is responsible for providing regulatory guidance for the implementation of the SAR Bacteria Monitoring Program. Specifically, the Santa Ana Water Board shall provide guidance to the parties implementing the SAR Bacteria Monitoring Plan and QAPP with regards to the requirements of the 2012 adoption of the Basin Plan Amendment (BPA) to *Revise Recreation Standards for Inland Freshwaters in the Santa Ana Region* (see Section 5 additional information). Accordingly, the Santa Ana Water Board has a Project Manager assigned to oversee implementation and that Project Manager will work with the State Water Resources Control Board's (State Water Board) QA Officer to ensure the program, as described, is consistent with California Surface Water Ambient Monitoring Program (SWAMP) requirements.

Following approval of the SAR Bacteria Monitoring Plan and QAPP, the Santa Ana Water Board Project Manager and QA Officer shall be responsible for approvals of subsequent modifications to the SAR Bacteria Monitoring Plan and/or QAPP. The process for modifications of these documents is discussed in Section 1.4 of the SAR Bacteria Monitoring Plan.

4.3 Responsible Agency

For the purposes of this QAPP a Responsible Agency is an agency that is responsible for the collection of water quality data from at least one priority monitoring site and/or collection of water quality data to fulfill additional monitoring requirements established by a Total Maximum Daily Load (TMDL). Implementation of the SAR Bacteria Monitoring Plan and QAPP shall be completed by the following Responsible Agencies:

- Agricultural/Dairy Representative
- City of Claremont
- City of Pomona
- Orange County Watersheds (Orange County Public Works)
- Riverside County Flood Control and Water Conservation District
- San Bernardino County Flood Control District
- Others, as needed[1]

For the purposes of this QAPP, Table 4-2 identifies the Responsible Agencies for implementation of water quality data collection at Regional Monitoring Program (RMP) priority monitoring sites and water quality data collection to fulfill additional TMDL monitoring requirements. It should be noted that two priority one sites (SAR at MWD Crossing and SAR at Pedley Avenue) and three priority two sites (Mill-Creek [Prado Area], Chino Creek at Central Avenue and Prado Park Lake) are shown as the responsibility of multiple entities. The Responsible Agencies for these sites will work collaboratively with the Project Director to determine final responsibility for collection of samples from these sites (e.g., by one of the Responsible Agencies, the Project Director, or a designated contractor) and establish any necessary cost-sharing agreements.

Within each Responsible Agency, five key positions have been identified to fulfill the requirements of the SAR Bacteria Monitoring Plan: Project Manager, Project QA Officer, Monitoring Manager, Data Manager and Sampling Personnel. Table 4-1 describes the duties assigned to each of the positions identified within each Responsible Agency. Where appropriate, a Responsible Agency may choose to combine two or more positions into a single position, e.g., combining Data Manager and Monitoring Manager activities. The Project QA Officer within each Responsible Agency shall ensure that the Quality Assurance and Quality Control (QA/QC) procedures contained herein are implemented as required within their area of responsibility.

Table 3-1 identifies the key roles and positions within each of the Responsible Agencies and the contact information for that position.

[1] Two monitoring sites in Orange County are surrounded by private or state lands. The agency that will be responsible for sampling these sites is still being determined.

4.4 Contract Laboratory

The Responsible Agencies shall select contract laboratories that have the capabilities to meet the requirements of this QAPP. Table 4-1 describes the responsibilities of each contract laboratory. The Laboratory Manager of each contract laboratory will be responsible for ensuring that Laboratory Personnel implement the requirements of this QAPP.

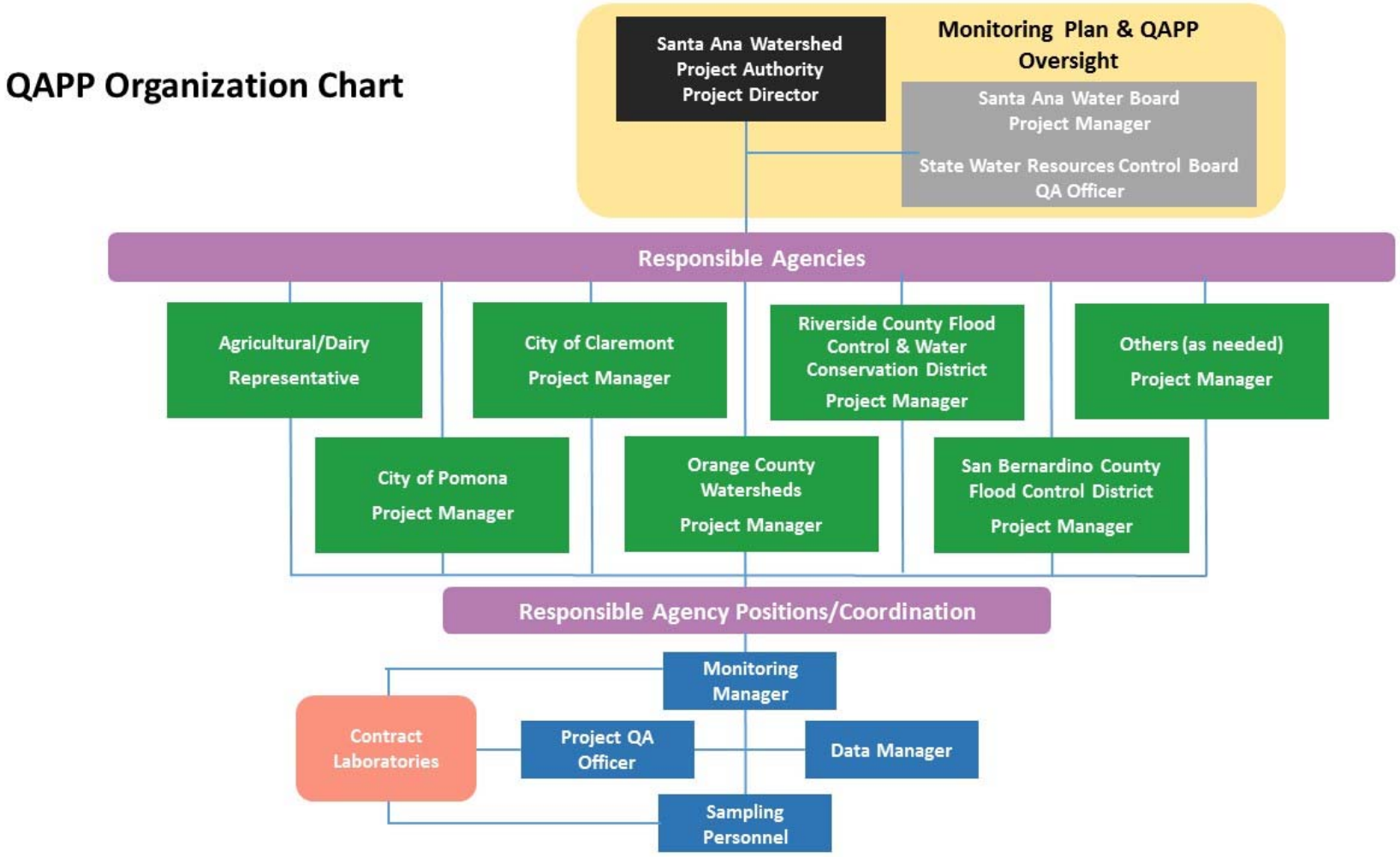

Figure 4-1. SAR Bacteria Monitoring Program organization chart

Table 4-1. Key positions & primary responsibilities for implementation of SAR Bacteria Monitoring Program

Position	Primary Responsibilities
Project Director	• Coordinate with Responsible Agencies to ensure that all monitoring sites shown in Table 4-2 are sampled annually as required by the Monitoring Plan and QAPP • Administration o Annual budget development and management o Establish/manage agreements/contracts, including cost share agreements where needed, taking into account which Responsible Agencies are collecting samples and where monitoring contracts need to be established o Coordination/communication with Regional Board, Counties, stakeholders • Reporting o Obtain all information/data results needed to prepare Annual Report o Complete data analyses as required o Prepare Annual Report; oversee review and revision process o Address data/information requests • Data Management o Provide database/spreadsheet template to Responsible Agencies for data entry during a sample year o Receive data transfers from Responsible Agencies o Conduct final data QA/QC o Annually upload dataset from previous sample year to California Environmental Data Exchange Network (CEDEN) • Oversee updates to the SAR Bacteria Monitoring Plan and QAPP, when required, and ensure appropriate approvals are obtained by Santa Ana Water Board
Santa Ana Water Board	• Provide guidance to the Project Manager and program management regarding the implementation of the SAR Bacteria Monitoring Plan and QAPP and the requirements set forth in the BPA to *Revise Recreation Standards for Inland Freshwaters in the Santa Ana Region* (approved by USEPA 2015) • Provide guidance to the Project Manager and program management with regards to California SWAMP requirements • Review and approval of revisions to originally approved SAR Bacteria Monitoring Plan and QAPP
Responsible Agency Project Manager	• Overall program management responsibility for the Responsible Agency • Coordinate with Project Director • Manage work of key positions within the Responsible Agency - either with in-house personnel or a contractor • Establish/manage contracts, as needed, to support monitoring activities • Invoice payment (e.g., contract laboratories/sampling, where contractors used) • Ensure sampling schedule is met (see Tables 10-1 and 10-2) • Ensure sufficient Sampling Personnel resources available • Address/solve programmatic issues as they arise • Manage project files while samples collected during a sample year • Ensure data uploaded into database/spreadsheet template provided by Project Director; at the end of a sample year, transmit all relevant project files/data to the Project Director • Coordinate with Project QA Officer; address/solve QA/QC issues as they arise • Make sure staff are properly trained

Table 4-1. Key positions & primary responsibilities for implementation of SAR Bacteria Monitoring Program

Position	Primary Responsibilities
Responsible Agency Project QA Officer	• Verify that the QA/QC procedures contained herein are implemented as required within their area of responsibility. • Verify QA/QC activities completed on data collected by a Responsible Agency before it is submitted to the Project Director and used to support development of the Annual Report. • The QA Officer may stop all actions, including those conducted by any subcontractor if there are significant deviations from required practices or if there is evidence of a systematic failure. Coordinate with Project Manager, Santa Ana Water Board and Project Director, as needed.
Responsible Agency Monitoring Manager	• Manage sampling personnel o Coordinate Sampling Personnel (in-house staff or contractors) to be sure sampling schedule for priority sites is met (see Tables 10-1 and 10-2) o If applicable – ensure TMDL-specific monitoring occurs as required, e.g., TMDL wet weather event o Conduct sample/equipment training as required o Ensure Sampling Personnel have all necessary equipment, forms, etc. to be successful • Manage equipment o Manage any equipment needs (e.g., flow meters, multi-parameter or similar instruments) o Ensure pre-field equipment procedures followed • Laboratory services o Coordinate sample collection with appropriate laboratories o If couriers used for sample delivery, coordinate courier scheduling o Ensure holding times are met o Ensure chain of custody (COC) forms properly managed • QA/QC o Coordinate with Project QA Officer to verify QA/QC procedures are followed, including equipment use, field blanks and replicates o Review field and COC forms for completeness o Work with Sampling Personnel, Contract Laboratories and Project QA Officer to resolve any issues of concern • Data Management o Receive data results from laboratories - verify completeness of results and conduct QA/QC check of laboratory results o Submit all field and laboratory documentation to Data Manager for data entry and filing
Responsible Agency Data Manager	• Enter field and laboratory data into database/spreadsheet template provided by Project Director • Conduct QA/QC of data entry process • Submit final dataset from a sample year to the Project Manager for transmittal to the Project Director

Table 4-1. Key positions & primary responsibilities for implementation of SAR Bacteria Monitoring Program

Position	Primary Responsibilities
Responsible Agency Sampling Personnel	• Trained in sample collection procedures and QAPP requirements • Complete field instrument pre- and post-sample collection calibrations • Collect field data and water sample as directed per the Monitoring Plan and QAPP • Complete COC forms and submit samples to the laboratory within holding times (including coordination with couriers if needed)
Contract Laboratories Laboratory Personnel	• Provide the necessary containers, preservatives (if required), COC forms to support sample collection • Analyze the samples for constituents as indicated in this QAPP and requested by the Monitoring Manager • Operate according to laboratory QA/QC program in accordance with guidelines established by the State of California and the U.S. Environmental Protection Agency (EPA) • Provide data in electronic and hard copy format to the Responsible Agency Monitoring Manager that submitted samples for analysis • Work with the Project QA Officers and Monitoring Manager for each Responsible Agency to resolve sample or data analysis issues when they arise

Table 4-2. Responsible agencies for RMP priority sites and additional TMDL monitoring

Responsible Agency	Monitoring Type	Monitoring Sites
Agricultural & Dairy	Priority 1	• SAR at MWD Crossing (also Priority 2) • SAR at Pedley Avenue (also Priority 2)
	Priority 2	• Chino Creek at Central Avenue • Mill Creek (Prado Area) • Prado Park Lake
	Priority 3	None
	Priority 4	None
	TMDL Specific	• Middle Santa Ana River Bacteria TMDL – Wet Weather Event
City of Claremont	Priority 1	• SAR at MWD Crossing (also Priority 2) • SAR at Pedley Avenue (also Priority 2)
	Priority 2	• Chino Creek at Central Avenue • Mill Creek (Prado Area) • Prado Park Lake
	Priority 3	None
	Priority 4	None
	TMDL Specific	• Middle Santa Ana River Bacteria TMDL – Wet Weather Event
City of Pomona	Priority 1	• SAR at MWD Crossing (also Priority 2) • SAR at Pedley Avenue (also Priority 2)
	Priority 2	• Chino Creek at Central Avenue • Mill Creek (Prado Area) • Prado Park Lake
	Priority 3	None
	Priority 4	None
	TMDL Specific	• Middle Santa Ana River Bacteria TMDL – Wet Weather Event sampling at
Orange County Watersheds (Orange County Public Works)	Priority 1	None
	Priority 2	None
	Priority 3	• Bolsa Chica Channel • Borrego Canyon Wash • Buck Gully Creek • Peters Canyon Wash • San Diego Creek, Reach 1 • San Diego Creek, Reach 2 • Santa Ana River, Reach 2 • Serrano Creek
	Priority 4	Santa Ana Delhi Channel
	TMDL Specific	None

Table 4-2. Responsible agencies for RMP priority sites and additional TMDL monitoring

Responsible Agency	Monitoring Type	Monitoring Sites
Riverside County Flood Control & Water Conservation District	Priority 1	• Canyon Lake • Lake Elsinore • Perris Lake • SAR at MWD Crossing (also Priority 2) • SAR at Pedley Avenue (also Priority 2)
	Priority 2	• Chino Creek at Central Avenue • Mill Creek (Prado Area) • Prado Park Lake
	Priority 3	• Goldenstar Creek • Lake Fulmor
	Priority 4	• Temescal Creek Reaches 1a and 1b
	TMDL Specific	• Middle Santa Ana River Bacteria TMDL – Wet Weather Event
San Bernardino County Flood Control District	Priority 1	• SAR at MWD Crossing (also Priority 2) • SAR at Pedley Avenue (also Priority 2) • Big Bear Lake at Swim Beach • Mill Creek Reach 2 • Lytle Creek, Middle Fork
	Priority 2	• Chino Creek at Central Avenue • Mill Creek (Prado Area) • Prado Park Lake
	Priority 3	• SAR above S. Riverside Avenue Bridge
	Priority 4	Cucamonga Creek, Reach 1
	TMDL Specific	• Middle Santa Ana River Bacteria TMDL – Wet Weather Event
Others, as needed	Priority 1	None
	Priority 2	None
	Priority 3	• Los Trancos Creek • Morning Canyon Creek
	Priority 4	None
	TMDL Specific	None

5. Problem Definition/Background

Bacterial indictor monitoring is conducted in the Santa Ana River watershed for three key purposes:

- Fulfill the monitoring and surveillance requirements for the 2012 adopted BPA to Revise Recreation Standards for Inland Freshwaters in the Santa Ana Region;
- Conduct sampling to support implementation of the Middle Santa Ana River (MSAR) Bacterial Indicator TMDL ("MSAR Bacteria TMDL"); and
- Support any additional bacterial indicator monitoring that may be conducted in the watershed to support regional regulatory activities.

5.1 Regulatory Background

This QAPP supports the implementation of several regulatory related activities associated with the protection of recreational uses in the Santa Ana River Watershed. The following subsections describe these activities and their regulatory importance.

5.1.1 Basin Plan Amendment

On June 15, 2012, the Santa Ana Water Board adopted the BPA to Revise Recreation Standards for Inland Freshwaters in the Santa Ana Region[2]. This BPA resulted in the following modifications to the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) for the Santa Ana region[3]:

- Addition of "Primary Contact Recreation" as an alternative name for the REC1 (water contact recreation) beneficial use;
- Addition of narrative text clarifying the nature of REC1 activities and the bacteria objectives established to protect these activities.
- Differentiation of inland surface REC1 waters on the basis of frequency of use and other characteristics for the purposes of assigning applicable single sample maximum values.
- Revision of REC1/REC2 (non-contact water recreation) designations for specific inland surface waters based on the results of completed Use Attainability Analyses.
- Revised water quality objectives to protect the REC1 use of inland freshwaters
- Identification of criteria for temporary suspension of recreation use designations and objectives (high flow suspension)

Santa Ana Water Board staff developed this BPA in collaboration with the Stormwater Quality Standards Task Force, comprised of representatives from various stakeholder interests, including SAWPA; the counties of Orange, Riverside, and San Bernardino; Orange County Coastkeeper; Inland

[2] Santa Ana Water Board Resolution: R8-2012-0001, June 15, 2012
[3] Page 2 of Attachment 2 to the Santa Ana Water Board Resolution: R8-2012-0001, as approved on June 15, 2012 and corrected on February 12, 2013 and November 15, 2013.

Empire Waterkeeper; and EPA Region 9. The BPA was approved by the State Water Board on January 21, 2014[4] and the Office of Administrative Law on July 2, 2014[5]. The EPA issued its findings by letter on April 8, 2015 and provided a letter of clarification on August 3, 2015.

The BPA requires establishment of a comprehensive monitoring program to support implementation of the changes to the Basin Plan[6]. This QAPP and its accompanying SAR Bacteria Monitoring Plan have been submitted to the Santa Ana Water Board for approval[7].

5.1.2 Bacteria TMDLs

Currently, there is one bacteria TMDL adopted for freshwaters in the Santa Ana River Watershed: MSAR Bacteria TMDL, which became effective in May 2007. Following is a brief summary of the establishment of this TMDL.

In 1994 and 1998, because of exceedances of the fecal coliform objective established to protect the REC1 use, the Santa Ana Water Board added the following waterbodies in the MSAR watershed to the state 303(d) list of impaired waters:

- Santa Ana River, Reach 3 – Prado Dam to Mission Boulevard
- Chino Creek, Reach 1 – Santa Ana River confluence to beginning of hard lined channel south of Los Serranos Road
- Chino Creek, Reach 2 – Beginning of hard lined channel south of Los Serranos Road to confluence with San Antonio Creek
- Mill Creek (Prado Area) – Natural stream from Cucamonga Creek Reach 1 to Prado Basin
- Cucamonga Creek, Reach 1 – Confluence with Mill Creek to 23rd Street in City of Upland
- Prado Park Lake

The Santa Ana Water Board adopted the MSAR Bacteria TMDL in 2005[8]; it was subsequently approved by the EPA on May 16, 2007. The TMDL established compliance targets for both fecal coliform and (*Escherichia coli*) *E. coli*:

- Fecal coliform: 5-sample/30-day logarithmic mean less than 180 organisms/100 milliliters (mL) and not more than 10 percent of the samples exceed 360 organisms/100 mL for any 30-day period.
- *E. coli*: 5-sample/30-day logarithmic mean less than 113 organisms/100 mL and not more than 10 percent of the samples exceed 212 organisms/100 mL for any 30-day period.

[4] State Water Board Resolution: 2014-0005, January 21, 2014
[5] Office of Administrative Law: #2014-0520 -02 S; July 2, 2014
[6] Page 76 of Attachment 2 to the Santa Ana Water Board Resolution: R8-2012-0001, as corrected
[7] Submitted June 30, 2015.
[8] Santa Ana Water Board Resolution: R8-2005-0001, August 26, 2005

Per the TMDL, the above compliance targets for fecal coliform become ineffective upon EPA approval of the BPA[9].

To focus MSAR Bacteria TMDL implementation activities, stakeholders established the MSAR Watershed TMDL Task Force (MSAR TMDL Task Force) to coordinate TMDL implementation activities designed to manage or eliminate sources of bacterial indicators to waterbodies listed as impaired. The MSAR TMDL Task Force includes representation by key watershed stakeholders, e.g., urban stormwater dischargers, agricultural operators, and the Santa Ana Water Board.

The MSAR Bacteria TMDL required urban and agricultural dischargers to implement a watershed-wide bacterial indicator compliance monitoring program by November 2007[10]. Stakeholders worked collaboratively through the MSAR TMDL Task Force to develop this program and prepared a Monitoring Plan and QAPP for submittal to the Santa Ana Water Board. The MSAR TMDL Task Force implemented the monitoring program in July 2007 following Santa Ana Water Board approval of monitoring program documents[11]. The Monitoring Plan and QAPP have been updated as needed since 2007 with the most recent update occurring in 2013.

The MSAR Bacteria TMDL also required the development and implementation of plans by urban and agricultural dischargers within six months of the TMDL effective date:

- *Urban Dischargers* – Municipal Separate Storm Sewer System (MS4) permittees in Riverside and San Bernardino Counties within the MSAR watershed were required to submit a bacterial indicator Urban Source Evaluation Plan (USEP) within six months of the TMDL effective date. The purpose of this program was to identify activities, operations, and processes in urban areas that contribute bacterial indicators to MSAR watershed waterbodies.

  The USEP was submitted to the Santa Ana Water Board in November 2007 and approved April 18, 2008[12]. The USEP was replaced by Comprehensive Bacteria Reduction Plans (CBRP) prepared by Riverside and San Bernardino MS4 permittees to fulfill 2010 MS4 Permit requirements applicable to urban dischargers subject to the MSAR Bacteria TMDL requirements. The Santa Ana Water Board approved the CBRPs for these counties on February 10, 2012[13]. To fulfill 2012 MS4 Permit requirements, additional CBRPs were completed by the Cities of Pomona and Claremont for the portions of their cities that are within the MSAR watershed and subject to MSAR Bacteria TMDL requirements. These CBRPs were approved by the Santa Ana Water Board on March 14, 2014[14]. All CBRPs completed by MS4 dischargers include monitoring activities that to date have been covered by the Monitoring Plan and QAPP prepared by the MSAR TMDL Task Force (see above).

- *Agricultural Dischargers* – Agricultural operators in the MSAR watershed were required to submit an Agricultural Source Evaluation Plan (AgSEP) within six months of the TMDL effective date. The

[9] Page 3 of 15 of Attachment A to Santa Ana Water Board Resolution R8-2005-0001.
[10] Page 6 of 15, Table 5-9y of Attachment A to Santa Ana Water Board Resolution R8-2005-0001
[11] Santa Ana Water Board Resolution: R8-2008-0044, April 18, 2008
[12] Santa Ana Water Board Resolution: R8-2008-0044, April 18, 2008
[13] Santa Ana Water Board Resolutions: R8-2012-0015 (Riverside County MS4 Program; R8-2012-0016 (San Bernardino County MS4 Program)
[14] Santa Ana Water Board Resolution: R8-2014-0030 (City of Claremont); R8-2014-0031 (City of Pomona)

purpose of the AgSEP was to identify activities, operations, and processes in agricultural areas that contribute bacterial indicators to MSAR watershed waterbodies. The AgSEP included monitoring activities that have been covered by the Monitoring Plan and QAPP prepared by the MSAR TMDL Task Force (see above).

The AgSEP was submitted to the Santa Ana Water Board in November 2007 and approved April 18, 2008[15]. Currently, a Bacterial Indicator Agricultural Source Management Plan (BASMP) is under development. Once completed and approved by the Santa Ana Water Board, the BASMP will replace the AgSEP.

This QAPP incorporates all existing MSAR Bacteria TMDL QAPP requirements as described above. Accordingly, upon execution of the RMP, this QAPP replaces the existing MSAR Bacteria TMDL QAPP.

5.1.3 Waters Impaired for Bacterial Indicators

The State Water Board periodically publishes a list of impaired waters for the State of California, which is prepared according to the requirements of the State Water Board's *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List*[16]. Subject to EPA Region 9 approval, the most recently approved 303(d) List is contained within the State Water Board's 2010 Integrated Report[17]. The State Water Board's 2010 Integrated Report website provides an estimated date for development of a TMDL for each listed waterbody. Any bacteria-related monitoring activities conducted in these 303(d) listed waterbodies are covered by this QAPP and accompanying Monitoring Plan.

5.2 Watershed Description

The Santa Ana River watershed covers an area of approximately 2,650 square miles and includes portions of Orange, Riverside, and San Bernardino County, and a small portion of Los Angeles County (see Figure 2-1 in the SAR Bacteria Monitoring Plan). The mainstem Santa Ana River is the primary waterbody in the watershed. It flows in a generally southwest direction nearly 100 miles, from its headwaters to the Pacific Ocean. The watershed can be generally divided into three major geographic areas:

- *San Jacinto River and Temescal Creek Region* – This area covers much of the south central and southeastern portions of the watershed and is located mostly within Riverside County. The San Jacinto River drains an area of approximately 780 square miles to Canyon Lake and Lake Elsinore. Often flows from the upper San Jacinto River watershed are captured by Mystic Lake, which is a natural sump or hydrologic barrier to flows moving further downstream to Canyon Lake or Lake Elsinore. Downstream of Lake Elsinore, Temescal Creek carries surface flow, when it occurs, from below Lake Elsinore to its confluence with Prado Basin.

- *Santa Ana River above Prado Dam and Chino Basin Region* – This area includes much of the north central and northeastern portions of the watershed and is located mostly within San Bernardino

[15] Santa Ana Water Board Resolution: R8-2008-0044, April 18, 2008
[16] http://www.waterboards.ca.gov/water_issues/programs/tmdl/docs/ffed_303d_listingpolicy093004.pdf
[17] Final EPA approval – October 11, 2011; list of impaired waters in California , by region: http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/category5_report.shtml

County. This region drains to Prado Basin where Prado Dam captures all surface flows from this region and the Temescal Creek watershed. The Santa Ana River headwaters are located in the San Bernardino Mountains in the northeastern part of the watershed. Major tributaries to the Santa Ana River in this region include Warm Creek, Lytle Creek, and San Timoteo Creek. In the north central portion several major Santa Ana River tributaries arise in the San Gabriel Mountains and drain generally south into the Chino Basin before their confluence with the Santa Ana River, including Day Creek, Cucamonga Creek and San Antonio Creek. Many of these drainages carry little to no flow during dry conditions because of the presence of extensive recharge basins in this region. Prado Basin above Prado Dam is a flood control basin that captures all flows from the upper part of the Santa Ana River Watershed. For the most part the basin is an undisturbed, dense riparian wetland.

- *Santa Ana River below Prado Dam and Coastal Plains Region* – This area covers the western portion of the Santa Ana River watershed and includes coastal waterbodies that are not part of the Santa Ana River drainage area. This area is located within Orange County. Below Prado Dam the Santa Ana River flows through the Santa Ana Mountains before crossing the coastal plain and emptying into the Pacific Ocean near Huntington Beach. Groundwater recharge areas near the City of Anaheim capture water in the Santa Ana River and the Santa Ana River is often dry below this area. Other watersheds on the Coastal Plain include Newport Bay, Anaheim Bay-Huntington Harbour and Coyote Creek.

5.3 Purpose of the QAPP

This QAPP supports the SAR Bacteria Monitoring Plan which was prepared to fulfill three objectives:

(a) Fulfill the monitoring and surveillance requirements for the 2012 adopted BPA to *Revise Recreation Standards for Inland Freshwaters in the Santa Ana Region*;

(b) Conduct sampling to support implementation of the MSAR Bacteria TMDL, including requirements to implement a watershed-wide compliance monitoring program and source evaluation programs for urban and agricultural dischargers; and

(c) Support any additional bacterial indicator monitoring that may be conducted in the watershed to support regional regulatory activities.

6. Project/Task Descriptions

6.1 Work Statement and Produced Products

The following Regional and TMDL Bacteria Monitoring Programs are addressed by this QAPP:

- Regional Monitoring Program
  - Priority 1 - REC1 Tier A Waters
  - Priority 2 – Waterbodies with an Adopted TMDL
  - Priority 3 - 303(d) Listed Waterbodies without an Adopted TMDL
  - Priority 4 – REC2 Only Waterbodies
- TMDL Monitoring Programs
  - MSAR Bacteria TMDL Wet Weather Event Monitoring
  - Urban Source Evaluation Monitoring Program
  - Agricultural Source Evaluation Monitoring Program (AgSEMP)

Following is a description of the monitoring activities associated with each program.

6.2 Regional Monitoring Program

6.2.1 Priority 1 REC1 Tier A Waters

6.2.1.1 Introduction

The purpose of Priority 1 REC1 Tier A waters monitoring is to assess compliance with REC1 use water quality objectives for *E. coli*. For the most part, Priority 1 waters are generally those waterbodies listed in Table 5-REC1-Tiers of the BPA with a Tier A designation and no "N" characterization[18]. The potential for human health impacts as a result of exposure to pathogens is highest in REC1 Tier A waters where water contact recreational activities are most likely to occur.

6.2.1.2 Monitoring Sites

Table 6-1 identifies seven waterbodies as REC1 Tier A waters for Priority 1 monitoring (Table 6-1). These waterbodies include four lakes: Big Bear Lake, Lake Perris, Canyon Lake, and Lake Elsinore, and three flowing waters, Santa Ana River Reach 3 (two sites), Lytle Creek (Middle Fork) and Mill Creek Reach 2. Eight sample sites were selected to assess water quality on these waterbodies, with one site per waterbody except for Santa Ana River Reach 3 where two stations were selected. Five sites are located in Riverside County and three sites are located in San Bernardino County (Figure 6-1).

The two Priority 1 Santa Ana River sites (MWD Crossing and @ Pedley Avenue) are also MSAR Bacteria TMDL compliance sites (Table 6-1). Data collected from these sites will also be used for evaluating compliance with the MSAR Bacteria TMDL.

[18] An "N" designation means "Natural Conditions" and per the BPA, "includes freshwater lakes and streams located in largely undeveloped areas where ambient water quality is expected to be better than necessary to protect primary contact recreational activities regardless of whether such activities actually occur in these waterbodies" (Page 56 in Attachment 2 to the Santa Ana Water Board Resolution R8-2012-0001, as corrected).

Table 6-1. Priority 1 REC1 Tier A monitoring sites

Site ID	Site Description	RMP Priority	Latitude	Longitude
P1-1	Canyon Lake at Holiday Harbor	1	33.6808	-117.2724
P1-2	Lake Elsinore	1	33.6753	-117.3674
P1-3	Lake Perris	1	33.8614	-117.1908
P1-4	Big Bear Lake at Swim Beach	1	34.2482	-116.9034
P1-5	Mill Creek Reach 2	1	34.0891	-116.9247
P1-6	Lytle Creek (Middle Fork)	1	34.2480	-117.5110
WW-S1	Santa Ana River Reach 3 at MWD Crossing	1	33.9681	-117.4479
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	1	33.9552	-117.5327

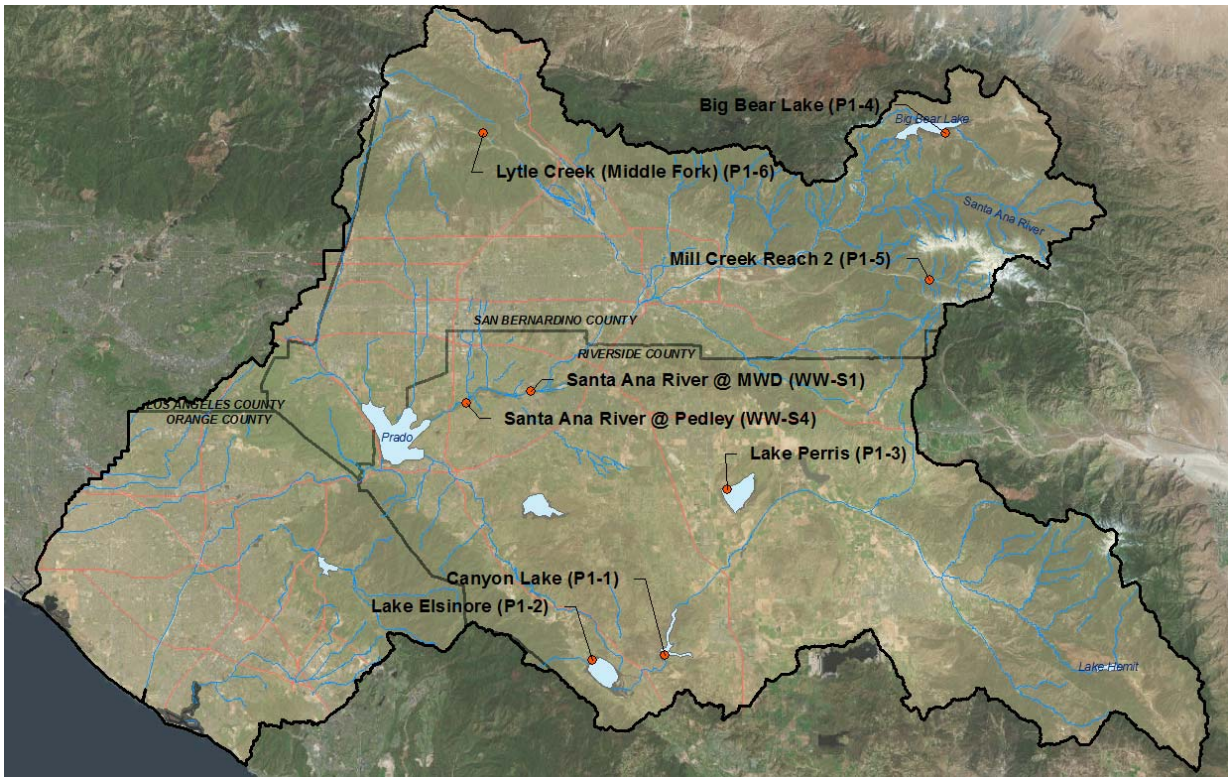

Figure 6-1. Priority 1 REC1 Tier A monitoring sites

6.2.1.3 Sample Frequency

Priority 1 sample sites will be sampled during dry weather (defined as no measurable rainfall within a 72 hour period prior to sampling) for a 20-week period during the warmest part of the year between May 1 and September 30. In addition, Priority 1 sample sites will also sampled during one 5-week period from end of October through most of November each year during the cooler season. The resulting dataset will include 25 samples each year from each site and provide sufficient data to calculate 16 geometric means during the 20-week sample period and one geometric mean during the cool season. Data will be used to evaluate compliance with:

- Santa Ana region *E. coli* water quality objective: 5-sample/30-day geometric mean of < 126 *E. coli* organisms per 100 mL.
- MSAR Bacteria TMDL dry weather numeric targets for *E. coli*: 5-sample/30-day geometric mean < 113 organisms/100 mL and not more than 10 percent of the samples exceed 235 organisms/100 mL for any 30-day period. The MSAR Bacteria TMDL requires compliance with the dry weather numeric targets by December 31, 2015.

While it is unlikely that ice conditions will occur during each year's cool season sample period, if ice conditions prevent sampling at a Priority 1 site, that finding will be documented on the field form and photo documentation will be provided.

6.2.2 Priority 2 – Waterbodies with an Adopted TMDL

6.2.2.1 Introduction

The purpose for monitoring Priority 2 waters is to evaluate attainment of water quality objectives in waters that have an adopted bacteria TMDL. Currently, only one bacteria TMDL has been adopted for inland waters in the watershed: MSAR Bacteria TMDL. Dry weather sampling has been ongoing in these waters since 2007 to satisfy TMDL implementation requirements. This dry weather sampling will continue as described in this section of the RMP; any other monitoring necessary to satisfy TMDL requirements, e.g., wet weather event sampling is described in Section 6.3.1.

6.2.2.2 Monitoring Sites

Monitoring for Priority 2 waters will occur at the same five monitoring sites previously established for evaluating compliance with the numeric targets in the MSAR Bacteria TMDL: Two Santa Ana River Reach 3 sites (@ MWD Crossing and @ Pedley Avenue), and one site each on Mill-Cucamonga Creek, Chino Creek, and Prado Park Lake[19] (Table 6-2; Figure 6-2). As discussed in Section 6.2.1.2, the two Santa Ana River sites are also Priority 1 waters, i.e., as Tier A waters they are locations where the risk of exposure to pathogens during recreational activities is highest. Both Figure 6-2 and Table 6-2 indicate the dual designation for these sites. With the exception of the Mill-Cucamonga Creek monitoring site, the location of each sample site remains the same as previously sampled under the MSAR Bacteria TMDL. The Mill-Cucamonga Creek site has been moved to take into account changes in the local area, resulting from the completion of the Mill Creek Wetlands.

Table 6-2. Priority 2 monitoring sites (Note that WW-S1 and WW-S4 sites are also Priority 1 sites)

[19] See Monitoring Plan Section 4.1.1 for the original basis for the selection of these monitoring sites.

Site ID	Site Description	RMP Priority	Latitude	Longitude
WW-M6	Mill-Cucamonga Creek below Wetlands	2	33.9268	-117.6250
WW-C7	Chino Creek at Central Avenue	2	33.9737	-117.6889
WW-C3	Prado Park Lake	2	33.9400	-117.6473
WW-S1	Santa Ana River Reach 3 at MWD Crossing	1,2	33.9681	-117.4479
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	1,2	33.9552	-117.5327

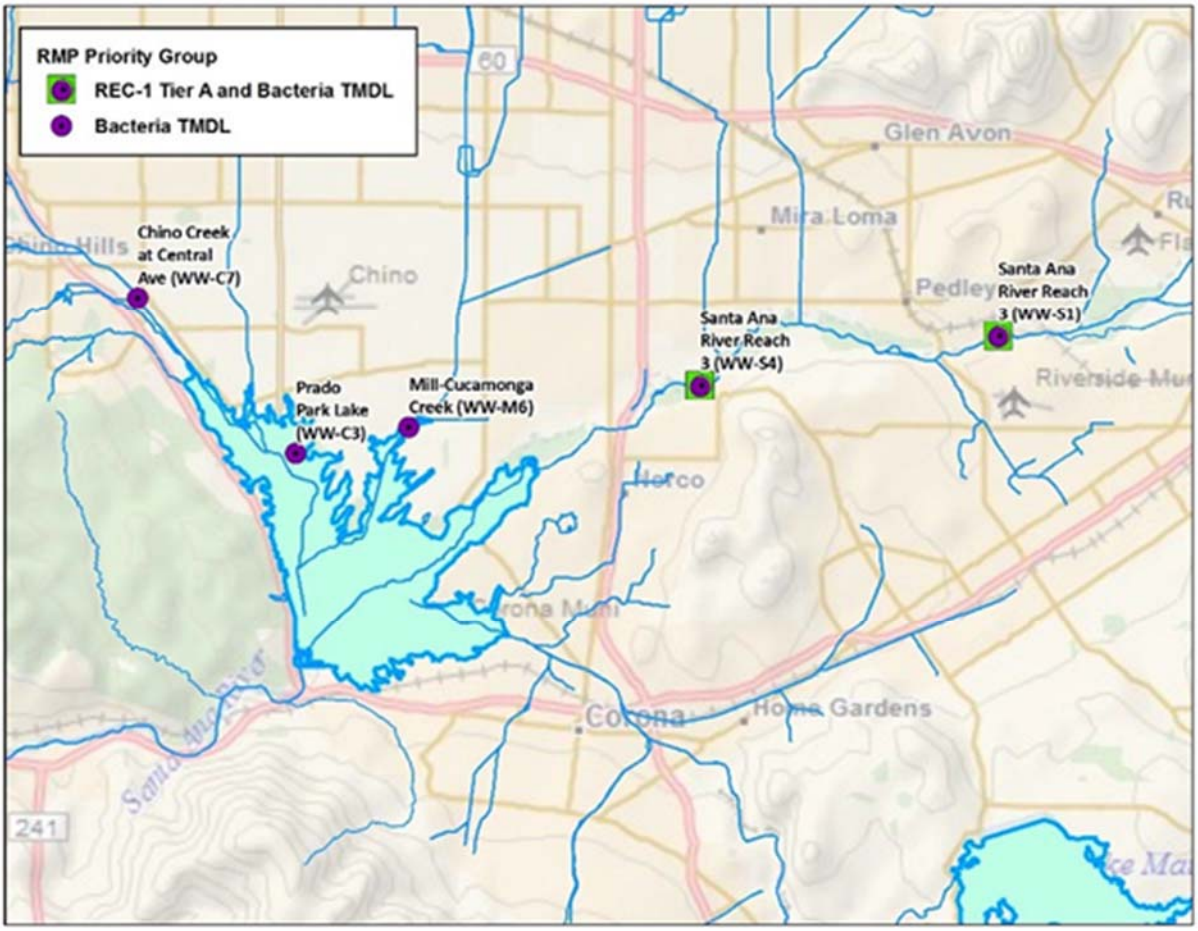

Figure 6-2. Priority 2 monitoring sites (note that the two monitoring sites on the Santa Ana River are also Priority 1 sites, see text for explanation)

6.2.2.3 Sample Frequency

The sampling frequency for dry weather (defined as no measurable rainfall within a 72 hour period prior to sampling) for Priority 2 waters is the same as described for Priority 1 waters in Section 6.2.1.3. Any additional monitoring required to satisfy MSAR Bacteria TMDL-specific requirements, e.g., wet weather event monitoring, is described in Section 6.3.1 below.

6.2.3 Priority 3 – 303(d) Listed Waterbodies without Adopted TMDL

6.2.3.1 Introduction

Priority 3 waters are those that have been listed as impaired for bacterial indicators and have been placed on the state's 303(d) List, but do not have an adopted TMDL. The most recent EPA-approved list of impaired waters is based on the State Water Board's 2010 Integrated Report[20]. These waters can be removed from the 303(d) List (per the requirements of the State Water Board's Listing Policy), if water quality data indicate that removal from the list is appropriate; otherwise, it is anticipated that a TMDL will be established for Priority 3 waters in the future. The purpose for monitoring these waters is gather data to support eventual regulatory decisions regarding the degree of impairment in each Priority 3 waterbody (e.g., to support a delisting decision).

6.2.3.2 Monitoring Sites

In the Santa Ana River watershed 21 waterbodies are currently on the 303(d) List with no adopted TMDL: twelve in Orange County; four in Riverside County, and five in San Bernardino County (see Table 1.1 in the Monitoring Plan). The following waterbodies have not been included in this RMP as Priority 3 waterbodies for the following reasons:

- Silverado Creek in Orange County is expected to be delisted in the next 303(d) listing cycle;
- Santa Ana Delhi Channel in Orange County because REC1 has been removed as a beneficial use by an approved use attainability analysis and the 303(d) listing is based on REC1; accordingly this waterbody considered a Priority 4 waterbody under this RMP;
- Canyon Lake in Riverside County is also classified as a Priority 1 waterbody; in addition, work carried out by others has shown that bacterial indicator concerns in this waterbody are associated with wet weather conditions;
- Temescal Creek Reach 6 in Riverside County is a listing error.
- The 303(d) listing for Knickerbocker Creek in San Bernardino County is being addressed through that county's MS4 Permit (R8-2010-0036); recent studies have shown that impairment is due to wildlife concentration.
- Lytle Creek and Mill Creek Reach 2 in San Bernardino County are also designated as a Priority 1 waterbody in this RMP.
- Mill Creek Reach 1 is an old listing and there is no data available that provides the original basis for its current listing as impaired. In addition, this reach is designated with an intermittent REC1 beneficial use and a recent reconnaissance found no surface water. Given the likelihood that REC1

[20] The final list which includes waterbodies added to the list by EPA Region 9 is found here: http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/category5_report.shtml

activity would be limited in this reach and more likely to occur in the upstream Reach 2, this waterbody was not included as a Priority 3 waterbody.

Figure 6-3 shows the general location for each of Priority 3 waterbody in each county. Selection of a sample site for each waterbody relied on the following criteria:

- One sample site per waterbody, unless there is a compelling need for a second site, e.g., significant differences exist in the waterbody's characteristics in different reaches;
- Site should be close to areas of existing or potential water contact recreational activities;
- For sites near the Pacific Ocean, site is upstream of the tidal prism; and
- If possible, maintain historical monitoring sites.

Table 6-3 provides a brief description of each site, including known water quality data and basis for 303(d) listing, and Attachment A, Section A.3, of the SAR Bacteria Monitoring Plan provides detailed descriptions and photographs for each site.

6.2.3.3 Sample Frequency

Water quality samples will be collected during dry weather (defined as no measurable rainfall within a 72 hour period prior to sampling) according to the frequency shown in Table 10-2. The overall sample schedule for these sites overlaps with the Priority 1 & 2 sample site schedule to maximize efficiency with the collection of samples. The resulting dataset for these sites will consist of five samples per year from each site. Data from each year will represent a different five week period.

6.2.4 Priority 4 – REC2 Only Waterbodies

6.2.4.1 Introduction

Priority 4 waters are those where the REC1 beneficial use has been removed as a result of an approved use attainability analysis (UAA). The applicable *E. coli* or *Enterococcus* water quality objectives for these waters are based on antidegradation targets established by the BPA[21]. Currently, there are four inland freshwaters with a REC2 only designation: Temescal Creek (Reaches 1a and 1b; Riverside County); Santa Ana Delhi Channel (Tidal Prism and Reaches 1 and 2; Orange County): Greenville-Banning Channel (Tidal Prism Reach, Orange County); and Cucamonga Creek (Reach 1, San Bernardino County).

[21] The BPA presents antidegradation targets and describes the statistical methodology employed to develop the numeric values. In short, historical data was fitted to a lognormal distribution, and the 75th percentile of the fitted lognormal distribution was selected as the antidegradation target. Accordingly, the 75th percentile of the fitted log-normal distribution for a newly acquired dataset with comparable spatial (within reach) and temporal (seasonal) variability, should be less than or equal to that of the historical dataset.

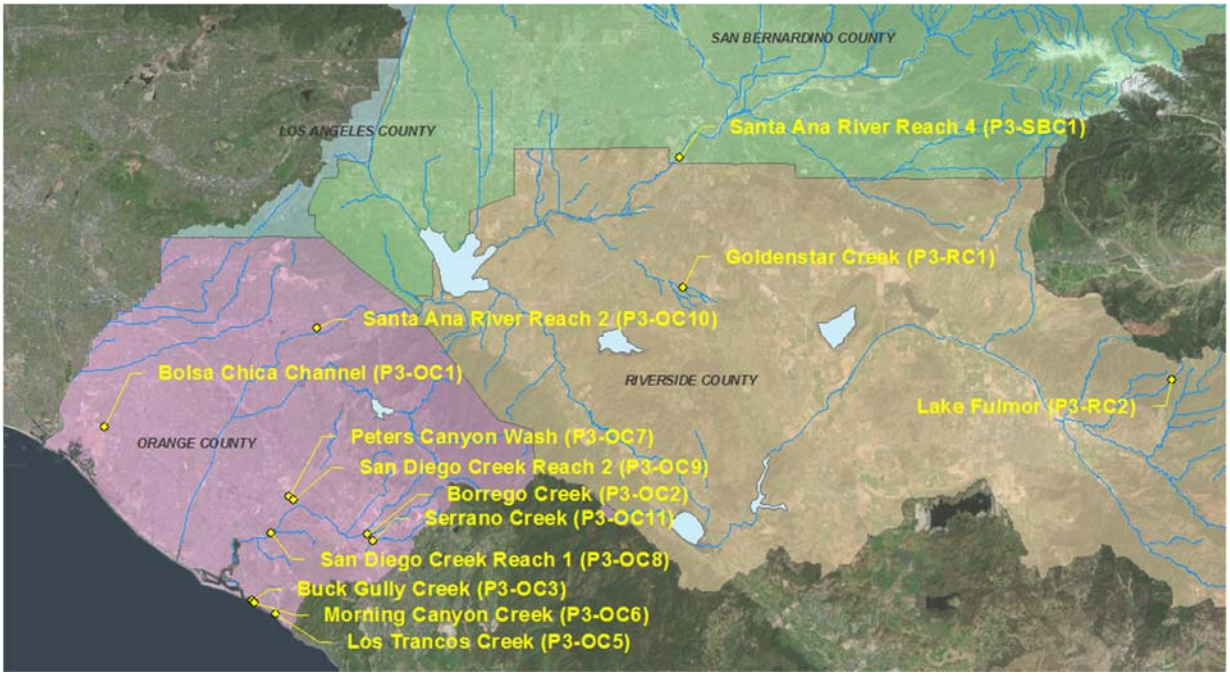

Figure 6-3. Priority 3 monitoring sites by County within the Santa Ana River watershed.

Table 6-3. Priority 3 monitoring sites and the basis for 303(d) listing.

Site ID	Site Description	Latitude	Longitude	Frequency of *E. coli* Exceedance[1,2]	Comments[2]
P3-OC1	Bolsa Chica Channel upstream of Westminster Blvd/Bolsa Chica Rd	33.75958	-118.04295	*E.coli* 49/63	Based on Orange County Coastkeeper Coastal Watersheds Project Report. Data collected between March 31, 2004 and March 30, 2006 from two sites: "bc1" – in Cypress in the upper Bolsa Chica Channel at Warland Street Bridge; "bc2" – in Huntington Beach in the lower Bolsa Chica Channel at the intersection of Bolsa Chica Rd. and Rancho Rd.
P3-OC2	Borrego Creek upstream of Barranca Parkway	33.65457	-117.73213	*E.coli* 37/43	Based on Orange County Coastkeeper Coastal Watersheds Project Report. Data collected between March 11, 2004 and March 29, 2006 from two sites: "bor1" – in Foothill Ranch in upper Borrego Channel on Town Center Dr.; "bor2" – in Irvine in the lower Borrego Channel on Barranca Pkwy next to the train station.
P3-OC3	Buck Gully Creek Little Corona Beach at Poppy Avenue/Ocean Blvd	33.59000	-117.86841	*E.coli* 23/68	303(d) list states that listing is for reach downstream of Pacific Coast Highway; state website states that listing decision made prior to 2006 and there is no information in state assessment database. However, Orange County Coastkeeper (OCC) database shows two sites labeled "bg1" 'and "bg2" that were sampled from March 8, 2004 to April 13, 2006 (exceedance frequency in this table based on those results); no information in OCC database regarding where sites are located.
P3-OC5	Los Trancos Creek at Crystal Cove State Park	33.57601	-117.84062	Fecal coliform 5/9	303(d) list states that listing is for reach downstream of Pacific Coast Highway; state website states that listing decision made prior to 2006 and there is no information in state assessment database. However, data obtained from Regional Board shows three sample locations sampled for fecal coliform in July and September in 2000. All exceedances (5 of 9) occurred at a sample site adjacent to the most upstream golf cart bridge of the Pelican Hill Golf Course
P3-OC6	Morning Canyon Creek at Morning Canyon Beach	33.58759	-117.86575	*E.coli* 17/61	Based on Orange County Coastkeeper Coastal Watersheds Project. Data collected between March 8, 2004 and April 10, 2006 from two sites: "mc1" – in Newport Beach in the upper part of Morning Canyon Creek at Surrey street; "mc2" – in Newport Beach in the lower part of Morning Canyon Creek at Morning Canyon Beach.
P3-OC7	Peters Canyon Wash downstream of Barranca Parkway	33.69076	-117.82404	*E.coli* 40/66	Based on Orange County Coastkeeper Coastal Watersheds Project. Data collected between March 9, 2004 and March 29, 2006 from two sites: "pc1" – in Irvine in upper Peter's Canyon Channel on Bryan Street between Jamboree Rd. and Culver Dr.; "pc2" – in Irvine in lower Peter's Canyon Channel on Barranca Pkwy between Jamboree Rd. and Harvard Ave.
P3-OC8	San Diego Creek downstream of Campus Drive (Reach 1)	33.65530	-117.84535	*E.coli* 33/84	State website states that listing decision made prior to 2006 and there is no information in state assessment database. However, based on Orange County Coastkeeper Coastal Watersheds Project, data was collected between October 22, 2002 and June 21, 2004 from three sites: "sd4", "sd5", and "sd6". Exceedance frequency shown in this table is from OCC report; no information available on specific sample locations.

Table 6-3. Priority 3 monitoring sites and the basis for 303(d) listing.

Site ID	Site Description	Latitude	Longitude	Frequency of *E. coli* Exceedance[1,2]	Comments[2]
P3-OC9	San Diego Creek at Harvard Avenue (Reach 1)	33.6880	-117.8187	*E.coli* 31/64	Based on Orange County Coastkeeper Coastal Watersheds Project. Data collected between October 22, 2002 and June 21, 2004 from three sites: "sd1" – Bake Parkway, site is located off of Irvine Center Dr. on the right hand side before Wild Rivers water park; "sd2" – 133 Fwy, the 133 Fwy is located off of Pacifica and Alton in the dead end down the ramp in the riverbed; and "sd3"- Sand Canyon, site is located off of the 405 Fwy at Sand Canyon Avenue past Alton at the bridge on the NE corner of Barranca and Sand Canyon Avenue.
P3-0C10	Santa Ana River Reach 2 downstream of Imperial Highway	33.857440	-117.791617	*E.coli* 37/150	Based on Orange County Coastkeeper Coastal Watersheds Project. Data collected between October 28, 2002 and June 10, 2004 from six sites: "sar1" – Green River, off the 91 Fwy at Green River exit under the bridge at the golf course; "sar2" – Gypsum Canyon, off of Gypsum Canyon Rd. and Yorba Linda Blvd, across street from the "Fantasy Restaurant"; "sar3" – Yorba Linda Park, Santa Ana River east of Lakeview St. off of the 91 Fwy; "sar4" – Lakeview, off the 91 Fwy and Lakeview St. across from Kaiser Permanente; "sar5" – Lincoln, off 57 Fwy N before it meets the 91 Fwy off of Lincoln St. on the NE corner of the bridge; and "sar6" – Katella, off the 57 Fwy N at the Katella exit, across from the Anaheim Pond Sports arena.
P3-OC11	Serrano Creek upstream of Barranca/Alton Parkway	33.6483	-117.7248	*E.coli* 35/68	Based on Orange County Coastkeeper Coastal Watersheds Project. Data collected between March 11, 2004 and March 29, 2006 from two sites: "ser1" – in Forest Grove in the upper Serrano Channel in Trabuco Rd and Peachwood under the bridge; "ser2" – in Irvine in the lower Serrano Channel, next to the Alton/Barranca intersection.
P3-RC1	Goldenstar Creek at Ridge Canyon Drive	33.8964	-117.3586	*E.coli* 19/79	Based on Orange County Coastkeeper Coastal Watersheds Project. Data collected between October 29, 2002 and June 3, 2004 from three sites: "gs1" – near the intersection of Van Buren Boulevard and Wood Road in City of Riverside; "gs2" – located at the end of Ridge Run Road in City of Riverside; and "gs3" – downstream of Golden Star Creek Road in City of Riverside. Exceedances at gs1 and gs2 only.
P3-RC2	Lake Fulmor at the Lakeside Boardwalk	33.8052	-116.7798	Data unavailable	State website states that listing decision made prior to 2006 and there is no information in state assessment database.
P3-SBC1	Santa Ana River Reach 4 above S. Riverside Avenue Bridge	34.0248	117.3628	Data unavailable	State website states that listing decision made prior to 2006 and there is no information in state assessment database.

[1] X/Y = First number is the number of exceedances; the second number is the number of samples.
[2] Source for information regarding exceedances is (a) the State Water Board's website for 2010 Integrated Report: http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/category5_report.shtml (find the relevant waterbody and click on the specific pollutant for summary of available data and listing history.; and (b) Santa Ana River Citizen Monitoring Project Final Report ("Orange County Coastkeeper Coastal Watersheds Project", November 2004.

6.2.4.2 Monitoring Sites

The monitoring sites for each Priority 4 waterbody are as follows (see Table 6-4, Figure 6-4 and SAR Bacteria Monitoring Plan, Section A.4 in Attachment A for additional location information):

- *Santa Ana Delhi Channel* – The Santa Ana Delhi Channel has two reaches that are REC2 only: (a) Reach 2 is within the City of Santa Ana, Orange County, CA and extends from Sunflower Avenue upstream to Warner Avenue, a distance of approximately 1 mile; (b) Reach 1 is within the cities of Costa Mesa and Newport Beach, CA and extends from the tidal prism upstream to Sunflower Avenue, a distance of approximately 2.5 miles. Two monitoring sites have been selected for the Santa Ana Delhi Channel to provide sample results from freshwater and tidal prism areas: (a) Upstream of Irvine Avenue; and (b) within the tidal prism at the Bicycle Bridge.
- *Greenville-Banning Channel Tidal Prism Segment*– This segment of the Greenville-Banning channel is designated REC2 only. It begins at its confluence with the Santa Ana River and extends upstream approximately 1.2 mile to the inflatable rubber dam operated by the Orange County Public Works Department. The monitoring site is located at an access ramp approximately 60 meters downstream of the trash boom below the rubber diversion dam.
- *Temescal Creek* – Temescal Creek has two reaches that are REC2 only: (a) Reach 1a is within the City of Corona, Riverside County and extends from Lincoln Avenue to confluence with Arlington Channel, a distance of approximately 3 miles; (b) Reach 1b within City of Corona and extends from Arlington Channel confluence to 1400 feet (ft) upstream of Magnolia Avenue (City of Corona). The monitoring site for Temescal Creek is located upstream of Lincoln Avenue.
- *Cucamonga Creek Reach 1* – Cucamonga Creek Reach 1 extends from the confluence with Mill Creek in the Prado area to near 23rd Street in the City of Upland. The monitoring site for Cucamonga Creek Reach 1 is at Hellman Road.

6.2.4.3 Sample Frequency

Water quality samples will be collected during dry weather (defined as no measurable rainfall within a 72 hour period prior to sampling) once per year until an *E. coli* or *Enterococcus* result exceeds the antidegradation target threshold value for the site (equal to the 75th percentile of the lognormal distribution fitted to historical data). If an exceedance of the antidegradation target is observed, additional bacterial indicator samples will be collected once/month for the three following months. If any of the follow-up samples exceed the antidegradation target, then sampling will continue on a monthly basis until source(s) of the increased bacterial indicator concentration is identified and mitigated and *E. coli* or *Enterococcus* levels return to below the antidegradation target in three of four samples collected over three consecutive months.

Table 6-4. Priority 4 monitoring sites

Site ID	Site Description	RMP Priority	Latitude	Longitude
P4-RC2	Temescal Creek at Lincoln Avenue	4	33.8941	-117.5772
P4-OC1	Santa Ana Delhi Channel Upstream of Irvine Avenue	4	33.6602	-117.8810
P4-OC2	Santa Ana Delhi Channel in Tidal Prism	4	33.6529	-117.8837
P4-OC3	Greenville-Banning Channel in Tidal Prism	4	33.6594	-117.9479
P4-SBC1	Cucamonga Creek at Hellman Avenue	4	33.9493	-117.6104

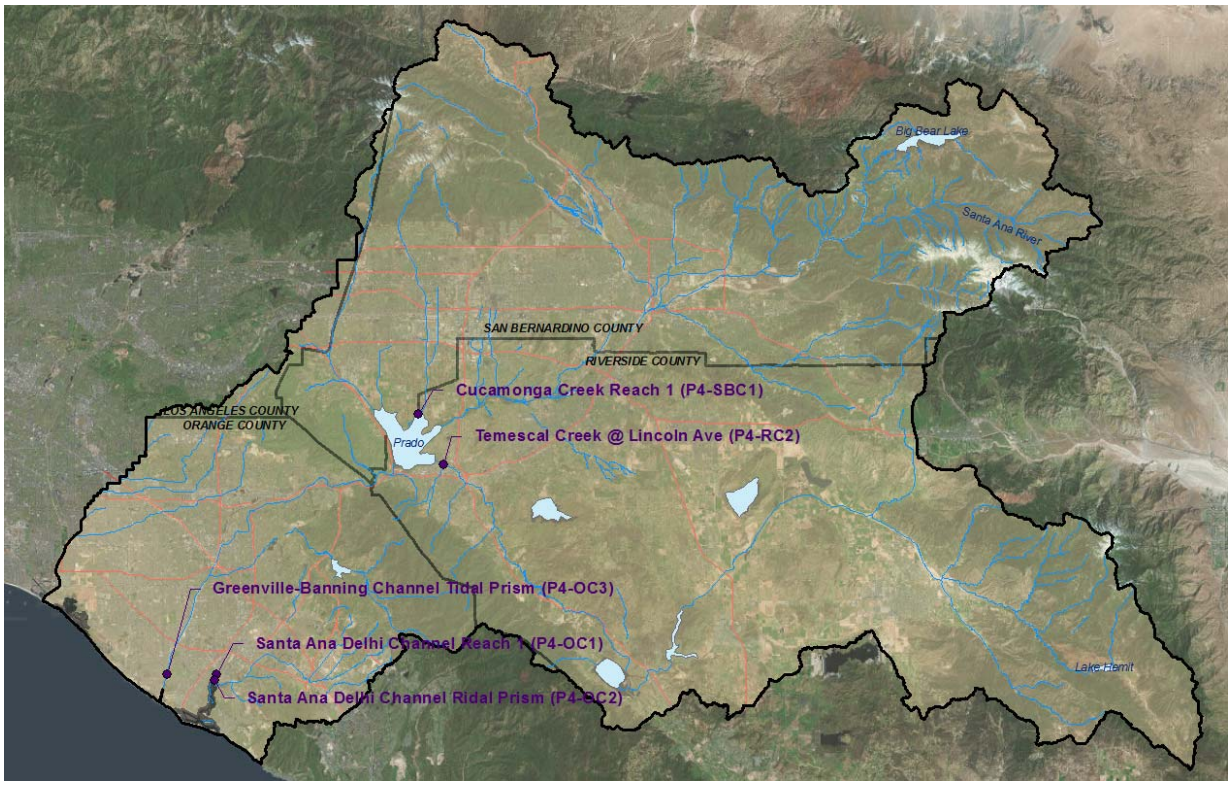

Figure 6-4. Priority 4 monitoring sites by County within the Santa Ana River watershed.

6.3 TMDL Monitoring Program

6.3.1 MSAR Bacteria TMDL Wet Weather Event Monitoring

6.3.1.1 Introduction

The purpose of the MSAR Bacteria TMDL watershed-wide compliance monitoring program is to assess compliance with wasteload allocations in the MSAR Bacteria TMDL (see Section 5.1.2). Compliance monitoring for the MSAR Bacteria TMDL during dry weather is addressed by monitoring conducted for Priority 1 and Priority 2 (described above in Sections 6.2.1 and 6.2.2, respectively). The MSAR Bacteria TMDL also requires the collection of bacteria water quality samples during one wet weather event each year. Monitoring for one storm event per wet season is carried out as a component of the TMDL Monitoring Program.

The same concentration based TMDL wasteload and load allocations for *E. coli* apply to both wet weather and dry weather conditions:

- *MSAR Bacteria TMDL wet weather numeric targets for E. coli:* 5-sample/30-day geometric mean < 113 organisms/100 mL and not more than 10 percent of the samples exceed 235 organisms/100 mL for any 30-day period.

Per the MSAR Bacteria TMDL, compliance with these numeric targets during wet weather shall be achieved by December 31, 2025. The TMDL allowed for an extended compliance timeline for wet weather conditions, because of the "expected increased difficulty in achieving compliance under [wet weather] conditions"[22].

6.3.1.2 Monitoring Sites

Table 6-5 and Figure 6-5 identify the monitoring sites for evaluating compliance with MSAR Bacteria TMDL numeric targets during wet weather.

6.3.1.3 Sample Approach and Frequency

One wet weather event is targeted for sampling each wet season, defined as November 1 through March 31 in the MSAR Bacteria TMDL. The goal of wet weather event sampling is to collect bacterial indicator data during the rising and falling limbs of the hydrograph. To accomplish this goal, a wet weather sample event requires the collection of four samples over an approximately four day period:

- *Sample 1* – Target sample collection on the day of the storm event when it is apparent that flow within the channel is elevated above typical dry weather conditions as a result of rainfall induced runoff.
- *Sample 2* – Collect samples approximately 48 hours after collection of Sample 1.
- *Sample 3* – Collect samples approximately 72 hours after collection of Sample 1.
- *Sample 4* – Collect samples approximately 96 hours after collection of Sample 1.

The decision whether to conduct wet weather sampling will be made by implementing the following steps:

- *Step 1* - Prepare to deploy the sampling team if rain is forecast (National Weather Service forecast on http://www.Accuweather.com), i.e., the sample teams are put on stand-by;
- *Step 2* - If rain develops, monitor rain gauges in the area (Riverside Municipal Airport and Ontario International Airport); and

[22] Page 3 of 15, Attachment A to Santa Ana Water Board Resolution R8-2005-0001

Table 6-5. MSAR Bacteria TMDL wet weather event monitoring sites

Site ID	Site Description	Latitude	Longitude
WW-M6	Mill-Cucamonga Creek below Wetlands	33.9410	-117.6209
WW-C7	Chino Creek at Central Avenue	33.9737	-117.6889
WW-C3	Prado Park Lake	33.9400	-117.6473
WW-S1	Santa Ana River Reach 3 at MWD Crossing	33.9681	-117.4479
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	33.9552	-117.5327

Coordinates are shown as Geographic WGS 1984 World Datum

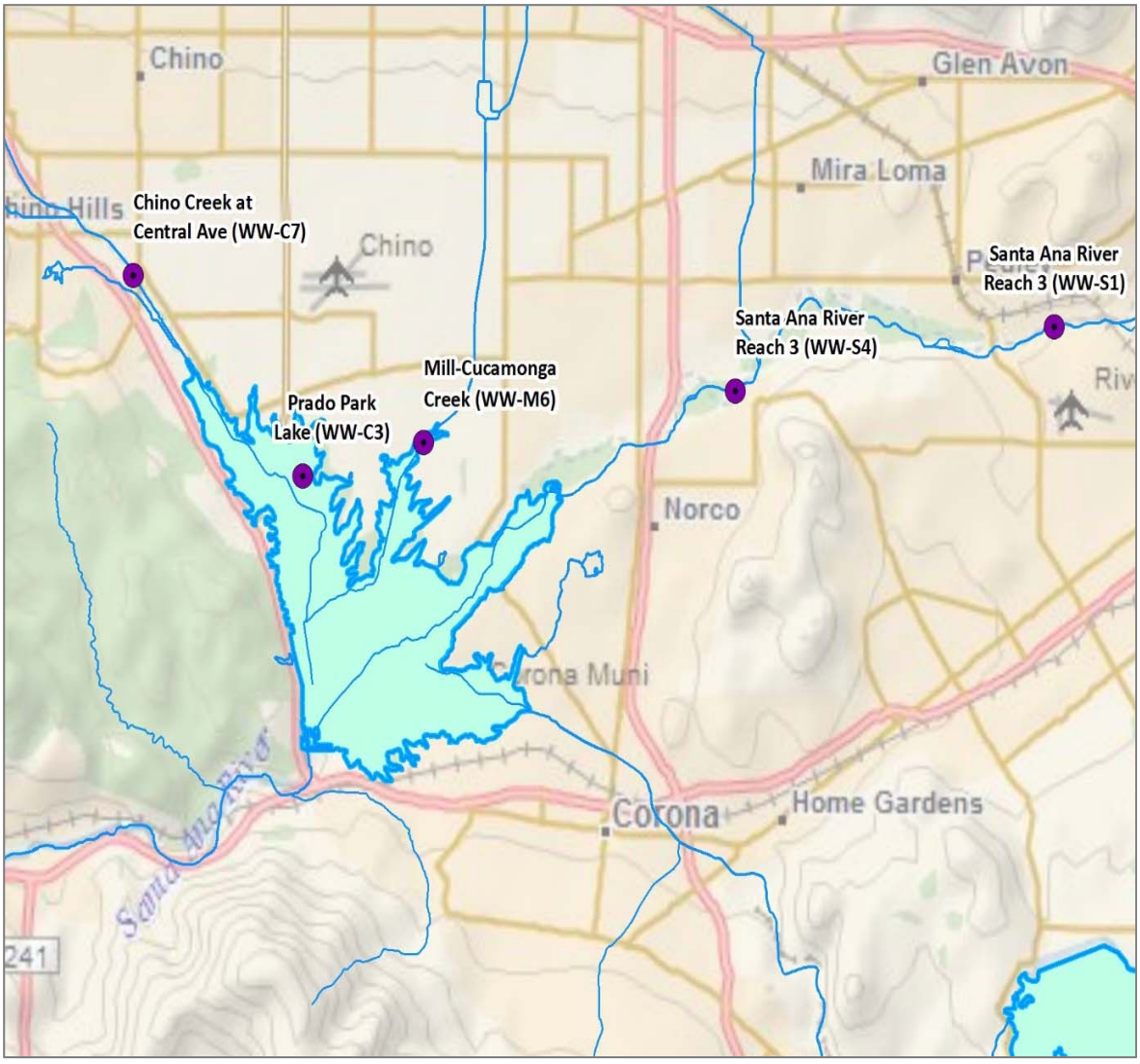

Figure 6-5. MSAR Bacteria TMDL wet weather event monitoring sites

- *Step 3* - Mobilize sampling crews at first daylight on the appropriate morning for sampling based upon the time that rainfall is expected. For instance, if rainfall onset is predicted for 0400 hours, samplers will be mobilized so that they arrive at sampling sites by daylight on the day of the predicted rainfall. If rainfall is predicted for 1300 hours, then samplers will mobilize at daylight of the next morning. Regardless of when rainfall begins, mobilization of sample teams is limited to first daylight to meet two sampling requirements:
  - For safety purposes, sampling may only be conducted during daylight hours; and
  - Samples must be dropped off at the laboratory, typically no later than 1500 hours to comply with laboratory processing procedures and to meet holding times.

Samples shall not be collected if conditions are determined to be unsafe by an on-site assessment conducted by the field team leader. If a wet weather event occurs during weekends or holidays, then additional coordination with the laboratory will be necessary to ensure water samples can be accepted for processing.

6.3.2 Urban Source Evaluation Program

6.3.2.1 Introduction

The MSAR Bacteria TMDL required MS4 dischargers to develop a USEP by November 30, 2007, six months after EPA approval of the MSAR TMDL. The purpose of the USEP was to identify specific activities, operations, and processes in urban areas that contribute bacterial indicators to waterbodies under the MSAR Bacteria TMDL. Prepared through the MSAR TMDL Task Force, the USEP was submitted to the Santa Ana Water Board in a timely manner and formally approved on April 18, 2008[23]. The approved USEP included the following objectives:

- Describe an Urban Source Evaluation Monitoring Program to be implemented to identify urban bacterial indicator sources;
- Establish a risk-based framework for evaluating water quality data obtained with regards to human illness from the Urban Source Evaluation Monitoring Program;
- Identify investigative activities that may be implemented to the maximum extent practicable based on water quality data; and
- Provide a schedule for USEP implementation with contingencies built in to allow for consideration of new data, modified regulations, changed priorities, or new technologies.

On January 29, 2010 the Santa Ana Water Board adopted new MS4 permits for Riverside and San Bernardino Counties. These permits required that each County develop a CBRP to meet MSAR TMDL wasteload allocations for the dry season. The source evaluation activities described in the USEP were incorporated into the CBRP. Accordingly, following Santa Ana Water Board approval of the CBRPs for each County on February 10, 2012[24], the CBRPs superseded the previously approved USEP and became the basis for bacterial indicator urban source evaluation activities carried out in the MSAR

[23] Santa Ana Water Board Resolution: R8-2008-0044; April 18, 2008
[24] Santa Ana Water Board Resolutions: R8-2012-0015 (Riverside County MS4 Program; R8-2012-0016 (San Bernardino County MS4 Program)

watershed (see page A-11 in the Riverside County CBRP; similar language is contained in the San Bernardino County CBRP)[25].

The Los Angeles Regional Water Quality Control Board (Los Angeles Water Board) adopted a new Los Angeles County MS4 Permit in 2012 that became effective December 28, 2012[26]. This permit required the Cities of Pomona and Claremont to develop CBRPs for the portions of their cities that are within the MSAR watershed[27]. Because the Santa Ana Water Board oversees MSAR Bacteria TMDL implementation, the Santa Ana Water Board oversaw development of the CBRPs for these cities. The Santa Ana Board approved the CBRPs for the Cities of Pomona and Claremont on March 14, 2014[28].

The primary goal of the source evaluation monitoring program is to guide efforts to identify and where possible mitigate controllable sources of bacterial indicator derived from discharges covered by MS4 permits. Source evaluation activities seek to answer the following questions:

- Which subwatershed areas are hydrologically connected to the waterbodies listed as impaired (in particular the Santa Ana River) by the MSAR Bacteria TMDL during dry flow conditions?
- What is the concentration of *E. coli* and rate of urban dry weather flow from MS4 facilities outfalls to a downstream TMDL compliance monitoring sites?
- What is the running geometric mean of *E. coli* in water samples collected from MS4 facilities?

The CBRPs establish an implementation approach to address these questions through source evaluation monitoring and elimination of controllable bacteria sources.

6.3.2.2 CBRP Implementation Approach

The MS4 permittees in each county implement source evaluation activities using a comprehensive, methodical approach that provides data to make informed decisions regarding the potential for an MS4 outfall or group of outfalls to discharge controllable sources of bacterial indicators. This approach relies on the following activities:

- *Tier 1 Reconnaissance* – Tier 1 sites are defined as sites where urban sources of dry weather flow may directly discharge to a downstream watershed-wide compliance site (see Table 6-6). Some of the Tier 1 sites are at the same sites sampled as part of implementation of the USEP in 2007-2008. Additional Tier 1 sites were included, where needed, to supplement existing information. Some Tier 1 locations were dry or had minimal dry weather flow, or in some instances were hydrologically disconnected to downstream waters. The data collected during Tier 1 was used to determine each outfall's potential to contribute controllable sources of bacterial indicators.
- *Prioritization of MS4 Drainage Areas* – Based on the findings from Tier 1 reconnaissance activities, MS4 drainage areas with potentially controllable urban sources of bacterial indicators are prioritized based on factors such as the magnitude of bacterial indicator concentrations and

[25] CBRPs available at http://www.waterboards.ca.gov/santaana/water_issues/programs/tmdl/msar_tmdl.shtml
[26] Los Angeles Water Board Resolution R4-2012-0175
[27] See Attachment R, Los Angeles Water Board Resolution R4-2012-0175
[28] Santa Ana Water Board Resolution: R8-2014-0030 (City of Claremont); R8-2014-0031 (City of Pomona)

results from source tracking analyses. Areas with controllable sources of bacteria (as determined through the use of *Bacteroides* testing for human marker) receive the highest priority for action.

- *Tier 2 Source Evaluation* – Source evaluation activities are being implemented first in the MS4 drainage areas with the highest priority Tier 1 sites. These activities include a strategically timed mix of field reconnaissance, secondary screening tool deployment, and bacterial water quality sample collection. Tier 2 sites are tributary to a Tier 1 site. Implementation of source evaluation activities at Tier 2 sites can be unique and is tailored for each drainage area. This ensures that source evaluation activities are as effective as possible given the large amount of potential monitoring sites within large urbanized drainage areas to an MS4 outfall. Methods for conducting Tier 2 source evaluation studies are provided in Section 11 of this QAPP.

The frequency of sample collection at any Tier 1 or Tier 2 site is determined by the need for source evaluation data to identify controllable sources of bacterial indicators.

6.3.2.3 Monitoring Sites

Table 6-6 lists the 34 Tier 1 locations that comprise all of the MS4 outfalls with existing or potential dry weather flow (Figure 6-6). These sites were recommended for sampling in the CBRPs prepared for Riverside and San Bernardino Counties, and the Cities of Pomona and Claremont, located in Los Angeles County.

For Tier 2, the selection of sample sites is determined by the characteristics of the drainage area upstream of the prioritized MS4 outfalls. As a consequence, there is no list of specific sites for Tier 2 source evaluations. Based on the Tier 1 reconnaissance in 2011-2012, the subwatersheds to the Tier 1 sites shown in Table 6-7 were the subject of Tier 2 source evaluation in the 2013 and 2014 dry seasons. The schedule contained in the CBRPs all provided for two dry seasons of Tier 2 source evaluation (2013, 2014). Future Tier 2 source evaluation will be conducted as the MS4 Permittees continue the process of tracking down controllable sources of bacterial indicators within MS4s.

6.3.2.4 Sampling Frequency

Within the MS4 drainage areas there is a vast drainage system that would be nearly impossible to completely monitor in a timely basis using water quality sample collection and analysis alone. To optimize resources, alternative monitoring methods have been identified that are recommended for use to track controllable sources of human fecal bacteria in prioritized MS4 drainage areas. Many of these methods are adapted from a Center for Watershed Protection guidance document[29].

Two bacteria source evaluation approaches are available for use by any MS4 permittee within any high priority drainage area, referred to as broad-brush or subregional approaches. The difference in these approaches involves the order of different types of investigation and the number of sites and frequency of water quality sample collection. Each approach is described below.

[29] Brown, E., Caraco, D., Pitt, R. 2004. *Illicit Discharge Detection and Elimination: Technical Appendices*. Center for Watershed Protection, Ellicott City, MD & University of Alabama, Tuscaloosa, AL.

Table 6-6. Tier 1 sample sites in the MSAR watershed[1]

Site ID	Site Description	Longitude	Latitude
Riverside County			
T1-64ST	64th Street Storm Drain (SAR Reach 3)	-117.488532	33.970798
T1-ANZA	Anza Drain (SAR Reach 3)	-117.463100	33.95869
T1-BXSP	Box Springs Creek @ Tequesquite Ave	-117.403599	33.975899
T1-CREST	City of Riverside Outfall (Crest/Ontario) (SAR Reach 3)	-177.476290	33.963361
T1-IDST	City of Riverside (Industrial/Freemont) (SAR Reach 4)	-117.436110	33.967330
T1-EVAN	City of Riverside Outfall (Lake Evans) (SAR Reach 4)	-117.381757	33.997002
T1-RBDX	City of Riverside Outfall at Rubidoux (SAR Reach 3)	-117.410220	33.968060
T1-DAY	Day Creek	-117.532980	33.975010
T1-EVLA	Eastvale MPD Line A (Mill-Cucamonga Creek)	-117.602032	33.967602
T1-EVLB	Eastvale MPD Line B (Mill-Cucamonga Creek)	-117.601892	33.960098
T1-EVLD	Eastvale MDP Line D (SAR Reach 3)	-117.579781	33.946701
T1-EVLE	Eastvale MDP Line E (SAR Reach 3)	-117.553434	33.950298
T1-MCSD	Magnolia Center SD (SAR Reach 3)	-117.415473	33.965599
T1-PHNX	Phoenix Storm Drain (SAR Reach 3)	-117.427128	33.963600
T1-SSCH	San Sevaine Channel	-117.506433	33.974300
T1-SNCH	Sunnyslope Channel	-117.427180	33.976200
T1-WLSD	Wilson Storm Drain (SAR Reach 4)	-117.372187	34.018700
San Bernardino County			
T1-SACH	San Antonio Channel @ SR 60	-117.72811	34.02470
T1-BRSC	Boys Republic South Channel @ confluence with Chino Creek	-117.72611	34.00208
T1-PPLN	Pipeline Ave 84" RCP outlet under bridge	-117.71506	33.98930
T1-CCCH	Carbon Canyon Creek @ Pipeline Ave	-117.71543	33.98620
T1-YRBA	Chino Creek, @ Yorba Ave ext., large outlet to SE of extension	-117.70192	33.98362
T1-LLSC	Lake Los Serranos Channel @ Red Barn Court crossing, above confluence with Chino Creek	-117.69106	33.97542
T1-CBLD	Chino Creek/San Antonio Creek @ ext. of Flowers St., behind Big League Dreams	-117.67493	33.95864
T1-CYP	Cypress Channel @ Kimball Avenue	-117.66039	33.96860
T1-CAPT	Cucamonga Creek @ Airport Drive	-117.60123	34.06294
T1-CNRW	Cucamonga Creek @ North Runway	-117.60072	34.05930
T1-CFRN	Cucamonga Creek @ Francis	-117.59848	34.04077
T1-WCUC	West Cucamonga Creek @ Cucamonga Creek	-117.59893	34.03257
T1-SR60	Cucamonga Creek @ above SR 60	-117.59929	34.03029
T1-CHRIS	Chris Basin Outflow @ Cucamonga Creek	-117.59906	34.00277
T1-CLCH	County Line Channel @ Cucamonga Creek	-117.60094	33.97431
T1-RISD	SW of Riverside Avenue @ SAR - City S.D.	-117.36447	34.02774
Los Angeles County			
CHINOCRK	Chino Creek upstream of San Antonio Channel	-117.73057	34.01343

[1] Coordinates are shown as Geographic WGS 1984 World Datum

Table 6-7. Prioritized Tier 1 drainage areas for Tier 2 source evaluation activities

Site ID	Jurisdictions	Drainage Acres	Human Presence[1]	MS4 Drainage Features
T1-EVLD	Eastvale	852	30%	Storm drains
T1-EVLE	Eastvale	798	100%	Storm drains
T1-CYP	Chino, Ontario	4,952	20%	Open channel with storm drain outfalls
T1-EVLB	Eastvale	334	80%	Storm drains
T1-ANZA	Riverside	7,313	20%	Open channel with storm drain outfalls
T1-CAPT	Ontario	1,050	40%	Storm drains
T1-CHRIS	Ontario	5,774	30%	Open channel with storm drain outfalls, culvert
T1-SSCH	Jurupa Valley, Fontana	3,337	40%	Open channel with storm drain outfalls
T1-EVLA	Eastvale	498	10%	Storm drains
CHINOCRK	Pomona, Claremont	6,032	30%	Storm drains
T1-PHNX	Riverside	503	10%	Storm drains
T1-CCCH	Chino Hills	3,934	0%[1]	Open channel with storm drain outfalls
T1-BRSC	Chino Hills	1,160	10%	Open channel with storm drain outfalls

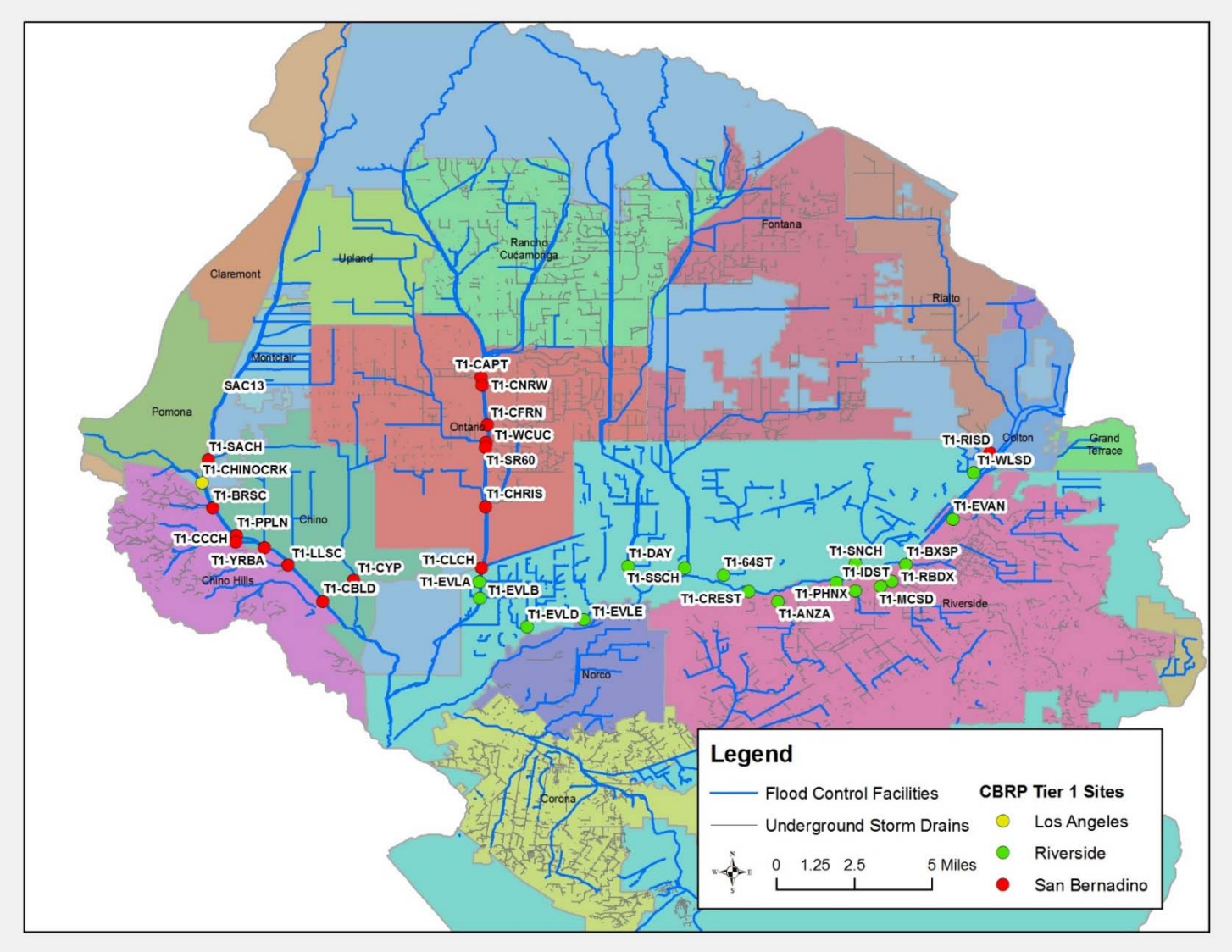

Figure 6-6. Tier 1 source evaluation Sites in the MSAR watershed to support implementation of the MSAR Bacteria TMDL

Broad-brush Approach

The broad-brush approach attempts to identify specific sources of human fecal bacteria by initially performing extensive field reconnaissance and screening investigations. These relatively low cost activities include field reconnaissance and deployment of secondary screening tools, and can be implemented at a large number of Tier 2 sites (see Section 11.4.2).

Results from field reconnaissance and secondary screening tool deployment are used to identify Tier 2 sites for bacterial water quality sample collection. On days when samples are collected from Tier 2 sites within the MS4s, samples are also collected from downstream Tier 1 sites to assess the relative role of the Tier 2 measurements in downstream bacteria characteristics.

The broad-brush approach provides a spatially robust dataset and has the potential to pinpoint specific management actions at an individual property scale to eliminate bacteria sources. MS4 permittees use results from field reconnaissance, secondary screening, and bacterial water quality analysis to guide implementation of short term management actions that address bacteria sources of concern. At the end of the dry season, a follow-up snapshot survey can be performed to determine the effectiveness of any management actions implemented.

The risk associated with this approach stems from the temporal variability in human *Bacteroides* detection, which was typically less than 40 percent of samples in the 2012 dry season at the downstream Tier 1 sites. Accordingly, there is a greater chance of missing the human fecal bacteria signal taking an approach with a single snapshot survey.

Subregional Approach

The subregional approach attempts to develop a better understanding of dry weather flow and water quality from subareas within the prioritized Tier 1 MS4 drainages. This approach involves weekly sample collection from the downstream Tier 1 site and at one or more major trunk confluences within the MS4 drainage system (Tier 2 sites). Samples are analyzed for *E. coli* over ten consecutive weeks to develop a baseline longitudinal characterization. Secondary screening tools are used in 5 of the 10 weeks to assess water quality at Tier 2 sites selected for source evaluation in neighborhood scale subareas upstream of each baseline bacterial water quality site. Field reconnaissance is important to identify the Tier 2 sites for baseline characterization in the initial weeks, and then to aid in selection of Tier 2 sites for source evaluation incorporating secondary screening tracer sample collection in the middle of the dry season. Lastly, in the latter portion of the dry season, samples are collected and analyzed for human *Bacteroides* at a subset of the Tier 2 sites based on information gathered from secondary screening and field reconnaissance. MS4 permittees use results from all phases of the source evaluation to guide implementation of short term management actions that address bacteria sources of concern.

The risk associated with this approach stems from the aggregation of large spatial areas, which may not provide the resolution needed to identify specific sources for focusing or targeting short-term management actions. However, since the Tier 2 source evaluations occur over two dry seasons, a subregional approach in the first year could be followed by adopting the broad-brush approach in smaller more manageable subareas in the second year of the program.

6.3.3 AgSEP Monitoring Program

6.3.3.1 Introduction

With EPA approval of the MSAR Bacteria TMDL in May 2007, agricultural dischargers (as defined by the TMDL) were required to complete specific implementation activities either in collaboration with other TMDL responsible parties or separately. Specifically, agricultural discharges were required to complete the following activities:

- Implement a watershed-wide compliance monitoring program (currently being implemented in collaboration with urban dischargers; see Section 6.3.1);
- Develop an AgSEP by November 30, 2007; and
- Develop a BASMP.

Agricultural Source Evaluation Plan

The purpose of the AgSEP was to identify specific activities, operations and processes in agricultural areas that contribute bacterial indicators to MSAR watershed waterbodies. The plan was to include a proposed schedule for the steps identified and include contingency provisions as needed to reflect any uncertainty in the proposed steps or schedule. Information from implementation of the AgSEP would be used by the Santa Ana Water Board and agricultural stakeholders to support development of the BASMP.

The AgSEP was submitted to the Santa Ana Water Board by November 30, 2007; it was approved on April 18, 2008[30]. A component of the AgSEP involved implementation of an AgSEMP at key sites to gather bacterial indicator data. Monitoring was conducted during wet weather in the 2008-2009 wet season at four monitoring sites and included collection of field parameters, bacterial indicator data, and microbial source identification analyses (Table 6-8 and Figure 6-7). No additional sample collection from the AgSEP sample sites is currently planned. More details on the AgSEP program implementation are provided in Section 4.1.3.2 of the SAR Bacteria Monitoring Plan.

Bacterial Indicator Agricultural Source Management Plan

Per the MSAR Bacteria TMDL, the BASMP should include, plans and schedules for the following:

- Implementation of bacteria indicator controls, Best Management Practices (BMPs) and reduction strategies designed to meet load allocations;
- Evaluation of effectiveness of BMPs; and
- Development and implementation of compliance monitoring program(s).

A BASMP is currently under development by agricultural dischargers in the MSAR watershed. When complete it is expected to replace the AgSEP. Because this document is still under development, this section will be updated once the BASMP is finalized. Moreover, the final BASMP may include monitoring requirements designed to support implementation of the BASMP. If included in the final program, then these monitoring requirements will be incorporated into the SAR Bacteria Monitoring Plan and QAPP.

[30] Santa Ana Water Board Resolution: R8-2008-0044; April 18, 2008

Table 6-8. AgSEMP monitoring sites

Site ID	Site Description	Longitude	Latitude
Prado Park Lake Drainage Area			
AG-G2	Grove Avenue Channel at Merrill Avenue	-117.37685	33.58986
AG-G1	Eucalyptus Avenue at Walker Avenue	-117.37163	33.59425
AG-E2	Euclid Avenue Channel at Pine Avenue	-117.38926	33.57220
Cucamonga Creek, Reach 1 Drainage Area			
AG-CL1	Eucalyptus Avenue at Cleveland Avenue (*Backup to Walker Avenue, depending on flow conditions)* (CL1)	-117.34031	33.59405
Chino Creek, Reach 1 Drainage Area			
AG-CYP1	Cypress Channel at Kimball Avenue (*dual site; same as USEP site US-CYP*)	-117.66043	33.96888

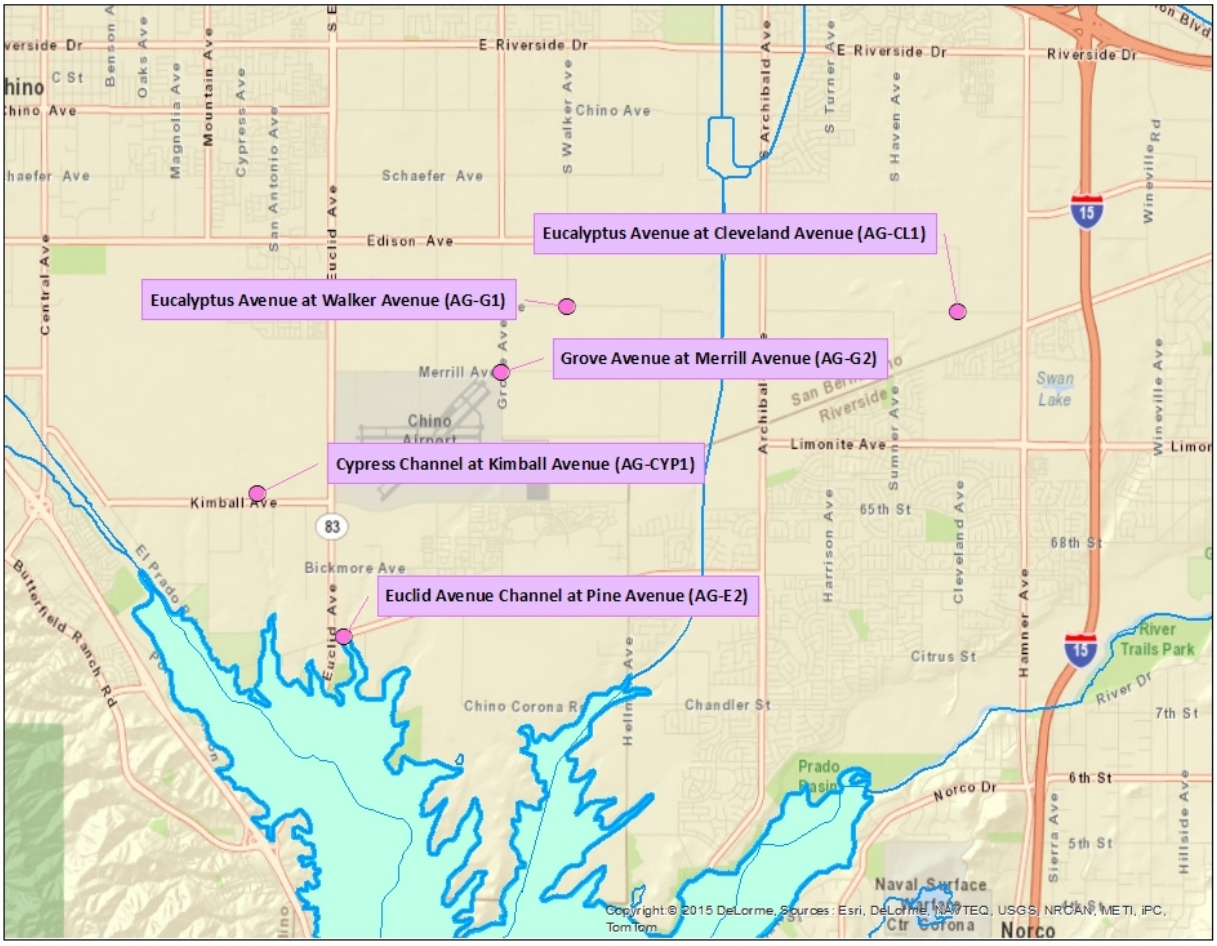

Figure 6-7. Location of AgSEMP sites sampled in 2008-2009.

6.4 Constituents to be Monitored and Measurement Techniques

The following water quality indicators will be measured at the Regional Monitoring Program (Section 6.2), watershed-wide wet weather (Section 6.3.1), Urban Source Evaluation (Section 6.3.2), and Agricultural Source Evaluation (Section 6.3.3.) monitoring sites, respectively.

6.4.1 Regional Monitoring Program Monitoring Sites

The following water quality indicators will be analyzed in water samples collected at each priority monitoring site on each sample date:

- *Field Analysis*: Temperature, conductivity, pH, dissolved oxygen, and turbidity will be measured with a Horiba multi-parameter probe or related instrument.
- *Flow*: During each time a site is sampled, if conditions are safe, flow will be characterized using a either a volumetric, cross-section velocity profile, or a visual estimate method.
- *Water Quality Analysis*: *E. coli*, and total suspended solids (TSS) concentrations in grab samples will be analyzed by a qualified laboratory for all Priority 1, 2 and 3 sites and all Priority 4 sites except P4-OC2 and P4-OC3. For P4-OC2 and P4-OC3, grab samples will be analyzed for *Enterococcus* and TSS

6.4.2 MSAR Bacteria TMDL Wet Weather Event Monitoring

Consistent with the MSAR Bacteria TMDL, the following water quality indicators will be analyzed in water samples collected at each site on each sample date:

- *Field Analysis*: Temperature, conductivity, pH, dissolved oxygen, and turbidity will be measured with a Horiba multi-parameter probe or related instrument.
- *Flow*: During each time a site is sampled, if conditions are safe, flow will be characterized using a either a volumetric, cross-section velocity profile, or a visual estimate method.
- *Water Quality Analysis*: *E. coli*, and TSS concentrations in grab samples will be analyzed by a qualified laboratory included in this QAPP (see appendices).

6.4.3 Urban Source Evaluation Monitoring Program

The following data will be collected when each Tier 1 or Tier 2 site is sampled:

- *Field Analysis*: Temperature
- *Water Quality Analysis*: *E. coli*, TSS, and *Bacteroides* analysis will be analyzed by a qualified laboratory included in this QAPP (see appendices).
- *Flow*: During each time a site is sampled, if conditions are safe, flow will be characterized using a volumetric, cross-section velocity profile, or visual estimate method
- *Bacteroides Analysis*: OCWD or qualified laboratory will use a semi-quantitative presence/absence method to analyze for human source *Bacteroides*.

In addition to measuring flow at Tier 1 sites, samplers assess the hydrologic connectivity of the surface flow at each site to the downstream impaired waterbody (Santa Ana River Reach 3, Mill Creek, Cucamonga Creek, and Chino Creek Reach 1 and 2) to evaluate if the tributary drain is actually discharging any runoff to the downstream waterbody. Under dry weather conditions, many Tier 1 locations, particularly along Santa Ana River Reach 3 are likely to not have hydrologic connectivity due to the long distance between Tier 1 discharge outfalls and the Santa Ana River. If there is no connection of surface waters, then the flow rate is assumed to be zero for that date only; collection of a water sample for laboratory analysis is optional, depending on the need for the data.

A variety of water quality screening tools can be effective at identifying specific MS4 sources of bacterial contamination with limited resources. These tools will be employed for Tier 2 bacteria source evaluation and are described in more detail in Section 11 of this QAPP:

- Ammonia Testing
- Potassium Testing
- Chlorine Test Strips
- Copper Test Strips
- Surfactant/Detergent Screening
- Canine scent tracking

6.4.4 Agricultural Source Evaluation Monitoring Program

The following data will be collected when each site is sampled:

- *Field Analysis*: Temperature, conductivity, pH, dissolved oxygen, and turbidity will be measured with a Horiba Multi-parameter probe or related instrument.
- *Water Quality Analysis*: *E. coli*, and TSS concentrations in grab samples will be analyzed by a qualified laboratory included in this QAPP (see appendices).
- *Flow*: During each time a site is sampled, if conditions are safe, flow will be characterized using a visual estimate method.
- *Bacteroides Analysis*: A qualified laboratory will assay water grab samples for *Bacteroides* host-specific markers for humans, ruminant, and domestic canine to determine if they are present and to provide a semi-quantitative estimate of their relative abundance.

6.5 Constraints to Monitoring

Under some circumstances, collection of water samples or field measurements may not be possible. For example, if flow in the channel is elevated, conditions may be too dangerous for taking a flow measurement by developing a cross section velocity profile. Another potential constraint would occur if the channel is dry, thus making it impossible to collect surface water samples. The field team will document any constraints in the field on the Field Data Forms. The data manager will incorporate

observational data from these site visits into the water quality database, indicating the reason why data were not collected at a given site.

6.6 Project Schedule

The project schedule is documented in in the SAR Bacteria Monitoring Plan and in Section 10 of this QAPP.

7. Quality Objectives and Criteria for Measurement Data

Table 7-1 summarizes the applicable data quality objectives for the types of measurements or analyses conducted under this project. Tables 7-2 and 7-3 summarize the specific data quality objectives for field measurements or constituents measured in the laboratory, respectively.

Table 7.1. Project data quality objectives

Measurement or Analyses Type	Applicable Data Quality Objective
Field Measurements	Accuracy, Precision, Completeness
Bacterial Analyses	Precision, Presence/Absence, Completeness
Water Quality Analyses, Surfactant Analyses	Accuracy, Precision, Recovery, Completeness

Accuracy will be determined by measuring one or more selected from performance testing samples or standard solutions from sources other than those used for calibration. Accuracy criteria for bacterial testing will be based on presence/absence testing rather than numerical limits owing to the difficulty in preparing solutions of known bacterial concentration.

Precision measurements will be determined on both field and laboratory replicates. The number of replicates for field measurements will be three, the number for TSS, ammonia, potassium, and surfactants will be two, and for bacterial testing, the number of replicates will be five.

Recovery measurements will be determined by laboratory spiking of a replicate sample with a known concentration of the analyte. The target level of addition is at least twice the original sample concentration and is applicable to TSS, ammonia, potassium, and surfactant analyses.

Completeness is the number of analyses generating useable data for each analysis divided by the number of samples collected for that analysis.

Method sensitivity is dealt with by the inclusion of the required SWAMP Target Reporting Limits, where such values exist. Target Reporting Limits exist for *E. coli*, *Enterococcus*, TSS, and ammonia.

No Target Reporting Limits were set for the potassium and surfactant laboratory analyses, or for the field analyses.

Table 7-2. Data quality objectives for field measurements

Group	Parameter	Accuracy	Precision	Recovery	Target Reporting Limit	Completeness
Field Measurements	Conductivity	+/-5%	± 5%	NA	NA	90%
Field Measurements	Dissolved Oxygen	±0.5 milligrams/Liter (mg/L)	± 0.5 or 10%; whichever is greater	NA	NA	90%
Field Measurements	pH	+/- 0.5 units	± 0.5 or 5%, whichever is greater	NA	NA	90%
Field Measurements	Temperature	+/- 0.5ºC	± 0.5 or 5%, whichever is greater	NA	NA	90%
Field Measurements	Turbidity	+/-10% or 0.1, whichever is greater	± 10% or 0.1, whichever is greater	NA	NA	90%
Field Measurements	Flow (visual estimate)	+/- 25% or 0.25, whichever is greater	± 25% or 0.25, whichever is greater	NA	NA	90%
Field Measurements	Flow (via flow instruments)	+/-10% or 0.1, whichever is greater	± 10% or 0.1, whichever is greater	NA	NA	90%
Field Measurements	Ammonia	+/-20%	+/-10%	NA	NA	90%
Field Measurements	Chlorine	+/-20%	+/-10%	NA	NA	90%
Field Measurements	Copper	+/-20%	+/-10%	NA	NA	90%
Field Measurements	Detergents/ Surfactants	+/-20%	+/-10%	NA	NA	90%
Field Measurements	Canine Scent Tracking	+/-20%	+/-10%	NA	NA	90%

Table 7-3. Data quality objectives for laboratory measurements

Group	Parameter	Accuracy	Precision	Recovery	Target Reporting Limits	Completeness
Bacterial Analyses	*E. coli*	Positive results for target organisms. Negative results for non-target organisms	R_{log} within 3.27*mean R_{log} (reference is section 9020B 18th, 19th, or 20th editions of *Standard Methods*)	NA	10 colony forming units (cfu)/100 mL	90%
	Enterococcus	Positive results for target organisms. Negative results for non-target organisms	R_{log} within 3.27*mean R_{log} (reference is section 9020B 18th, 19th, or 20th editions of *Standard Methods*)	NA	10 colony forming units (cfu)/100 mL	90%
Bacteria Source Analyses	Genetic markers for human and canine (*Bacteroides thetaiotaomicron*), horse (*Bacteroides* spp.), bird (*Heliobacter*), and rumen (*Prevotella*)	Positive results for target organisms. Negative results for results below detection limit of assay	NA	NA	10 cells/ 100 mL	90%
Conventional Constituents in Water	TSS	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by provider of material. If not available then with 80% to 120% of true value	Blind field duplicate and Laboratory duplicate, or MS/MSD 25% RPD	Matrix spike 80% - 120% or control limits at $\pm$ 3 standard deviations based on actual lab data, whichever is more stringent	1.0 mg/L	No SWAMP requirement; will use 90%
Nutrients in Water	Ammonia	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by provider of material. If not available then with 80% to 120% of true value	Blind field duplicate and Laboratory duplicate, or MS/MSD 25% RPD	Matrix spike 80% - 120% or control limits at $\pm$ 3 standard deviations based on actual lab data, whichever is more stringent	0.1 mg/L	No SWAMP requirement; will use 90%
Inorganic Analytes in Water	Potassium	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by provider of material. If not available then with 80% to 120% of true value	Blind field duplicate and Laboratory duplicate, or MS/MSD 25% RPD	Matrix spike 80% - 120% or control limits at $\pm$ 3 standard deviations based on actual lab data, whichever is more stringent	NA	No SWAMP requirement; will use 90%
Detergents/ Surfactants in Water	MBAS	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by provider of material. If not available then with 80% to 120% of true value	Blind field duplicate and Laboratory duplicate, or MS/MSD 25% RPD	Matrix spike 80% - 120% or control limits at $\pm$ 3 standard deviations based on actual lab data, whichever is more stringent	NA	No SWAMP requirement; will use 90%

8. Special Training Needs/Certification

All persons involved in the field sampling activities to implement the SAR Bacteria Monitoring Plan will be trained prior to any field sampling. Training will take place to ensure that sampling field members are familiar with the protocols and sampling sites.

All individuals that participate in sampling activities are required to have attended (at a minimum) the "4-hour Basic Site Safety Training" provided by an appropriately qualified trainer and/or contractor of the Health and Safety branch of the State, and/or equivalent university training. The training will cover the general health and safety issues associated with fieldwork, including sampling. The Project Manager for each Responsible Agency will provide specific training, pertinent to the details of a particular sampling program. This training will include, but not be limited to, proper use of field equipment, health and safety protocols, sample handling protocols, and chain of custody protocols.

Field staff training is documented and filed at the office of the Project Manager for each Responsible Agency. Documentation consists of a record of the training date, instructor, whether initial or refresher, and whether the course was completed satisfactorily.

All commercial laboratories will provide appropriate training to its staff as part of its Standard Operating Procedure. All laboratories will maintain their own records of its training that comply with OSHA requirements. Those records can be obtained, if needed, from each contract laboratory through their Quality Assurance Officer.

9. Documents and Records

The following documentation and records procedures will be followed (Table 9-1):

- A Final Annual Report will be submitted electronically to the Santa Ana Water Board by June 30th of each year to document the findings from the previous sample year.[31] Electronic copies will be provided to each Responsible Agency. The first Final Annual Report will be submitted by June 30, 2017.

- Each Responsible Agency's Project Manager will maintain a record of all field data collection activities and samples collected and analyzed. All samples delivered to contract laboratories for analysis will include completed Field COC forms (Attachment E). Upon request, all contracted laboratories will generate records for sample receipt and storage, analyses, and reporting.

- Contract laboratories will submit the results of all laboratory analyses to the Responsible Agency Monitoring Manager that submitted the samples for analysis. Field data collected by each Responsible Agency will be maintained onsite and uploaded into a spreadsheet/database while sampling is ongoing within a sample year. The spreadsheet/database format will be provided to all Responsible Agency Project Managers by the Project Director.

- For each sample year, electronic records of field data and laboratory sample results, copies of COC and original field data sheets and flow measurement forms for sites where a velocity cross section profile method was used to measure flow will be kept on file by the Responsible Agency. By January 15th of each reporting year, all forms, data sheets, or electronic files associated with non-wet weather event sampling will be provided to the Project Director to support preparation of the Annual Report. Within 15 days after completion of wet weather event sampling, all forms, data sheets, or electronic files associated with the sampling event will be provided to the Project Director to support preparation of the Annual Report.

- Contract laboratories will maintain electronic or paper records pertinent to the implementation of the SAR Bacteria Monitoring Plan at the laboratory's main office for at least three years. By January 15th of each year, each contract laboratory will provide to the Project Director a QA/QC Report that assesses compliance with laboratory QA/QC protocols for dry weather samples processed during the previous sample year (generally May 1 through November 30). In addition, by April 15th of each year, each contract laboratory will provide to the Project Director a QA/QC Report that assesses compliance with laboratory QA/QC protocols for wet weather event samples processed during the previous sample year during the wet season (between November 1 and March 31). At any time, copies of records or QA/QC reports held by the contract laboratories will be provided to a Responsible Agency Project Manager (or Project QA Officer) or Project Director upon request.

[31] A sample year is the period from May 1 through April 30 and includes the following sample activity: (a) collection of dry weather samples from Priority 1, 2, 3, and 4 sites from May through September; (b) collection of dry weather samples from Priority 1, 2 and 3 sites in late October through November; and (c) collection of samples from one wet weather event in the MSAR watershed between November 1 and March 31. See Section 10 for specific sample schedules for each priority site.

- Each Responsible Agency's Data Manager will manage field and laboratory data results by ensuring that all such data are uploaded into a database or spreadsheet template provided by the Project Director. By January 15th of each year, each Responsible Agency Project Manager will submit to the Project Director the database or spreadsheet file containing the previous sample year's field and laboratory data for dry weather samples collected during the previous sample year (generally May 1 through November 30). In addition, by April 15th of each year, each Responsible Agency Project Manager will submit to the Project Director the database or spreadsheet file containing the previous sample year's field and laboratory data for wet weather event samples collected during the previous sample year during the wet season (between November 1 and March 31).,

- As part of the preparation of each Annual Report, the Project Director will ensure that all field data and laboratory data results (including QA/QC data) from each Responsible Agency are combined and uploaded to CEDEN. Data will be uploaded no later than 30 days after submittal of the Final Annual Report to the Santa Ana Water Board.

- Copies of this QAPP will be distributed to all Responsible Agencies involved with the SAR Bacteria Monitoring Program. Copies will be sent to each Contract Laboratory QA Officer for distribution to appropriate Laboratory Personnel. Any future amended QAPPs will be held and distributed in the same manner. All originals of this QAPP and its amendments will be held by the Project Director. Copies of versions, other than the most current, will be discarded so as not to create confusion.

- The Project Director will prepare a Draft Annual Report by April 30th of each year to reflect findings from sampling conducted during the previous sample year. This report will include findings from (a) all RMP sites; and (b) any required TMDL monitoring activities conducted to support implementation of a bacteria TMDL, e.g., wet weather sampling. After providing an opportunity for review of the Draft Annual Report and revising the draft report based on comments received, a Final Annual Report will be submitted electronically to the Santa Ana Water Board by June 30 of each year.

- At a minimum, the Final Annual Report will be electronically distributed to each Responsible Agency and the Santa Ana Water Board. The Final Annual Report will be made available to the public on either the Santa Ana Water Board or Project Director's website.

Table 9-1. Record retention, archival, and disposition information

Record Type	Document Type	Retention	Archival	Disposition
Sample Collection Records	Field Logs	Responsible Agency during sample year	Project Director	Project Director
Analytical Records	Laboratory results	Responsible Agency and Contract Laboratories during sample year	Project Director	Project Director
	COC Forms	Responsible Agency and Contract Laboratories during sample year	Project Director	Project Director
Assessment Reports	QA/QC Updates	Responsible Agency during sample year	Project Director	Project Director
	QA/QC Final Report	Responsible Agency during sample year	Project Director	Project Director
	Field Sampling Review	Responsible Agency Project QA Officer during sample year	Project Director	Project Director
	Internal Technical Audit of Database Management	Responsible Agency Data Manager during sample year	Project Director	Project Director
Reports	Santa Ana River Bacteria Monitoring Program Annual Report	Responsible Agency Project Manager	Project Director	Project Director and Santa Ana Water Board

Group B: Data Generation and Acquisition

10. Sampling Process Design

10.1 Regional Monitoring Program

For dry weather monitoring activities at RMP Sites (see Section 6.2), the sampling effort is generally described as follows (see Tables 10-1 and 10-2):

- *Priority 1 and 2 Sites*: Priority 1 and 2 sample sites will be sampled during dry weather (defined as no measurable rainfall within a 72 hour period prior to sampling) for a 20-week period during the warmest part of the year between May 1 and September 30. In addition, Priority 1 sample sites will also sampled during one 5-week period from end of October through most of November each year during the cooler season. The resulting dataset will include 25 samples each year from each site and provide sufficient data to calculate 16 geometric means during the 20-week sample period and one geometric mean during the cool season. Table 10-1 provides a sampling schedule from January 1, 2016 through 2020.

- *Priority 3 Sites, (five-week sample events rotated on annual basis)*: Fourteen monitoring sites are included in this Priority category. These sites have been grouped, generally by location, into five groups (Table 10-2). The goal is to collect five samples over a five week consecutive period during dry weather once each year. Accordingly, grouped sites will be sampled during dry weather (defined as no measurable rainfall within a 72 hour period prior to sampling) on a rotational basis over a period of a year so that all sites are sampled at least once each year (Table 10-2). The overall sample schedule for these sites overlaps with the Priority 1 & 2 sample site schedule to maximize efficiency with the collection of samples. In the first year of implementation, Groups 1 through 5 will be sampled in order over a one year period. In subsequent years, the order of groups varies so that a Group's assigned five-week sample period varies by season over the long-term (e.g., summer vs. fall or winter).

- *Priority 4 Sites, (once per year)*: Water quality samples will be collected during dry weather once per year and analyzed for *E. coli* or *Enterococcus* to determine if the result exceeds the antidegradation target threshold value for the site (equal to the 75th percentile of the lognormal distribution fitted to historical data). If an exceedance of the antidegradation target is observed, additional *E. coli* or *Enterococcus* samples will be collected once/month for the three following months. If any of the follow-up samples exceed the antidegradation target, then sampling will continue on a monthly basis until source(s) of the increased bacterial indicator concentration is identified and mitigated and bacterial indicator levels return to below the antidegradation target in three of four samples collected over three consecutive months. The annual dry weather sample will be collected during the summer season between June 21 and September 21 when REC2 activities are most likely to occur. If additional sampling is required due to an observed exceedance, the schedule will be determined based on the process described above.

10.2 TMDL Monitoring Programs

10.2.1 MSAR Bacteria TMDL Wet Weather Event Monitoring

One wet weather event is targeted for sampling each wet season, defined as November 1 through March 31 in the MSAR Bacteria TMDL. The goal of wet weather event sampling is to collect bacterial indicator data during the rising and falling limbs of the hydrograph. To accomplish this goal, a wet weather sample event requires the collection of four samples over an approximately four day period:

- Sample 1 – Target sample collection on the day of the storm event when it is apparent that flow within the channel is elevated above typical dry weather conditions as a result of rainfall induced runoff.
- Sample 2 – Collect samples approximately 48 hours after collection of Sample 1.
- Sample 3 – Collect samples approximately 72 hours after collection of Sample 1.
- Sample 4 – Collect samples approximately 96 hours after collection of Sample 1.

10.2.2 Urban Source Evaluation Monitoring Program

Tier 1 and 2 source evaluation activities contained in the CBRP schedule were completed during the period from 2012 to 2014. Additional site-specific monitoring activities are ongoing where needed to answer local questions. Any water quality samples collected as part of these activities are conducted according to the requirements of this QAPP.

10.2.3 Agricultural Source Evaluation Monitoring Program

Prior agricultural source evaluation monitoring occurred in 2008-2009. A BASMP is currently under development by agricultural dischargers in the MSAR watershed. The final BASMP may include monitoring requirements designed to support implementation of the management plan. If included in the final program, then the approach and schedule will be added to Section 10 of this QAPP.

Table 10-1. Sample schedule for Priority 1 and 2 waters during dry weather conditions (2016 - 2020)

Year	Sample Season	First Week of Sampling	Last Week of Sampling	Priority 1 Waters	Priority 2 Waters
2016	Warm Season	May 8	September 18	All Table 3.1 Waters	All Table 3.3 Waters
	Cool Season	October 30	November 27	All Table 3.1 Waters	All Table 3.3 Waters
2017	Warm Season	May 7	September 17	All Table 3.1 Waters	All Table 3.3 Waters
	Cool Season	October 29	November 26	All Table 3.1 Waters	All Table 3.3 Waters
2018	Warm Season	May 6	September 16	All Table 3.1 Waters	All Table 3.3 Waters
	Cool Season	October 28	November 25	All Table 3.1 Waters	All Table 3.3 Waters
2019	Warm Season	May 5	September 15	All Table 3.1 Waters	All Table 3.3 Waters
	Cool Season	October 27	November 24	All Table 3.1 Waters	All Table 3.3 Waters
2020	Warm Season	May 10	September 20	All Table 3.1 Waters	All Table 3.3 Waters
	Cool Season	October 25	November 22	All Table 3.1 Waters	All Table 3.3 Waters

Table 10-2. Sample schedule for Priority 3 waters during dry weather conditions (2016 - 2020)

Year	First Week of Sampling	Last Week of Sampling	Priority 3 Waters
2016	May 8	June 5	**Group 1**: Bolsa Chica Channel, , Santa Ana River Reach 2
	June 12	July 10	**Group 2**: Peters Canyon Wash, San Diego Creek Reach 1, San Diego Creek Reach 2, Borrego Creek, Serrano Creek
	July 17	August 14	**Group 3**: Los Trancos Creek, Morning Canyon Creek, Buck Gully Creek
	August 21	September 18	**Group 4**: Santa Ana Reach 4
	October 30	November 27	**Group 5**: Goldenstar Creek, Lake Fulmor
2017	May 7	June 4	**Group 2**: Peters Canyon Wash, San Diego Creek Reach 1, San Diego Creek Reach 2, Borrego Creek, Serrano Creek
	June 11	July 9	**Group 3**: Los Trancos Creek, Morning Canyon Creek, Buck Gully Creek
	July 16	August 13	**Group 4**: Santa Ana Reach 4
	August 20	September 17	**Group 5**: Goldenstar Creek, Lake Fulmor
	October 29	November 26	**Group 1**: Bolsa Chica Channel, , Santa Ana River Reach 2
2018	May 6	June 3	**Group 3**: Los Trancos Creek, Morning Canyon Creek, Buck Gully Creek
	June 10	July 8	**Group 4**: Santa Ana Reach 4
	July 15	August 12	**Group 5**: Goldenstar Creek, Lake Fulmor
	August 19	September 16	**Group 1**: Bolsa Chica Channel, , Santa Ana River Reach 2
	October 28	November 25	**Group 2**: Peters Canyon Wash, San Diego Creek Reach 1, San Diego Creek Reach 2, Borrego Creek, Serrano Creek
2019	May 5	June 2	**Group 4**: Santa Ana Reach 4
	June 9	July 7	**Group 5**: Goldenstar Creek, Lake Fulmor
	July 14	August 11	**Group 1**: Bolsa Chica Channel, , Santa Ana River Reach 2
	August 18	September 15	**Group 2**: Peters Canyon Wash, San Diego Creek Reach 1, San Diego Creek Reach 2, Borrego Creek, Serrano Creek
	October 27	November 24	**Group 3**: Los Trancos Creek, Morning Canyon Creek, Buck Gully Creek
2020	May 10	June 7	**Group 5**: Goldenstar Creek, Lake Fulmor
	June 14	July 12	**Group 1**: Bolsa Chica Channel, , Santa Ana River Reach 2
	July 19	August 16	**Group 2**: Peters Canyon Wash, San Diego Creek Reach 1, San Diego Creek Reach 2, Borrego Creek, Serrano Creek
	August 23	September 20	**Group 3**: Los Trancos Creek, Morning Canyon Creek, Buck Gully Creek
	October 25	November 22	**Group 4:** Santa Ana Reach 4

11. Sampling Methods

11.1 Sample Collection

Dry weather sampling at priority sites should only occur under dry weather conditions defined as no measurable rainfall within a 72 hour period prior to sampling. During dry weather conditions, if flow is elevated due to non-wet weather sources, e.g., upstream dam releases or dewatering activities, sample collection should still occur as long as conditions are safe. The elevated water levels will be documented on the field data sheet and flow will be estimated (see Section 11.3).

11.1.1 Water Samples

In-stream sampling consists of grab samples collected approximately mid-stream and at the water surface during designated sample activities following sampling methods provided below. Water samples are best collected before any other work is done at the site. If other work is done prior to the collection of water samples (for example, flow measurements or other field measurements), bottom sediment may be disturbed into the water column, which many not reflect representative conditions for water chemistry and bacteria analyses. Wading by sample collection staff shall not occur during collection of samples for bacterial and TSS analyses.

To the extent practical, water samples are collected from a location in the stream (or storm drain as may be the case for urban or agricultural source evaluation activities) where the stream visually appears to be well-mixed and flowing. Ideally this would be at the centroid of the flow (*Centroid* is defined as the midpoint of that portion of the stream width that contains 50% of the total flow), but depth and flow do not always allow collection of samples from the centroid location. Ultimately, the selection of the best location to collect water samples is based on best professional judgment. In addition, the sample should be collected in an area free of debris or algae. Samples shall not be collected if conditions are determined to be unsafe during an on- site assessment by the field team leader. Photo documentation shall be provided to illustrate unsafe conditions and the specific issues of concern shall be noted on the field form.

For sites where the samples will be taken from a distance, a sampling pole will be used. This sampling pole is approximately 7 feet long and has a mechanism that holds the sample bottle in place. The mechanism should be sterilized in the field with a 70 percent ethanol solution prior to the collection of each sample. After being cleaned with ethanol (70%) the sampling pole should be rinsed thoroughly. Allow the pole to air-dry before the sample is taken. A similar sampling pole that extends to a greater height may be used for sites where sampling from a bridge is necessary.

Table 11-1 summarizes information relevant to sample collection. The following text lists steps to take when collecting a water sample, (including, but not limited to steps from *EPA's Volunteer Stream Monitoring: A Methods Monitoring Manual*, EPA 841-B-97-003, November 1997):

(1) Label each sample container with a site identification number (Site ID), sample identification number (Sample ID), analysis information, project identification number (Project ID), date, and time (ideally, some of this information may be pre-labeled on the containers). After sampling, if waterproof labels are not used, secure the label by taping it around the bottle with clear packaging tape.

(2) For *E. coli* and *Enterococcus* samples the sterilized bottle will contain sodium thiosulfate for chlorine elimination. For ammonia and potassium samples, the bottles will contain sulfuric acid and nitric acid for preservation, respectively. Therefore, the bottles for analysis of these constituents cannot be held under the water to collect a sample. In contrast, the sterilized TSS bottle contains no preservatives and no such restrictions exist.

(3) When wading (if applicable) to the sampling point, try not to disturb bottom sediment before collection of a sample.

a. To collect a water sample with a bottle containing a preservative, stand in the water facing upstream. Open the lid carefully; at all times, avoid touching the inside of the bottle or cap. If you accidentally touch the inside of the bottle or cap, use another bottle. The sample should be collected from the surface from your upstream side, i.e., in front of you, by holding the bottle at an angle so that the preservative does not flow out and sample does not overflow the bottle. Fill the bacteria bottle to the 100 or 125 mL mark. Do not overfill the sample bottles (so the sample can be shaken before analysis). Recap the bottle, remembering not to touch the inside.

b. To collect a water sample with a bottle without preservative, stand in the water facing upstream. The sample should be collected from the surface from your upstream side, i.e., in front of you, by holding the bottle upright under the surface while it is capped. Open the lid carefully to let the water run in. At all times, avoid touching the inside of the bottle or cap. If you accidentally touch the inside of the bottle or cap, use another bottle. Once the bottle is filled, recap the bottle, remembering not to touch the inside.

c. An alternative approach to (3).a and (3).b above is to use a separate sterilized bottle to collect a water sample to transfer to the sample containers with or without preservatives. If using a sterilized transfer vessel for both TSS and *E. coli* samples, water can then be decanted from this bottle (after shaking the sample) into the sample containers that will be submitted to the laboratory.

(4) When flow is too shallow to collect a surface sample, such as when there is sheet flow across a channel, the sample should be collected at a location where there is greater water depth, such as at a seam in the channel, or near an obstruction, or where the flow spills over a concrete apron or lip. Follow the sample collection procedures for bottles with and without preservative as described above.

If there are no features in the channel that increase water depth and it is not possible to fill the bottle directly from the flow, then carefully collect a sample as follows (adapted from *Standard Operating Procedure for the Collection of Bacteria Samples from Storm Drains and Receiving Waters (Creeks, lagoons, bays, and ocean) for the City of San Diego 2002-03 Coastal Monitoring Annual Report*):

Use a clean, sterile syringe to collect a water sample from the surface without sampling floating particulates, yet far enough away from the bottom to avoid suction of soil, silt, and organic matter. Care should be taken to not touch the tip of the syringe. Draw back the plunger slowly while monitoring the syringe for organic matter, silt, sand, and floating particulates. Without

touching the syringe to the sample bottle, dispense the sample into the sample bottle. Repeat until the sample bottle is full. Appropriately discard used syringe after each sample.

(5) Place the bottles in a cooler with cold packs for transport to the laboratory. The maximum holding time prior to water quality analysis for bacteria concentrations is 6 hours; the maximum holding time prior to *Bacteroides* analysis is 24 hours. Bottles will be provided by the laboratories for each sample and depending on the water quality analyses required may include:

(a) Water quality analysis laboratory – A single 100 to 125 mL bottle for *E. coli*, one 1,000 mL bottle for TSS, one 500 mL bottle for surfactants, a single 500 mL bottle for potassium, and a 100 mL bottle for ammonia

(b) OCWD – One 1,000 mL bottle for *Bacteroides* analysis

(6) Field QA Samples:

(a) *Field Equipment Blanks*

(i) *Regional Monitoring Program and TMDL Program Monitoring (wet weather and Tier 1)* - One set of field equipment blank samples (equal volume for each constituent) will be included for each sample event.

- Sterile deionized (DI) water is poured through any equipment used to collect *E. coli* or *Enterococcus* samples at the site where the field equipment blank is being collected and then into the 100 or 125 mL *E. coli* sample containers.

- For the *Bacteroides* equipment blanks, high purity water (in amber bottles) from an approved laboratory will be poured into the 1 liter sample bottle.

- For the TSS field equipment blank, distilled water is poured through any equipment used to collect the TSS sample at the site where the field equipment blank is being collected and then into the 1 liter TSS sample bottle. If no equipment is used to collect the TSS sample, then the distilled water is poured directly into the 1 liter TSS sample bottle.

- One set of field equipment blank samples will be collected for each sample event (one sample event encompasses all samples collected within a given week); the site for collection of blank samples will be selected on a rotational basis. After field equipment blanks have been collected from all monitoring sites, the rotation will start again with the first monitoring site.

(ii) *Urban Source Evaluation Program Tier 2 Monitoring* – No field equipment blanks are collected.

(b) *Field Replicates* – Field replicates are taken by collecting two sets of samples at the same location within five minutes of each other. Field replicates are collected as follows:

(i) *Regional Monitoring Program Sites* – One set of field replicates will be collected for each sample event (one sample event encompasses all samples collected within a given week) conducted at Priority 1, 2, 3 or 4 sites. The site for collection of replicate samples will be selected on a rotational basis (if more than one site sampled during a sample event. After replicates have been collected from all monitoring sites, the rotation will start again with the first monitoring site. .

(ii) *MSAR Bacteria TMDL Wet Weather Event* – During the four day sample event, replicates are collected from one site on one of the sample days. Site is randomly selected.

(iii) *Urban Source Evaluation Program Tier 2 Monitoring* - No replicate samples are collected.

11.1.2 Sediment and Biofilm Samples

Sampling of sediment or biofilms may occur as part of Tier 1 or Tier 2 sampling events (see Section 6.3.2.2) to support TMDL-related source evaluation activities. Surface sediment and biofilm grab samples will be collected from the midpoint of shallow, wadable channel and stream widths. When multiple samples are collected along a transect of the stream, sample locations should reflect 25 percent, 50 percent, and 75 percent of the stream width. In cases where both water and samples are collected from the same study site, water should be collected first and care should be taken to not disturb the sediment.

The following lists contain specific steps to take when collecting a sediment sample (adapted from *EPA's Field Sampling Guidance Document #1215 for Sediment Sampling*, September 1999):

(1) Label each container with Site ID, Sample ID, analysis information, Project ID, date, and time (some of this information may be pre-labeled on the containers). After sampling, secure the label by taping it around the bottle with clear packaging tape.

(2) When wading (if applicable) to the sampling point, do not disturb bottom sediment.

(3) Stand in the water, facing upstream. Collect the sediment and biofilm sample on your upstream side, i.e., in front of you.

(4) Use a sterile stainless steel or plastic scoop or similar equipment type to scoop sediment along the bottom of the waterbody surface in the upstream direction. For biofilms, scoop along the surface the biofilms are attached to. Do not use plated scoops (e.g., garden spades) as they can result in contamination of samples.

(5) Decant excess water without loss of fine particles from the scoop and deposit sediment into sterile sample container. Avoid touching the inside of the bottle or cap with anything but sample material. If you accidentally touch the inside, use another bottle. Fill the bottle leaving a 1-inch air space.

(6) Carefully recap the bottle without touching the inside of the container.

(7) Place the bottles in a cooler with cold packs for transport to the laboratory. The maximum holding time prior to water quality analysis for *E. coli* bacteria concentrations is 6 hours; the maximum

holding time prior to *Bacteroides* analysis is 24 hours. Bottles will include a single, sterile 50 mL tube for both *E. coli* and bacterial indicator source analyses.

(8) Field QA Samples

(a) *Field Blanks* – One set of field equipment blanks will be included for each sample event (one sample event encompasses all samples collected within a given week). The site for collection of blank samples will be selected on a rotational basis. After blanks have been collected from all monitoring sites, the rotation will start again with the first monitoring site. To collect the sample, sterile deionized water is poured through any equipment used to collect samples at the site where the field equipment blank is being collected and then into the respective sample containers for each constituent.

(b) *Field Replicates* – Field replicates are taken by collecting two sets of samples at the same location within five minutes of each other. Field replicates will be collected from at least one sample site per sample event (one sample event encompasses all samples collected within a given week). The site for collection of replicate samples will be selected on a rotational basis. After replicates have been collected from all monitoring sites, the rotation will start again with the first monitoring site.

11.2 Field Measurements

Field measurements are made at all monitoring sites except Tier 2 sites. For Tier 2 sites, field measurements will be made on an as needed basis where necessary to support the purposes of monitoring activities at these sites.

After collecting the water samples, record the water temperature, pH, conductivity, turbidity, and dissolved oxygen concentration. These parameters as well as other field data are measured and recorded using a multi-parameter probe. When field measurements are made with a multi-parameter instrument, sufficient time should be allowed for the instrument to equilibrate in the water before field measurements are recorded.

Field measurements are made at the centroid of surface flow if the stream visually appears to be completely mixed from shore to shore. For routine field measurements, the date, time and depth are reported as a grab. Below is a brief discussion of each field parameter to be measured:

- *Dissolved Oxygen* – Calibrate the dissolved oxygen sensor on the multi-probe instrument at the beginning of each day of field measurements. Preferably, dissolved oxygen is measured directly in-stream close to the flow centroid. The dissolved oxygen probe must equilibrate for at least 90 seconds before dissolved oxygen is recorded to the nearest 0.1 mg/L. Since dissolved oxygen takes the longest to stabilize, record this parameter after temperature, conductivity, turbidity, and pH.

- *pH* – Preferably, specific conductance is measured directly in-stream close to the surface flow centroid. 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. 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 minutes, and then read the pH in the upper layer of sample without agitating the sample. With care, pH measurements should be accurately measured to the nearest 0.1 pH unit.

- *Conductivity* – Preferably, specific conductance is measured directly in-stream close to the surface flow centroid. 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 µS/cm). 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.

- *Temperature* - Temperature is measured directly in-stream close to the surface flow centroid. Measure temperature directly from the stream by immersing a multi-parameter instrument.

- *Turbidity* - Turbidity is measured directly in-stream close to the surface flow centroid. Measure turbidity directly from the stream by immersing a multi-parameter instrument or use of a Hach turbidimeter.

11.3 Instantaneous Flow Monitoring

With one exception, flow measurements will be recorded by field personnel for every site visited using one of the methods described below. The exception is monitoring sites near a stream gage station that provides representative flow data for the monitoring site. The data from the gage station may be used instead of estimating flow in the field.

11.3.1 Visual Flow Estimate

Flow estimate data may be recorded for a non-tidally influenced stream when it is not possible to measure flows by the volumetric or cross section velocity profile methods described above either because flows are too high or so shallow that obtaining a velocity measurement is difficult or impossible. Visual flow estimates are subjective measures based on field personnel's experience and ability to estimate distances, depths, and velocities.

(1) 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 (feet) at that reach and record.

(2) Estimate average stream depth (feet) at that reach and record.

(3) 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. This can be done by selecting points of reference along the stream channel which can be used as upper and lower boundaries for an area of measurement. After establishing the boundaries, measure the length of the flow reach. One person stands at the upper end of the reach and drops a floating object and says “start.” A second person stands at the lower end of the reach and times the number of seconds for the floating object to float the reach. This measurement is conducted three times and the three results are averaged. The velocity is the length of the reach in feet divided by the average time in seconds.

(4) If doing this method from a bridge (for example, because flows are too high to be in the channel), 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 should be measured at multiple locations along the bridge at least three times. These velocities are averaged.

(5) Multiply stream width (feet) by average stream depth (feet) to determine the cross sectional area (ft^2) which when multiplied by the stream velocity (ft/s) and a correction constant, gives an estimated flow (ft^3/s).

11.3.2 Measured Flow Estimate

Where possible, volumetric measurements will be collected according to the following procedures:

- *Volumetric Flow (Q) Estimate* - Where possible, a volumetric flow measurement approach will be used. This method shall not be used if conditions are determined to be unsafe by an on-site assessment by the field team leader. A volumetric flow measurement entails estimation of the time in seconds (*t*) required to fill a 5 gallon bucket with concentrated runoff. Sites with low flow and a free outfall would allow for this type of flow measurement. The following equation would then give the flow rate for a test with one 5-gallon bucket of volume captured, Q (cfs or ft^3/sec) = 0.67 * *t*. If there are multiple points where runoff is concentrated, then volumetric measurements can be made at each point along the stream and summed to provide total discharge.

  If volumetric measurements is not feasible at a site, then a depth-velocity estimate will be developed according to the cross-section velocity profile procedures.

- *Cross-Section Velocity Profile Flow Measurement* - The following steps guide the development of a velocity profile for a streamflow cross section. This approach will require that the field personnel be equipped with a Marsh-McBirney flow meter or equivalent, top-setting wading rod (preferably measured in tenths of feet), and a tape measure (with gradations every tenth of a foot). The following procedure is used to collect data:

Table 11-1. Sample collection for field measurements (see discussion in QAPP Section 10 or Monitoring Plan)

Sampling Location	Site ID Number	Matrix	Depth (units)	Analytical Parameter	No. Samples (w/replicates)	Sampling SOP	Sample Volume	Containers #, size, type	Preservation (chemical, temperature, light protected)	Maximum Holding Time: Preparation/ Analysis
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	Conductivity	QAPP Sections 10 & 11 or MP	Section 11.2	Instream	NA	NA	NA: Site measurement
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	Dissolved Oxygen	QAPP Sections 10 & 11 or MP	Section 11.2	Instream	NA	NA	NA: Site measurement
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	pH	QAPP Sections 10 & 11 or MP	Section 11.2	Instream	NA	NA	NA: Site measurement
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	Temperature	QAPP Sections 10 & 11 or MP	Section 11.2	Instream	NA	NA	NA: Site measurement
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	Turbidity	QAPP Sections 10 & 11 or MP	Section 11.2	Instream	NA	NA	NA: Site measurement
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	Flow	QAPP Sections 10 & 11 or MP	Section 11.2	Instream	NA	NA	NA: Site measurement
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	Ammonia	QAPP Sections 10 & 11 or MP	Section 11.2	Instream	NA	NA	NA: Site measurement
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	Chlorine	QAPP Sections 10 & 11 or MP	Section 11.2	Instream	NA	NA	NA: Site measurement
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	Copper	QAPP Sections 10 & 11 or MP	Section 11.2	Instream	NA	NA	NA: Site measurement
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	Surfactants	QAPP Sections 10 & 11 or MP	Section 11.2	Instream	NA	NA	NA: Site measurement
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	Canine Scent Tracking	QAPP Sections 10 & 11 or MP	Section 11.2	Instream	NA	NA	NA: Site measurement

Table 11-2. Sample collection for constituents for laboratory analysis (also see discussion in QAPP Section 10 or Monitoring Plan)

Sampling Location	Site ID Number	Matrix	Depth (units)	Analytical Parameter	No. Samples (w/replicates)	Sampling SOP	Sample Volume	Containers #, size, type	Preservation (chemical, temperature, light protected)	Maximum Holding Time: Preparation/ Analysis
Laboratory Analyses										
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	*E. coli*	QAPP Sections 10 & 11 or MP	Section 11.1.1	100 or 125 mL	1 bottle, 125 mL, sterile plastic (high density polyethylene or polypropylene)	Sodium thiosulfate pre-added to containers in the laboratory (chlorine elimination). Cool to 4 °C; dark	6 hours at 4 °C, dark; laboratory must be notified well in advance
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	*Enterococcus*	QAPP Sections 10 & 11 or MP	Section 11.1.1	100 or 125 mL	1 bottle, 125 mL, sterile plastic (high density polyethylene or polypropylene)	Sodium thiosulfate pre-added to containers in the laboratory (chlorine elimination). Cool to 4 °C; dark	6 hours at 4 °C, dark; laboratory must be notified well in advance
QAPP Sections 6 & 10 or MP	See MP	Sediment	Sediment surface	*E. coli*	QAPP Sections 10 & 11 or MP	Section 11.1.2	125 mL	10 grams	1 50 mL sterile conical tube	Cool to 4 °C, dark
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	TSS	QAPP Sections 10 & 11 or MP	Section 11.1.1	1000 mL	1 bottle, 1000 mL, cool to 4 °C, dark	Cool to 4 °C, dark	7 days at 4 °C, dark
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	Ammonia	QAPP Sections 10 & 11 or MP	Section 11.4.2	100 mL	1 bottle, 100 mL, cool to 4 °C, high density polyethylene, dark	Sulfuric acid pre-added to containers in the laboratory. Cool to 4 °C, dark	28 days at 4 °C, dark
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	Potassium	QAPP Sections 10 & 11 or MP	Section 11.4.2	500 mL	1 bottle, 100 mL, cool to 4 °C, high density polyethylene or glass, dark	Nitric acid pre-added to containers in the laboratory. Cool to 4 °C, dark	6 months at 4 °C, dark
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	Surfactants	QAPP Sections 10 & 11 or MP	Section 11.4.2	500 mL	1 bottle, 100 mL, cool to 4 °C, high density polyethylene or glass, dark	Cool to 4 °C, dark	48 hours at 4 °C, dark
Molecular Analyses										
QAPP Sections 6 & 10 or MP	See MP	Water	Water surface	Genetic markers for human and canine *(Bacteroides thetaiotaomicron)*, horse *(Bacteroides spp.)*, bird (*Heliobacter*), and rumen (*Prevotella*)	QAPP Sections 10 & 11 or MP	Section 11.1.1	1000 mL	1 bottle, 1000 mL, cool to 4 °C; dark	Cool to 4 °C; dark	24 hours at 4 °C, dark; laboratory must be notified in advance
QAPP Sections 6 & 10 or MP	See MP	Sediment	Sediment surface	Genetic markers for human and canine *(Bacteroides thetaiotaomicron)*, horse *(Bacteroides spp.)*, bird (*Heliobacter*), and rumen (*Prevotella*)	QAPP Sections 10 & 11 or MP	Section 11.1.1	10 grams	1 50 mL sterile conical tube	Cool to 4 °C; dark	24 hours at 4 °C, dark; laboratory must be notified in advance

(1) 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). Avoid measuring flow in areas with back eddies. The first choice would be to select a site with no back eddy development. However, this cannot be avoided in certain situations. Measure the negative flows in the areas with back eddies. 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

(2) Record the following information on the flow measurement form (Attachment 3):

(a) Monitoring site and Site ID

(b) Date

(c) Time measurement is initiated and ended

(d) Name of person(s) measuring flow

(e) Note if measurements are in feet or meters

(f) Total stream width and width of each measurement section

(g) For each cross-section, record the mid-point, section depth, and flow velocity

(3) Determine the spacing and location of flow measurement sections. Measurements will be taken at the midpoint of each of the flow measurement sections. Flow measurements will be taken at the following locations:

(a) A point from the left bank representing 10 percent of the total width. This measurement will provide a velocity estimate for the section representing 0 percent – 20 percent of the total width from the left bank.

(b) A point from the left bank representing 50 percent of the total width. This measurement will provide a velocity estimate for the section representing 20 percent – 80 percent of the total width from the left bank.

(c) A point from the left bank representing 90 percent of the total width. This measurement will provide a velocity estimate for the section representing 80 percent – 100 percent of the total width from the left bank.

(4) Place the top setting wading rod at each flow measurement point.

(5) Using a tape measure, measure the depth of water to the nearest ½ inch.

(6) Adjust the position of the sensor to the correct depth at each flow measurement point. The purpose of the top setting wading rod is to allow the user to easily set the sensor at 20 percent, 60 percent, and 80 percent of the total depth. On the wading rod, each single mark represents 0.10 foot, each double mark represents 0.50 foot, and each triple mark represents 1.00 foot. Position the meter at 60 percent of the total depth from the water surface (if depth of flow is greater than 2.5ft, then take two readings, at 20 percent and 80 percent of total depth).

(7) Measure and record the velocity and depth. The wading rod is kept vertical and the flow sensor kept perpendicular to the cross section. Permit the meter to adjust to the current for a few seconds. Measure the velocity for a minimum of 20 seconds with the Marsh-McBirney meter. 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 feet downstream and off to the side of the flow sensor.

(8) Report 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.

(9) Calculate flow by multiplying the width x depth (ft^2) to derive the area of each 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 each flow measurement section. 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. When flow is calculated for all of the measurement sections, they are added together for the total stream flow.

11.4 Secondary Screening Tools

The following is a summary of secondary screening tools that can be used while conducting Tier 2 source evaluation activities.

11.4.1 Storm Drain Visual Observations (including flow)

Determination of flow within a storm drain during dry weather can provide an understanding of the magnitude of a potentially illicit discharge during dry weather.

11.4.1.1 Manhole Cover Removal Procedures

Underground MS4 systems may require the removal of manholes to assess the presence of dry weather flow. The process for removing the manhole cover is based on the process described as follows (Center for Watershed Protection, *Illicit Discharge Detection and Elimination Guide* (2004) :

(1) Locate the manhole cover to be removed.

(2) Divert road and foot traffic away from the manhole using traffic cones. For more information on traffic control, see the California Manual on Uniform Traffic Control Devices guideline for temporary traffic control (2006).

(3) Use the tip of a crowbar to lift the manhole cover up high enough to insert the gas monitor probe. Take care to avoid creating a spark that could ignite explosive gases that may have accumulated under the lid.

(4) Follow procedures outlined for the gas monitor to test for accumulated gases.

(5) If the gas monitor alarm sounds, close the manhole immediately. Do not attempt to open the manhole until sometime is allowed for gases to dissipate.

(6) If the gas monitor indicates the area is clear of hazards, remove the monitor probe and position the manhole hook under the flange. Remove the crowbar. Pull the lid off with the hook.

(7) When testing is completed and the manhole is no longer needed, use the manhole hook to pull the cover back in place. Make sure the lid is settled in the flange securely.

(8) Check the area to ensure that all equipment is removed from the area prior to leaving.

The following safety considerations should be taken into account when sampling from a manhole:

(1) Do not lift the manhole cover with your back muscles.

(2) Wear steel-toed boots or safety shoes to protect feet from possible crushing injuries that could occur while handling manhole covers.

(3) Do not move manhole covers with hands or fingers.

(4) Wear safety vests or reflective clothing so that the field crew will be visible to traffic.

(5) Manholes may only be entered by properly trained and equipped personnel and when all OSHA and local rules are followed.

References

California Department of Transportation (Caltrans). 2006. *California Manual on Uniform Traffic Control Devices for Streets and Highways, Part 6: Temporary Traffic Control*. Available online at: http://www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/pdf/camutcd/CAMUTCD-Part6.pdf

11.4.1.2 Storm Drain Visual Observations

Next, visually inspect inside the storm drain for the presence or absence of dry weather flow. If flow is present, other observations regarding the storm drain discharge may include presence of staining, odors, floatable materials, or colors. Record observations on field data sheet or log book.

11.4.1.3 Estimate Depth of Water in Storm Drain

If there appears to be a significant amount of flow, additional observations may be desired regarding the amount of water that is present within the storm drain. This procedure is loosely based on Oklahoma State Extension Service (2000) and US EPA (1989).

(1) Remove manhole as described in Section 11.4.1.1.

(2) Prepare steel measuring tape with lead weight at end or telescoping survey rod for use by running carpenter chalk along the last few feet of the tape or survey rod.

(3) Place the steel tape or survey rod into the manhole and ensure that they are completely submerged, reaching the bottom of the manhole. Care should be taken to ensure the steel tap or rod stay perpendicular to the bottom of the manhole and that the steel tape does not bend.

(4) Pull the tape or rod back up to ground surface and observe the point at which a color change between dry and wet chalk occurs. This line denotes the length of tape/road that was immersed in water.

(5) Record the depth measurement on field sheet or log book.

References

Center for Watershed Protection. 2004. *Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments*. Available online at: http://cfpub.epa.gov/npdes/docs.cfm?program_id=6&view=allprog&sort=name#iddemanual

Oregon State Extension Service. 2000. *Measuring Water Well Levels*. Available online at: http://extension.oregonstate.edu/catalog/pdf/ec/ec1368.pdf

US EPA. 1989. *Accuracy of Depth to Water Measurements*. Available online at: http://www.epa.gov/superfund/remedytech/tsp/download/accur.pdf

11.4.2 Field-based Monitoring Procedures

There are several useful monitoring procedures that can be used to conduct secondary screening to support bacteria source evaluation activities. The following section summarizes a menu of options that can be applied when evaluating potential sources of bacteria from an outfall or storm drain exhibiting dry weather flow.

11.4.2.1 Sample collection

Underground storm sewer sampling may be accomplished without entering the manhole by utilizing an intermediate sampling device, such as an extension pole with a sampling bottle/bag (Figure 11-1). Procedures adapted from Washington State Department of Ecology (2010).

(1) Proceed to sample location. Remove manhole cover as described in Section 11.4.1.1.

(2) Appropriate gloves (latex or rubber) are worn ***at all times*** when handling samples or conducting test kit analyses. Other appropriate Personal Protection Equipment (PPE) should be worn, as required.

(3) Secure clean sample bottle or bag to sampling pole. This may necessitate the use of filament strapping tape or zip ties.

(4) Lower sampling devise into sewer. Holding the device so the bottle or bag faces upstream, allow the water to enter the sampler. Rinse the sample bottle or bag at least three times with flowing sample water.

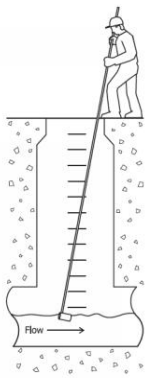

Figure 11-1
Sampling from Manhole with Extension Pole
(Washington State Department of Ecology. 2010. How to do Stormwater Sampling: A guide for industrial facilities. Available online at: https://fortress.wa.gov/ecy/publications/publications/0210071.pdf

(5) Take sample from the central portion of flow in an area of some turbulence, if possible.

(6) Raise sampling devise out of manhole and, keeping hands from the opening of the bottle or bag, fill sample containers. Repeat steps 4-6 as necessary until all sample containers are filled.

(7) Repeat steps 4-6 as necessary to measure field parameters.

(8) Note on field sheets whether flow is coming from laterals or main sewer pipe. If coming from laterals, note the direction of flow (e.g., NW lateral).

References

Washington State Department of Ecology. 2010. *How to do Stormwater Sampling: A Guide for Industrial Facilities*. Available online at: https://fortress.wa.gov/ecy/publications/publications/0210071.pdf

11.4.2.2 Ammonia Test Strips

Nitrogen is a fundamental nutrient in the aquatic ecosystem and is required for survival by all plants and animals. In aquatic ecosystems, nitrogen is present in different forms: nitrate, nitrite, ammonia, and organic nitrogen. Of particular interest to storm drain systems is ammonia-nitrogen, which could indicate illegal wastewater connections to the sanitary sewer system, poorly functioning septic systems, or wildlife.

Implementation of the following procedures will require that the field personnel be equipped with ammonia test strips by Hach or similar manufacturer.

(1) To use the ammonia test strips, gloves should first be donned. Appropriate gloves (latex or rubber) are worn ***at all times*** when handling samples or conducting test kit analyses. Other appropriate PPE should be worn, as required.

(2) A sample should then be collected from an outfall or storm sewer line using a sample dipper or other sample collection tool as described in Section 11.4.2.1.

(3) Samples for ammonia will be poured directly from the sample collection tool into a sample cup which will be rinsed three times with the sample.

(4) Analysis will proceed as directed on the ammonia test strip box but will generally proceed in the following manner:

   (a) Remove one test strip from the box. Replace top of box tightly immediately.

   (b) Dip the test strip into the water sample for the suggest time (5 to 30 seconds). The time the strip is submerged will depend on the brand of test strip. Vigorously move the strip up and down in the water, making sure the test strip pad is always submerged.

   (c) Remove the test strip from the water and shake off any excess water. Wait the suggested amount of time for the test strip to change color.

   (d) To read result, turn test strip over so that the testing pad is facing away from you.

(e) Compare the color of the test strip pad to the color chart above. Estimate results if the color on the test strip falls between two color blocks.

(5) The results of the analysis will be recorded on a field sheet or log book.

(6) The sample in the cup can be discarded and the sample cup should be rinsed twice with deionized water.

11.4.2.3 Chlorine Test Strips

Chlorine is used in water treatment and wastewater treatment processes to disinfect water. Presence of chlorine in storm drain discharges could indicate an illicit connection with the water supply system, wastewater effluent or another human source.

There are different types of chlorine analyses available for use in the field. Test strips are available from Hach for chlorine residual (i.e., free chlorine); test kits are also available using the N,N-Diethylparaphenylenediamine (DPD) method which will cause a color change which can then be evaluated using color discs or field spectrophotometers.

Procedures are provided in the following section for chlorine residual test strips. Other analyses should proceed as directed in test equipment SOPs.

(1) To use the chlorine test strips, gloves should first be donned. Appropriate gloves (latex or rubber) are worn at ***all times*** when handling samples or conducting test kit analyses. Other appropriate PPE should be worn, as required.

(2) A sample should be collected from an outfall or storm sewer line using a sample dipper or other sample collection tool as described in Section 11.4.2.1.

(3) Samples for chlorine will be poured directly from the sample collection tool into a sample cup which will be rinsed three times with the sample.

(4) Analysis will proceed as directed on the chlorine test strip box but will generally proceed in the following manner:

(a) Remove one test strip from the box. Replace top of box tightly immediately.

(b) Dip the test strip into the water sample for the suggest time (5 to 30 seconds). The time the strip is submerged will depend on the brand of test strip. Vigorously move the strip up and down in the water, making sure the test strip pad is always submerged.

(c) Remove the test strip from the water and shake off any excess water. Wait the suggested amount of time for the test strip to change color.

(d) To read result, turn test strip over so that the testing pad is facing away from you.

(e) Compare the color of the test strip pad to the color chart above. Estimate results if the color on the test strip falls between two color blocks.

(5) The results of the analysis will be recorded on a field sheet or log book.

(6) The sample in the cup can be discarded and the sample cup should be rinsed twice with deionized water.

11.4.2.4 Copper Test Strips

Copper is a metallic element essential to human growth and is literally found all over the world. Detection of copper during secondary screening may indicate an illicit discharge into the storm drain system from human sources, such as algicides, copper pipes, or electrical components.

There are different types of copper field analyses available for use. Test strips are available from Hach for copper providing readings between 0 and 3 mg/L while colorimetric test kits are also available and provide more precise readings between 0.2 and 5 mg/L.

Procedures are provided in the following section for copper test strips. Other analyses should proceed as directed in test equipment SOPs.

(1) To use the copper test strips, gloves should first be donned. Appropriate gloves (latex or rubber) are worn ***at all times*** when handling samples or conducting test kit analyses. Other appropriate PPE should be worn, as required.

(2) A sample should be collected from an outfall or storm sewer line using a sample dipper or other sample collection tool as described in Section 11.4.2.1.

(3) Samples for copper will be poured directly from the sample collection tool into a sample cup which will be rinsed three times with the sample.

(4) Analysis will proceed as directed on the copper test strip box but will generally proceed in the following manner:

   (a) Remove one test strip from the box. Replace top of box tightly immediately.

   (b) Dip the test strip into the water sample for the suggest time (5 to 30 seconds). The time the strip is submerged will depend on the brand of test strip. Vigorously move the strip up and down in the water, making sure the test strip pad is always submerged.

   (c) Remove the test strip from the water and shake off any excess water. Wait the suggested amount of time for the test strip to change color.

   (d) To read result, turn test strip over so that the testing pad is facing away from you.

   (e) Compare the color of the test strip pad to the color chart above. Estimate results if the color on the test strip falls between two color blocks.

(5) The results of the analysis will be recorded on a field sheet or log book.

(6) The sample in the cup can be discarded and the sample cup should be rinsed twice with deionized water.

11.4.2.5 Surfactant/Detergent Colorimetric Screening

Many illicit discharges into storm drains will have elevated concentrations of surfactants and detergents. Industrial cleaning, commercial wash water and car washes may also be sources of surfactants and detergents in storm drains. Leaking sanitary sewers could also contribute detergents used in household cleaning.

Procedures are provided in the following section for the Hach Detergents Test Kit (Model DE-2). Other analyses should proceed as directed in test equipment SOPs.

(1) To use the detergent test kit, gloves should first be donned. Appropriate gloves (latex or rubber) are worn ***at all times*** when handling samples or conducting test kit analyses. Other appropriate PPE should be worn, as required.

(2) Prepare a sample from the outfall/storm drain dry weather discharge

(a) A sample should be collected from an outfall or storm sewer line using a sample dipper or other sample collection tool as described in Section 11.4.2.1.

(b) Rinse the test tube three times with sample water.

(c) Pour 20 mL directly from the sample collection tool directly into the provided test tube (20 mL will be the upper mark on the test tube).

(d) Add 12 drops of the Detergent Test Solution. Place stopper on test tube and shake to mix.

(e) Add chloroform to the lowest mark (5 mL) on the test tube. Chloroform is heavier than water and will sink. Place stopper on test tube and vigorously shake for 30 seconds. All test tube to stand for 1 minute to allow chloroform to separate.

(f) Using the draw off pipet provided in the test kit, remove water from the test tube and discard.

(g) Refill the test tube to the upper 20 mL mark with the Wash Water buffer. Then immediately use the draw off pipet to remove the Wash Water buffer and discard. This step washes away the remaining water sample.

(h) Should the sample be turbid, it may be necessary to filter the chloroform solution. If this is the case, the following steps should be followed:

(i) Place a small ball (about the size of a large pea) of glass wool in the filter thimble.

(ii) Using the draw off pipet, remove the chloroform and filter through the glass wool back into the test tube

(i) Refill the test tube to the upper mark with the Wash Water buffer, place stopper on the test tube and shake vigorously for 30 seconds. Allow to stand one minute to allow chloroform to separate.

(3) While waiting for the chloroform to separate, fill another test tube with demineralized water and place it in the left opening of the color comparator.

(4) Insert the test tube containing the prepared sample into the right opening of the color comparator.

(5) Hold the comparator up to a light and view through the two openings in the front. Rotate the Detergents Color Disc until a color match is obtained. Read the ppm Detergents from the scale window.

(6) The results of the analysis will be recorded on a field sheet or log book.

(7) The sample in the cup can be discarded into a container. The sample cup should be rinsed twice with deionized water and also poured into container for disposal at a later time.

If the color is darker than the highest reading on the color disc, a sample dilution can be performed. To prepare a 20:1 dilution, add 1 mL sample and filling test tube with demineralized water to the 20 mL mark. Follow sample preparation process outlined in Step 2 of this procedure and re-analyze the sample.

It should also be noted that this test may generate waste that is considered hazardous. This waste cannot be dumped into the sanitary sewer system but must be collected and disposed of properly

References

Center for Watershed Protection. 2004. *Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments*. Available online at: http://cfpub.epa.gov/npdes/docs.cfm?program_id=6&view=allprog&sort=name#iddemanual

11.4.2.6 Canine Scent tracking

The use of canines to track human sources of storm drain illicit discharges have been reported as an accurate method that results in very few false positives (Murray et al., 2011). Canine scent tracking should be used to assist in locating specific sources of human-specific bacteria within a storm drain system as follows.

(1) A provider of canine scent tracking should be contacted to secure a dog-handler pair to conduct the monitoring. One provider of canine scent tracking is Environmental Canine Services, LLC.

(2) If operating canine scent tracking in the field, proceed to storm drain of interest with dog-handler pair. If operating canine scent tracking in the laboratory or office, skip to next section.

(3) At a storm drain of interest, remove the manhole cover as described in Section 11.4.1.1

(4) Once the cover is removed, the handler will give the canine its individual search command and walk to the open structure.

(5) If the canine alerts at the storm drain, the handler will provide interpretation to confirm the presence or absence of human sewage in the storm drain.

(6) The results of the canine scent tracking should be recorded on a field data sheet or logbook.

Canine scent tracking may also be used in a laboratory or office setting as follows. Methods are adapted from the Ottawa County Health Department (2011).

(1) Contact a provider of canine scent tracking to secure a dog-handler pair. Prior to sampling, coordinate a time when sampling will be complete to meet dog-handler pair in a scent-neutral area.

(2) Proceed to storm drain of interest with sampling team only.

(3) At a storm drain of interest, remove the manhole cover as described in Section 11.4.1.1

(4) Once the cover is removed, proceed to take a sample according to procedures outlined in Section 11.4.2.1. Collect at least one 60 mL sample.

(5) Preserve sample on ice at 4 °C. Store for no longer than 8 hours.

(6) Proceed to scent-neutral area to conduct canine scent sampling. Canine scent sampling must be completed within 8 hours of sample collection.

(7) If canine alerts at the sample, the handler will provide interpretation to confirm the presence or absence of human sewage in the sample.

(8) The results of the canine scent tracking should be recorded on a field sheet or logbook.

References

Murray, Jill, Scott Reynolds, Patricia Holden, Laurie Van De Werfhorst. 2011. *Canine Scent and Microbial Source Tracking in Santa Barbara, California*. Water Environment Research Foundation Report U2R09.

Ottawa County Health Department. 2011. *Ottawa County Health Department's Beach Monitoring Project Quality Assurance Project Plan (QAPP)*.

12. Sample Handling and Custody

12.1 Pre-Sampling Procedures

Prior to the collection of field data, the sample team will complete the following activities:

(1) Prepare and calibrate a multi-parameter instrument for use in collecting field measurements prior to sampling (See the equipment operation manual for specific calibration instructions). Calibrations will be conducted by the Responsible Agency's Project QA Officer or Monitoring Manager or their designee. Sampling activities will not be conducted until calibrations can be completed per equipment operations manual.

(2) Gather equipment for measurement of field parameters, including multi-parameter instrument, applicable test strips and test kits, and, if sampling underground storm drains, sampling pole.

(3) Prepare and calibrate a portable Turbidity Meter (e.g., Hach or equivalent), as necessary.

(4) Prepare ice coolers with ice packs or crushed ice to transport samples to the laboratory.

(5) Obtain sample containers from laboratories, including bottles for field blanks and water collection bottles. For sampling underground storm drains, also obtain sterile whirl-pak® bags or equivalent, if necessary.

(6) Prepare pre-label sampling containers as appropriate, e.g., Site ID, Sample ID, and Project ID, and leave blank fields for date and time.

(7) Prepare a solution of 70 percent ethanol for field sterilization of sampling equipment.

(8) Pack a flat head screw driver – used to loosen the band that holds the sampling bottle to the sampling pole.

(9) Check safety gear, including rubber boots and waders, protective gloves, and safety vests.

(10) Pack a waterproof pen and field log book and/or field data sheets.

(11) Pack peristaltic pump and sterile tubing.

(12) Pack box cutter and razor blades.

(13) Pack duct tape.

(14) Prepare vehicle, including fueling.

(15) Pack supplies for shipping samples, if applicable.

(16) Pack chain of custody forms, field data sheets, camera with flash, and zip lock bags.

(17) Ensure keys to monitoring sites with locked access are available.

12.2 Field Documentation

Field crews are required to keep a field log or complete appropriate data forms. Field documentation will be completed using indelible ink, with any corrections made by drawing a single line through the error and entering the correct value. Electronic mobile databases may be used in place of a field log or data forms to directly input data from the field. Taking into account the type of sampling being conducted, e.g., Regional Monitoring Program vs. TMDL Program monitoring, the following items should be recorded in the field log or on data forms for each sample collected at each monitoring site (An example Field Data Sheet Form is included as Attachment 1):

- Date and time of sample collection.
- Site Name and Site ID.
- Unique identification numbers for any replicate or blank samples collected from the site.
- Site IDs of the proximate upstream and downstream sampling locations (for Tier 2 urban source evaluation screening investigations only).
- The results of any field measurements (conductivity, dissolved oxygen, flow, pH, temperature, turbidity, ammonia, chlorine, copper, and detergents) and the time that measurements were made. For underground storm drain sampling, depth measurements may be reported in place of flow.
- Qualitative descriptions of relevant water conditions (e.g., color, flow level, clarity, or odor) or weather (e.g., wind, rain) at the time of sample collection.
- For collection of samples to evaluate bacteria sources, a qualitative description of the surrounding drainage area including evidence of flow in street gutters, presence of road sediments and debris, and indications of excess irrigation. Also note the approximate surface area draining to the inlet.
- For bacteria source evaluation sites, when such characterizations are required, a characterization of the hydrologic connectivity of the surface flow at the site to the downstream impaired water to which it is tributary. If no connectivity is observed, then the characterization shall, at a minimum, describe the general distance between the point where surface flow ceases and the channel confluences with the downstream impaired water. If connectivity is observed, then the characterization shall, at a minimum, describe the typical width and depth of the surface flow reaching the downstream impaired water, any observations that suggest that flows have recently been higher than what is currently observed.
- A description of any unusual occurrences associated with the sampling of that site, particularly those that may affect sample or data quality.

Field crews are required to take digital photographs when sampling each site and maintain a photo log of all photographs taken. At a minimum, the following digital photographs should be taken at each site, regardless of the purpose for sampling:

- A photograph which shows a view of the waterbody upstream of the sample site;
- A photograph which shows a view of the waterbody downstream of the sample site; and

- Photographs which characterize the width and depth of flow and aesthetic characteristics such as water clarity and algal growth.

For Tier 2 urban source evaluations, the following photographs should be taken:

- A photograph which shows the drain inlet;
- A photograph which shows the sampling point inside the storm sewer (it may be necessary to utilize a camera with flash enabled);
- A photograph which shows the drainage area upstream of the sample site; and
- A photograph which shows the drainage area downstream of the sample site

To the extent possible, the photographs that provide an upstream and downstream view of the waterbody should be taken from the same point during each site visit. A photo log of all photographs taken at each sample site shall be maintained that documents the purpose of each photograph (for example, upstream or downstream view) and the date and time of the photograph.

12.3 Sampling Handling, Delivery to Laboratory and Chain of Custody

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). Wear at least one layer of gloves, but two layers help protect against leaks. One layer of shoulder high gloves worn as 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.

Properly store and preserve samples as soon as possible. Usually this is done immediately after returning from the collection by placing the containers on top of bagged, crushed or cube ice in an ice chest. Sufficient ice will be needed to lower the sample temperature to at least 4 °C within 45 minutes after time of collection. Sample temperature will be maintained at 4 °C until delivered to the appropriate laboratory. Care should be taken at all times during sample collection, handling, and transport to prevent exposure of the sample to direct sunlight.

Samples that are to be analyzed for bacterial indicators must be kept on ice or in a refrigerator and delivered to a qualified laboratory included in the appendices of this QAPP within 6 hours of sample collection.

Samples analyzed for *Bacteroides* must be kept on ice or in a refrigerator and delivered to a qualified laboratory included in the appendices of this QAPP within 24 hours of collection.

A detailed sample delivery schedule is presented in Tables 10-1 and 10-2 of this QAPP for collection of water samples from RMP Priority 1, 2, and 3 sites. Other monitoring programs have flexible schedules.

Samples will be delivered to analytical laboratories by the Responsible Agency's sampling personnel either directly or via courier.

Every shipment must contain a complete COC Form (see Attachment 2) that lists all samples taken and the analyses to be performed on these samples. COCs must be completed every time samples are transported to a laboratory. Include any special instructions to the laboratory. The original COC sheet (not the copies) is included with the shipment (insert into zip lock bag); one copy goes to the sampling coordinator; and the sampling crew keeps one copy. Samples collected should have the depth of collection and date/time collected on every COC.

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 placed inside a large plastic bag inside the ice chest for shipping. The 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 laboratory beyond the required holding time. Although glass containers are acceptable for sample collection, bubble wrap must be used when shipping glass.

13. Analytical Methods

Samples collected for the Regional and TMDL Monitoring Programs will be analyzed for various chemical and biological constituents. Field parameters will be monitored at the sampling sites using a multi-parameter water quality probe (or equivalent) and includes conductivity, dissolved oxygen, pH, temperature, and turbidity. Additional constituents (ammonia, chlorine, copper, and surfactants) will be quantified in the field using Hach Company water chemistry kits. Samples for biological constituents, *E.coli*, *Enterococcus* and *Bacteroides*, and other chemical constituents will be quantified at a qualified laboratory.

Multiple EPA approved methods may be used to analyze *E.coli* or *Enterococcus* concentrations in water samples including (a) EPA Method 1603, Standard Methods (SM) 9223B, and IDEXX (18 hour) for *E coli*; and (b) EPA Method 1600 and IDEXX Enterolert for *Enterococcus*. Sediment samples will be sonicated to release all E.coli from sediment and biofilms and then analyzed using method EPA 1603.

Analytical methods used to quantify constituent levels are summarized in Tables 13-1 and 13-2.

Table 13-1. Analytical methods for field parameters

Analyte	Laboratory / Organization	Project Action Limit (units, wet or dry weight)	Target Reporting Limit (units, wet or dry weight)	Field Method	
				Analytical Method/ SOP[2]	Modified for Method (Yes/No)
Conductivity[1]	Field monitoring	1.09 µS/cm	0 - 100 µS/cm	SM 2510B	No
Dissolved Oxygen	Field monitoring	5 mg/L	0 - 19.9 mg/L	SM 4500OG	No
pH	Field monitoring	6.5 to 8.5	0 – 14 pH Units	SM 4500-H+B	No
Temperature (water)[3]	Field monitoring	June to Oct: not > 90 °F (32°C); Rest of Year: not > 78°F (25°C) as a result of controllable water quality factors	0 – 50 °C	SM 2550B	No
Turbidity	Field monitoring	5 to 10 Nephalometric Units (NTU)	0 – 800 NTU	SM 2130B	No
Flow	Field monitoring	NA	-0.5 to 19.99 ft/sec	Cross-section velocity profile or Visual flow estimate (see text)	No
Ammonia[4]	Field monitoring	1 mg/L	0 – 6 mg/L[5]	NA	No
Chlorine[4]	Field monitoring	NA	0 – 10 mg/L[5]	NA	No
Copper[4]	Field monitoring	0.1 mg/L	0 – 3 mg/L[5]	NA	No
Surfactants[4]	Field monitoring	0.01 mg/L	0 – 3 mg/L[6]	NA	No
Canine Scent Tracking[4]	Field monitoring	Positive detection indicated by vocalization or active response	No positive response -- Positive response	NA	No

Notes:

[1] Project Action Limits: Applied Basin Plan Water Quality Objectives for conductivity by converting a total dissolved solids value of 700 ppm to a conductivity value.

[2] SM: *Standard Methods for the Examination of Water and Wastewater*, 20th edition.

[3] Urban Source Evaluation Monitoring Program will only measure water temperature

[4] Optional Tier 2 secondary screening methodologies; Project Action Limits based on potential ranges for chemical tracers indicating sewage, as indicated in monitoring plan.

[5] Target Reporting Limit based on test kits sold and distributed by Hach; other manufacturers may specify alternative reporting limits.

[6] Target Reporting Limit based on test kit sold and distributed by Chemets; other manufacturers may specify alternative reporting limits.

Table 13-2. Laboratory analytical methods

Analyte	Laboratory/ Organization	Project Action Limit (units, wet or dry weight)	Target Reporting Limit (units, wet or dry weight)	Analytical Method		Achievable Laboratory Limits	
				Analytical Method/ SOP	Modified for Method (Yes/No)	Method Detection Limits	Method
E. coli	OC Public Health Water Quality Lab	See notes below[1]	10 cfu/100 mL	EPA 1603[2]	No	Not applicable	Varies[3]
E. coli	OC Public Health Water Quality Lab; Babcock Laboratories; Clinical Lab	See notes below[1]	10 Most Probable Number (MPN)/ 100 mL	SM 9223B IDEXX 18HR	No	Not applicable	Varies[3]
Enterococcus	OC Public Health Water Quality Lab	See notes below[1]	10 cfu/100 mL	EPA 1600	No	Not applicable	Varies[3]
Enterococcus	OC Public Health Water Quality Lab	See notes below[1]	10 cfu/100 mL	IDEXX Enterolert	No	Not applicable	Varies[3]
Genetic markers for human and canine *(Bacteroides thetaiotaomicron),* bird (*Heliobacter*), and rumen (*Prevotella*)	Orange County Water District	Presence / Absence	10 gene copies / 1000 mL	qPCR assays	No	Not applicable	10 gene copies/ 1000 mL
Genetic markers for horse *(Bacteroides)*	Weston Solutions	Presence / Absence	10 gene copies / 1000 mL	qPCR HoF597 assay	No	Not applicable	10 gene copies / 1000 mL
Total Suspended Solids	OC Public Health Water Quality Lab; Associated Labs; Weck Labs; Babcock Laboratories; Clinical Lab	See notes below[4]	1.0 mg/L	SM 2540D	No	Not applicable	1.0 mg/L
Ammonia	Babcock Laboratories	1.0 mg/L; Ammonia/ Potassium Ratio > 0.6 mg/L	0.1 mg/L	SM 4500	No	Not applicable	0.1 mg/L

Table 13-2. Laboratory analytical methods

Analyte	Laboratory/ Organization	Project Action Limit (units, wet or dry weight)	Target Reporting Limit (units, wet or dry weight)	Analytical Method		Achievable Laboratory Limits	
				Analytical Method/ SOP	Modified for Method (Yes/No)	Method Detection Limits	Method
Ammonia	Clinical Lab	1.0 mg/L; Ammonia/ Potassium Ratio > 0.6 mg/L	0.1 mg/L	EPA 350.1	No	Not applicable	0.01 mg/L
Potassium	Babcock Laboratories; Clinical Lab	Ammonia/ Potassium Ratio > 0.6 mg/L	NA	EPA 200.7	No	Not applicable	1.0 mg/L
Surfactants (MBAS)	Babcock Laboratories	0.01 mg/L	NA	SM 5540C	No	Not applicable	0.05 mg/L
Surfactants (MBAS)	Clinical Lab	0.01 mg/L	NA	SM 5540C	No	Not applicable	0.1 mg/L

Notes:

[1] Project Action Limits for *E. coli* and TSS are as follows: (based on the TMDL): *E. coli*: 5-sample/30-day Logarithmic Mean less than 113 organisms/100 mL, and not more than 10% of the samples exceed 212 organisms/100 mL for any 30-day period.

[2] Sediment samples will be sonicated to release all *E.coli* from sediment and biofilms and then analyzed using method EPA 1603.

[3] The achievable laboratory limits are dependent on analytical methods and sample dilutions conducted by laboratories.

[4] TSS: in inland surface waters shall not contain suspended or settleable solids in amounts which cause a nuisance or adversely affect beneficial uses as a result of controllable water quality factors.

14. Quality Control

All contract laboratories used to implement the SAR Bacteria Monitoring Plan will follow QA/QC programs in accordance with guidelines established by the State of California and the U.S. EPA. Laboratories are required to submit a copy of their SOPs for laboratory quality control to the Responsible Agency's Project QA Officer for review and approval (see Appendices to this QAPP for the SOPs of laboratories being used by this project).

All field and laboratory data will be entered by the Responsible Agency's Data Manager into a database/spreadsheet template provided by the Project Director. Annually, after the end of a sample year, each Responsible Agency's Project Manager will submit the previous sample year's completed database/spreadsheet to the Project Director to support preparation of the Annual Report. The Project Director will upload all previous sample year data to CEDEN. Any electronic or paper files will be filed in the project archives maintained by the Project Director along with related materials such as field forms, chain of custody forms, photographs, correspondence, etc.

The Responsible Agency's Monitoring Manager or Project QA Officer will review all laboratory data and will request additional re-analysis of samples as warranted. Tables 14-1 through 14-3 describe Sampling (Field) QC activities. Tables 14-4, 14-5 and 14-6 describe Analytical QC activities.

Table 14-1. Field Sampling QC (Field Parameters)

Sample Matrix: Water		
• Sampling SOP: per Monitoring Plan and QAPP Sections 11 and 12 • Analytical Parameter(s): Field Parameters • Analytical Method/SOP Reference: NA		
Field QC	**Frequency/Number per Sampling Event**	**Acceptance Limits**
Other: Field Measurements	When taking readings, at least 1 minute or longer (if needed) shall be allowed for until stabilization of readings.	See Section 7, Table 7-1

Table 14-2. Field Sampling QC (TSS, Ammonia, Potassium, Surfactants)

Sample Matrix: Water		
• Sampling SOP: per Monitoring Plan and QAPP Sections 11 and 12 • Analytical Parameter(s): TSS, Ammonia, Potassium, Surfactants • Analytical Method/SOP Reference: TSS (SM 2540D); Ammonia (SM 4500); Ammonia (EPA 350.1); Potassium (EPA 200.7); Surfactants (SM 5540C)		
Field QC	**Frequency/Number per Sampling Event**	**Acceptance Limits**
Equipment Blanks	1/sample event	< Target reporting limit
Cooler Temperature	4 °C	4 °C
Field Replicate Pairs[1]	5 percent of total number of samples collected per sample event	< 25 percent

[1] Urban Source Evaluation Monitoring Program will not collect field replicates

Table 14-3. Field Sampling QC (*E. coli*, *Enterococcus, Bacteroides*)

Sample Matrix: Water		
• Sampling SOP: per Monitoring Plan and QAPP Sections 11 and 12 • Analytical Parameter(s): *E. coli, Enterococcus, Bacteroides* • Analytical Method/SOP Reference: *E. coli* (EPA 1603, SM 9223B, IDEXX 18HR); *Bacteroides* (presence/absence *Bacteroides thetaiotaomicron*)		
Field QC	**Frequency/Number per Sampling Event**	**Acceptance Limits**
Equipment Blanks	1/ sample event	No detectable amounts or < 1/5 of sample concentration
Cooler Temperature	4 ºC	4 ºC
Field Replicate Pairs[1]	5 percent of total number of samples collected per sample event	< 25 percent

[1] Urban Source Evaluation Monitoring Program will not collect field replicates

Table 14-4. Laboratory analytical QC (TSS, Ammonia, Potassium, Surfactants)

Sample Matrix: Water		
• Sampling SOP: per Monitoring Plan and QAPP Sections 11 and 12 • Analytical Parameter(s): TSS, Ammonia, Potassium, Surfactants • Analytical Method/SOP Reference: TSS (SM 2540D); Ammonia (SM 4500); Ammonia (EPA 350.1); Potassium (EPA 200.7); Surfactants (SM 5540C)		
Laboratory QC	**Frequency/Number**	**Acceptance Limits**
Method Blank	1/20 samples or 1/batch	< Target Reporting Limit
Laboratory Duplicate	1/20 samples or 1/batch	< 25 percent
Laboratory Matrix Spike	1/20 samples or 1/batch	80 - 120
Matrix Spike Duplicate	1/20 samples or 1/batch	80 – 120; RPD < 25 percent

Table 14-5. Laboratory analytical QC (*E. coli, Enterococcus, Bacteroides* - water)

Sample Matrix: Water		
• Sampling SOP: per Monitoring Plan and QAPP Sections 11 and 12 • Analytical Parameter(s): *E. coli, Enterococcus, Bacteroides* • Analytical Method/SOP Reference: *E.coli* (EPA 1603); *E.coli* (SM 9223B); *E. coli* (IDEXX 18 hour); *Enterococcus* (EPA 1600); *Enterococcus* (IDEXX Enterolert); Genetic markers for human and canine *(Bacteroides thetaiotaomicron)*, horse *(Bacteroides spp.),* bird (*Heliobacter*), and rumen (*Prevotella*).		
Laboratory QC	**Frequency/Number**	**Acceptance Limits**
Method Blank	1/lot minimum	No detectable amounts
Laboratory Duplicate	10 percent of samples or one sample per test run	< 3.27*R*
Laboratory Control sample (Accuracy)	For each lot of medium received from manufacturer or prepared in laboratory	Verify appropriate response by testing with known positive and negative control cultures for the organism(s) under test

Table 14-6. Laboratory analytical QC (*E. coli, Bacteroides* - sediment/biofilm)

Sample Matrix: Sediment/Biofilm		
• Sampling SOP: per Monitoring Plan and QAPP Sections 11 and 12 • Analytical Parameter(s): *E. coli* • Analytical Method/SOP Reference: *E.coli* (EPA 1603); Genetic markers for human and canine *(Bacteroides thetaiotaomicron*[1]*)*, horse *(Bacteroides spp.),* bird (*Heliobacter*), and rumen (*Prevotella*).		
Laboratory QC	**Frequency/Number**	**Acceptance Limits**
Method Blank	1/lot minimum	No detectable amounts
Laboratory Duplicate	10 percent of samples or one sample per test run	< 3.27*R*
Laboratory Control sample (Accuracy)	For each lot of medium received from manufacturer or prepared in laboratory	Verify appropriate response by testing with known positive and negative control cultures for the organism(s) under test

15. Instrument/Equipment Testing, Inspection, and Maintenance

All laboratories used to implement the SAR Bacteria Monitoring Plan will operate using QA/QC programs to maintain their equipment in accordance with their SOPs, which include those specified by the manufacturer and those specified by the analytical method. Laboratories are required to submit a copy of their SOPs for laboratory equipment maintenance to the QA Officer for review and approval (see Appendices to this QAPP for the SOPs of laboratories being used by this project). .

Instruments used to gather field measurements (temperature, conductivity, dissolved oxygen, pH and turbidity) will be properly maintained and calibrated per the manufacturers requirements (Table 15-1). Instruments will be tested prior to the start of field sampling to verify that each instrument is operating appropriately. If the instrument fails to operate within appropriate parameters the Responsible Agency's Project Manager in collaboration with the Monitoring Manager will take the appropriate steps to ensure that the equipment is repaired or replaced in a timely manner.

Table 15-1. Testing, inspection, maintenance of sampling equipment and analytical instruments

Equipment / Instrument	Maintenance Activity, Testing Activity or Inspection Activity	Responsible Person	Frequency	SOP Reference
Multi-parameter Probe	Maintenance and Calibrations	Responsible Agency Monitoring Manager	▪ Maintenance – conducted per manufacturer (mfg) specifications; ▪ Calibrations - prior to each sampling activity	Per manufacturer specifications
Marsh McBirney Model 2000 flow meter	Maintenance and Calibrations	Responsible Agency Monitoring Manager	▪ Maintenance – conducted per mfg specifications; ▪ Calibrations - prior to each sampling activity	Per manufacturer specifications
Laboratory analytical instruments for Conventional Constituents	Maintenance and Calibrations	Contract Laboratory Personnel	▪ Maintenance – conducted per mfg specifications; External calibration with 3 – 5 standards covering the range of sample concentrations prior to sample analysis. At low end, the lowest standard at or near the MDL. Linear regression r^2 < 0.995 ▪ Calibrations - verification every 20 samples after initial calibration. Standard source different than that used for initial calibration. Recovery 80% - 120%.	Per individual laboratory SOP manual and per equipment maintenance specifications

16. Instrument/Equipment Calibration and Frequency

All contract laboratories will implement QA/QC programs to calibrate their equipment in accordance with their SOPs, which include those specified by the manufacturer and those specified by the method. Contract laboratories are required to submit a copy of their SOPs for laboratory equipment calibration to each Responsible Agency's Project QA Officer for review and approval (see Appendices to this QAPP for the SOPs of laboratories being used by this project).

A Horiba or similar multi-parameter probe will be used to make field measurements for conductivity, dissolved oxygen, pH, temperature, and turbidity (a Hach turbidimeter may be used to measure turbidity). The instruments will be properly calibrated according to manufacturer specifications prior to each use.

A Marsh-McBirney Model 2000 flow meter will be used to make flow measurements. It will be properly calibrated according to manufacturer specifications prior to each use (see Table 15-1).

17. Inspection/Acceptance of Supplies and Consumables

Contract laboratories will supply all the sample containers necessary for the monitoring program. Other consumable supplies such as latex gloves, plastic storage bags, and waterproof pens will be provided by the Responsible Agency's Monitoring Manager or an appropriate designee (Table 17-1).

All laboratories will implement QA/QC programs to calibrate their equipment in accordance with their SOPs, which include those specified by the manufacturer and those specified by the method. Contract laboratories are required to submit a copy of their SOPs for laboratory equipment calibration to each Responsible Agency's Project QA Officer or its designee for review and approval (see Appendices to this QAPP for the SOPs of laboratories being used by this project).

Table 17-1. Inspection/acceptance testing requirements for consumables and supplies

Project-Related Supplies / Consumables	Inspection / Testing Specifications	Acceptance Criteria	Frequency	Responsible Individual
Sample bottles	Check integrity of bottles; check for preservatives (*E. coli*, *Enterococcus*)	Ensure no cracks, intact bottle caps; preservative present	Prior to sample collection	Sampling Personnel
Sample bags	Look for tears/holes	Intact, no tears	Prior to sample collection	Sampling Personnel
Test strips	Check test strips for dampness, evidence of color change	Test strips are dry; no color change noted	Prior to use	Sampling Personnel
Colorimetric test kits	Presence/absence of all chemicals and test solutions	Ensure all necessary chemicals are in the kit	Prior to going to field	Sampling Personnel
Latex gloves	Look for tears/holes	Intact, no tears	Prior to use	Sampling Personnel
Storage bags, pens	Presence/absence of supplies	Ensure supplies are in field bin	Prior to going to field	Sampling Personnel

18. Non-Direct Measurements (Existing Data)

18.1 Data Sources and Uses

During the course of the implementation of the Regional and TMDL Monitoring Programs previously existing relevant water quality and flow data from the monitoring sites will be gathered and stored by the Project Director.

As required to meet program reporting requirements, water quality analyses will be periodically conducted by the Project Director to evaluate water quality data collected from monitoring sites. At a minimum, water quality data collected under the SAR Bacteria Monitoring Plan will be evaluated to determine the following:

- Compliance with applicable water quality objectives for REC1;
- Compliance with applicable antidegradation targets for waters classified as REC2 only;
- Progress towards achieving attainment of MSAR Bacteria TMDL numeric targets for *E. coli*; and
- Impairment status of waterbodies listed as impaired in the watershed but a TMDL has not been adopted.

As part of the effort to evaluate the above, water quality analyses will include descriptive statistics such as geometric mean and percentile calculations. In addition where appropriate, water quality results may be compared to historical data to assess temporal trends at monitoring sites. Descriptive data for each of the monitoring sites has been established in the SAR Bacteria Monitoring Plan (see Attachments A and C in the Monitoring Plan). These data are used by field sampling personnel to determine exact sample collection locations and provide information regarding how to best access the site.

18.2 Data Acceptability

Existing data are considered acceptable for inclusion in data analyses to support the purposes of this the monitoring program only if it meets the following criteria:

- Data was collected with an approved QAPP;
- The sampling methodology and timing are functionally equivalent, including the method for collecting the water samples and the timing of sample collection (e.g., collection during dry versus wet weather or collection from baseflows vs. storm flows); and
- The laboratory analysis methods are functionally equivalent.

Other existing data may be reviewed and discussed to provide additional waterbody or watershed information (e.g., data collected by entities other than those approved in this QAPP), but the use of the data is for qualitative purposes only and will not be incorporated into quantitative data analyses. If these data are used, the constraints associated with the use and interpretation of the data will be described.

19. Data Management

Data will be maintained as described in Section 9 (Documents and Records). During each sample year, each Responsible Agency's Project Manager will maintain an inventory of data and its forms, and will periodically check the inventory against the records in their possession. Data checks (which may be completed by the Monitoring Manager or the Project QA Officer) include:

- Samples are collected according to the procedures outlined in Section 10 (Sampling Process Design).
- Field measurements are recorded on standard Field Log forms included as Attachment 1. Analytical samples are transferred to a contract laboratory under required COC procedures using a standard COC form included as Attachment 2.
- For any site where a velocity cross section profile flow measurement is taken, standard forms are being used to record necessary measurements (Attachment 3).

All laboratory and field data submitted to the Project Director for upload into CEDEN will follow the guidelines and formats established by SWAMP http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml.

All contract laboratories will maintain a record of transferred records and will periodically assess their record of transferred records against those actually held by a Responsible Agency or the Project Director. Prior to submittal of data by a Responsible Agency to the Project Director, a QA/QC review of the data will be conducted by the Responsible Agency's Data Manager. When all data within a batch set (sample year) have passed QA/QC requirements, the Responsible Agency will submit the data to the Project Director for use in completing the Annual Report. A unique batch number, date loaded, originating laboratory, and the person who loaded the data will be recorded by the Project Director, so that data can be identified and removed in the future if necessary.

The Project Director will compile all data received from Responsible Agencies into a single project spreadsheet/database (annual master dataset). Prior to uploading the annual master dataset into CEDEN as a batch set, the Project Director will conduct an additional final QA/QC review of the data received from each Responsible Agency. The QA/QC review is conducted to:

- Ensure the completeness of the data for the prior sample year;
- Verify the validity of analytical methods, monitoring sites, and sample dates; and
- Ensure that monitoring site information is correctly referenced and that identifiers and descriptions match those provided in the SAR Bacteria Monitoring Plan and this QAPP.

The QA/QC review process implemented by a Responsible Agency or Project Director may involve using automated data checking tools, which assess that new data to be uploaded for consistency with specified rules, including rules that check alpha-numeric formatting, units of measurement, missing information, and others. Data not passing this QA/QC review will be returned to the originating contract laboratory or generator (e.g., a Responsible Agency) for clarification and or correction. Any changes made by the Project Director of data provided by a Responsible Agency will be noted in the annual master dataset.

Responsible Agencies are responsible for ensuring their annual sample year field and laboratory data electronic files are backed-up on a regular basis per the procedures/processes established by their respective agencies. While the Project Director will annually upload the previous sample year's field and laboratory data to CEDEN, the Project Director will maintain a local backup of all electronic files uploaded to CEDEN.

Data submittals from Responsible Agencies to the Project Director will occur by January 15 (dry weather samples) and April 15 (wet weather event samples) of each year and include all data collected in the previous sample year. The Project Director will upload data into CEDEN one time each year within 30 days of submittal of the Final Annual Report.

Group C: Assessment and Oversight

20. Assessments & Response Actions

Data reviews will occur prior to the preparation of the Annual Report (see Section 21). These reviews will be conducted by each Responsible Agency's Project QA Officer and Project Manager. Periodic reviews will always include review of the data to be entered into the SWAMP compatible database to evaluate data accuracy and completeness. Where appropriate, e.g., situations where the laboratory results frequently suggest data quality concerns, audits of laboratory or field sampling teams will be scheduled and conducted. The Santa Ana River Watershed Bacteria Monitoring Program Annual Report will include a data quality assessment section, which will provide documentation of any identified data quality concerns.

If an audit discovers any discrepancy, the Responsible Agency's Project Manager and Project QA Officer will discuss the observed discrepancy with the Monitoring Manager. The discussion will begin with whether the information collected is accurate, what were the cause(s) leading to the data discrepancy, how the deviation might impact data quality, and what corrective actions might be considered.

The Responsible Agency's Project Manager and/or Project QA Officer have the power to halt all sampling and analytical work by field sample teams or contract laboratories if the data discrepancies noted are considered detrimental to data quality. Alternatively, a Project QA Officer can require that certain corrective actions be made within a defined time schedule. This approach may be used as a means to meet the monitoring schedule presented in Section 10.

If sampling work is halted for any reason, the Responsible Agency's Project Manager shall notify the Project Director and the Santa Ana Water Board Project Manager of the issue(s) and expected resolution – both approach and schedule.

21. Reports to Management

21.1. Periodic Reporting

Responsible Agency Project Managers may periodically share data and results from preliminary analyses from Priority site sampling efforts conducted under the SAR Bacteria Monitoring Plan Other data collected under the SAR Bacteria Monitoring Plan, e.g., specialized studies, may be shared as well.

21.2 Annual Report

The Project Director will be responsible for the development of the Draft and Final Annual Reports and submittal of the Final Annual Report to the Santa Ana Water Board. After the completion of dry weather sampling each sample year (generally May 1 through November 30, see Section 10), the Project Director will send out a reminder to each Responsible Agency and Contract Laboratory to submit all program-related information described above to the Project Director by January 15th. After the completion of wet weather event sampling that will occur each sample year sometime between November 1 and March 31, the Project Director will send out a reminder to each Responsible Agency and Contract Laboratory to submit all program-related information described above to the Project Director by April 15th.

Under the SAR Bacteria Monitoring Program, the Project Director will prepare a Draft Annual Report by April 30th of each year to reflect findings from sampling conducted during the previous sample year (May 1 through April 30). Findings will include a presentation of the data results and any data analyses completed, e.g., descriptive statistics or trend analyses (see Section 7.3). Each Annual Report will include (a) findings from all RMP sites (See Section 3.3); and (b) findings from any additional required monitoring conducted to support implementation of a bacteria TMDL (e.g., see Section 4.1.1.2).

At a minimum, the Draft Annual Report will be submitted to each Responsible Agency and the Santa Ana Water Board for review. A Final Annual Report will be prepared based on the comments received on the Draft Annual Report. The Final Annual Report will be submitted electronically to each Responsible Agency and the Santa Ana Water Board by June 30th of each year. The Final Annual Report will be made available to the public on either the Santa Ana Water Board or Project Director's website.

Group D: Data Validation and Usability

22. Data Review, Verification, and Validation Requirements

Data generated by project activities will be reviewed by each Responsible Agency's Project QA Officer against the data quality objectives cited in Section 7 and the QA/QC practices cited in Sections 14, 15, 16 and 17. Data validation will be performed for each indicator regardless of waterbody. Data validation protocols are presented in Section 23 of this QAPP.

Data will be separated into three categories: (1) Data meeting all data quality objectives; (2) data failing precision or recovery criteria; and (3) data failing to meet accuracy criteria. Data meeting all data quality objectives, but with failures of QA/QC practices will be set aside until the impact of the failure on data quality is determined. Once determined, the data will be moved into either the first or last category.

Data falling in the first category are considered usable by the project. Data falling in the last category are considered not usable. Data falling in the second category will have all aspects assessed. If sufficient evidence is found supporting data quality for use in this project, the data will be moved to the first category, but will be flagged with a "J" as per EPA specifications.

23. Verification and Validation Methods

All data recorded in the field including field measurements, observations, and COC will be checked visually by each Responsible Agency's Project QA Officer and recorded as checked by initials and dates. Field data will be checked to ensure that all necessary data and activities were completed; including collection of all water samples, field blanks, and field replicates, correct units of measurement are reported and values fall within expected ranges. The validation will also check to ensure that samples were delivered to laboratories within required holding times and that all sample handling and custody protocols were followed.

In addition to field data validation, there will be a validation of water quality analysis results. This will involve a review of 10 percent of all laboratory water quality analysis reports. The review will involve verifying that all required parameters were measured, reported in the correct units, and that results fall within expected ranges.

Each Responsible Agency's Project Manager will be responsible for all field data validation reviews. Each of the Laboratory QA Officers will perform checks of all of its records and each of the contract Laboratory Directors will recheck 10 percent. All checks by the laboratories will be reviewed by each Responsible Agency's Project QA Officer and Project Manager.

Issues, including missing data, incomplete site visits, reporting errors (such as incorrect units of measure or incorrect date/time information, etc.), or data management errors will be communicated to the responsible party immediately and documented in the Annual Report for either field sampling, laboratory activities, or database management. If reconciliation and correction of the data are necessary, this will be done through coordination with the Project Director. Any corrections require a unanimous agreement that the correction is appropriate.

24. Reconciliation with User Requirements

The purposes of the Regional and TMDL Monitoring Programs addressed by this QAPP are described in the following sections.

24.1 Regional Monitoring Program

The primary basis for the establishment of a RMP is to evaluate compliance with bacterial indicator water quality objectives established in the Basin Plan for inland freshwaters. The BPA (see Section 5 of this QAPP and SAR Bacteria Monitoring Plan) that established these objectives also established minimum monitoring requirements for the RMP. The RMP is structured to direct water quality monitoring resources to the highest priority waterbodies. As such, the RMP is designed to:

- Provide the data needed to determine if water quality is safe when and where people are most likely to engage in water contact recreation.
- Facilitate the TMDL implementation process and track progress toward attainment of applicable water quality standards, where water quality is impaired due to excessive bacterial indicator levels.
- Apply a risk-based implementation strategy to allocate public resources in a manner that is expected to produce the greatest public health benefit.

With these considerations in mind, priority waterbodies for monitoring under this RMP are described as follows:

- *Priority 1*: The first priority is to establish a monitoring program that can determine whether bacteria levels are "safe" at those locations and seasons where people are most likely to engage in water contact recreation. The Santa Ana Water Board identified these waterbodies in the 2012 BPA as Tier A waters.
- *Priority 2*: The second priority is to focus monitoring resources on those waterbodies that have been identified as "impaired" due to excessive bacterial indicator concentrations and a TMDL has already been adopted. Monitoring efforts to evaluate progress toward attainment with the water quality standard in these impaired waters fall with priority two. This will ensure that the RMP is closely coordinated with TMDL-related sampling efforts.
- *Priority 3*: The third priority is 303(d)-listed or impaired waterbodies where a TMDL has not yet been developed. For these Priority 3 sites the RMP includes periodic sample collection on an annual basis.
- *Priority 4*: The fourth priority is to collect the bacteria indicator data needed to implement the antidegradation targets that have been established for waterbodies designated as REC2 only (i.e., the REC1 beneficial use has been de-designated through an approved UAA). Data collection from these Priority 4 waterbodies provides the Santa Ana Water Board with the ability to assess the status and trend of bacterial indicator water quality as part of the normal Triennial Review process.

24.2 TMDL Monitoring Programs

24.2.1 Watershed-wide Compliance Monitoring

The MSAR Bacteria TMDL required the establishment of a watershed-wide compliance monitoring program to measure compliance with numeric targets established by the TMDL, which were derived from Basin Plan objectives established to protect the REC1 beneficial use. Dry weather monitoring to assess compliance with the MSAR Bacteria TMDL during dry weather has been incorporated into the RMP as Priority 1 or 2 sites.

Wet weather monitoring for bacterial indicators is a requirement of the MSAR Bacteria TMDL. The same concentration based wasteload and load allocations for *E. coli* in the TMDL apply to wet weather as well as dry weather conditions. The Monitoring Plan targets sampling one storm event per wet season to meet this TMDL monitoring requirement.

24.2.2 Urban Source Evaluation Monitoring Program

The purpose of the Urban Source Evaluation Monitoring Program is to identify specific activities, operations, and processes in urban areas that contribute bacterial indicators to waterbodies under the MSAR Bacteria TMDL. This monitoring program also seeks to identify which waters are of greatest concern with regards to the source of the bacteria. Sites where human sources of bacteria are most commonly observed have the highest priority for the implementation of source controls and/or additional monitoring efforts to further refine the identification of sources.

Source evaluation activities in major MS4 drainage areas (Tier 1 sites) and at outfalls within prioritized MS4 drainage areas (Tier 2) have been conducted in 2012-14, and have successfully identified and where possible mitigated controllable sources of bacterial indicator derived from discharges covered by MS4 permits. Continued implementation of source evaluation activities, as needed, is a component of the TMDL Monitoring Program and integral to achieving compliance with the TMDL.

24.2.3 Agricultural Source Evaluation Monitoring Program

The purpose of the AgSEMP is to identify specific activities, operations and processes in agricultural areas that contribute bacterial indicators to MSAR watershed waterbodies. Monitoring data is then intended to be used by the Santa Ana Water Board and agricultural stakeholders to support development of the BASMP. Per the TMDL, the BASMP should include, plans and schedules for the following:

- Implementation of bacteria indicator controls, BMPs and reduction strategies designed to meet load allocations;
- Evaluation of effectiveness of BMPs; and
- Development and implementation of compliance monitoring program(s).

Monitoring downstream of agricultural lands was conducted during wet weather in the 2008-2009 wet season from four monitoring sites and included collection of field parameters, bacterial indicator data, and microbial source identification analyses.

A BASMP is currently under development by agricultural dischargers in the MSAR watershed. Because this document is still under development, this section may be updated once the BASMP is finalized.

Moreover, the final BASMP may include monitoring requirements designed to support implementation of the BASMP. If included in the final program, then these monitoring requirements may be incorporated into the Santa Ana River Watershed Bacteria Monitoring Plan and QAPP.

ATTACHMENT 1

SANTA ANA RIVER WATERSHED BACTERIA MONITORING PROGRAM
FIELD DATA SHEET FORMS

Santa Ana River Watershed Bacteria Monitoring Program - Field Data Sheet

General Information:

Site Name: _____

Site ID: _____

Date: _____/_____/_____

Time (24-hr clock): _____

Sampling Team: _____/_____

Field Measurements: *(average of three readings)*

	Reading #1	Reading #2	Reading #3	Average
Conductivity: mS/cm ☐ µS/cm ☐	_____	_____	_____	_____
Dissolved Oxygen: (mg/L)	_____	_____	_____	_____
pH:	_____	_____	_____	_____
Turbidity: (NTU)	_____	_____	_____	_____
Temp (water): (°C)	_____	_____	_____	_____
Other: _____	_____	_____	_____	_____

Flow Connectivity: Y/N (Describe) _____

Flow measurements *(check boxes for units of measure)*:

Total Section Width (*W*): _____ feet ☐ meters ☐

Cross-section:	Depth (*D*)	Velocity (*V*)	Comments
10% across	_____ in ☐ cm ☐	_____ ft/sec ☐ m/sec ☐	_____
50% across	_____ in ☐ cm ☐	_____ ft/sec ☐ m/sec ☐	_____
90% across	_____ in ☐ cm ☐	_____ ft/sec ☐ m/sec ☐	_____

Estimated Flow _____ ft^3/sec ☐ m^3/sec ☐ $Q\ (ft^3/sec) = (0.2*W*D_{10}/12*V_{10}) + (0.6*W*D_{50}/12*V_{50}) + (0.2*W*D_{90}/12*V_{90})$

Grab Sampling: Filled and labeled *(check if applicable)*

1 – 100 mL or 125 mL polyethylene bottle (w/ $NaSO_4$ preservative) for ***E. coli*** *or* ***Enterococcus***: ..... _____

1 – 1,000 mL polyethylene bottle for **TSS**: ..... _____

1 – 1,000 mL polyethylene bottle for ***Bacteroides:*** ..... _____

1 – 100 mL polyethylene bottle for **Ammonia:** ..... _____

1 – 500 mL polyethylene bottle for **Potassium:** ..... _____

1 – 500 mL polyethylene bottle for **Surfactants:** ..... _____

Additional bottle sets are included for field duplicates and trip blanks ..... _____

Site Observations:

Weather: _____

Visual Evidence of REC-1 Activity: _____

_____

Other: _____

_____

_____

ATTACHMENT 2

SANTA ANA RIVER WATERSHED BACTERIA MONITORING PROGRAM
EXAMPLE CHAIN OF CUSTODY FORMS

County of Orange, Health Care Agency Water Quality Laboratory (ELAP # 2545) 600 Shellmaker Rd. Bldg. A Newport Beach, CA 92660 Phone:(949)219-0423 FAX:(949)219-0426	Client:	**OCPW**
	Study/Billing Code:	Santa Ana Regional Monitoring Program
	Contact Info:	
	Date Collected:	mm/dd/yyyy
	Sampler Name:	County of Orange

Bottle #	Time Collected	MRN/Station ID, Location	Sampler Comments	Submitter Accession #	Lab Accession #	Test Requested
1		*1000-34-2417* Site1Name	Matrix: FW W: Ht: Q: FTO: Temp:	WRzzzzzz Notes:		Total Coliform Fecal Coliform Enterococci x E. coli Can Bacrio Hum Bacrio Coliphage
Water Type: Domestic Surface Marine Ground Reclaimed Other				**Preservative:** $Na_2S_2O_3$ None Other		
2		*1000-34-2418* Site2Name	Matrix: FW W: Ht: Q: FTO: Temp:	WRzzzzzz Notes:		Total Coliform Fecal Coliform Enterococci X E. coli Can Bacrio Hum Bacrio Coliphage
Water Type: Domestic Surface Marine Ground Reclaimed Other				**Preservative:** $Na_2S_2O_3$ None Other		
3		*1000-34-2418* Site3Name	Matrix: SW W: Ht: Q: FTO: Temp:	WRzzzzzz Notes:		Total Coliform Fecal Coliform Enterococci X E. coli Can Bacrio Hum Bacrio Coliphage
Water Type: Domestic Surface Marine Ground Reclaimed Other				**Preservative:** $Na_2S_2O_3$ None Other		
4		*1000-21-6890* Site4Name	Matrix: FW W: Ht: Q: FTO: Temp:	WRzzzzzz Notes:		Total Coliform Fecal Coliform Enterococci X E. coli Can Bacrio Hum Bacrio Coliphage
Water Type: Domestic Surface Marine Ground Reclaimed Other				**Preservative:** $Na_2S_2O_3$ None Other		

Name / Date / Time	Comments:
Relinquished by:	
Received by:	
Analyzed by:	
Reviewed by:	
Reported to:	Transport Conditions:

ORANGE COUNTY WATER DISTRICT

10500 Ellis Avenue, Fountain Valley, CA 92708

Telephone: (714) 378-3200 Fax: (714) 378-3373

CHAIN OF CUSTODY RECORD

NO.	SAMPLING AGENCY	WRMS STATION NAME	Sample Date	Sample Time	Sampled BY	COMMENTS		NO. OF Bottles	ANALYSIS
1						EC=	Ph=		
						TEMP=	DO=		
2						EC=	Ph=		
						TEMP=	DO=		
3						EC=	Ph=		
						TEMP=	DO=		
4						EC=	Ph=		
						TEMP=	DO=		
5						EC=	Ph=		
						TEMP=	DO=		
6						EC=	Ph=		
						TEMP=	DO=		
7						EC=	Ph=		
						TEMP=	DO=		
8						EC=	Ph=		
						TEMP=	DO=		
9						EC=	Ph=		
						TEMP=	DO=		
10						EC=	Ph=		
						TEMP=	DO=		

RELINQUISHED BY: DATE/TIME	ED BY:
RELINQUISHED BY: DATE/TIME	ED BY: DATE/TIME
SPECIAL INSTRUCTIONS:	BILL ACCOUNT NO.:

Babcock Laboratories, Inc.
(951) 653-3351 FAX (951) 653-1662
www.babcocklabs.com

Chain of Custody Sample Information Record

Client:	Contact:	Phone No. 213-457-2141
FAX No.	Email:	Additional Reporting Requests
Project Name:	Turn Around Time: Routine / *3-5 Day Rush / *48 Hour Rush / *24 Hour Rush	Include QC Data Package: ☐ Yes ☐ No
Project Location:	*Lab TAT Approval: By: *Additional Charges May Apply	FAX Results: ☐ Yes ☐ No Email Results: ☐ Yes ☐ No State EDT: ☐ Yes ☐ No (Include Source Number in Notes)

Sampler Information

Name: _____

Employer: _____

Signature: _____

Sample ID	Date	Time	# of Containers & Preservatives: Unpreserved	H2SO4	HCl	HNO3	Na2S2O3	NaOH	NaOH/ZnAcetate	NH4Cl	MCAA			Total # of Containers	Sample Type: Routine	Resample	Special	Analysis Requested: QT 18hr T.Coliform/E.Coli								Matrix	Notes

DW = Drinking Water
GW = Groundwater
WW = Wastewater
S = Source
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/Acceptance Criteria**

Sample(s) Submitted on Ice?	Yes	No	Sample Meets Laboratory Acceptance Criteria?	Yes	No
Custody Seal(s) Intact?	Yes	No N/A	Permission to continue:	Yes	No
Sample(s) Intact?	Yes	No	Deviation/Notes:		
Temperature: _____ °C	☐ Cooler Blank		Signature/Date:		

Logged in By/Date: _____

Page _____ of _____

ATTACHMENT 3

SANTA ANA RIVER WATERSHED BACTERIA MONITORING PROGRAM
FLOW MEASUREMENT FORM

SANTA ANA RIVER WATERSHED BACTERIA MONITORING PROGRAM

FLOW MEASUREMENTS

Location _____

Portable Flowmeter Used _____ Recorder _____

Date _____

Time _____

Left Bank _____ Right Bank _____ Page _____ of _____

	Distance from IP	Width	Total Depth	Flow Velocity				Average V*	Area A**	Discharge (avg VXA)
				VO.6	VO.2	VO.8	VO.9			
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
								Total Discharge		

Stream Flow Conditions (I.e., muddy, clear, debris, etc…): _____

_____

* Average Velocity =VO.6 for stream depths between 0.3 and 2.5 feet (six-tenths method).
=(VO.2 + VO.8)/2 for stream depths greater than 2.5 feet (two-point method).
=VO.9 if flow is less than 0.3 feet deep (maximum velocity X 0.9).

** Area =total depth x width

IP =Initial Point

APPENDICES

APPENDIX A

ORANGE COUNTY PUBLIC HEALTH WATER QUALITY LABORATORY
STANDARD OPERATING PROCEDURES

APPENDIX B

ORANGE COUNTY WATER DISTRICT LABORATORY
STANDARD OPERATING PROCEDURES

APPENDIX C

CLINICAL LABORATORY OF SAN BERNARDINO, INC.
STANDARD OPERATING PROCEDURES

APPENDIX D

BABCOCK LABORATORIES, INC.
STANDARD OPERATING PROCEDURES

APPENDIX E

WECK LABORATORIES, INC.
STANDARD OPERATING PROCEDURES

APPENDIX F

ENTHALPY ANALYTICAL
STANDARD OPERATING PROCEDURES

APPENDIX G

WESTON SOLUTIONS
STANDARD OPERATING PROCEDURES

APPENDIX H

SOURCE MOLECULAR
STANDARD OPERATING PROCEDURES