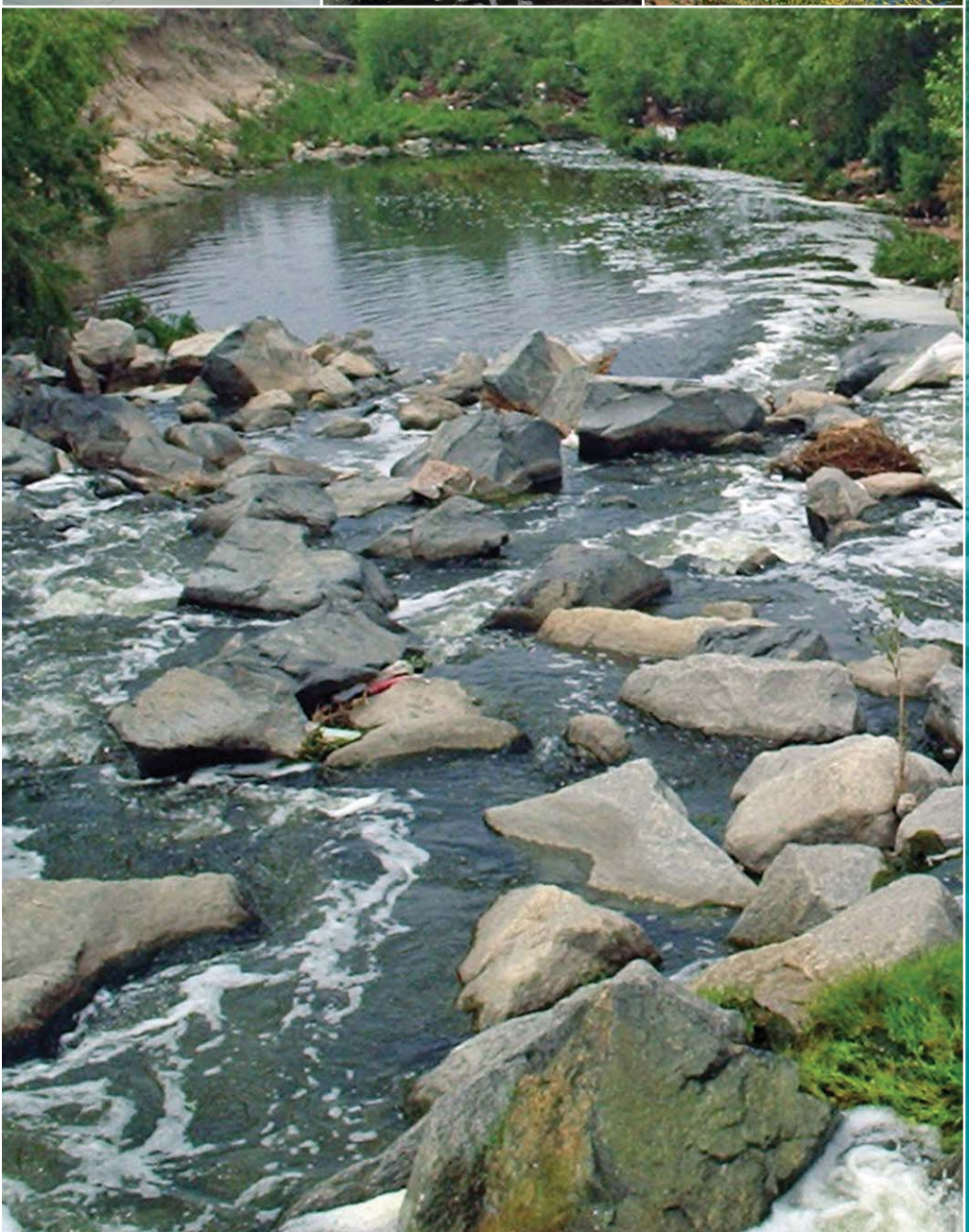
SANTA ANA WATERSHED PROJECT AUTHORITY



Santa Ana River Watershed Bacteria Monitoring Program Annual Report: 2018-2019

June 2019

Final

CDM Smith

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Acronyms and Abbreviations

AgSEP	Agricultural Source Evaluation Plan
Babcock	Babcock Laboratories
Basin Plan	Santa Ana Region Basin Plan
BPA	Basin Plan Amendment
CEDEN	California Environmental Data Exchange Network
cfs	Cubic Feet per Second
CFU	Colony Forming Units
COC	Chain of Custody
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
MPN	Most Probable Number
MSAR	Middle Santa Ana River
OCPHL	Orange County Public Health Laboratory
OCPW	Orange County Public Works
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance / Quality Control
RCFC&WCD	Riverside County Flood Control & Water Conservation District
RMP	Regional Monitoring Program
Santa Ana Water Board	Santa Ana Regional Water Quality Control Board
SAR	Santa Ana River
SAWDMS	Santa Ana Watershed Data Management System
SAWPA	Santa Ana Watershed Project Authority
SBCFCD	San Bernardino County Flood Control District
SOP	Standard Operating Procedures
SSV	Single Sample Value
State Water Board	State Water Resources Control Board
SWAMP	California's surface ambient monitoring program
SWQSTF	Stormwater Quality Standards Task Force
Task Force	MSAR TMDL / Regional Water Quality Task Force
TMDL	MSAR Bacteria Indicator Total Maximum Daily Limit
TSS	Total Suspended Solids
UAA	Use Attainability Analysis
USEP	Urban Source Evaluation Plan

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Section 1
Introduction

The Santa Ana River (SAR) Watershed Bacteria Monitoring Program or Regional Monitoring Program (RMP) was developed to achieve the following objectives regarding bacteria sampling:

- 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 Total Maximum Daily Load (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.

1.1 Regulatory Background

The SAR RMP supports the implementation of several regulatory-related activities associated with the protection of recreational uses in the Santa Ana River Watershed, including the Basin Plan Amendment (BPA) to *Revise Recreation Standards for Inland Freshwaters in the Santa Ana Region* and the Middle Santa Ana River (MSAR) Bacteria TMDL. Each of the activities addressed by the SAR RMP is described below.

1.1.1 Basin Plan Amendment

On June 15, 2012, the Santa Ana Regional Water Quality Control Board (Santa Ana Water Board) adopted the BPA to *Revise Recreation Standards for Inland Freshwaters in the Santa Ana Region.*[1] This BPA resulted in the following key modifications to the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) for the Santa Ana region:[2]

- 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 (UAA);

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[1] Santa Ana Water Board Resolution: R8-2012-0001, June 15, 2012

[2] Santa Ana Basin Plan Chapter 5, Page 5-92; http://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/docs/2016/Chapter_5_February_2016.pdf

- Revised water quality objectives to protect the REC1 use of inland freshwaters; and
- 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 (SWQSTF), comprised of representatives from various stakeholder interests, including the Santa Ana Watershed Project Authority (SAWPA); the counties of Orange, Riverside, and San Bernardino; Orange County Coastkeeper; Inland Empire Waterkeeper; and the Environmental Protection Agency (EPA) Region 9. The BPA was approved by the State Water Resources Control Board (State Water Board) on January 21, 2014[3] and the California Office of Administrative Law on July 2, 2014.[4] However, the EPA did not approve all provisions of the BPA, which required revisions in the form of letters. The EPA issued its comment letter on April 8, 2015 and provided a letter of clarification on August 3, 2015.[5]

The BPA required the establishment of a comprehensive monitoring program to support implementation of the changes to the Basin Plan.[6] The SAR RMP fulfills this requirement.

1.1.2 Statewide Bacteria Provisions

On August 7, 2018, the State Water Resources Control Board adopted Bacteria Provisions and a Water Quality Standards Policy for Inland Surface Waters, Enclosed Bays, and Estuaries of California (Statewide Bacteria Provisions)[7]. The Statewide Bacteria Provisions developed new statewide numeric water quality objectives for bacteria to protect primary contact recreation beneficial use, as follows:

- *E. coli*: For all waters where the salinity is equal to or less than 1 part per thousand (ppth) 95 percent or more of the time, a six-week rolling geometric mean not to exceed 100 cfu/100mL, calculated weekly, and a statistical threshold value (STV) of 320 cfu/100 mL not to be exceeded by more than 10 percent of the samples collected in a calendar month, calculated in a static manner.
- Enterococci: For all waters where the salinity is greater than 1 ppth 95 percent or more of the time, a six-week rolling geometric mean not to exceed 30 cfu/100mL, calculated weekly, and a STV of 110 cfu/100 mL not to be exceeded by more than 10 percent of the samples collected in a calendar month, calculated in a static manner.

The Statewide Bacteria Provisions supersede numeric WQOs for REC1 use contained in regional Basin Plans, expect for cases involving a site-specific standard (none exist within the SAR watershed) or if an existing TMDL was developed with targets based on prior regional Basin Plan REC1 WQOs (such as the MSAR Bacteria TMDL. The following section describes the MSAR Bacteria TMDL and associated numeric targets, which differ from those included in the Statewide

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[3] State Water Board Resolution: 2014-0005, January 21, 2014

[4] Office of Administrative Law: #2014-0520-02 S; July 2, 2014

[5] http://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/recreational_standards.shtml

[6] Santa Ana Basin Plan Chapter 5, Page 5-114; http://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/docs/2016/Chapter_5_February_2016.pdf

[7] State Water Board Resolution: 2018-0038, August 7, 2018

Bacteria Provisions. This comprehensive monitoring program is revised to facilitate data collection needed to evaluate both TMDL numeric targets and Statewide Bacteria Provisions WQOs for the TMDL waters. Compliance metrics will be based solely on the TMDL numeric targets.

Lastly, the Statewide Bacteria Provisions do not supersede narrative WQOs in regional Basin Plans. The BPA to *Revise Recreation Standards for Inland Freshwaters in the Santa Ana Region* is comprised of predominantly narrative criteria, which remain in effect for the Santa Ana region. The narrative criteria in the BPA are largely consistent with narrative criteria contained in the Statewide Bacteria Provisions.

1.1.3 MSAR Bacteria TMDL

There is currently one bacteria TMDL adopted for freshwaters in the Santa Ana River Watershed, the MSAR Bacteria TMDL, which became effective on May 16, 2007. Due to exceedances of the fecal coliform objective established to protect REC1 use during the 1990s, 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] and it was subsequently approved by the EPA on May 16, 2007. The TMDL established compliance targets for both fecal coliform and *E. coli*:

- Fecal coliform: 5-sample/30-day logarithmic mean less than 180 organisms/100 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.

Per the TMDL, the above compliance targets for fecal coliform are no longer effective as a result of EPA approval of the BPA.[9]

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[8] Santa Ana Water Board Resolution: R8-2005-0001, August 26, 2005

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

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, including 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 the MSAR Water Quality Monitoring Plan and associated Quality Assurance Project Plan (QAPP) for submittal to the Santa Ana Water Board. The MSAR TMDL Task Force implemented the TMDL monitoring program in July 2007; the Santa Ana Water Board formally approved the monitoring program documents in April 2008.[11] This TMDL monitoring program has been incorporated into the SAR RMP.

The MSAR Bacteria TMDL also required the development and implementation of source evaluation plans by urban and agricultural dischargers within six months of the TMDL effective date. These urban and agricultural source evaluations plans (USEP and AgSEP, respectively) were approved by the Santa Ana Water Board in 2008. These programs were incorporated into the SAR Watershed Bacteria Monitoring Program Monitoring Plan and QAPP.[12]

1.1.4 Antidegradation Targets

The BPA established site-specific antidegradation targets for waterbodies with only a REC2 designation. For each of these waterbodies, the REC1 beneficial use was de-designated through an approved UAA. The antidegradation targets serve as triggers for additional monitoring or efforts to prevent degradation of water quality in REC2 waterbodies. The targets were developed using a statistical method that fits historical dry weather data to a lognormal distribution. The 75th percentile of the fitted lognormal distribution was selected as the antidegradation target when relying on a single sample result. The geomean targets are selected from at least five samples within 30 days. These targets provide the Santa Ana Water Board with the ability to assess status and trend of bacterial indicator water quality as part of the Triennial Review process. Table 1-1 summarizes the antidegradation targets for the REC2 waterbodies included in the SAR RMP.

Table 1-1 *E. coli* Antidegradation Targets for Waterbodies with only a REC2 Designation in the SAR RMP

Waterbody	Geomean Target	75th Percentile Target
Temescal Creek Reach 1a/1b	353 MPN/100 mL	725 MPN/100 mL
Santa Ana Delhi Channel Reach 1/2	399 MPN/100 mL	1,067 MPN/100 mL
Santa Ana Delhi Channel in Tidal Prism[1]	240 MPN/100 mL	464 MPN/100 mL
Greenville-Banning Channel in Tidal Prism[1]	24 MPN/100 mL	64 MPN/100 mL
Cucamonga Creek Reach 1	509 MPN/100 mL	1,385 MPN/100 mL

[1] Targets are for *Enterococcus* instead of *E. coli* due to location in tidal prism

[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] SAR Monitoring Plan and QAPP Version 1.0 February 2016: http://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/recreational_standards.shtml

1.2 Monitoring Strategy

One of the principal goals for updating recreational water quality standards in the Santa Ana region was to encourage the most cost-effective allocation of finite public resources. As such, all efforts undertaken to assure compliance with these revised standards should concentrate on projects and programs that are likely to produce the greatest public health benefit.

When the Basin Plan was amended in 2012, the Santa Ana Water Board identified several high priority waterbodies where significant recreational use frequently occurred. They also assigned most of the remaining lakes and streams to "Tiers" based on the expected level of recreational use.[13] These tiered classifications were intended to help local authorities prioritize their implementation efforts by providing some indication of the potential risk exposure for each waterbody.

This risk-based approach, which is designed to guide all aspects of protecting water contact recreation, provides the foundation for this RMP. Just as it is prudent to prioritize mitigation projects in a manner that assures the greatest public health benefit, it is wise to organize related water quality monitoring efforts along the same lines. The RMP is structured to direct water quality monitoring resources to the highest priority waterbodies.

1.2.1 Priority Designation

Basin Plan requirements for a RMP and the risk-based approach described above were used as a basis for the development of a monitoring approach that designates varying levels of monitoring priority. General principles include:

- The most rigorous monitoring should occur in REC1 Tier A waterbodies during dry weather conditions. These are the waterbodies and the conditions where the expectation for water contact recreation is the highest. Data collection must occur at a sufficient frequency to demonstrate that these waters are safe for recreation.
- Where a waterbody has an adopted TMDL for bacterial indicators, consider existing monitoring requirements that have already been established to evaluate progress towards achieving attainment with water quality objectives.

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[13] The BPA (Santa Ana Water Board Resolution R8-2012-0001), which is incorporated into Chapter 5 of the Basin Plan (page 5-92), establishes four tiers of waterbodies: (a) Tier A REC1 Waters: includes freshwater lakes and streams that are or may be heavily used by the public for primary contact recreational activities, relative to other freshwater bodies in the Santa Ana Region; (b) Tier B REC1 Waters: includes freshwater lakes and streams that are or may be moderately-used by the public for primary contact recreational activities. Moderate use occurs where the number of people accessing the waterbody is approximately half that which generally occurs in Tier A waters; (c) Tier C REC1 Waters: includes freshwater lakes and streams that are or may be lightly-used by the public for primary contact recreational activities. Light use occurs where the number of people accessing the waterbody is less than half that which generally occurs in Tier A waters; and (d) Tier D REC1 Waters: includes freshwater lakes and streams that are infrequently used by the public for primary contact recreational activities. Infrequent use occurs where people only access the waterbody rarely or occasionally. For any waterbody regardless of Tier, 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." http://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/docs/2016/Chapter_5_February_2016.pdf

- For waterbodies listed as impaired, but no TMDL has been adopted, monitoring should occur periodically to provide additional data regarding the impairment status of these waterbodies.
- Ensure sufficient sample collection from REC2 only waters to assess compliance with antidegradation targets established per the BPA.

These general principles provide the foundation for the development of the SAR RMP which prioritizes waterbodies as follows:

- *Priority 1*: The first priority is to establish a monitoring program that can determine whether bacteria levels are "safe" at those locations where and when people are most likely to engage in water contact recreation. These waters are all Tier A waters per the 2012 BPA (Note: A Priority 1 water may also include impaired waterbodies that are designated Tier A REC1 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 (Note: A Priority 2 water may also be Priority 1 because it is also a Tier A REC1 Water). Monitoring efforts in these waters focus on evaluating progress toward attainment with the water quality standard in these impaired waters.
- *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 5-weeks of sample collection on an annual basis. Data from Priority 3 sites will be used to evaluate compliance with the Santa Ana region *E. coli* water quality objective.
- *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. Data from Priority 4 sites will be used to evaluate compliance with the site-specific antidegradation targets (see Table 1-1).

1.2.2 Monitoring Plan and Quality Assurance Project Plan

To support the watershed-wide SAR RMP, the MSAR TMDL Task Force was expanded to include SAR watershed stakeholders and formed the MSAR TMDL / Regional Water Quality Monitoring Task Force (Task Force). The Task Force stakeholders worked collaboratively to prepare the SAR RMP Monitoring Plan and QAPP[14] to support this monitoring program. The monitoring program documents were submitted on February 8, 2016 and were formally approved by the Santa Ana Water Board on March 11, 2016.[15] An update in currently underway to be considered for approval in 2019.

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[14] SAR RMP Monitoring Plan and QAPP, Version 1.0, February 2016: http://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/recreational_standards.shtml

[15] Resolution No. R8-2016-0022 http://www.waterboards.ca.gov/santaana/board_decisions/adopted_orders/resolutions/R8-2016-0022_Resolution_Santa_Ana_River_Watershed_Bacterial_Monitoring_Program.pdf

1.2.3 Annual Report

This Annual Report summarizes the results of the 2018-2019 monitoring efforts. Previous seasonal water quality reports prepared only for the sites subject to the MSAR Bacteria TMDL (2007 – 2015) are available from SAWPA.[16]

[16] http://www.sawpa.org/task-forces/middle-santa-ana-river-watershed-tmdl-taskforce/

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Section 2

Santa Ana River Study Area

This section describes the study area and identifies the monitoring locations sampled during the 2018-2019 monitoring year. The Monitoring Plan and QAPP provide a more detailed characterization of the watershed.

2.1 Physical Characteristics

The Santa Ana River watershed encompasses approximately 2,840 square miles of Orange, Riverside, San Bernardino, and a small portion of Los Angeles Counties (Figure 2-1). 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.

2.1.1 Major Geographic Subareas

The Santa Ana River watershed can be divided into three major geographic subareas:

- 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 where it drains into the Prado Basin Management Zone.

- 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 County. This region drains to the Prado Basin Management Zone 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.

  The Prado Basin Management Zone 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 Harbor and Coyote Creek.

2.1.2 Middle Santa Ana River Watershed

The MSAR watershed covers approximately 488 square miles and lies largely in the southwestern corner of San Bernardino County and the northwestern corner of Riverside County. A small part of Los Angeles County (Pomona/Claremont area) is also included. Per the TMDL, the MSAR watershed includes three sub–watersheds (Figure 2-2):

- Chino Basin (San Bernardino County, Los Angeles County, and Riverside Counties) – Surface drainage in this area, which is directed to Chino Creek and Mill-Cucamonga Creek, flows generally southward, from the San Gabriel Mountains, and west or southwestward, from the San Bernardino Mountains, toward the Santa Ana River and the Prado Management Zone.

- Riverside Watershed (Riverside County) – Surface drainage in this area is generally westward or southeastward from the City of Riverside and the community of Rubidoux to Reach 3 of the Santa Ana River.

- Temescal Canyon Watershed (Riverside County) – Surface drainage in this area is generally northwest to Temescal Creek (however, note that Temescal Creek is not included as an impaired waterbody in the MSAR Bacteria TMDL).

Land uses in the MSAR watershed include urban, agriculture, and open space. Although originally developed as an agricultural area, the watershed continues to rapidly urbanize. Incorporated cities in the MSAR watershed include Chino, Chino Hills, Claremont, Corona, Eastvale, Fontana, Jurupa Valley, Montclair, Norco, Ontario, Pomona, Rancho Cucamonga, Rialto, Riverside, and Upland. In addition, there are several pockets of urbanized unincorporated areas. Open space areas include National Forest lands and State Park lands.

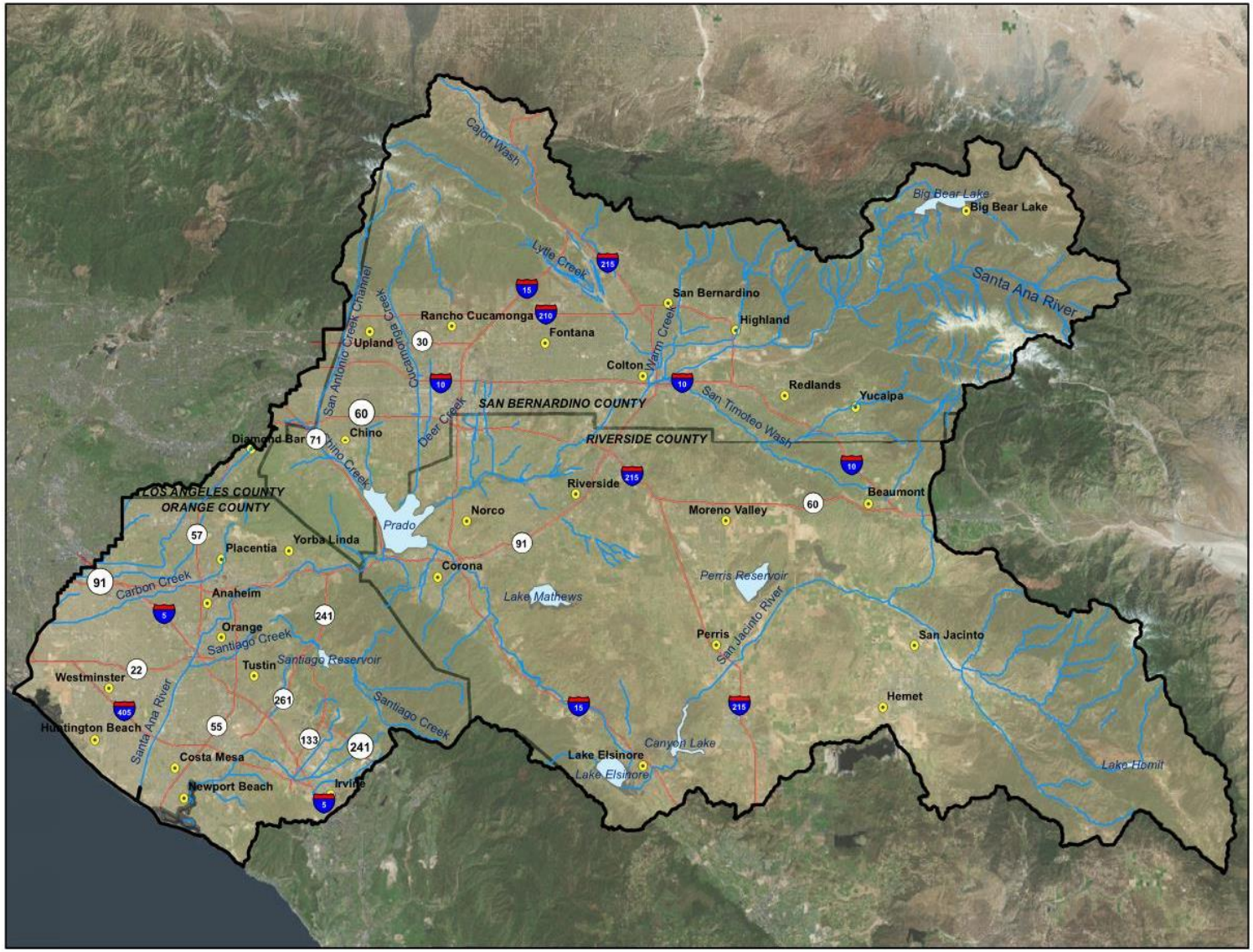

Figure 2-1
Santa Ana River Watershed and Location of Orange, Riverside and San Bernardino Counties (Source: SAWPA)

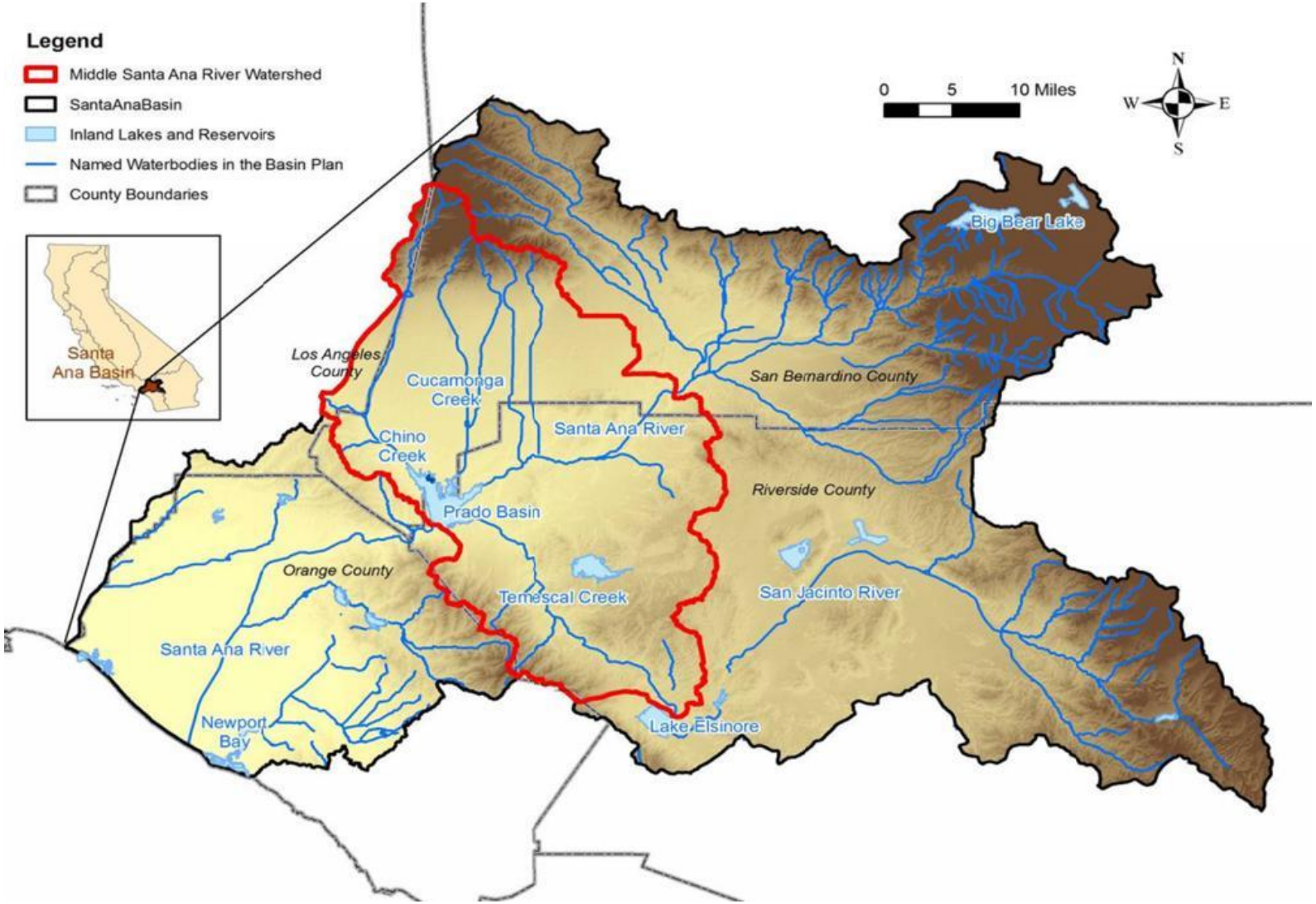

Figure 2-2
Middle Santa Ana River Watershed

2.1.3 Rainfall

Rainfall varies considerably across the watershed with highest average rainfall occurring in the upper mountain areas of the watershed (San Gabriel, San Bernardino, and San Jacinto mountains) (Figure 2-3). Historical average annual rainfall in the northern and eastern areas can be more than 35 inches but is much lower in the lowland regions and central parts of the watershed. In these areas that include Chino and Prado Basin, average annual rainfall ranges from approximately 11 to 19 inches.

Key rainfall gages in the SAR watershed were identified and considered representative of the variability across the watershed (Figure 2-4). Table 2-1 provides the locations of key rainfall gages in the watershed[17] and Table 2-2 summarizes the total monthly rainfall data from each location for the 2018 calendar year.

Table 2-1 Location of Key Rainfall Gages in the SAR Watershed

Station No.	Station Name	Source	Latitude	Longitude
178	Riverside North	RCFC&WCD	34.0028	-117.3778
179	Riverside South	RCFC&WCD	33.9511	-117.3875
35	Corona	RCFC&WCD	33.8450	-117.5744
131	Norco	RCFC&WCD	33.9215	-117.5724
067	Elsinore	RCFC&WCD	33.6686	-117.3306
90	Idyllwild	RCFC&WCD	33.7472	-116.7144
9022	Fawnskin	SBCFCD	34.2726	-116.9718
2965	Lytle Creek Canyon	SBCFCD	34.2164	-117.4553
2808	Highland Plunge Creek	SBCFCD	34.1120	-117.1278
61	Tustin-Irvine Ranch	OCPW	33.7200	-117.7231
169	Corona del Mar	OCPW	33.6093	-117.8583
219	Costa Mesa Water District	OCPW	33.6453	-117.9336
163	Yorba Reservoir	OCPW	33.8719	-117.8112
5	Buena Park	OCPW	33.8571	-117.9923

[17] Data provided by Orange County Public Works (OCPW), Riverside County Flood Control & Water Conservation District (RCFC&WCD), and San Bernardino County Flood Control District (SBCFCD)

Table 2-2 Monthly Rainfall Totals (inches) During 2018 at Key Rainfall Gages

Rainfall Gage	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Riverside North	1.9	0.5	1.7	0	0.4	0	0.1	0	0	0.8	0.9	1.3
Riverside South	1.5	0.7	1.8	0	0.3	0.01	0.01	0	0	0.9	0.8	1.3
Corona	1.8	0.4	1.8	0.02	0.3	0	0	0	0	0.9	1.7	1.5
Norco	1.6	0.5	1.1	0	0.09	0	0	0	0	0.7	1.3	1.1
Elsinore	1.9	0.1	0.9	0.01	0.03	0	0	0.05	0.02	1.3	0.6	1.6
Idyllwild	3.7	0.7	5.4	0.03	0.4	0	1.3	1.1	0	0.7	3.2	1.8
Fawnskin	4.2	0.5	4.0	0	0.4	0	2.6	0.7	0	1.5	2.3	2.8
Lytle Creek Canyon	2.8	0.7	2.4	0	0.6	0	0.1	0	0	1.1	1.4	1.6
Highland Plunge Creek	3.5	0.4	3.4	0	0.4	0	0.04	0.0	0.0	0.9	2.0	3.6
Tustin-Irvine Ranch	1.6	0.5	1.8	0.1	0.5	0	0	0	0	1.3	1.3	0.3
Corona del Mar	1.3	0.4	1.5	0.1	0.4	0	0	0	0	0.9	1.3	2.4
Costa Mesa Water District	1.3	0.4	1.3	0.1	0.09	0	0	0	0	1.0	1.4	2.5
Yorba Reservoir	1.7	0.5	1.6	0.01	0.09	0	0	0	0	1.0	1.8	2.8
Buena Park	1.7	0.3	1.5	0.01	0.03	0	0	0	0	2.4	1.9	1.5

Rainfall varies throughout the watershed with heavier precipitation recorded in the upper watershed and during winter months. Smaller storms occurred during the summer months, however, all dry weather monitoring adhered to the dry weather condition established in the Monitoring Plan, which states that dry weather samples will be collected only if there is no measurable rainfall in the preceding 72-hour period.

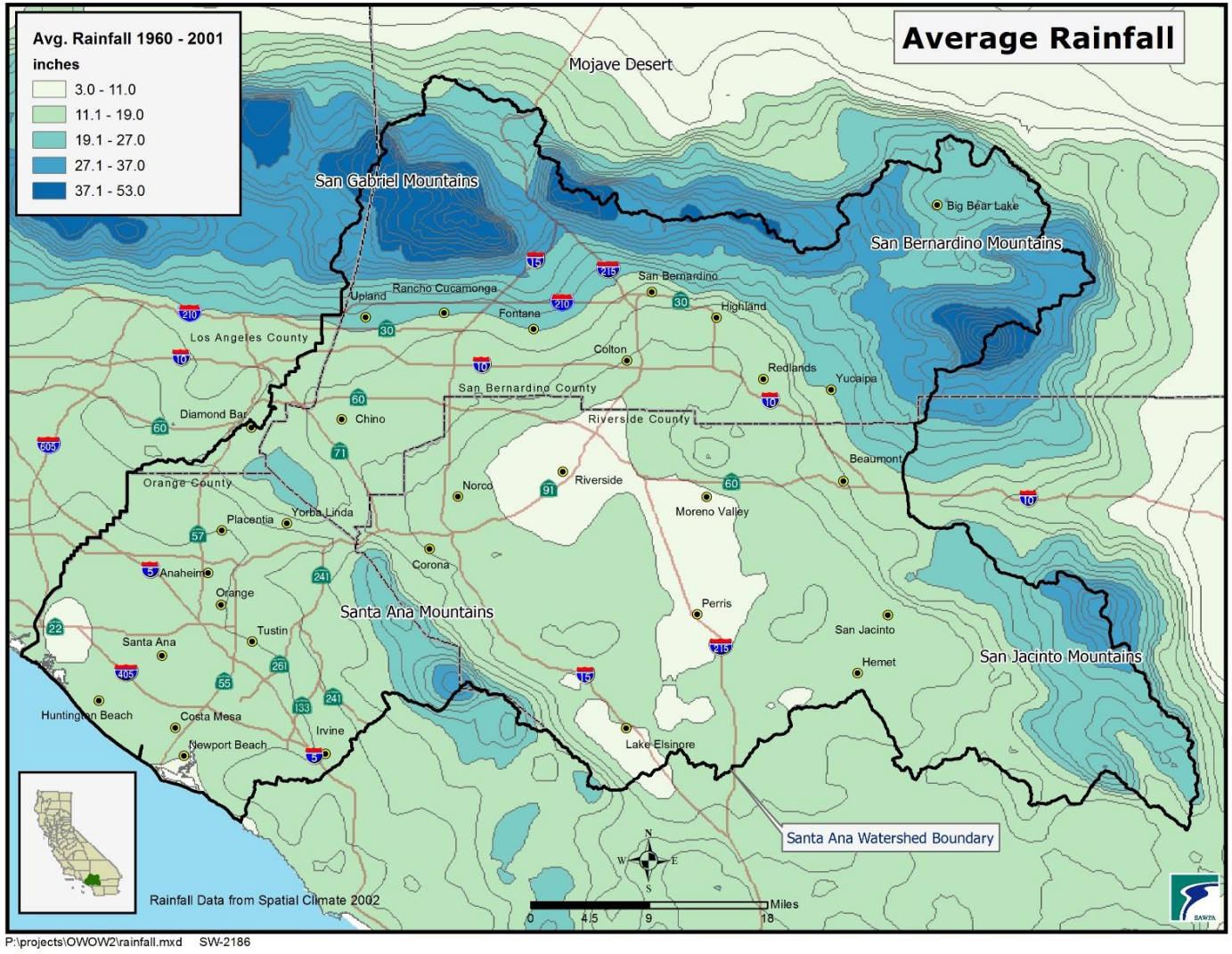

Figure 2-3
Historical Average Annual Rainfall in the Santa Ana River Watershed (Source: OWOW 2.0 Report SAWPA)

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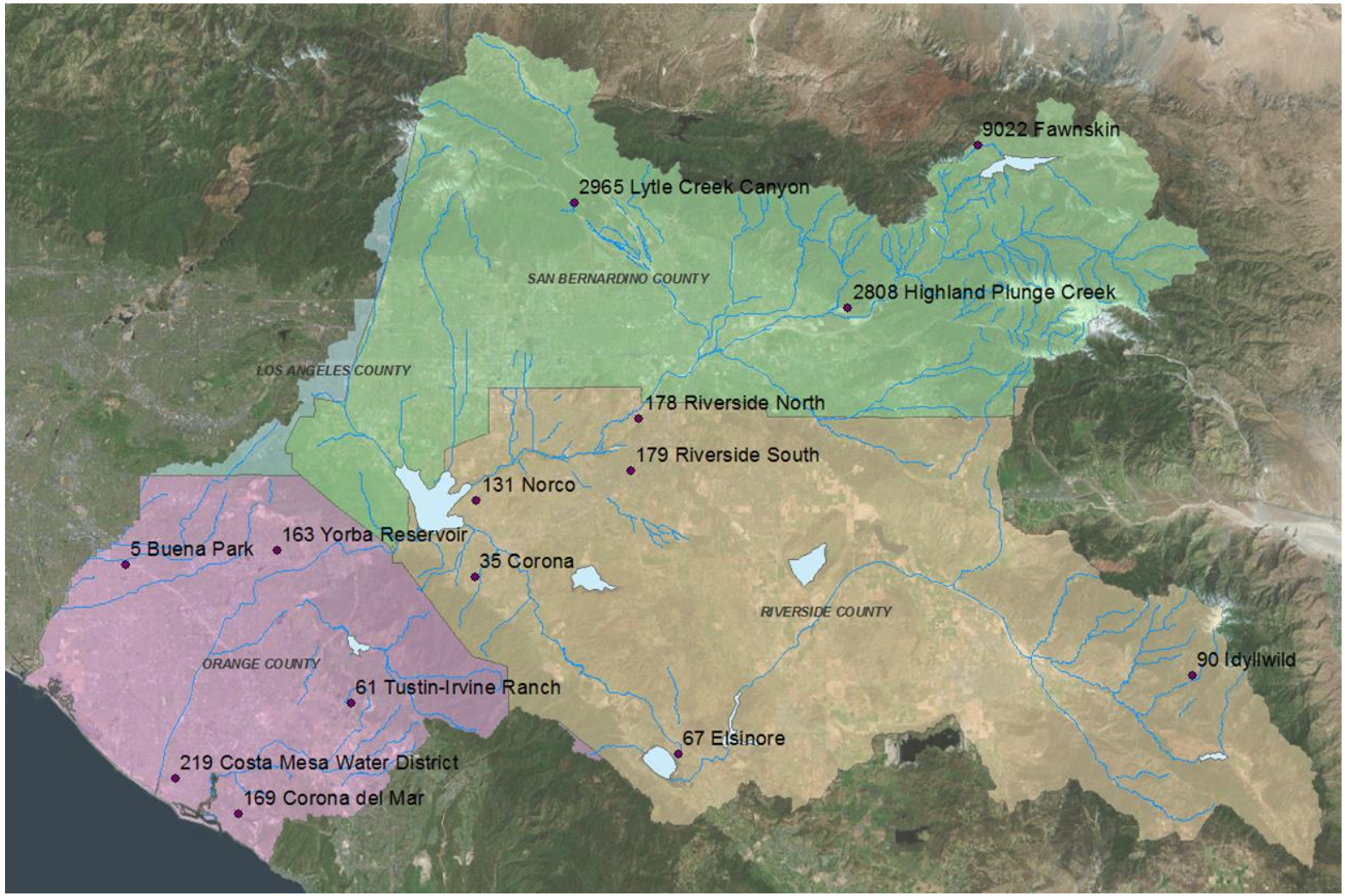

Figure 2-4
Key Rainfall Gages

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2.2 Monitoring Locations

The following sections describe the monitoring sites based on priority designations described in Section 1.2.1.

2.2.1 Priority 1

Eight monitoring sites, identified as REC1 Tier A waters, are included for Priority 1 monitoring. This includes four lakes: Big Bear Lake, Lake Perris, Canyon Lake, and Lake Elsinore; and four flowing water sites: SAR Reach 3 (two sites), Lytle Creek, and Mill Creek Reach 2. Five sites are located in Riverside County and two sites are located in San Bernardino County (Table 2-3, Figure 2-5).

The two Priority 1 Santa Ana River sites (MWD Crossing and Pedley Avenue) are also MSAR Bacteria TMDL compliance sites (Table 2-4). Data collected from these Priority 1 sites will also be used for evaluating compliance with the MSAR Bacteria TMDL.

Table 2-3 Priority 1 REC 1 Tier A Monitoring Sites

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

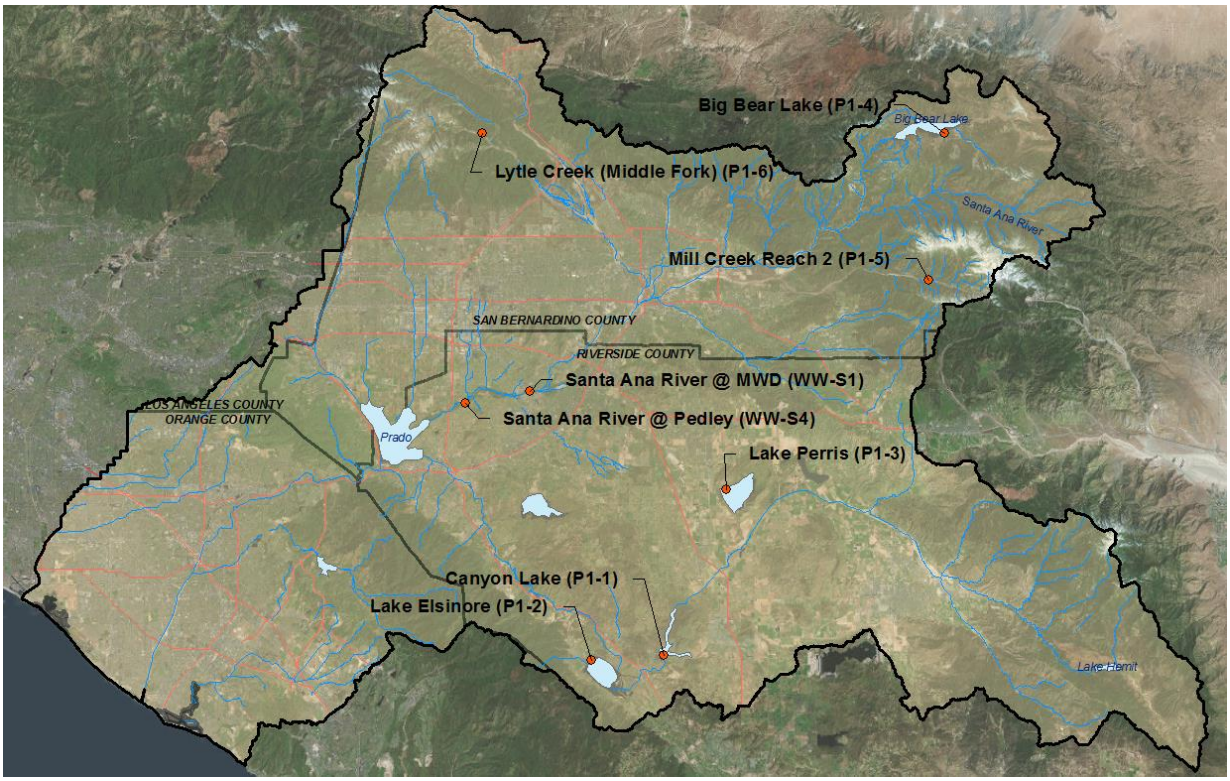

Figure 2-5
Priority 1 Monitoring Sites

2.2.2 Priority 2

Priority 2 monitoring sites are primarily the same monitoring sites previously established for evaluating compliance with the numeric targets in the MSAR Bacteria TMDL: two Santa Ana River Reach 3 sites (at MWD Crossing and at Pedley Avenue), and one site each on Mill-Cucamonga Creek, Chino Creek, and Prado Park Lake[18] (Table 2-4; Figure 2-6). As discussed in Section 2.2.1, 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. Figures 2-5 and 2-6 indicate the dual designation for these sites.

Table 2-4 Priority 2 Monitoring Sites

Site ID	Site Description	County	Latitude	Longitude
WW-M6	Mil-Cucamonga Creek below Wetlands	San Bernardino	33.9268	-117.6250
WW-C7	Chino Creek at Central Avenue	San Bernardino	33.9737	-117.6889
WW-C3	Prado Park Lake	San Bernardino	33.9400	-117.6473
WW-S1	Santa Ana River Reach 3 at MWD Crossing	Riverside	33.9681	-117.4479
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	Riverside	33.9552	-117.5327

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

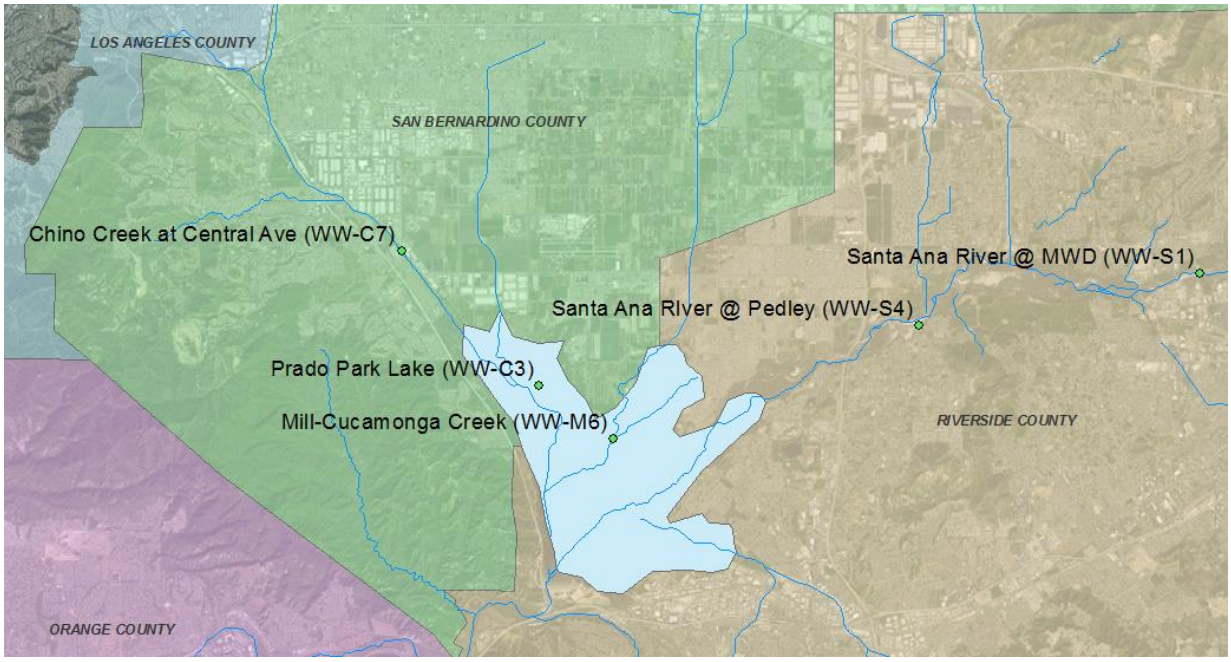

Figure 2-6
Priority 2 Monitoring Sites

2.2.3 Priority 3

In the Santa Ana River watershed, 23 waterbodies are currently on the 303(d) List as impaired for Indicator Bacteria, but no TMDL has been adopted. Eight waterbodies were not included in the original RMP for reasons described in the Monitoring Plan Section 3.3.3.2. As of 2018, two additional waterbodies were delisted and were not included in the 2018-2019 RMP. Of the eleven waterbodies that are monitored in the RMP in 2018-2019, nine are located in Orange County, one in Riverside County, and one in San Bernardino County (Figure 2-7). Table 2-5 provides the location of each Priority 3 monitoring site. Previous water quality data and the basis for listing these monitoring sites are described in the Monitoring Plan.

Table 2-5 Priority 3 Monitoring Sites

Site ID	Site Description	County	Latitude	Longitude
P3-OC1	Bolsa Chica Channel upstream of Westminster Blvd/Bolsa Chica Rd	Orange	33.7596	-118.0430
P3-OC2	Borrego Creek upstream of Barranca Parkway	Orange	33.6546	-117.7321
P3-OC3	Buck Gully Creek Little Corona Beach at Poppy Avenue/Ocean Blvd	Orange	33.5900	-117.8684
P3-OC5	Los Trancos Creek at Crystal Cove State Park	Orange	33.5760	-117.8406
P3-OC6	Morning Canyon Creek at Morning Canyon Beach	Orange	33.5876	-117.8658
P3-OC7	Peters Canyon Wash downstream of Barranca Parkway	Orange	33.6908	-117.82404
P3-OC8	San Diego Creek downstream of Campus Drive (Reach 1)	Orange	33.6553	-117.8454

Site ID	Site Description	County	Latitude	Longitude
P3-OC9	San Diego Creek at Harvard Avenue (Reach 1)	Orange	33.6880	-117.8187
P3-OC11	Serrano Creek upstream of Barranca/Alton Parkway	Orange	33.6483	-117.7248
P3-RC1	Goldenstar Creek at Ridge Canyon Drive	Riverside	33.8964	-117.3586
P3-SBC1	Santa Ana River Reach 4 above S. Riverside Avenue Bridge	San Bernardino	34.0248	-117.3628

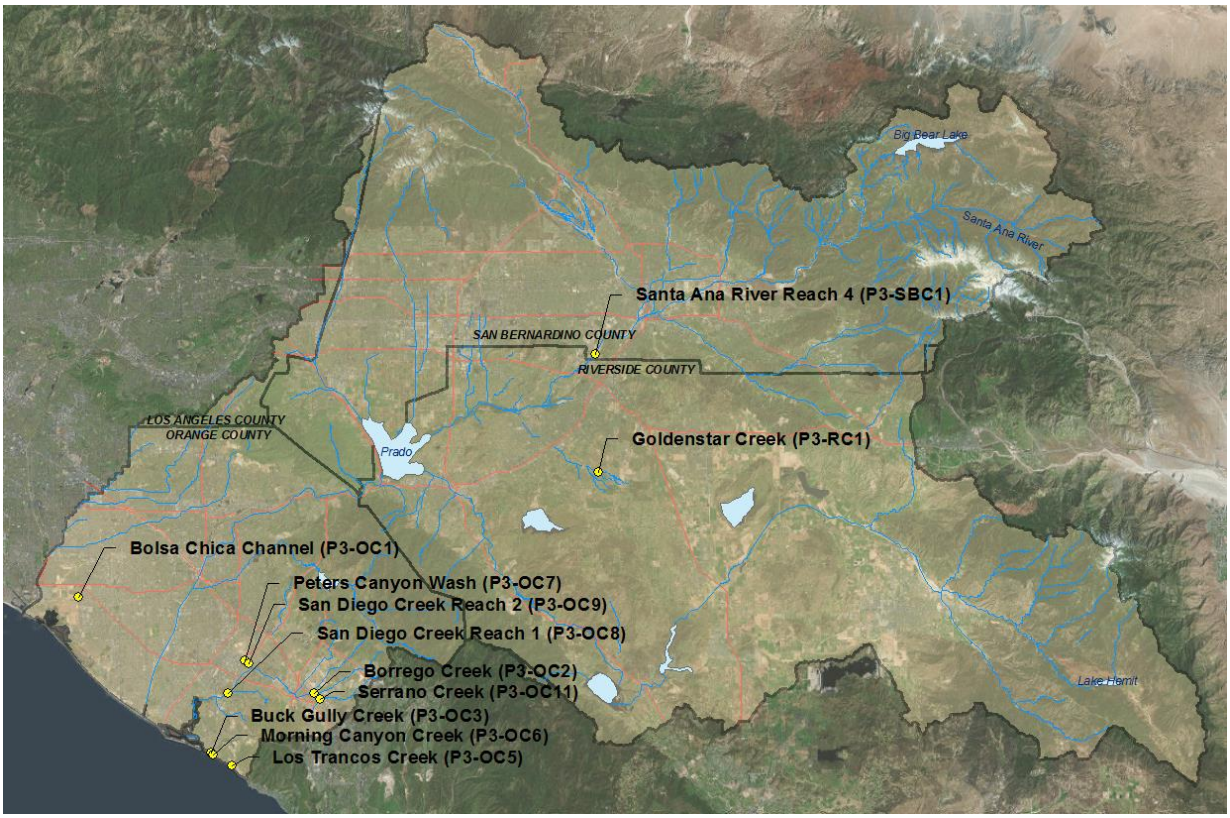

Figure 2-7
Priority 3 Monitoring Sites

2.2.4 Priority 4

Four waterbodies designated REC2 only as a result of approved UAAs were monitored as Priority 4 sites. San Bernardino County and Riverside County each have one Priority 4 waterbody. Two Priority 4 waterbodies are located in Orange County with one waterbody having two sites. These sites are summarized in Table 2-6 and Figure 2-8 and described as follows:

- *Santa Ana Delhi Channel* – The Santa Ana Delhi Channel has two reaches (Reaches 1 and 2) that are REC2 only. 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 (P4-OC1); and (b) within the tidal prism at the Bicycle Bridge (P4-OC2).

- *Greenville-Banning Channel Tidal Prism Segment*– The 1.2-mile segment extending upstream of the confluence between Santa Ana River and Greenville-Banning Channel is designated REC2 only. The monitoring site is located at an access ramp approximately 60 meters downstream of the trash boom below the rubber diversion dam.
- *Temescal Creek* – The monitoring site is located on the concrete section of Temescal Channel just upstream of the Lincoln Avenue Bridge.
- *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.

Table 2-6 Priority 4 Monitoring Sites

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

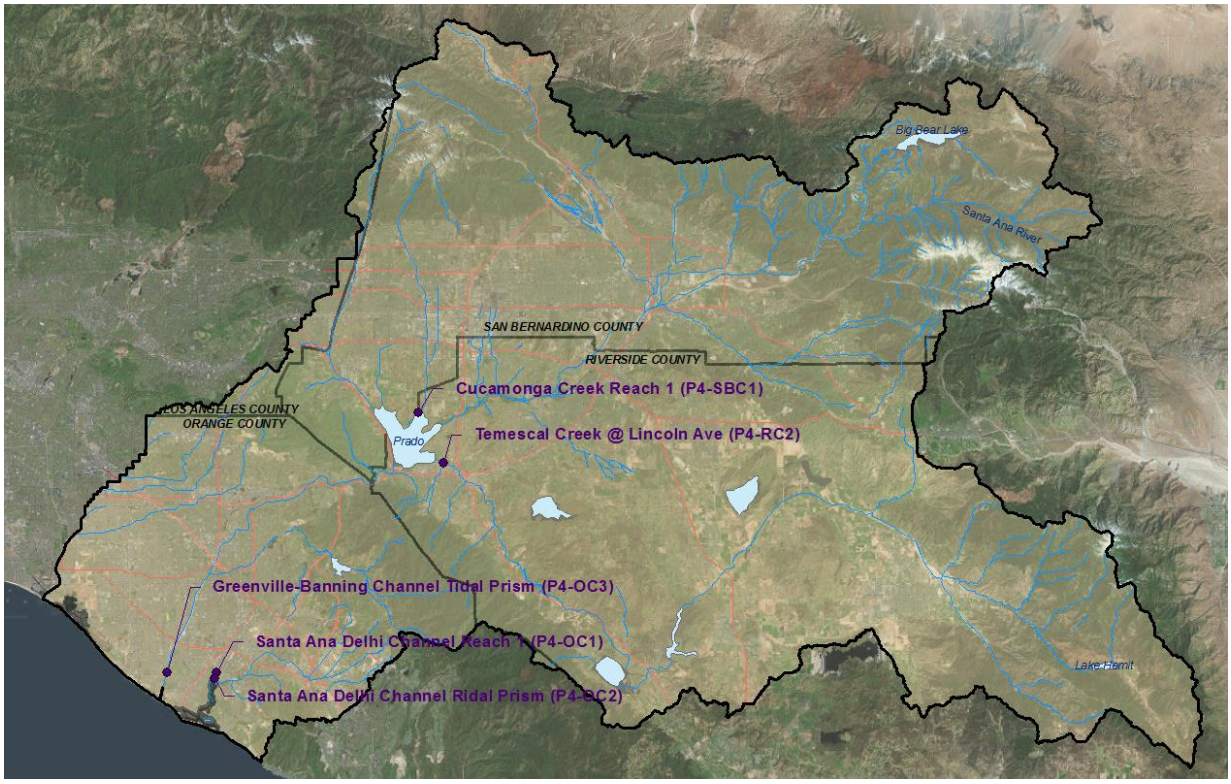

Figure 2-8
Priority 4 Monitoring Sites (top: Riverside County and San Bernardino County; bottom: Orange County)

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Section 3
Methods

The RMP Monitoring Plan and QAPP provide detailed information regarding the collection and analysis of field measurements and water quality samples. The following sections provide a summary of these methods.

3.1 Sample Frequency

3.1.1 Dry Weather

Dry weather sample collection occurs during both warm, dry (April 1 – October 31) and cool, wet (November 1 – March 31) season periods. Sample collection dates for each year of the monitoring program are established in Section 3.3 of the Monitoring Plan and are summarized in this section. Dry weather, warm season monitoring was conducted at most sites over a 20-week period from May 6, 2018 through September 16, 2018. Dry weather, cool season monitoring occurred over a five-week period from October 28, 2018, through November 25, 2018. Dry weather conditions are defined as no measurable rainfall within a 72-hour period prior to sampling.

During dry weather monitoring, the frequency of sample collection for each priority level varies as follows:

- Priority 1 and Priority 2 sites were monitored weekly for twenty consecutive weeks during the warm, dry season and for five consecutive weeks during the cool, wet season.
- Priority 3 sites were monitored weekly for five consecutive weeks during the warm, dry or cool, wet seasons. The fourteen Priority 3 sites were separated into five groups to maximize efficiency during sample collection periods.
- Priority 4 sites were sampled once per year between June 21 and September 13. All samples from the Priority 4 sites met the antidegradation targets and did not require follow-up sampling.

3.1.2 Wet Weather

Per the MSAR Bacteria TMDL, wet weather monitoring is conducted for one storm event per wet season. For each storm event, samples are collected from Priority 2 sites on the day of the storm event as well as 48, 72, and 96 hours after the onset of the storm. During the 2018-2019 wet season, samples were collected from the February 1, 2019, storm event with samples collected on February 1, 3, 4, and 5, 2019.

3.1.3 Summary of Sample Collection Effort

In general, the monitoring program was successful in meeting the requirements with the exception of some events where site conditions could not accommodate sampling. Dry weather samples are typically collected during consecutive weeks from May through September and October through November. Due to difficulties with coordination efforts, two sites (Los Trancos

Creek and Morning Canyon Creek) were monitored outside of the scheduled 5-week period. Instead, they were monitored six times from December 12, 2018 through January 30, 2019. Due to recorded rainfall in the watershed in the 2018-2019 season, weekly sampling could not be completed for those two sites due to repeated storms. The sampling schedule was modified to ensure samples were collected only under dry conditions. As such, samples were collected over a 7-week period and do not meet the geometric mean calculation requirements. The results of the sampling effort is summarized in Table 3-1 and described as follows:

- Two sites (Borrego Creek and Los Trancos Creek) were dry during the monitoring period. Although field crews went to each site during each scheduled monitoring event, samples from those sites were not collected due to dry conditions.
- Although only five weeks of monitoring were required for Priority 3 sites, a sixth week of monitoring (and sample collection) was conducted at Morning Canyon Creek and Goldenstar Creek in anticipation of a potentially higher sample requirement for geometric mean calculation by the Statewide Bacteria Provisions, which had not yet been adopted during the 2018-2019 monitoring program.
- Additional samples were collected at Buck Gully Creek to begin developing an increased dataset for potential delisting from the 303(d) List of Impaired Water in the future.

Table 3-1 Summary of Water Quality Sample Collection Activity

Priority	Planned/Collected	Dry Weather	Wet Weather
Priority 1	Planned	200	0
	Collected	200	0
Priority 2	Planned	125	20
	Collected	124 [A]	20
Priority 3	Planned	55	0
	Collected	53 [B]	0
Priority 4	Planned	5	0
	Collected	5	0

[A] Prado Park Lake (WW-C3) was dry during one week of monitoring.

[B] Five samples were not collected from Borrego Creek (P3-OC2) and five samples were not collected from Los Trancos Creek (P3-OC5) as conditions were dry during each monitoring event; Six extra samples collected at Buck Gully Creek (P3-OC3) and one extra sample collected at both Morning Canyon Creek (P3-OC6) and Goldenstar Creek (P3-RC1).

3.2 Sample Analysis

Monitoring at each site included recording field measurements and collection of water quality samples. OCPW staff monitored all sites located in Orange County under their jurisdiction, while CDM Smith and CWE, on behalf of the MSAR TMDL / Regional WQ Monitoring Task Force, monitored all sites located in Riverside County and San Bernardino County. Two sites located in Orange County that were not the responsibility of OCPW, Los Trancos Creek and Morning Canyon Creek, were monitored by Santa Ana Water Board staff. The following water quality data were gathered from each site:

- Field measurements: temperature, pH, dissolved oxygen (DO), conductivity, turbidity, and flow
- Laboratory analysis: total suspended solids (TSS), bacteria (*E. coli* or *Enterococcus)*
  - *E. coli* is quantified at all but two sites in this Regional Monitoring Program.
  - *Enterococcus* is quantified at two Orange County sites, Santa Ana Delhi Channel in Tidal Prism (P4-OC2) and Greenville-Banning Channel in Tidal Prism (P4-OC3) due to presence of marine water.

3.3 Sample Handling

Sample collection and laboratory delivery followed approved chain-of-custody (COC) procedures, holding time requirements, and required storage procedures for each water quality sample as described in the Monitoring Plan and QAPP. Samples collected from Riverside County and San Bernardino County were analyzed for *E. coli* and TSS concentrations by Babcock Laboratories (Babcock). Samples collected from Orange County by OCPW were analyzed by the Orange County Health Care Agency Water Quality Laboratory (OCPHL) for *E. coli* and by Weck Laboratories and Enthalpy Analytical for TSS. Samples collected from Los Trancos Creek and Morning Canyon Creek were collected by Santa Ana Water Board staff and analyzed for both *E. coli* and TSS by the American Environmental Testing Laboratory, Inc. Appendix C includes a brief summary of quality assurance/quality control (QA/QC) activities conducted during the period covered by this report, including field blanks and field duplicates

3.4 Data Handling

CDM Smith and SAWPA maintain a file of all laboratory and field data records (e.g., data sheets, chain-of-custody forms) as required by the QAPP. CDM Smith's field contractor, CWE, OCPW and the Santa Ana Water Board provided CDM Smith all field measurements and laboratory results, laboratory reports, field forms, photos, and COCs. CDM Smith compiled the field measurements and laboratory analysis results into a project database that is compatible with guidelines and formats established by the California Surface Water Ambient Monitoring Program for the California Environmental Data Exchange Network (CEDEN). CDM Smith conducts a QA/QC review of the data for completion and compatibility with the databases. After the QA/QC review, CDM Smith submits the data annually to CEDEN and to SAWPA.

3.5 Data Analysis

Data analysis relied primarily on the use of descriptive and correlation statistics. For any statistical analyses, the bacterial indicator data were assumed to be log-normally distributed as was observed in previous studies.[19] Accordingly, prior to conducting statistical analyses, the bacterial indicator data were log transformed.

[19] Middle Santa Ana River Bacterial Indicator TMDL Data Analysis Report, prepared by CDM Smith on behalf of the Task Force. March 19, 2009. http://www.sawpa.org/wp-content/uploads/2015/02/FinalDataAnalysisReport_033109.pdf

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Section 4
Results

This section summarizes the results of data analyses applied to the 2018-2019 dataset, which includes the 2018 dry season and the 2018-2019 wet season. Where appropriate to provide context, data results are compared to water quality results previously reported for the same locations. Appendix A (Tables A-1 through A-34) summarizes the water quality results observed at each site throughout the sample period covered by this report.

E. coli concentrations observed at each site is summarized and compliance is assessed using water quality standards or antidegradation targets established by the Basin Plan and numeric targets established by the MSAR Bacteria TMDL. Data analysis relied primarily on the use of descriptive and correlation statistics.

4.1 Priority 1

4.1.1 Water Quality Observations

Water quality parameters measured in the field during the warm, dry and cool, wet seasons at Priority 1 sites (Table 4-1) are summarized in Figures 4-1 through 4-7. Key observations are summarized as follows:

- Figure 4-1 shows that pH at the two Santa Ana River sites were within the allowable pH range of 6.5 to 8.5, established by the EPA water quality standards. Twelve percent of samples at Lytle Creek and 48 percent of Mill Creek samples exceeded the upper allowable pH limit. At the four lake sites, pH observations are slightly higher than in flowing waters, with 52 to 88 percent of observations at each lake site greater than 8.5. At Big Bear Lake, 4 percent (one sample) had a pH value below the lower limit of 6.5.

- Figure 4-2 shows results by station demonstrating that water temperature has a direct relationship with cooler ambient air temperatures (median less than 20 degrees Celsius) at higher elevations and higher ambient air temperatures (median greater than 23 degrees Celsius) in lower elevations. Likewise, water temperature responds directly to the seasonal ambient temperatures of the wet and dry seasons.

- Figure 4-3 shows that the majority of DO levels observed range from 6 to 10 mg/L. WQOs for minimum DO for waterbodies with the WARM and COLD habitat beneficial use designations are 5 mg/L and 6 mg/L, respectively.[20] These standards were met by five of the eight Priority 1 sites. The three sites that did not meet the DO standards were Canyon Lake (P1-1), Lake Elsinore (P1-2), and Big Bear Lake (P1-4). Both Canyon Lake and Lake Elsinore have the WARM habitat beneficial use designation with 12 and 24 percent of samples at Canyon Lake and Lake Elsinore, respectively, below the WARM DO threshold. More rigorous measurement of vertical DO profiles is conducted to support the implementation of the Lake Elsinore and Canyon Lake nutrient TMDL. Results should be

[20] Basin Plan Chapters 3 and 4. WARM represents warm freshwater habitat while COLD represents cold freshwater habitat.

consulted for a more complete assessment of DO in these waters.[21] Four percent of measurements at Big Bear Lake were below the minimum COLD habitat DO threshold. However, Big Bear Lake has dual designation and all samples met the WARM habitat DO threshold.

- Conductivity (Figure 4-4) appears to vary based on geography as sites located in the upper portions of the watershed (Mill Creek Reach 2, Big Bear Lake, and Lytle Creek) have lower conductivity (less than 300 µS/cm at two sites and less than 600 µS/cm at Big Bear Lake) than sites located in the downstream portions of the watershed (500 to 1,100 µS/cm). Waterbodies in the upper watershed generally consist of rain and snow melt, while waterbodies in the lower watershed also include groundwater and runoff, which commonly have higher salt concentrations. Lake Elsinore exhibits particularly high conductivity (4,359 to 5,679 µS/cm), which is not unusual for a terminal lake.

- Turbidity for Lake Elsinore and Big Bear Lake show substantial variability throughout the year ranging from 17 to 144 NTU, with the exception of an outlier (25,510 NTU) and 2.5 to 84 NTU, respectively. Turbidity at the remaining six sites is generally lower (less than 35 NTU).

- Similar to turbidity, Figure 4-6 shows TSS variability among Priority 1 sites, however, most measurements (80 percent of all measurements) are below 20 mg/L. TSS in Big Bear Lake (2 to 710 mg/L) is notably higher than other sites, although Lake Elsinore (18 to 66 mg/L, excluding an outlier of 7,200 mg/L) and Mill Creek (2 to 130 mg/L) are slightly higher as well. The TSS outlier at Lake Elsinore was observed on the same day as the turbidity outlier at Lake Elsinore.

- Flow is lower at the upstream sites, Mill Creek Reach 2 (2 to 7 cubic feet per second [cfs]) and Lytle Creek (1 to 7 cfs). Flow is greatest at SAR at Pedley Avenue (47 to 230 cfs), which is fed into by the other sites (Figure 4-7). Note that Figure 4-7 shows flow only for stream sites and does not include lake sites, where flow is not measured.

Table 4-1 Priority 1 Monitoring Sites

Site ID	Site Description	County
P1-1	Canyon Lake at Holiday Harbor	Riverside
P1-2	Lake Elsinore	Riverside
P1-3	Lake Perris	Riverside
P1-4	Big Bear Lake at Swim Beach	San Bernardino
P1-5	Mill Creek Reach 2	San Bernardino
P1-6	Lytle Creek (Middle Fork)	San Bernardino
WW-S1	Santa Ana River Reach 3 at MWD Crossing	Riverside
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	Riverside

[21] http://www.sawpa.org/task-forces/lake-elsinore-canyon-lake-tmdl-task-force/#monitoring-program

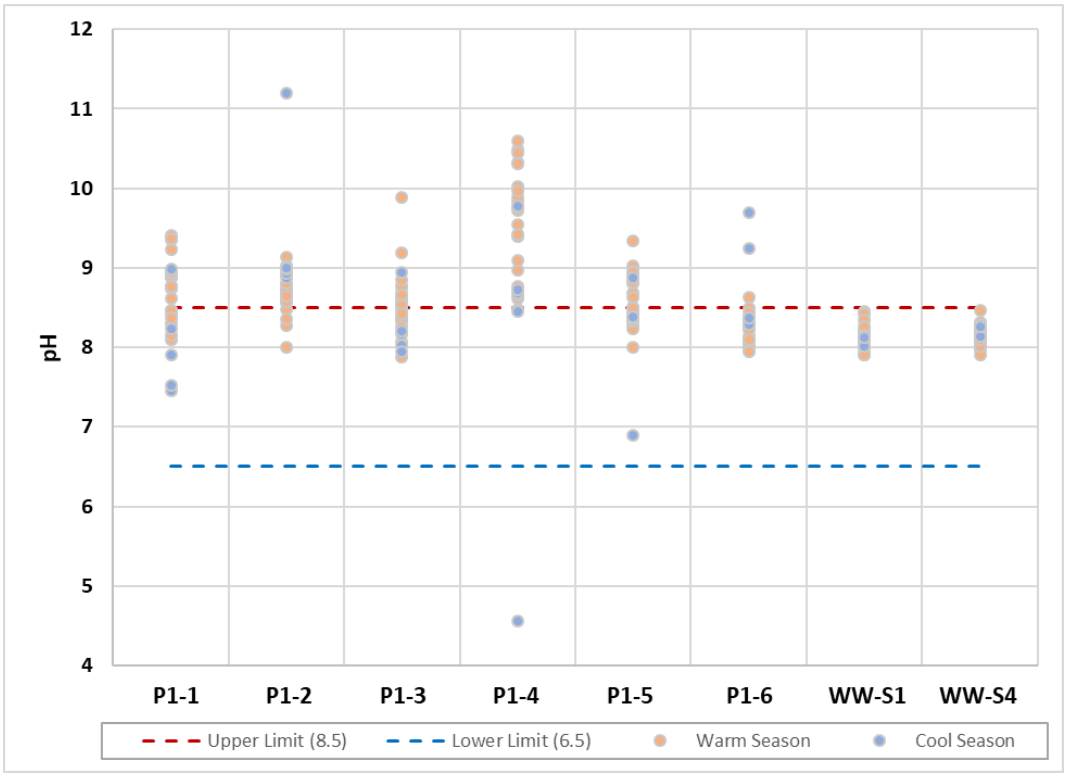

Figure 4-1
Distribution of pH Measurements at Priority 1 Sites

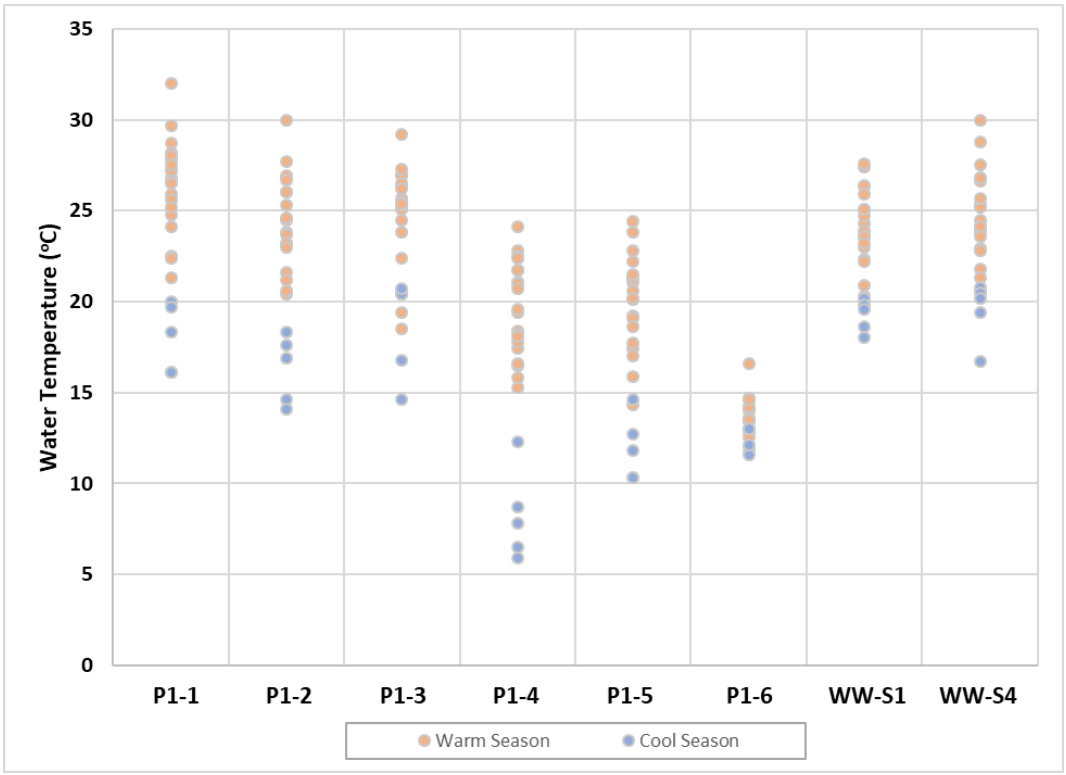

Figure 4-2
Distribution of Water Temperature Measurements at Priority 1 Sites

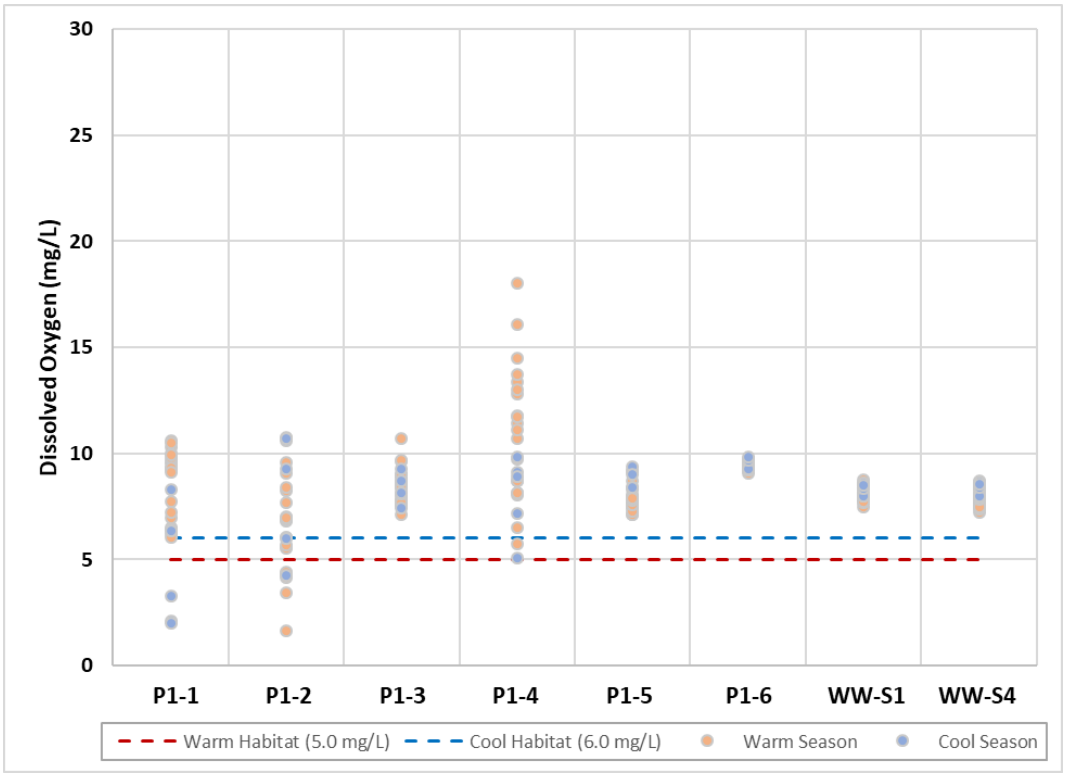

Figure 4-3
Distribution of Dissolved Oxygen Measurements at Priority 1 Sites

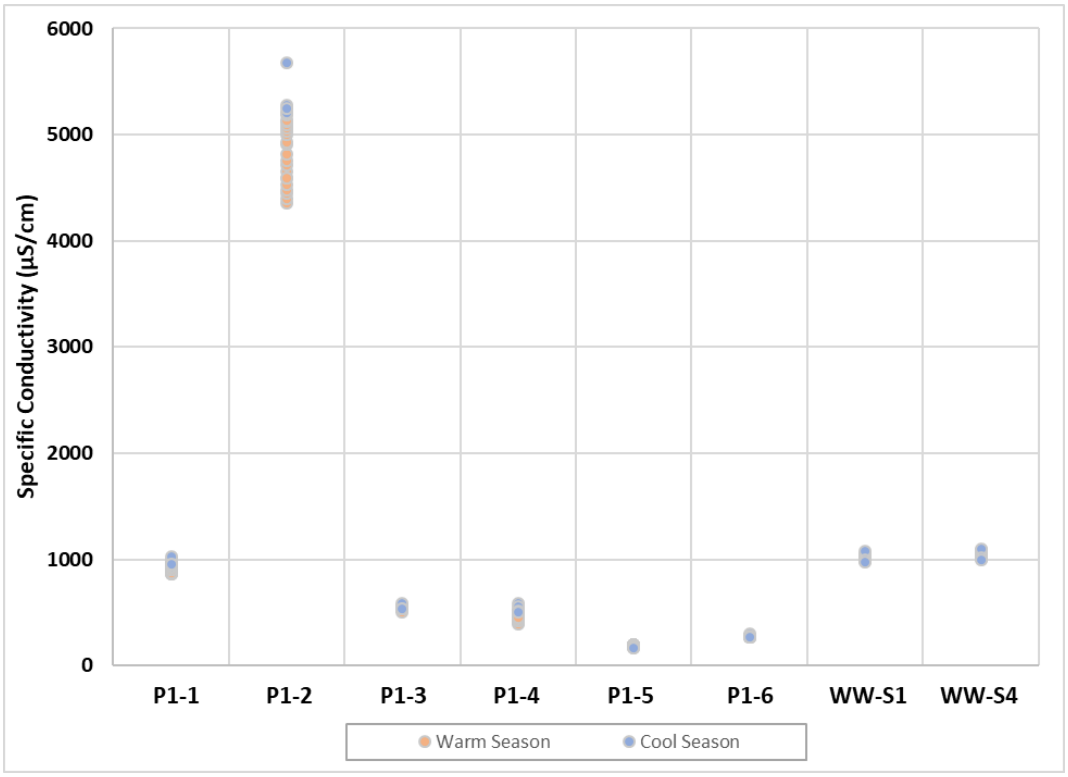

Figure 4-4
Distribution of Specific Conductivity Measurements at Priority 1 Sites

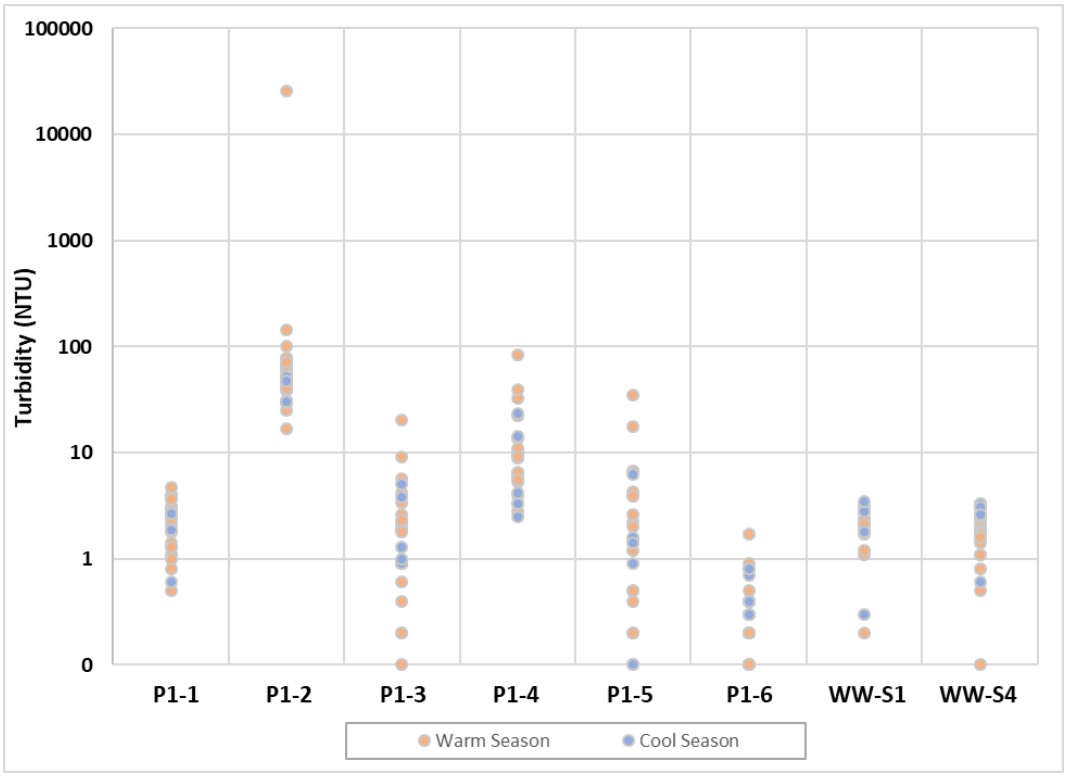

Figure 4-5
Distribution of Turbidity Measurements at Priority 1 Sites

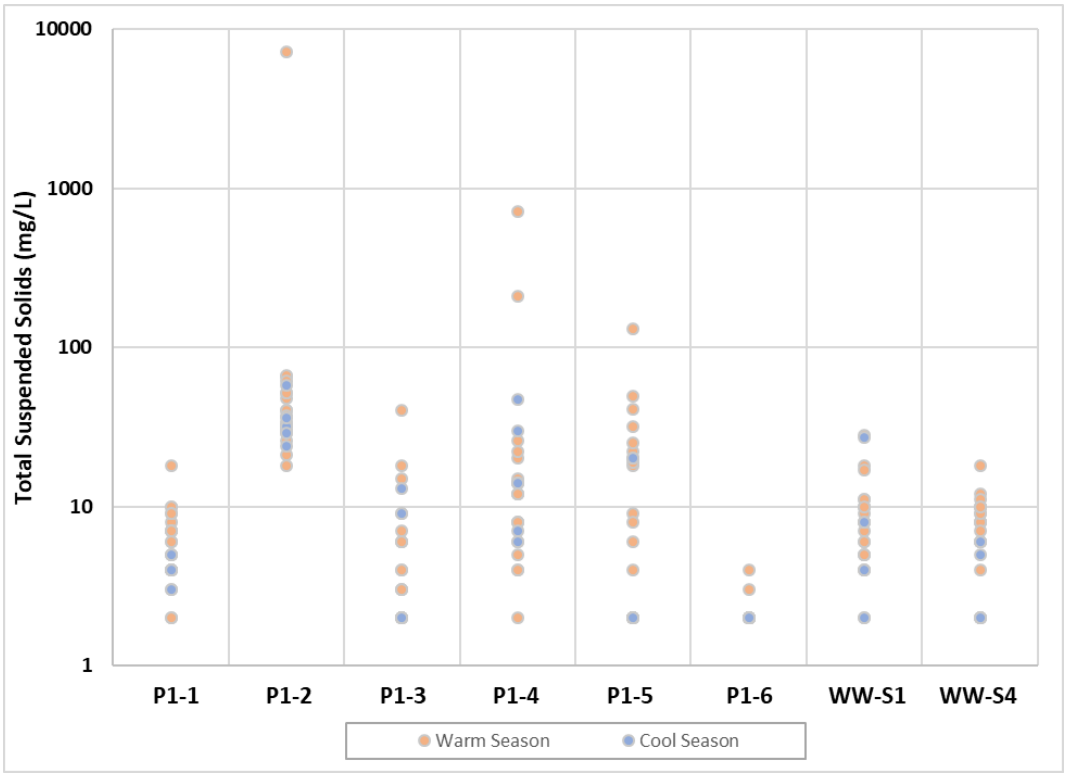

Figure 4-6
Distribution of TSS Measurements at Priority 1 Sites

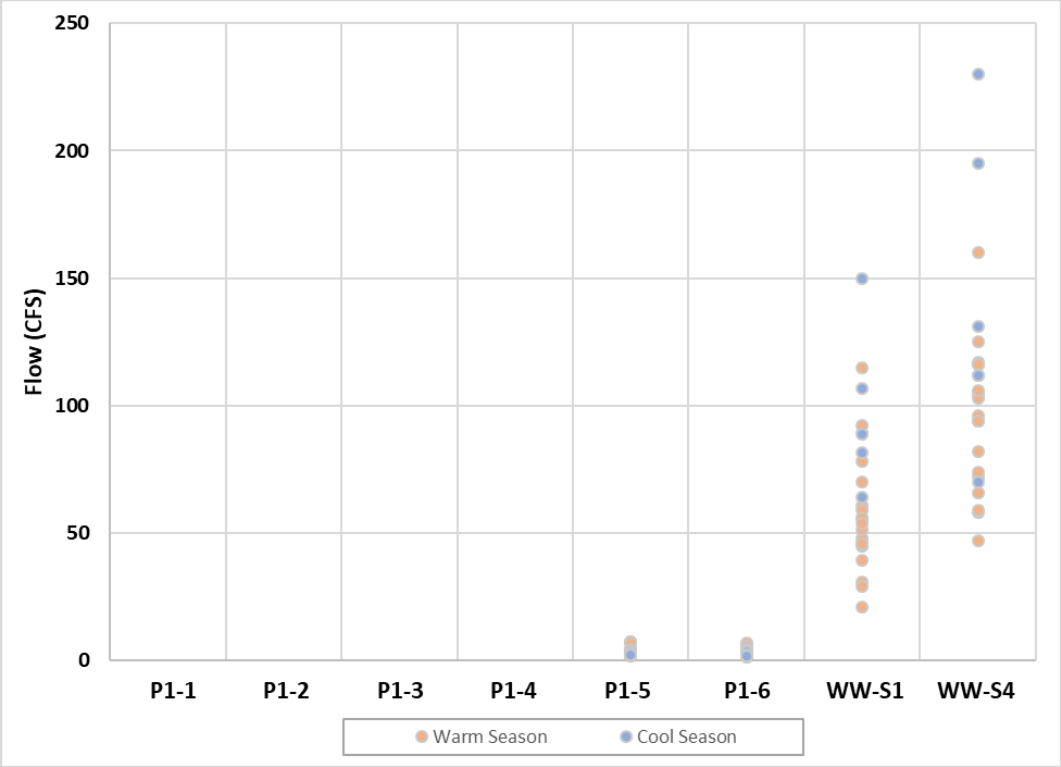

Figure 4-7
Distribution of Flow Measurements at Priority 1 Sites
**Note that lake sites are not monitored for flow*

4.1.2 Bacteria Characterization

Figure 4-8 presents the distribution of *E. coli* concentrations observed at Priority 1 sites during the warm, dry and cool, wet seasons. All sites not located in SAR had generally low concentrations of *E. coli*. Only 1 sample collected from Lake Elsinore, Big Bear Lake, and Lytle Creek were greater than 100 MPN/100mL. Canyon Lake had particularly low *E. coli* levels (less than 20 MPN/100mL for all samples).

E. coli concentrations at the two SAR sites were consistently higher than concentrations at all other Priority 1 sites (Figure 4-8). Approximately 99 percent of the individual *E. coli* sample results from the six sites not located in SAR were less than 100 MPN/100 mL while only 20 percent of the individual sample results from the two SAR sites were less than 100 MPN/100 mL. Seventy five percent of samples from the four lake sites had *E. coli* concentrations below the detection limit.

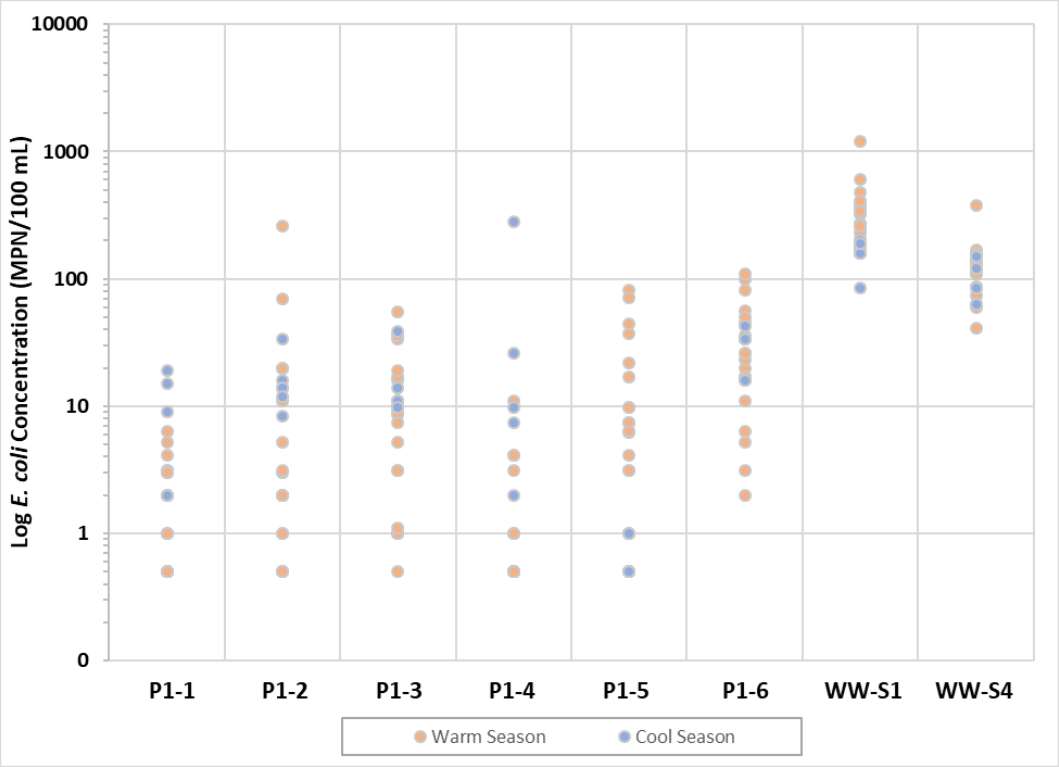

Figure 4-8
Distribution of *E. coli* Concentrations at Priority 1 Sites

Figures 4-9 through 4-16 show the individual and geomean *E. coli* concentrations for each Priority 1 site. Geomeans from the warm, dry season are 6-week rolling geomeans while the geomean from the cool, dry season is a 5-week geomean. They illustrate the variability in single sample results and the calculated rolling geometric mean values. The figures show that for several sites, the cool, wet season samples had slightly higher *E. coli* concentrations at several sites. Although there were a few small summer storms, they generally occurred outside of the warm, dry season and did not impact sample results and flow measurements.

Key observations from the Priority 1 site data include:

- The highest *E. coli* concentration observed at a Priority 1 site was 1,200 MPN/100 mL at SAR at MWD Crossing during the week of July 29, 2018 (Figure 4-15).
- *E. coli* concentrations are generally increasing throughout the summer at Mill Creek and Lytle Creek, which has been observed in previous years.

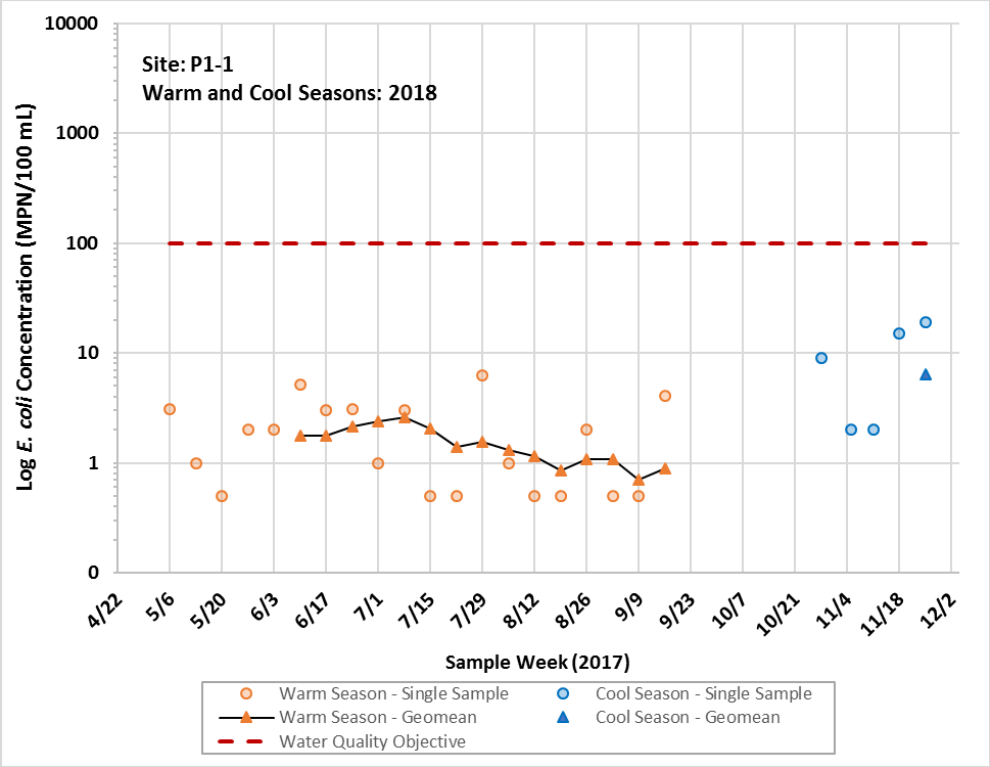

Figure 4-9
***E. coli* Concentrations and Geomeans at Canyon Lake (P1-1)**

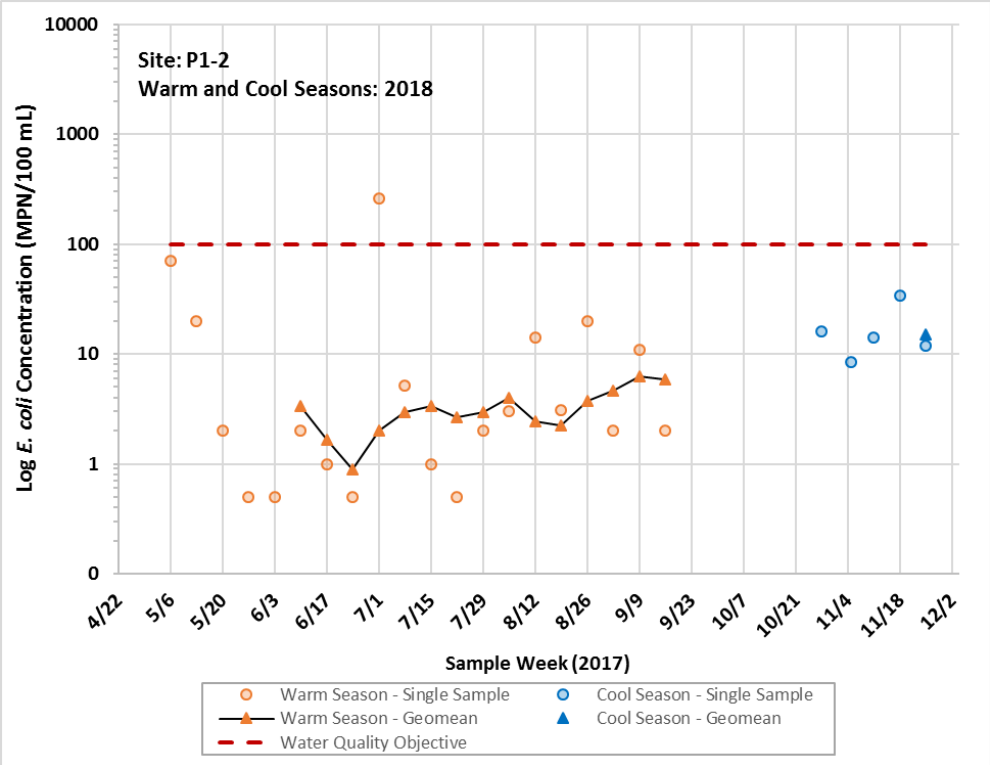

Figure 4-10
***E. coli* Concentrations and Geomeans at Lake Elsinore (P1-2)**

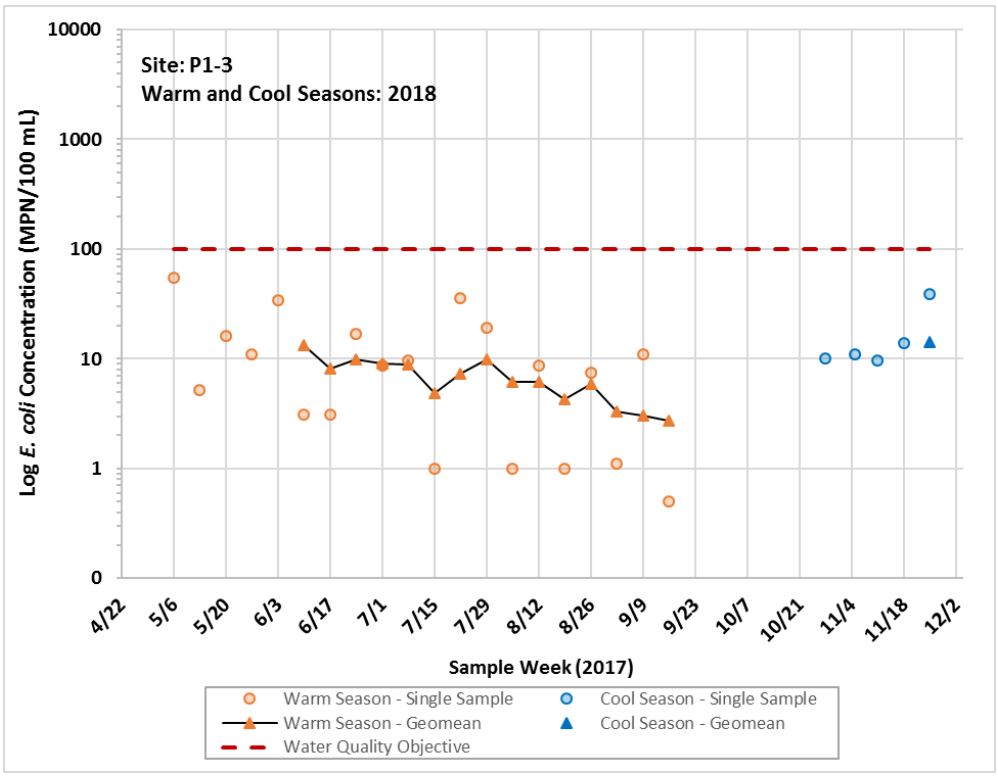

Figure 4-11
***E. coli* Concentrations and Geomeans at Lake Perris (P1-3)**

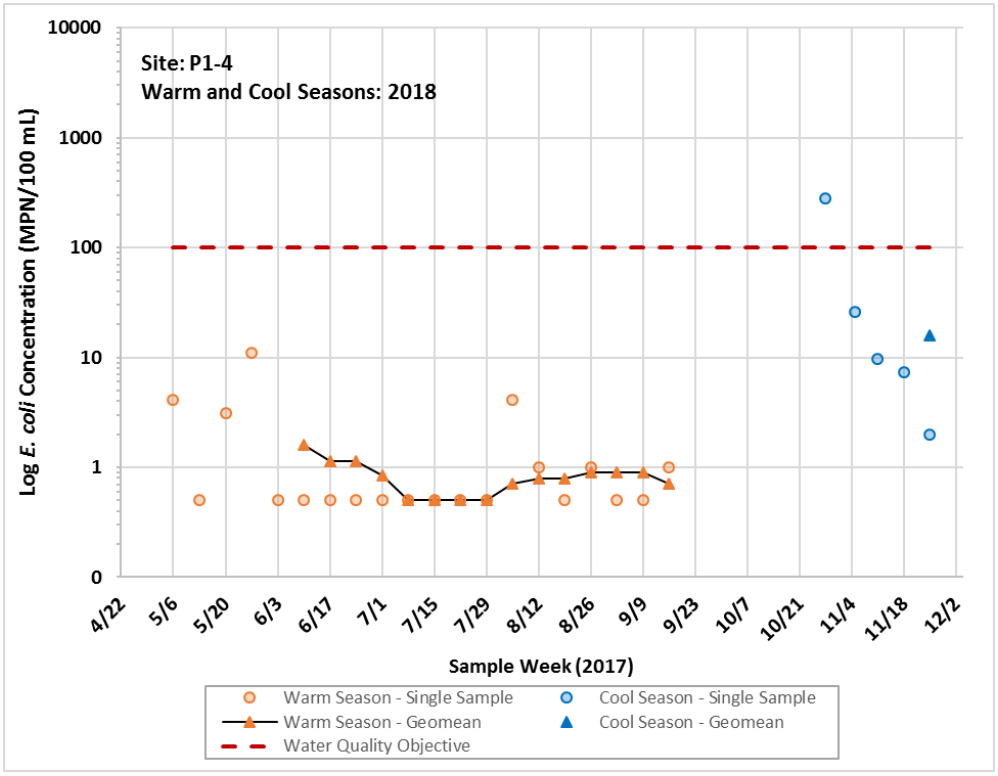

Figure 4-12
E. coli Concentrations and Geomeans at Big Bear Lake (P1-4)

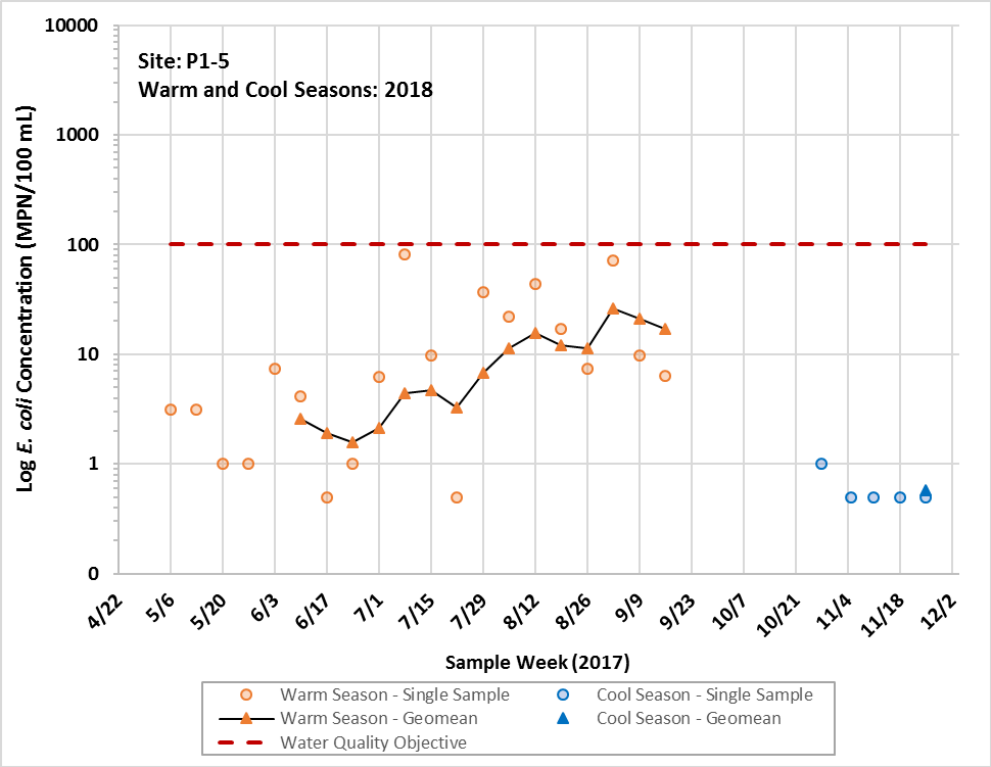

Figure 4-13
***E. coli* Concentrations and Geomeans at Mill Creek Reach 2 (P1-5)**

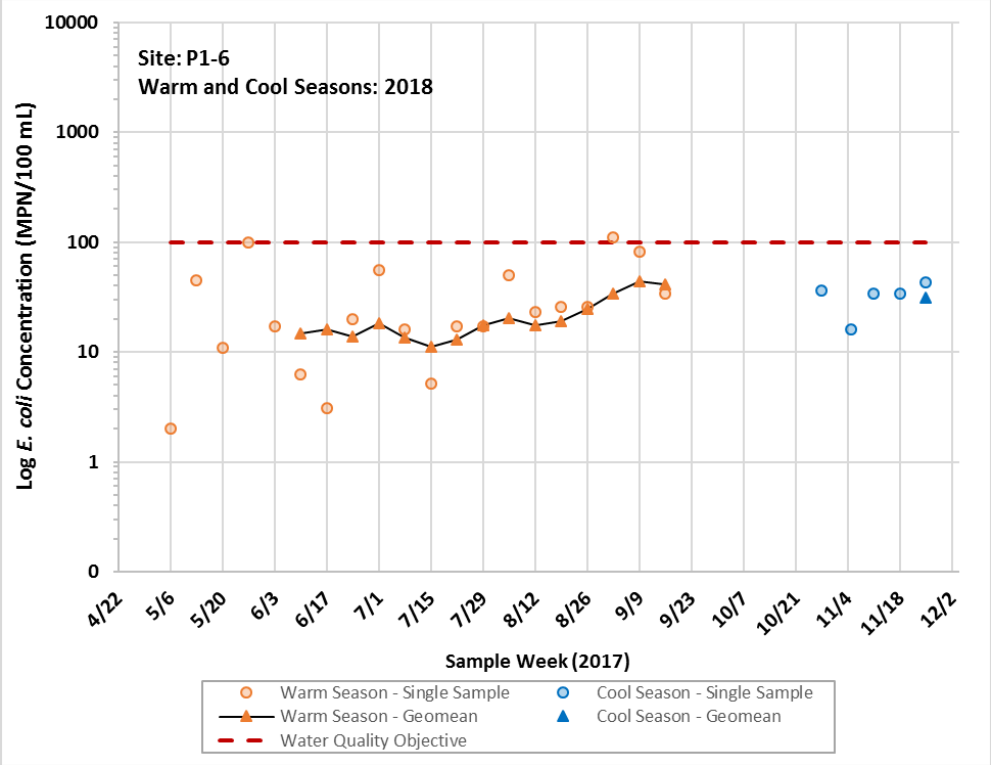

Figure 4-14
***E. coli* Concentrations and Geomeans at Lytle Creek (P1-6)**

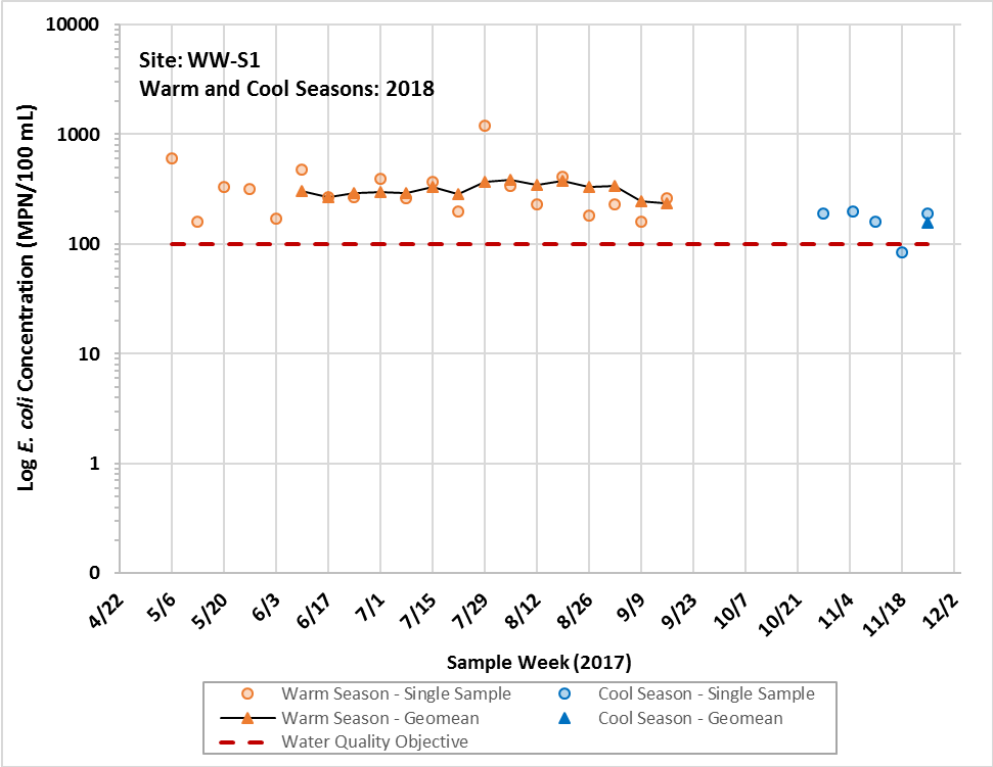

Figure 4-15
***E. coli* Concentrations and Geomeans at Santa Ana River at MWD Crossing (WW-S1)**

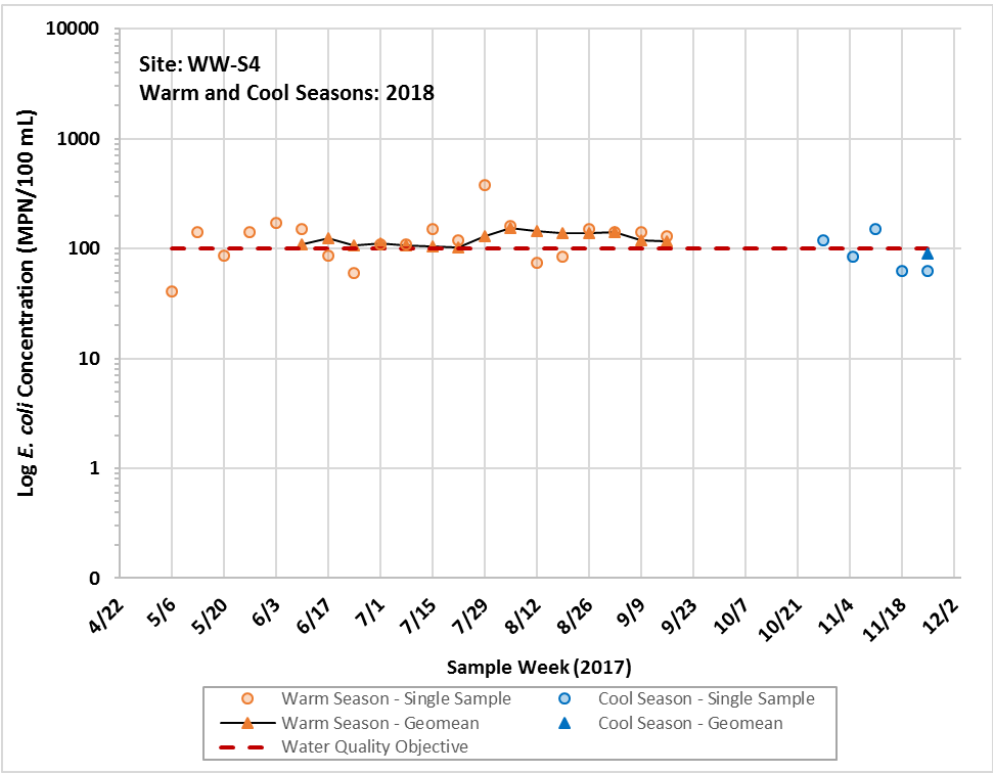

Figure 4-16
***E. coli* Concentrations and Geomeans at Santa Ana River at Pedley Avenue (WW-S4)**

4.1.3 Bacteria Compliance Analysis

The compliance analysis compared the *E. coli* geomeans to the new Statewide Bacteria Provisions geomean WQO of 100 MPN/100 mL. During the warm, dry season, rolling geometric means were calculated based on six weekly samples. During the cool, dry season, the geometric mean was calculated based on five weekly samples. The Statewide Bacteria Provisions also establishes a single statistical threshold value (STV) of 320 MPN/100 mL for Tier A REC-1 waters that cannot be exceeded by more than 10 percent of samples in any calendar month.

Six out of eight Priority 1 sites had 0 percent geomean and STV exceedances (Table 4-2). The two sites that exceeded the geomean WQO were SAR at MWD Crossing (WW-S1) and SAR at Pedley Avenue (WW-S4) with 100 percent and 94 percent exceedance frequencies, respectively. The same two sites also had samples that exceeded the STV. Only one sample at SAR at Pedley Avenue (WW-S4) exceeded the STV but with only five samples collected that month (July), the 10 percent per month exceedance allowance in the Statewide Bacteria Provision for STV is exceeded. Eight samples from the months of May through August at SAR at MWD Crossing (WW-S1) exceeded the STV and all four months do not meet the STV requirement of 10 percent or less exceedances (Table 4-3).

Table 4-2 Frequency of Exceedance with *E. coli* Geomean (100 MPN/100 mL) and STV (320 MPN/100 mL) Water Quality Objective During the 2018 Dry Weather Samples

Site ID	Site	Geometric Mean Criterion Exceedance Frequency (%)	STV Criterion Exceedance Frequency (%)
P1-1	Canyon Lake	0	0
P1-2	Lake Elsinore	0	0
P1-3	Lake Perris	0	0
P1-4	Big Bear Lake	0	0
P1-5	Mill Creek Reach 2	0	0
P1-6	Lytle Creek (Middle Fork)	0	0
WW-S1	Santa Ana River Reach 3 at MWD Crossing	100	32
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	94	4

Table 4-3 Frequency of Exceedance of STV (320 MPN/100 mL) Water Quality Objective During the 2018 Dry Weather Samples

Month	Number of Samples Collected	STV Criterion Exceedance Frequency (%)	
		SAR @ MWD Crossing	SAR @ Pedley Avenue
May	4	75	0
June	4	25	0
July	5	60	20
August	4	50	0
September	3	0	0
October	1	0	0
November	4	0	0

4.2 Priority 2

4.2.1 Water Quality Observations

Water quality parameters measured in the field at Priority 2 sites (Table 4-4) are summarized in Figures 4-17 through 4-23. Key observations are summarized as follows:

- Figure 4-17 shows that none of the pH measurements were below the lower allowable limit of 6.5, however, several measurements exceeded the upper allowable limit of 8.5. The exceedances were observed at Prado Park Lake (80 percent of measurements), Chino Creek (4 percent), and Mill-Cucamonga Creek (8 percent).
- Water temperatures are generally similar among Priority 2 sites and are slightly lower during the cold, wet season than the dry, warm season (Figure 4-18).
- All of the Priority 2 sites are designated with the WARM beneficial use and should meet a minimum DO level of 5 mg/L. All DO levels from the two SAR sites, Mill-Cucamonga Creek, and Prado Park Lake are greater than 5 mg/L (Figure 4-19), while eleven dry weather samples from Chino Creek were below 5 mg/L. Algae growth documented on the bottom of Chino Creek during dry sample events may have caused low DO levels.
- Specific conductivity is similar at the two SAR sites and ranged from 979 to 1103 µS/cm. A larger range of measurements was observed at the other three sites. At these three sites, measurements ranged from 538 to 1981 µS/cm.
- Turbidity (Figure 4-21) and TSS (Figure 4-22) show similar trends with lower levels in a narrow range (turbidity: 0.1 to 5.5 NTU; TSS: below detectable limit to 14 mg/L) at all sites except Prado Park Lake. Levels were more varied in Prado Park Lake, where turbidity ranged from 4.2 to 53.2 NTU and TSS ranged from 5 to 51 mg/L. Cool, wet season measurements are also generally, but not always, lower than warm, dry season measurements.
- Flow is lower at Prado Park Lake (spill from the lake) with rates ranging from 0.2 to 6 cfs. Chino Creek and Cucamonga Creek had similar ranges of flow (2 to 33 cfs and 1 to 35 cfs, respectively). Flow is notably higher in SAR and greatest at the most downstream site SAR at Pedley Avenue (Figure 4-23). Maximum flow at SAR at Pedley Avenue (230 cfs) is approximately 50 percent higher than the maximum flow at SAR at MWD Crossing (150 cfs).

Table 4-4 Priority 2 Monitoring Sites

Site ID	Site Description	County
WW-C7	Chino Creek at Central Avenue	San Bernardino
WW-C3	Prado Park Lake	San Bernardino
WW-M6	Mill-Cucamonga Creek below Wetlands	San Bernardino
WW-S1	Santa Ana River Reach 3 at MWD Crossing	Riverside
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	Riverside

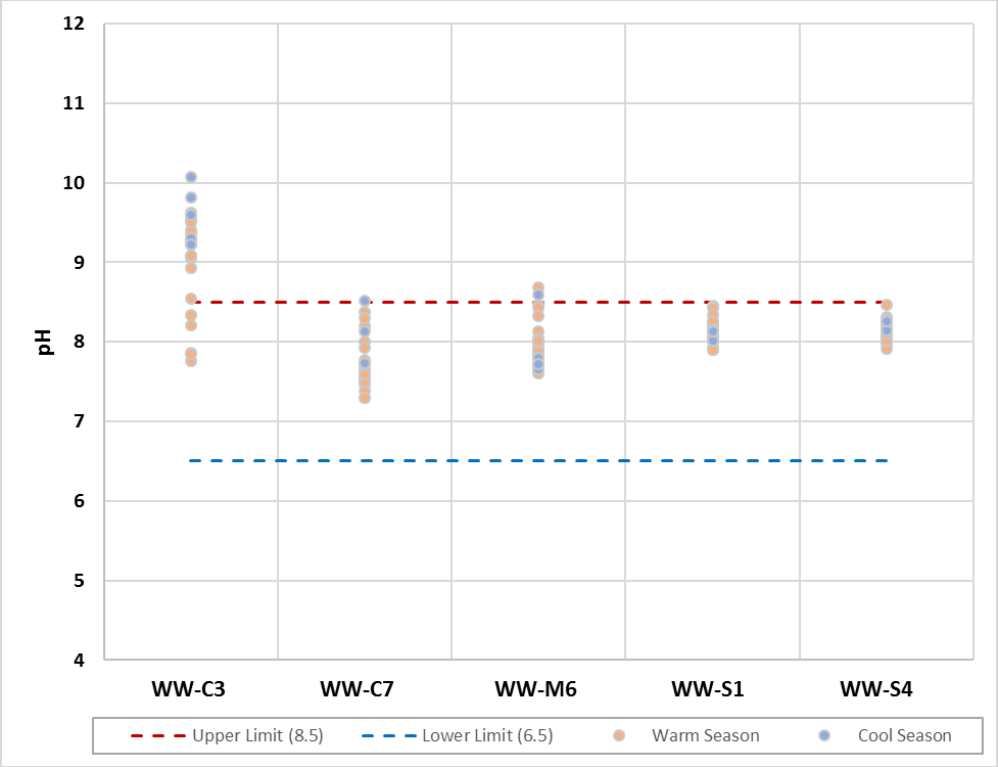

Figure 4-17
Distribution of pH Measurements at Priority 2 Sites

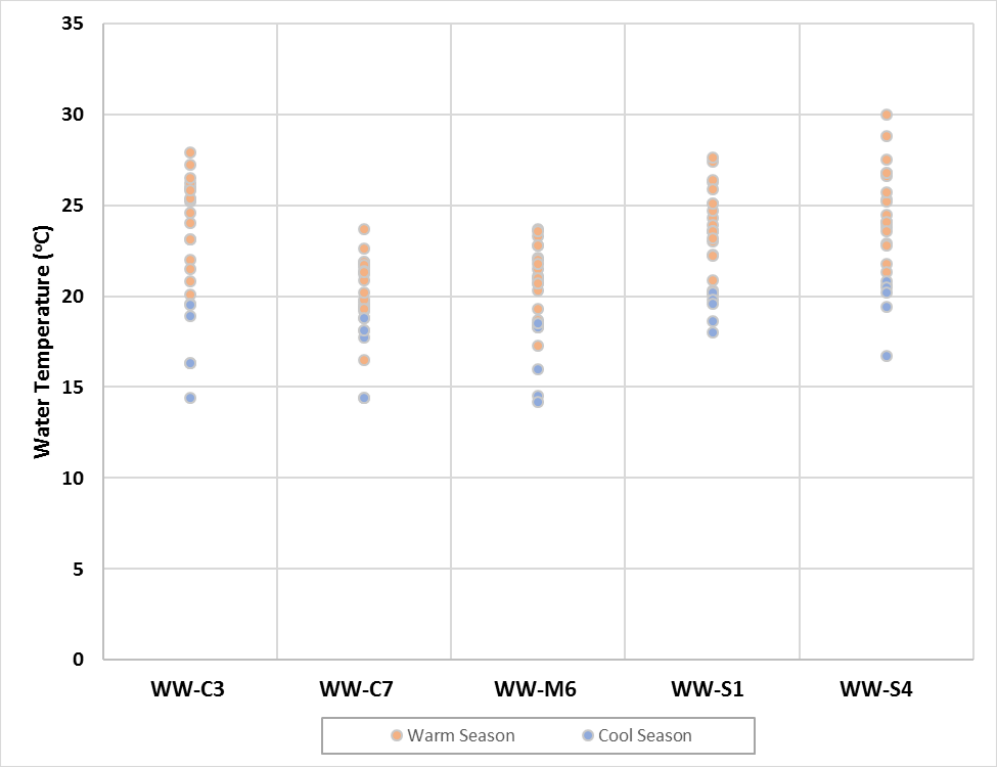

Figure 4-18
Distribution of Water Temperature Measurements at Priority 2 Sites

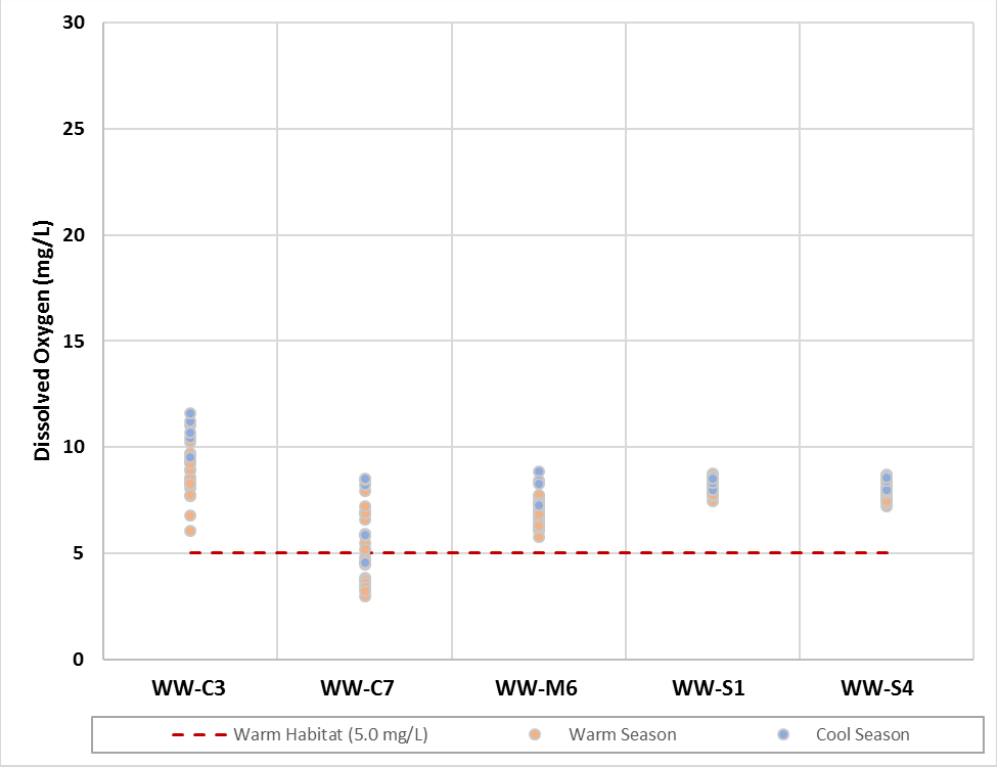

Figure 4-19
Distribution of Dissolved Oxygen Measurements at Priority 2 Sites

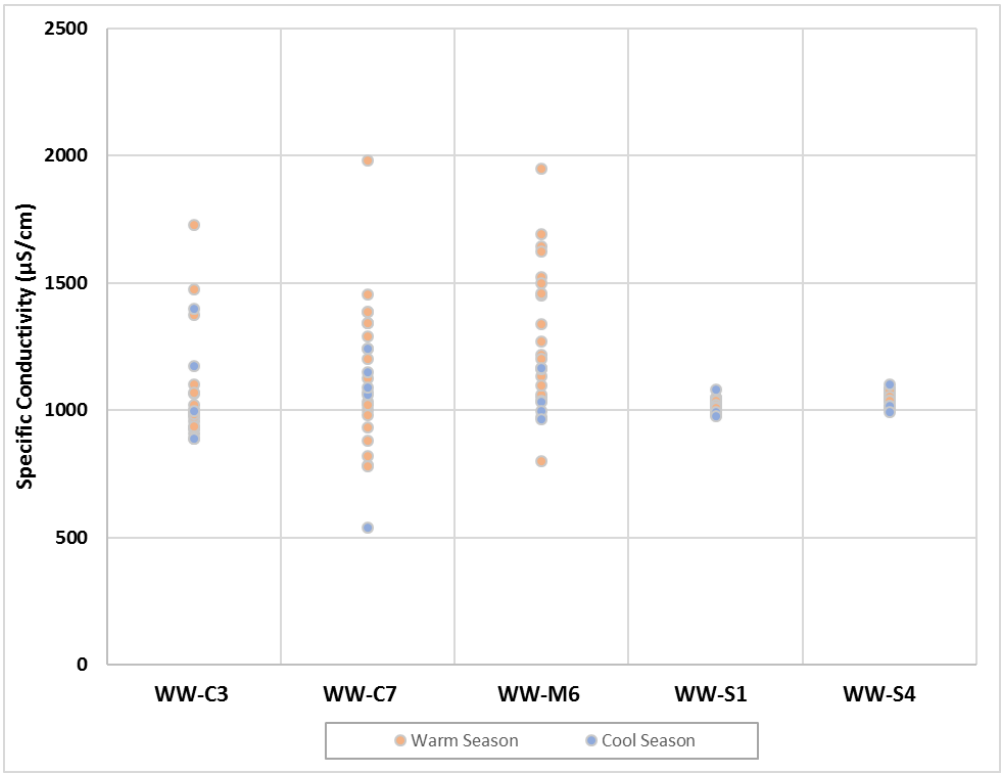

Figure 4-20
Distribution of Specific Conductivity Measurements at Priority 2 Sites

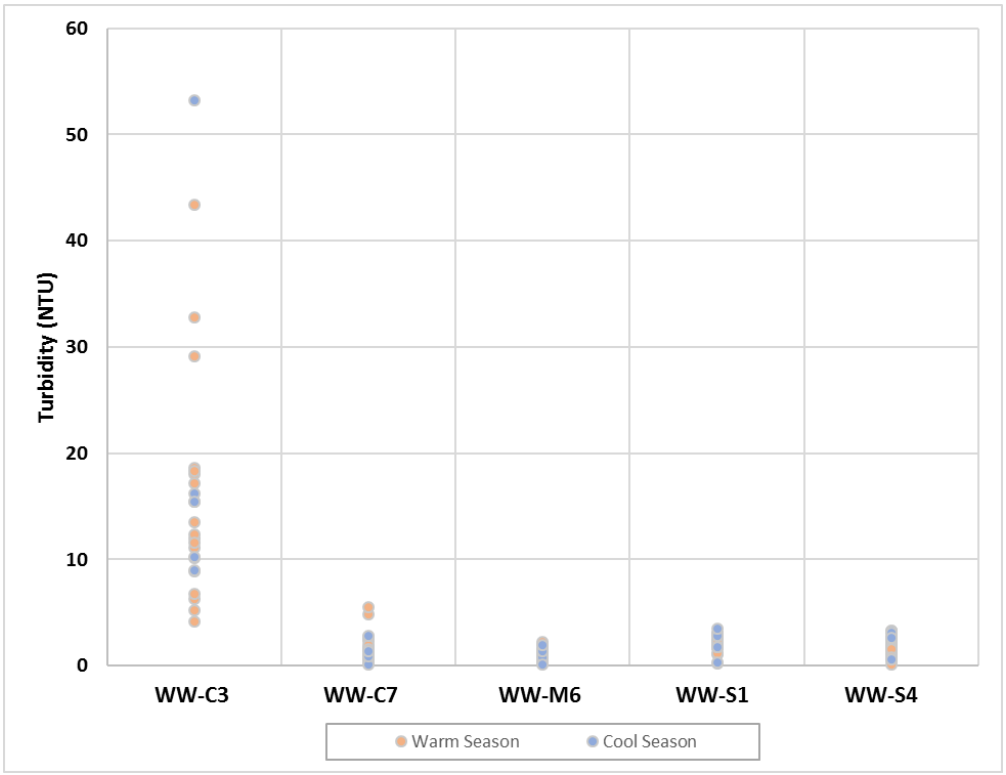

Figure 4-21
Distribution of Turbidity Measurements at Priority 2 Sites

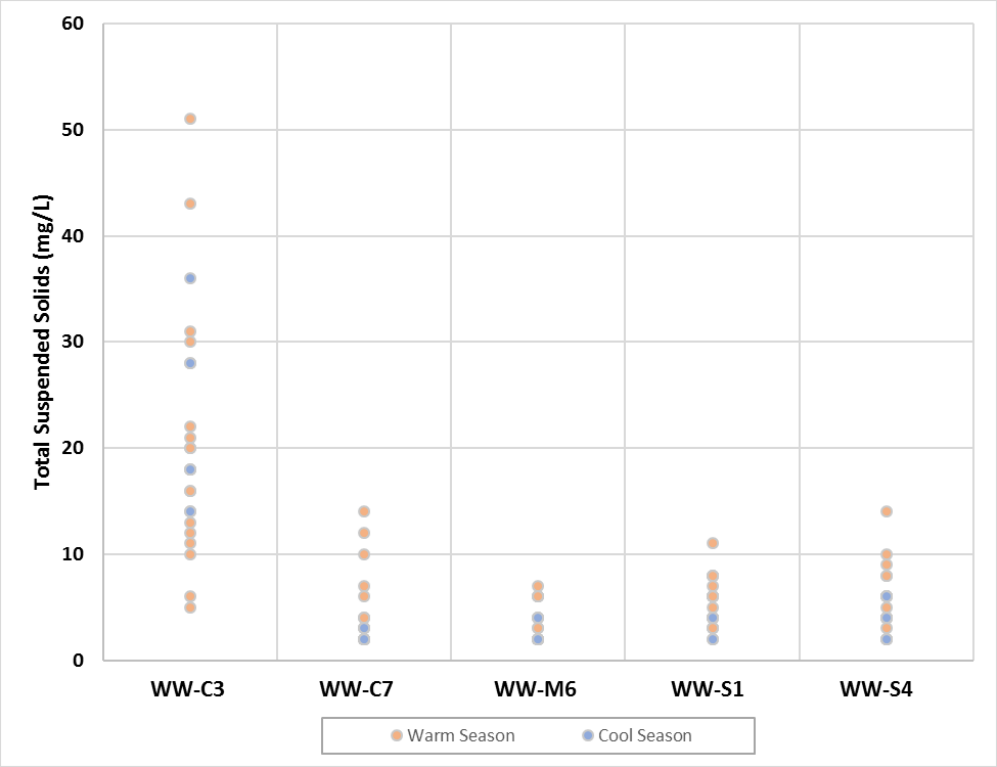

Figure 4-22
Distribution of TSS Measurements at Priority 2 Sites

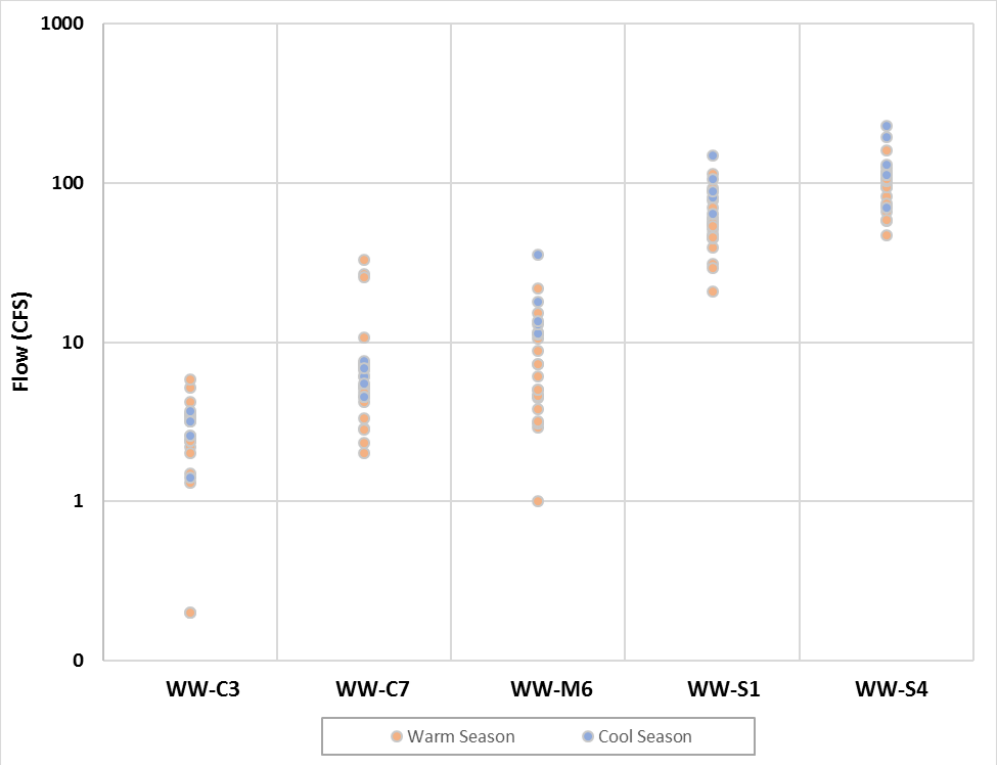

Figure 4-23
Distribution of Flow Measurements at Priority 2 Sites

4.2.2 Bacteria Characterization

Figure 4-24 summarizes the distribution of *E. coli* concentrations observed at Priority 2 sites during the warm, dry and cool, wet seasons.

4.2.2.1 Dry Weather

Prado Park Lake had the highest single-sample observed *E. coli* concentration of 4,900 MPN/100 mL. Aside from that sample, *E. coli* concentrations at Prado Park Lake ranged from 10 to 710 MPN/100 mL. Higher *E. coli* concentrations were also observed at Chino Creek and SAR at MWD Crossing, where concentrations ranged from 41 to 2,100 MPN/100 mL and 84 to 1,200 MPN/100 mL, respectively. Concentrations were lower at Mill-Cucamonga Creek (63 to 710 MPN/100 mL) and SAR at Pedley Crossing (41 to 380 MPN/100 mL).

Figure 4-24 illustrates individual wet weather storm samples from the 2018-2019 (green triangles) wet season.[22] Results from storm samples are summarized in Section 4.2.2.2. Figure 4-24 shows that peak concentrations from the storm samples are higher than most *E. coli* concentrations observed in dry weather samples. In particular, peak storm concentrations are greater than dry weather concentrations by over an order of magnitude at SAR at Pedley Avenue and at Mill-Cucamonga Creek.

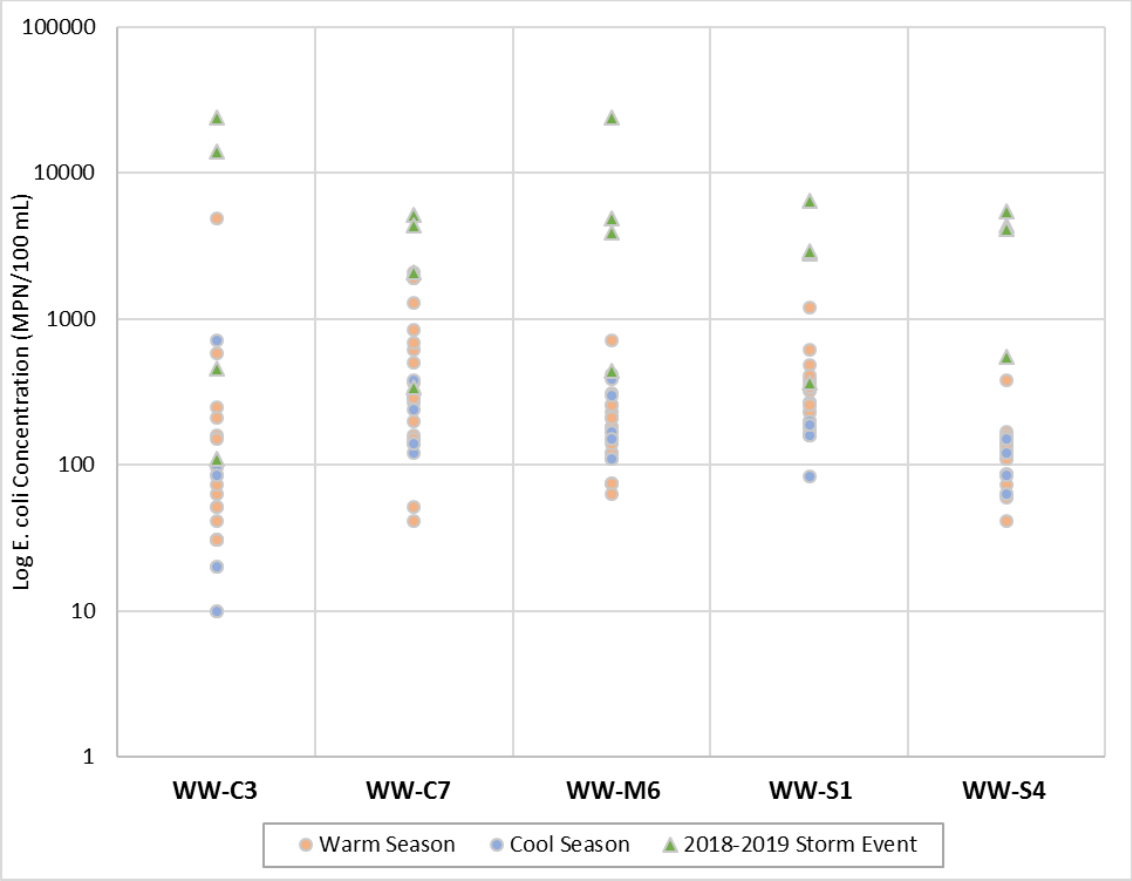

Figure 4-24
Distribution of *E. coli* Concentrations at Priority 2 Sites

[22] See Section 4.2.2.2 of this report for more information on wet weather event sampling.

Figures 4-25 through 4-29 show the individual and rolling geomean *E. coli* concentrations as well as concentrations from four storm samples during the 2018-2019 storm event. Geomeans during the warm, dry season were based on 6 weekly samples and the geomean from the cool, dry season were based on 5 weekly samples. They illustrate the variability in single sample results and rolling geometric mean values. Similar to Priority 1 sites, storms during the monitoring period did not appear to influence interevent dry weather bacteria as concentrations following storm events were not consistently higher.

Key observations from the Priority 2 site data include:

- Individual *E. coli* concentrations as well as geomeans show a generally decreasing trend during the warm, dry season at Prado Park Lake (Figure 4-25). Seventy one percent of the geomeans met the TMDL numeric target.
- All geomeans from Mill-Cucamonga Creek and SAR at MWD Crossing and nearly all geomeans (94 percent) at Chino Creek exceeded the TMDL numeric target. Fifty nine percent of geomeans at SAR at Pedley Avenue exceeded the TMDL numeric target (Figures 4-26 through Figure 4-29).
- *E. coli* concentrations at SAR at MWD Crossing (Figure 4-28), and SAR at Pedley Avenue (Figure 4-29) are relatively stable during the warm, dry season and do not exhibit the increasing trend during the end of the warm, dry season observed in previous years. Higher *E. coli* concentrations were observed in SAR at MWD Crossing than SAR at Pedley, suggesting a net dilution between the sites from Riverside WQCP effluent and in-stream decay.
- Peak storm *E. coli* concentrations are more than one order of magnitude greater than dry weather concentrations at SAR at Pedley Avenue (Figure 4-29) and Mill-Cucamonga Creek (Figure 4-27). At Prado Park Lake (Figure 4-25), Chino Creek (Figure 4-26), and SAR at MWD Crossing (Figure 4-28), peak storm concentrations are greater than most of the dry weather concentrations but similar in magnitude as peak dry weather concentrations.

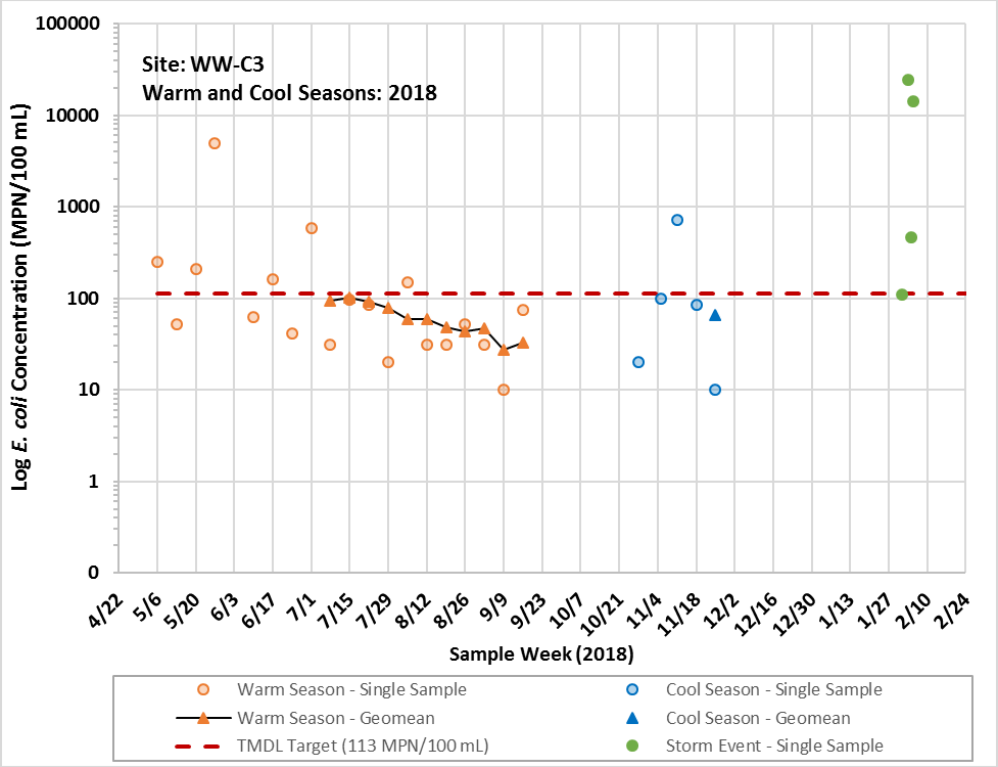

Figure 4-25
***E. coli* Concentrations and Geomeans at Prado Park Lake (WW-C3)**

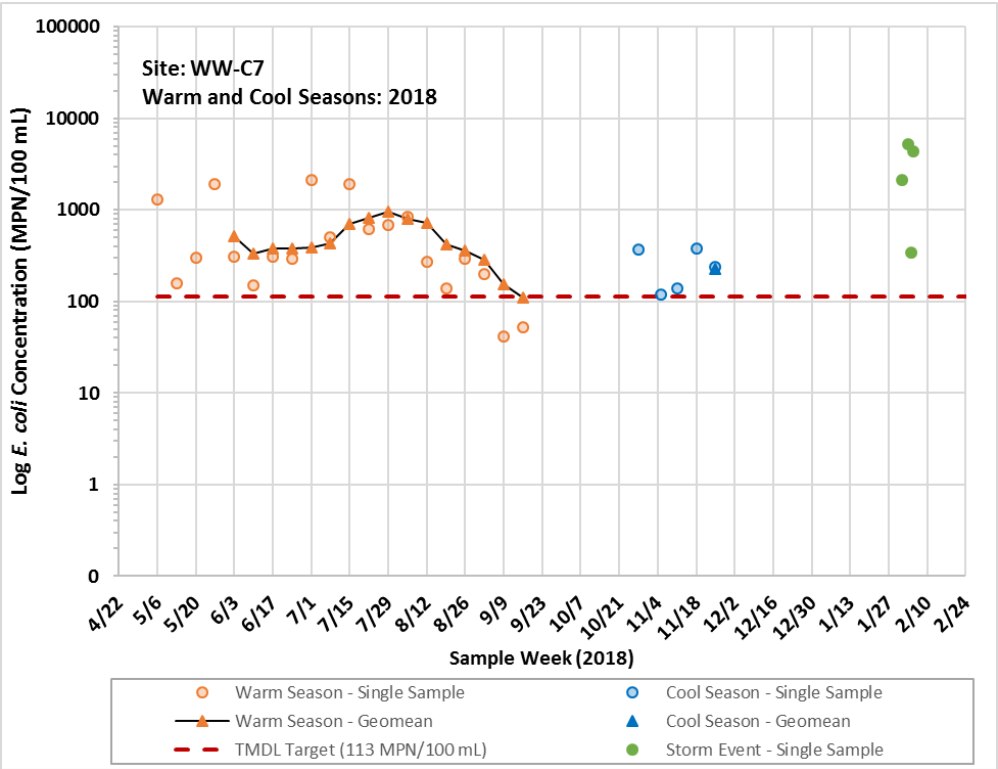

Figure 4-26
***E. coli* Concentrations and Geomeans at Chino Creek at Central Avenue (WW-C7)**

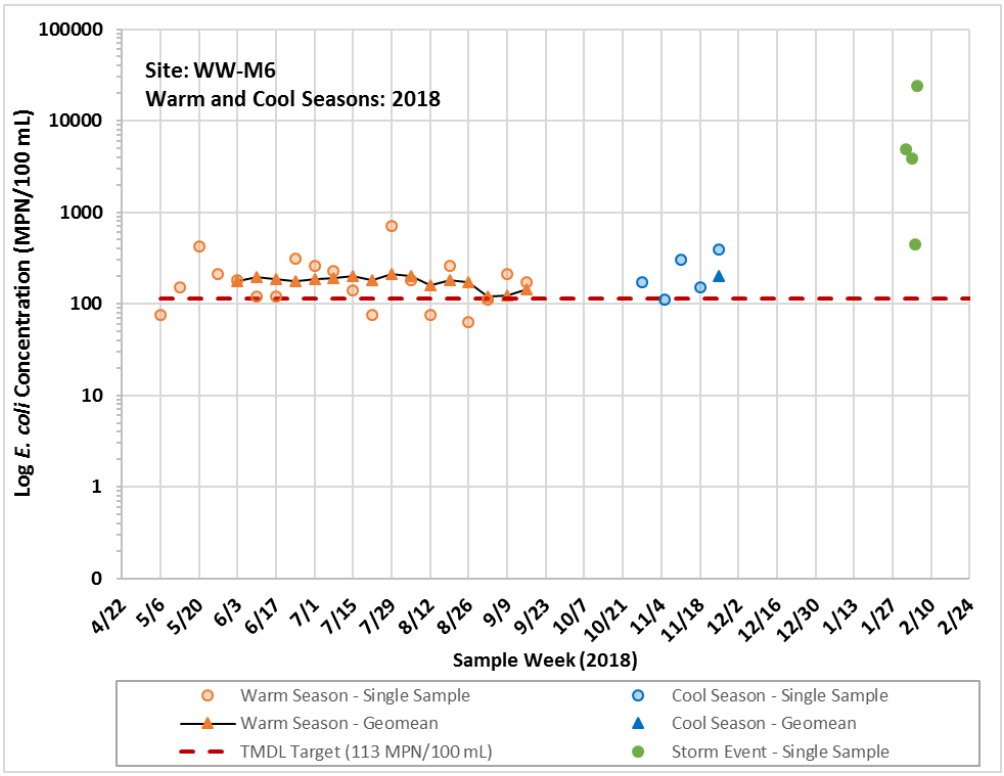

Figure 4-27
***E. coli* Concentrations and Geomeans at Mill-Cucamonga Creek Below Wetlands (WW-M6)**

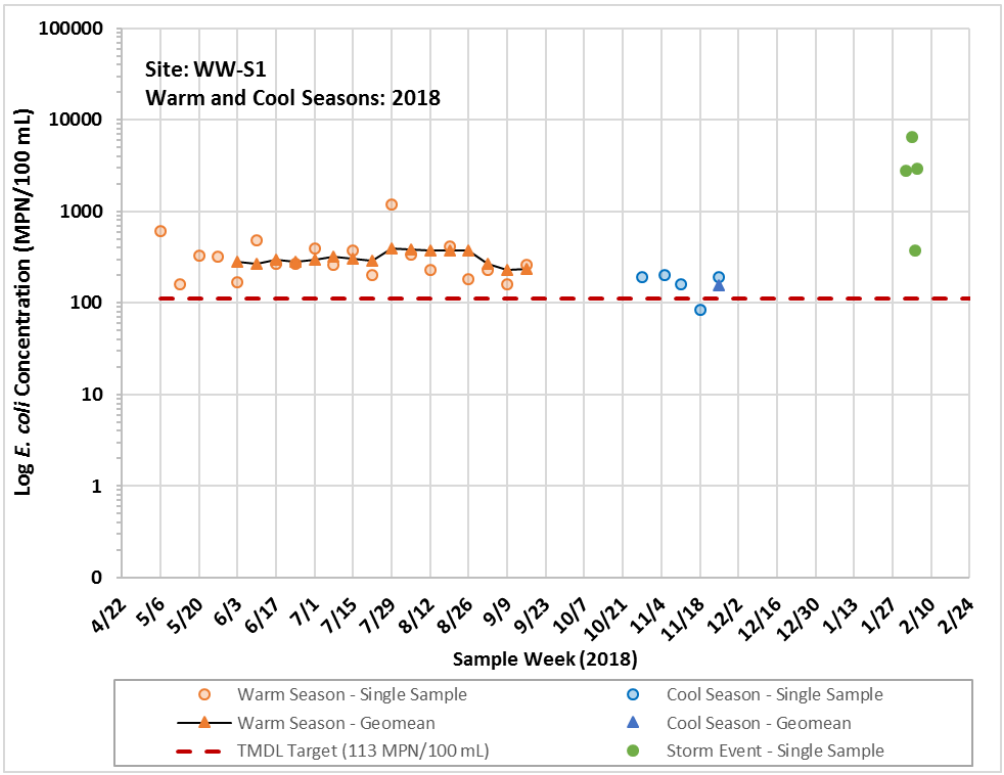

Figure 4-28
***E. coli* Concentrations and Geomeans at Santa Ana River at MWD Crossing (WW-S1)**

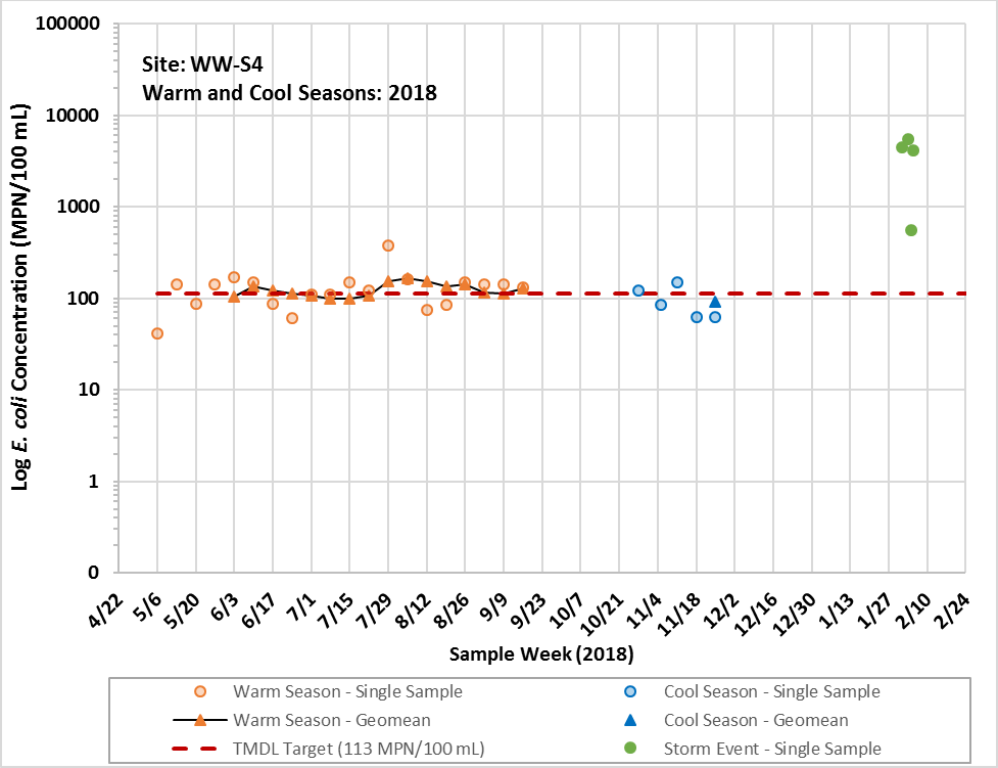

Figure 4-29
***E. coli* Concentrations and Geomeans at Santa Ana River at Pedley Avenue (WW-S4)**

4.2.2.2 Wet Weather

Storm samples collected for the February 1, 2019 storm event are summarized in Table 4-5. Figures 4-30 and 4-31 illustrate examples of changing *E. coli* concentrations over the sampling period during and after the storm at various sites with flows classified as wet weather conditions. Peak wet weather *E. coli* concentrations of 24,000 MPN/100 mL were observed at Prado Park Lake on February 3, 2019 and Mill-Cucamonga Creek on February 5, 2019. The peak wet weather concentrations at each site was observed on Day 2 (February 3, 2019) of the storm event at all sites except Mill-Cucamonga Creek. The range of concentrations (340 to 6,500 MPN/100 mL) were similar at Chino Creek, SAR at MWD Crossing, and SAR at Pedley Avenue. The February 1, 2019 storm event was particularly large with measurable rain for six consecutive days. Although the rain event began on February 1, 2019, the highest amount of rainfall was observed on February 3, 2019. Rainfall was greater on February 5 than February 4 as well. While field crews were unable to measure flow rates due to unsafe conditions, this pattern is observed in discharge measurements at USGS gages for SAR at MWD Crossing, Chino Creek, and Mill-Cucamonga Creek (Figures 4-30 and 4-31, respectively). As such, the decrease in *E. coli* concentrations typically observed Day 4 or Day 5 of the storm event was not observed during this storm event.

Table 4-5 *E. coli* Concentrations (MPN/100 mL) Observed During the 2018-2019 Storm Event

Site	2/1/2019	2/3/2019	2/4/2019	2/5/2019
Prado Park Lake (WW-C3)	110	24000	460	14000
Chino Creek at Central Avenue (WW-C7)	2100	5200	340	4400
Mill-Cucamonga Creek below Wetlands (WW-M6)	4900	3900	440	24000
SAR Reach 3 at MWD Crossing (WW-S1)	2800	6500	370	2900
SAR Reach 3 at Pedley Avenue (WW-S4)	4400	5500	550	4100

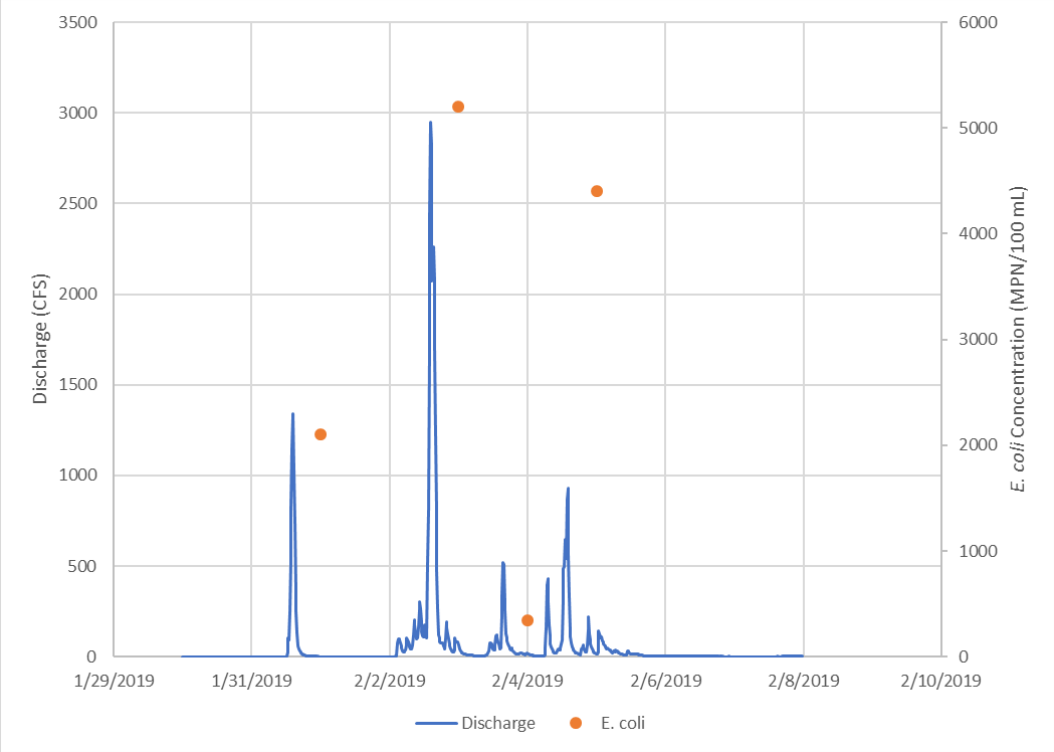

Figure 4-30
***E. coli* Concentrations Observed at Chino Creek During and After the February 1, 2019 Storm Event**

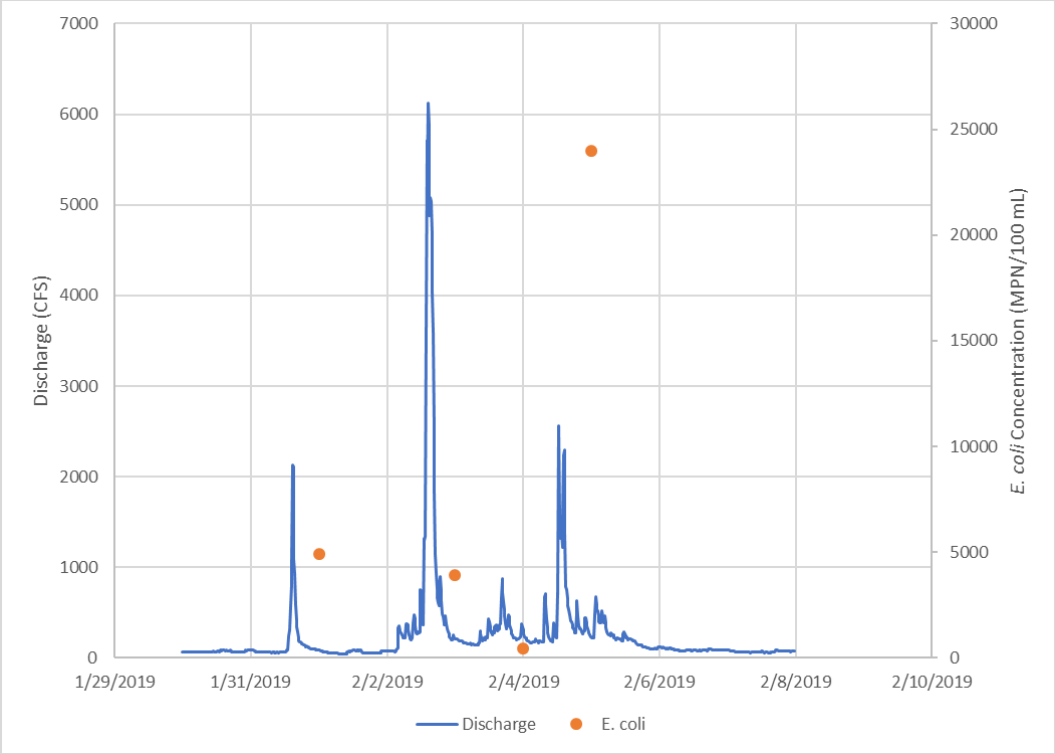

Figure 4-31
***E. coli* Concentrations Observed at Mill-Cucamonga Creek During and After the February 1, 2019 Storm Event**

4.2.3 Historical Trend

Figures 4-32 through 4-36 illustrate how the distribution and variability of rolling geometric mean values for *E. coli* have varied over time since 2007.[23] The period of record illustrates how *E. coli* geomean concentrations have been comparable for the period of record.
E. coli concentrations from 2007 through 2015 are presented in CFU/100 mL while 2016 and 2017 concentrations are presented in MPN/100 mL.

Figure 4-32 suggests that *E. coli* levels are improving at Prado Park Lake (WW-C3). The 2018-2019 *E. coli* geomeans (27 to 103 MPN/100 mL) are all below the MSAR Bacteria TMDL target of 113 MPN/100 mL. However, due to one dry monitoring event during the week of June 3, 2018, five geomeans were excluded as they were based on 4 samples and not 5 samples, as required by the TMDL numeric target. The excluded geomeans ranged from 124 to 340 MPN/100 mL.

[23] Results of previous sample collection activities may be obtained from seasonal reports posted at the Santa Ana Watershed Project Authority MSAR TMDL Task Force website: http://www.sawpa.org/collaboration/projects/tmdl-taskforce/

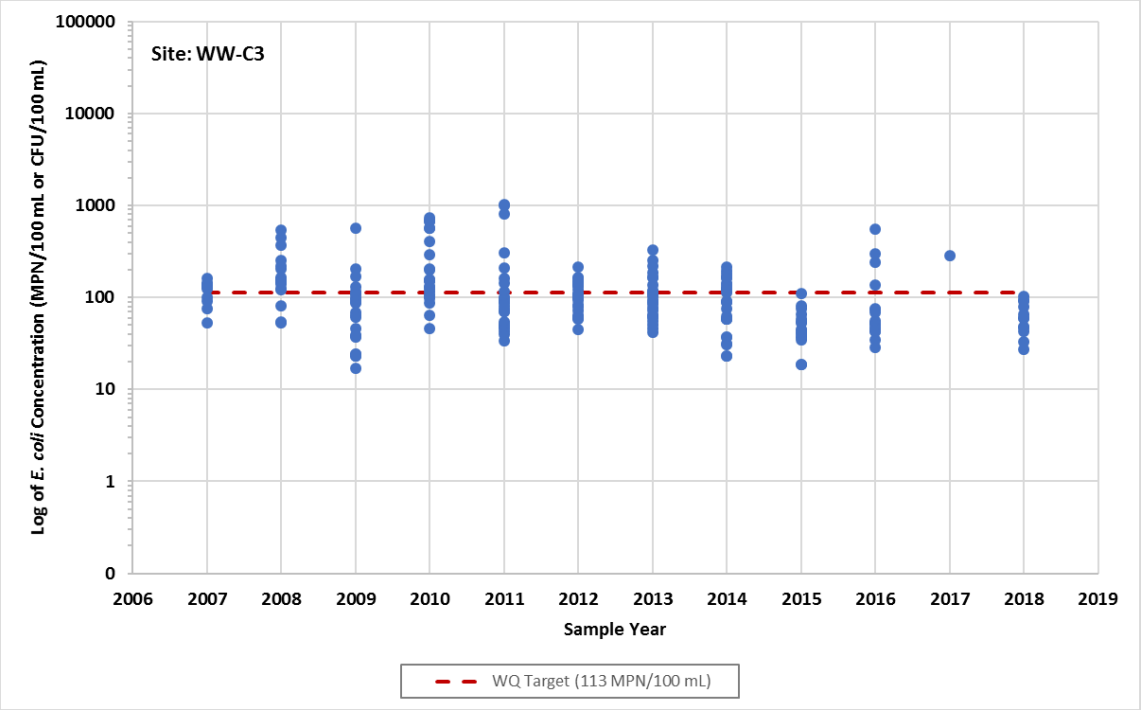

Figure 4-32
Time Series Distribution of *E. coli* Geomean Concentrations at Prado Park Lake from 2007 through 2018

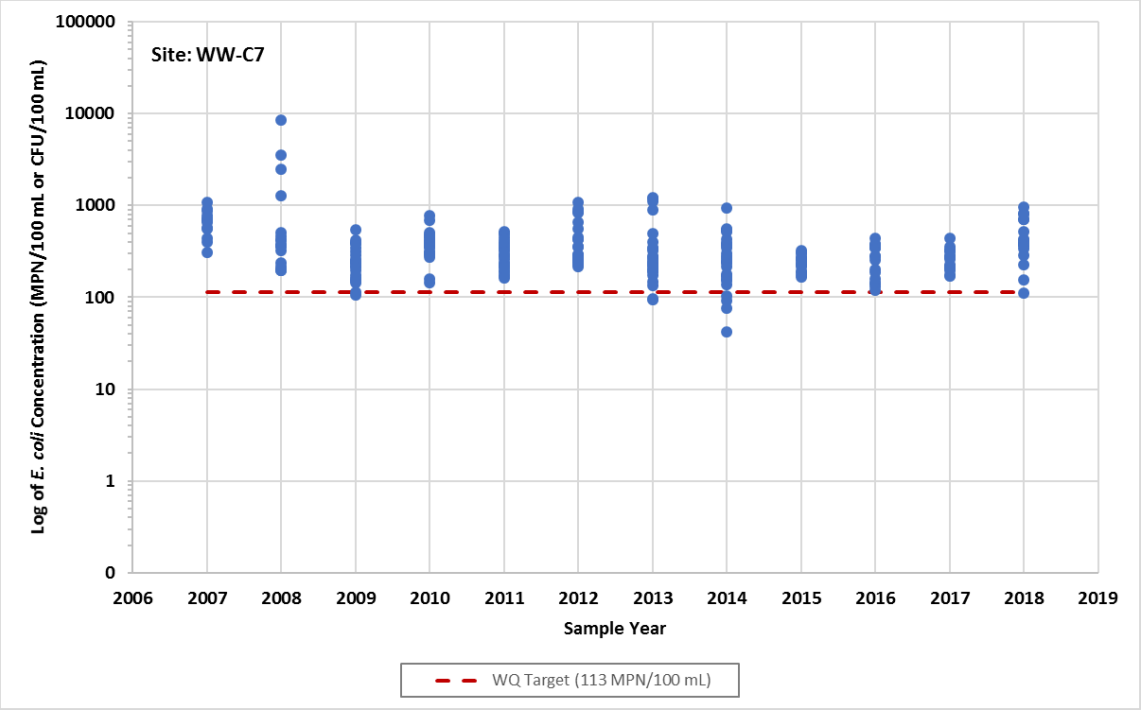

Figure 4-33
Time Series Distribution of *E. coli* Geomean Concentrations at Chino Creek from 2007 through 2018

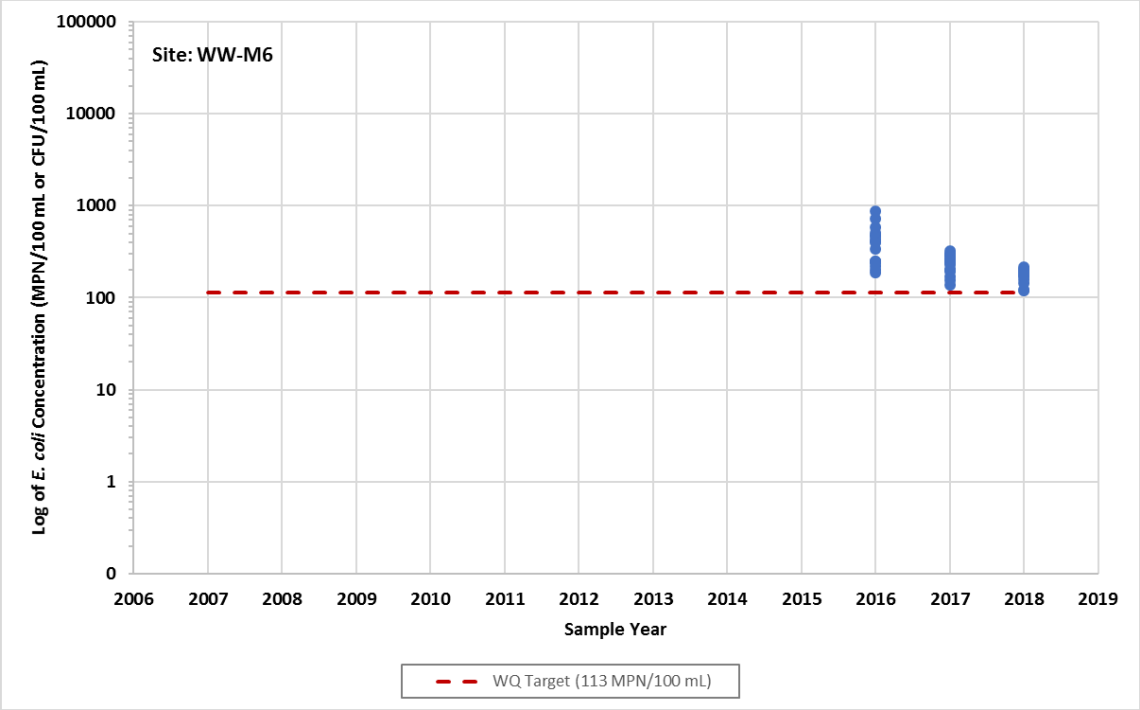

Figure 4-34
Time Series Distribution of *E. coli* Geomean Concentrations at Cucamonga Creek Below Wetlands from 2016 through 2018

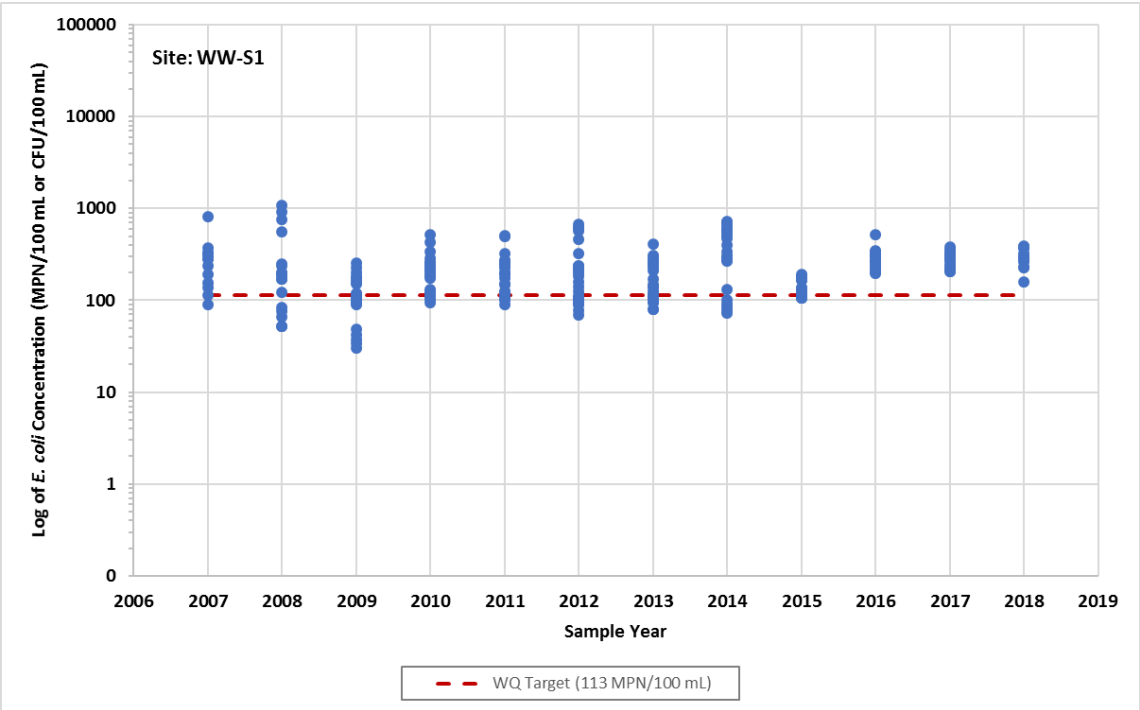

Figure 4-35
Time Series Distribution of *E. coli* Geomean Concentrations at Santa Ana River at MWD Crossing from 2007 through 2018

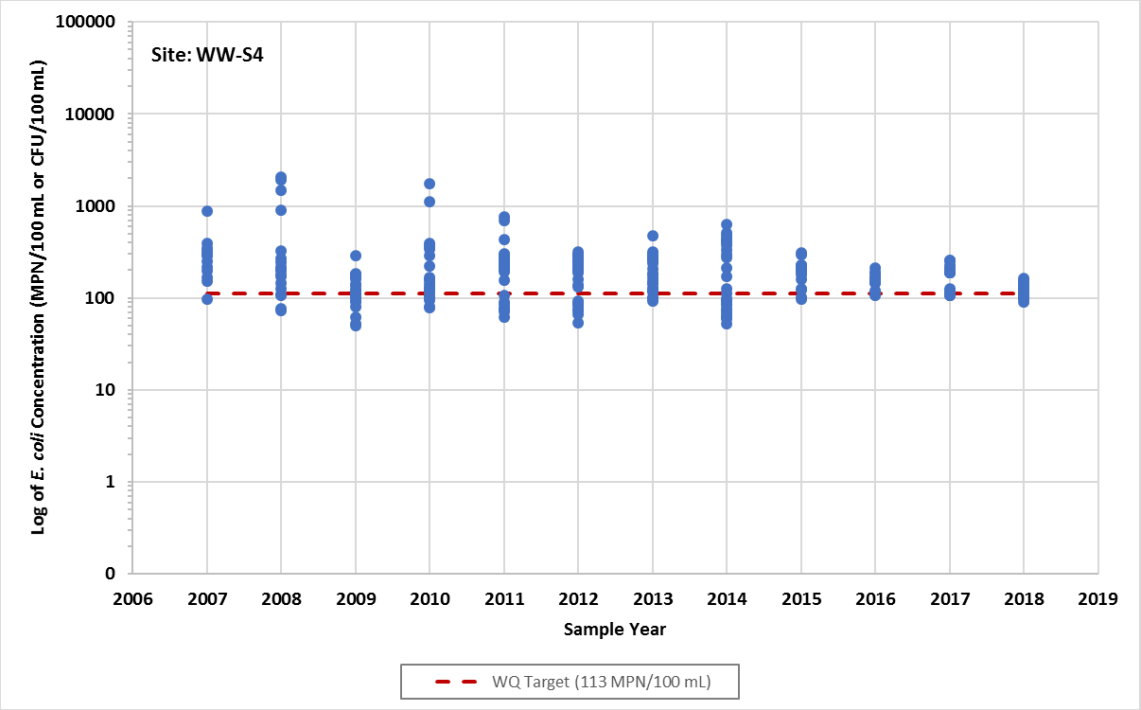

Figure 4-36
Time Series Distribution of *E. coli* Geomean Concentrations at Santa Ana River at Pedley Avenue from 2007 through 2018

4.2.4 Compliance Analysis

The compliance analysis compared the *E. coli* geomeans to the MSAR Bacteria TMDL geomean numeric target of 113 organisms/100 mL for a 5-sample/30-day geomean (see Section 1.2.1). Geometric means were calculated only when at least five sample results were available from the previous 30-day period. All of the Priority 2 sites except Prado Park Lake (WW-C3) had geomean exceedances (Table 4-6 with the lowest frequency of 59 percent occurring at SAR at Pedley Avenue (WW-S4). All or nearly all of the geomeans form the other three sites (Chino Creek, Mill-Cucamonga Creek, and SAR at MWD Crossing) exceeded the TMDL target.

None of the Prado Park Lake (WW-C3) geomeans exceeded the TMDL target, however this is based on twelve geomeans as opposed to seventeen geomeans at the other four sites. Due to one week of dry conditions in July, five geomeans were excluded as it did not meet the minimum 5-sample/30-day requirement.

Table 4-6 Frequency of Exceedance with MSAR TMDL Numeric Target for *E. coli* During the 2018 Dry Weather Samples (113 MPN/100 mL)

Site ID	Site	Geometric Mean Criterion Exceedance Frequency (%)
WW-C3	Prado Park Lake	0
WW-C7	Chino Creek at Central Avenue	94
WW-M6	Mill-Cucamonga Creek Below Wetlands	100
WW-S1	Santa Ana River Reach 3 at MWD Crossing	100
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	59

4.3 Priority 3

4.3.1 Water Quality Observations

Figures 4-37 through 4-43 summarize water quality field observations at Priority 3 sites (Table 4-7). Key observations are summarized as follows:

- Samples and measurements were not collected from Borrego Creek (P3-OC2) due to dry conditions. As such, Borrego Creek is not included in Figures 4-37 through 4-43.
- Los Trancos Creek (P3-OC5) and Morning Canyon Creek (P3-OC6) were not monitored during the scheduled 5-week period. They were monitored six times between December 12, 2018 and January 30, 2019. Weekly samples could not be collected due to many storms impacting dry weather conditions during that time period.
- Los Trancos Creek (P3-OC5) was dry during five of the six sampling events. During the week of January 6, 2019, flow was observed as the diversion was turned off but flow was not sampled or measured.
- Figure 4-37 presents pH measurements. During the cool, wet season pH observations were generally within the allowable range (6.5 to 8.5) except at three sites. Forty percent of the measurements exceeded 8.5 at Bolsa Chica Channel (P3-OC1) and San Diego Creek Reach 1 (P3-OC8) and all of the measurements exceeded 8.5 at Serrano Creek (P3-OC11).
- Water temperatures generally range from 10 degrees C to 25 degrees C with the highest temperatures (26 to 32 degrees C) observed at Bolsa Chica Channel (P3-OC1) and SAR Reach 4 (P3-SBC1) (Figure 4-38). Temperature at Peters Canyon Wash, San Diego Creek Reaches 1 and 2, and Serrano Creek are slightly higher than other sites. Generally, temperatures are in the upper range for measurements taken during the warm season.
- Figure 4-39 shows that DO levels at all sites met the WQO for a minimum of 5 mg/L for WARM use except for one measurement at Bolsa Chica Channel (P3-OC1), which was 2.8 mg/L. Both the highest and lowest DO levels were observed at Bolsa Chica Channel.
- Conductivity ranges from 804 to 8,088 µS/cm at Priority 3 sites (Figure 4-40). The lowest conductivity levels were observed at Serrano Creek (P3-OC11) and SAR Reach 4 (P3-SBC1). Conductivity levels at the sites near the coast (Buck Gully Creek [P3-OC3] and Morning Canyon Creek [P3-OC6]) are generally higher (greater than 5,000 µS/cm). At inland sites, conductivity ranges from 804 to 2,893 µS/cm while levels near the coast range from 4,928 to 8,088 µS/cm.
- Figure 4-41 shows that turbidity levels are generally low with 86 percent of measurements less than 10 NTU, and 14 percent of the measurements range from 11 to 20 NTU. The higher turbidity levels were all observed at Bolas Chica Channel (P3-OC1) and San Diego Creek Reach 1 (P3-OC8).
- Similar to turbidity, Figure 4-42 shows that TSS is generally low at all sites, with the maximum level of 23 mg/L observed at San Diego Creek Reach 1 (P3-OC8). TSS at Peters

Canyon Wash (P3-OC7), San Diego Creek Reach 1 (P3-OC8), and Serrano Creek (P3-OC11) is generally higher than TSS at the other Priority 3 sites.

- Figure 4-43 shows that flow was low at all of the Priority 3 sites (less than 7 cfs) except for SAR Reach 4 (P3-SBC1). Borrego Creek was dry during all monitoring events and is omitted from the figure. Los Trancos Creek was dry during all but one monitoring event but flow as not measured during that event and is omitted from the figure. Flow at SAR Reach 4 (18.6 to 53.8 cfs) was substantially higher than the other sites as a result of being downstream of Rialto/RIX effluent discharge.

Table 4-7 Priority 3 Monitoring Sites

Site ID	Site Description	County
P3-OC1	Bolsa Chica Channel upstream of Westminster Blvd/Bolsa Chica Rd	Orange
P3-OC2	Borrego Creek upstream of Barranca Parkway	Orange
P3-OC3	Buck Gully Creek Little Corona Beach at Poppy Avenue/Ocean Blvd	Orange
P3-OC5	Los Trancos Creek at Crystal Cove State Park	Orange
P3-OC6	Morning Canyon Creek at Morning Canyon Beach	Orange
P3-OC7	Peters Canyon Wash downstream of Barranca Parkway	Orange
P3-OC8	San Diego Creek downstream of Campus Drive (Reach 1)	Orange
P3-OC9	San Diego Creek at Harvard Avenue (Reach 2)	Orange
P3-OC11	Serrano Creek upstream of Barranca/Alton Parkway	Orange
P3-RC1	Goldenstar Creek at Ridge Canyon Drive	Riverside
P3-SBC1	Santa Ana River Reach 4 above S. Riverside Avenue Bridge	San Bernardino

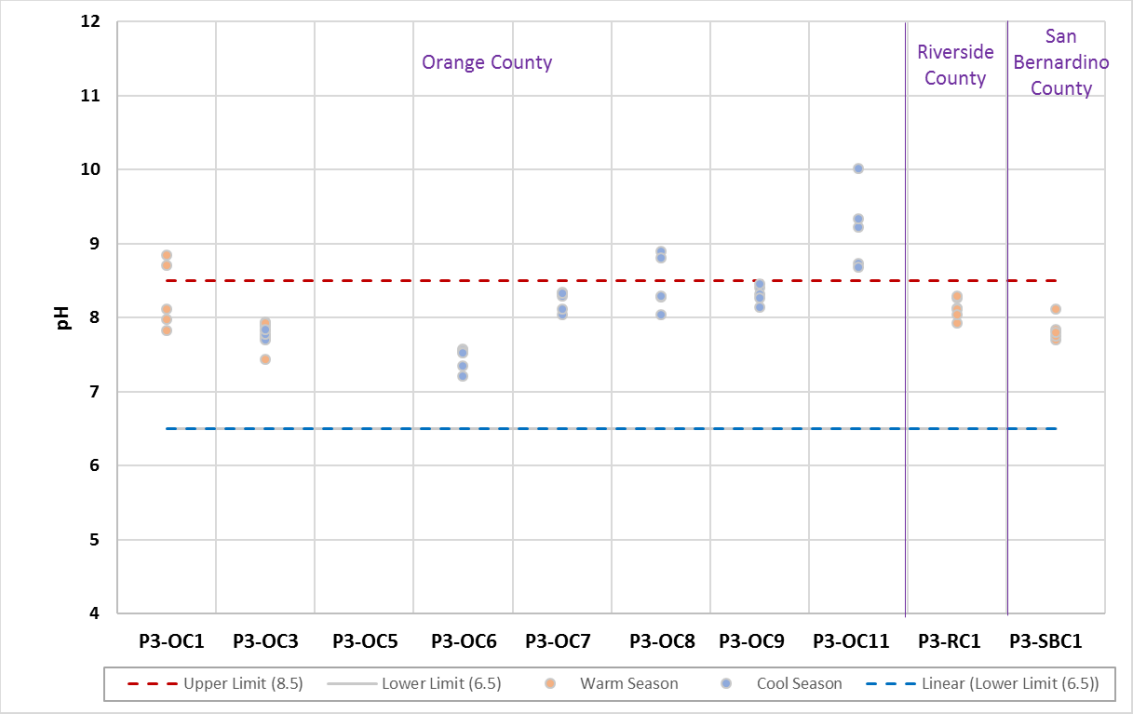

Figure 4-37
Distribution of pH Measurements at Priority 3 Sites

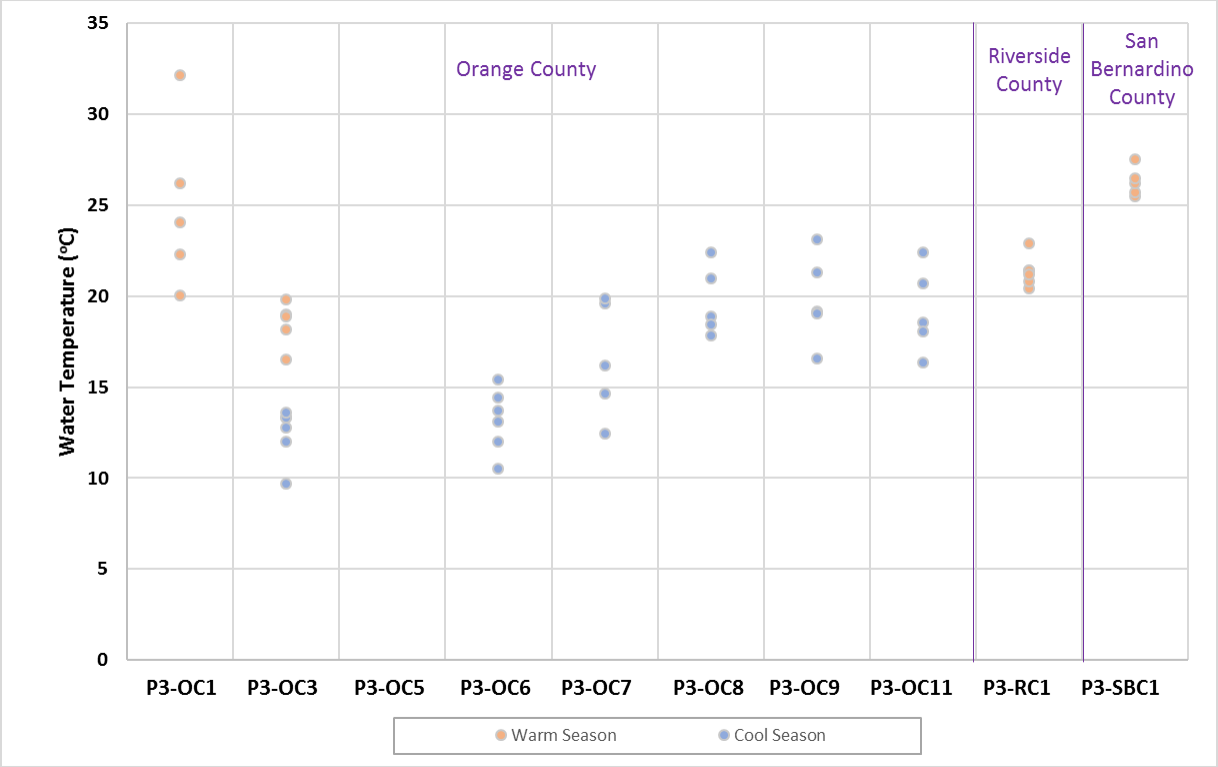

Figure 4-38
Distribution of Water Temperature Measurements at Priority 3 Sites

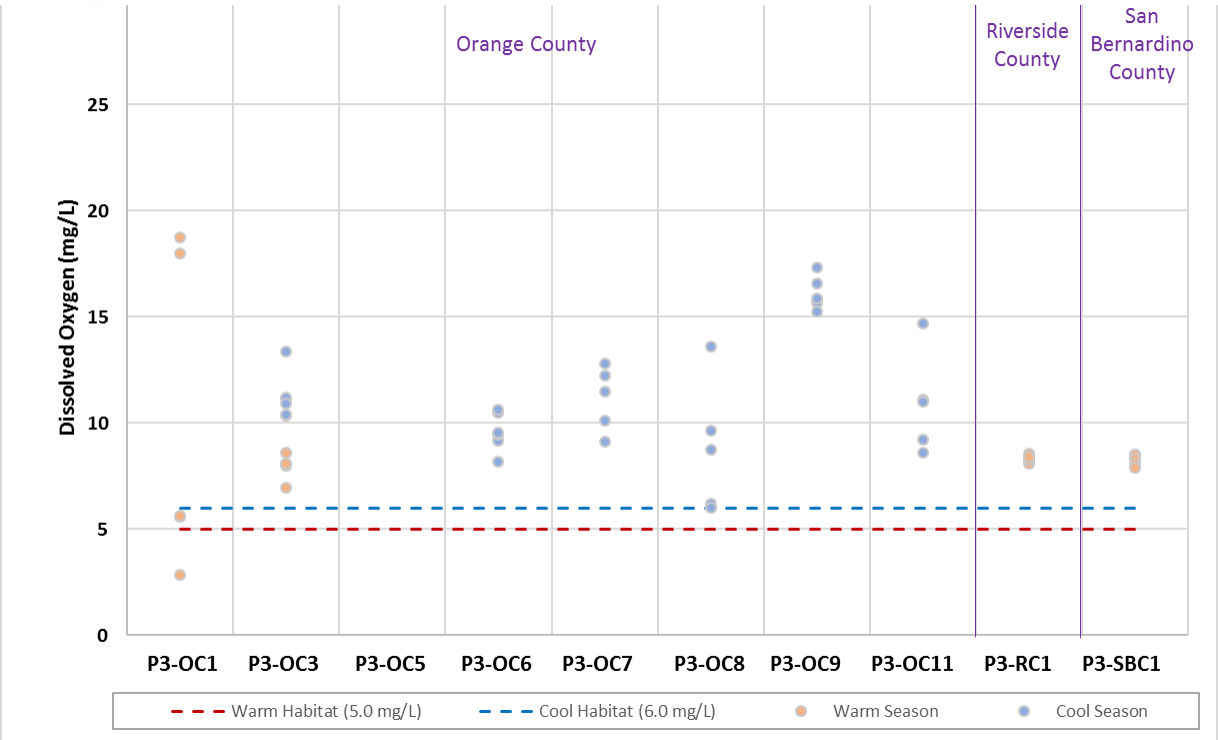

Figure 4-39
Distribution of Dissolved Oxygen Measurements at Priority 3 Sites

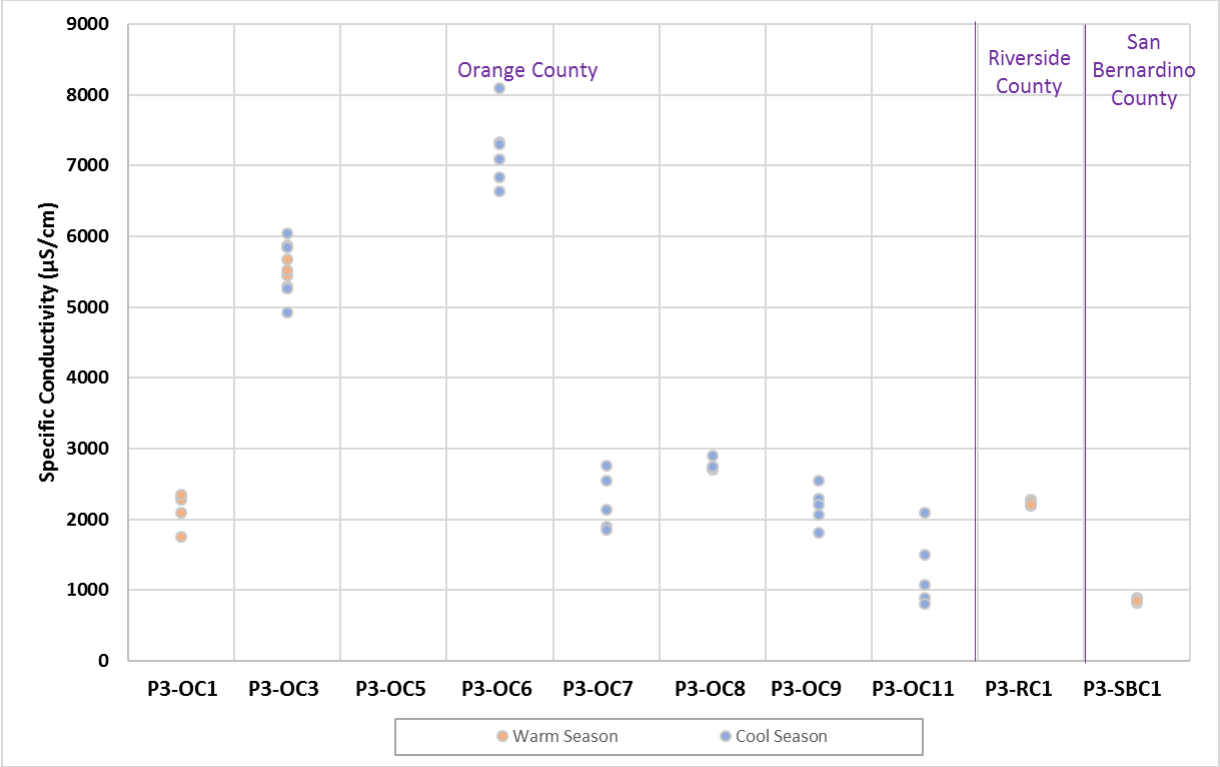

Figure 4-40
Distribution of Specific Conductivity Measurements at Priority 3 Sites

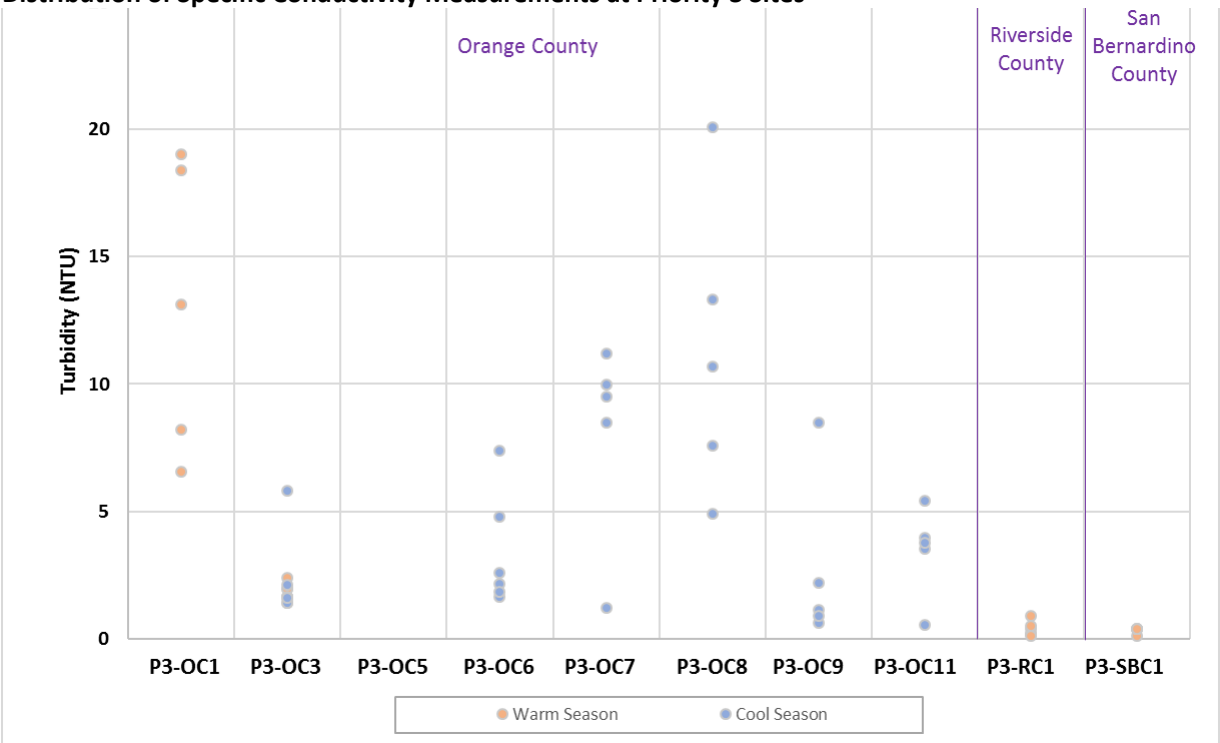

Figure 4-41
Distribution of Turbidity Measurements at Priority 3 Sites

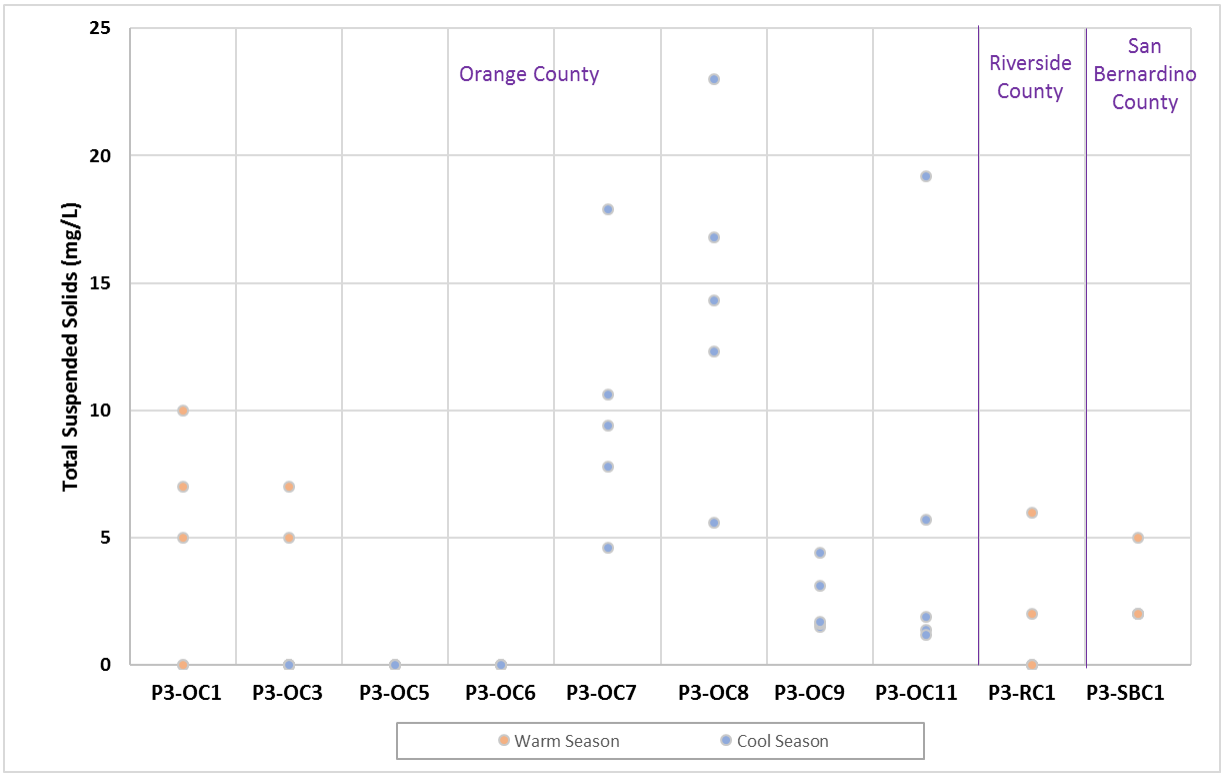

Figure 4-42
Distribution of TSS Measurements at Priority 3 Sites

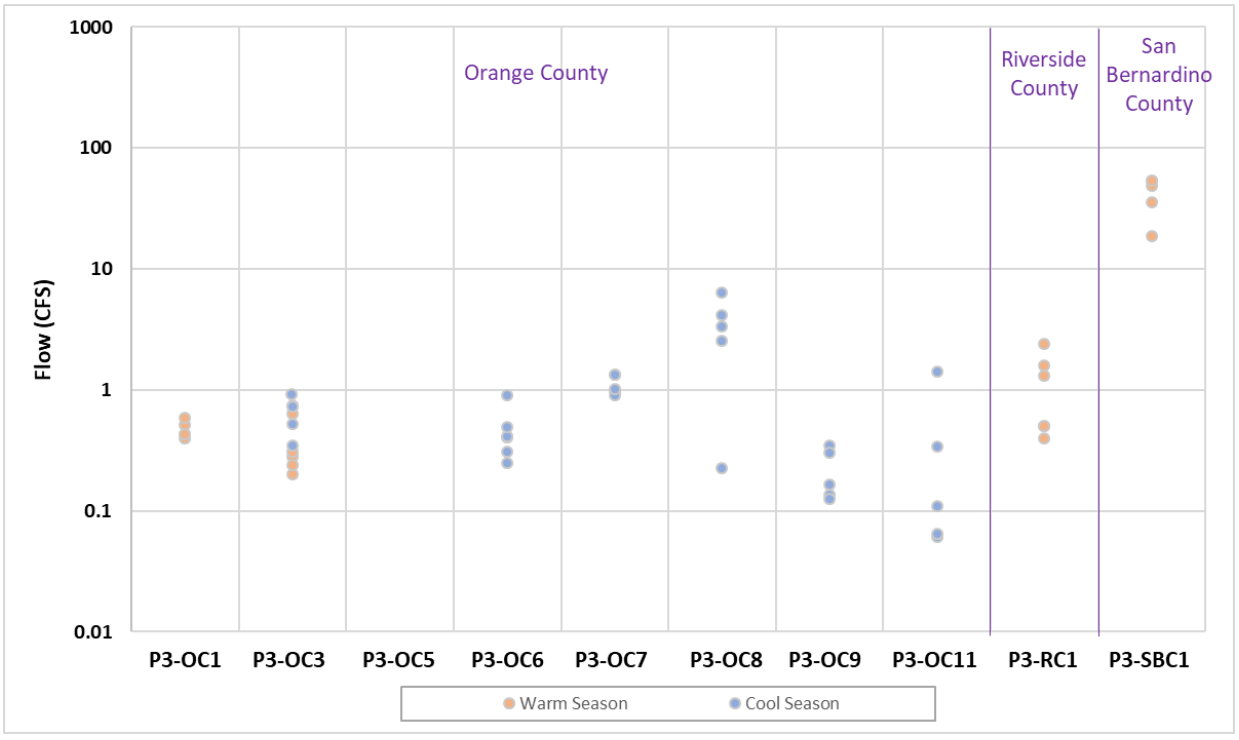

Figure 4-43
Distribution of Flow Measurements at Priority 3 Sites

4.3.2 Bacteria Characterization

Figure 4-44 summarizes the distribution of *E. coli* concentrations observed at Priority 3 sites during dry weather. Figure 4-45 further illustrates the distribution of concentrations. Table 4-8 provides the 5-sample geomean calculated for each site. Key observations are summarized as follows:

- The geomeans of *E. coli* concentrations from six Priority 3 sites were greater than the Statewide Bacteria Provision geomean WQO of 100 organisms/100 mL. The geomean at Bolsa Chica Channel (P3-OC1) and SAR Reach 4 (P3-SBC1) did not exceed the geomean WQO. Borrego Creek (P3-OC2) was dry during sampling events.
- Los Trancos Creek (P3-OC5) was dry during 5 out of 6 monitoring events and a sample was not collected during the one event due to time constraints.
- Samples from Morning Canyon Creek (P3-OC6) were collected over a 7-week period instead of the 6-week period due to an unusually wet year with frequent storms, which impacted the ability to collect weekly samples under dry conditions. *E. coli* concentrations at Morning Canyon Creek were higher than several other sites but were influenced by wet weather.
- *E. coli* concentrations at Peters Canyon Wash (P3-OC7) and Serrano Creek (P3-OC11), ranging from 281 to 1274 MPN/100 mL and 31 to 1674 MPN/100 mL, respectively, were higher than several other sites also. These sites receive flow from smaller, inland, urban drainage areas, which typically result in higher bacteria concentrations.
- Conversely, San Diego Creek (P3-OC8 and P3-OC9), which has *E. coli* concentrations lower than Peters Canyon Wash and Serrano Creek, has a large drainage area. Concentrations in San Diego Creek are also impacted by dilution effects from baseflow as well in-stream decay.
- Bolsa Chica Channel (P3-OC1) and Buck Gully Creek (P3-OC3) have lower *E. coli* concentrations (10 to 132 MPN/100 mL and 18 to 345 MPN/100 mL, respectively) than other sites. However, historical Enterococci data have been higher concentrations at both sites.
- The same Priority 3 sites that exceeded the geomean WQO also exceeded the Statewide Bacteria Provisions STV exceedance allowance. Each of the seven sites had at least one sample greater than 320 organisms/100 mL, with four of the five samples from Peters Canyon Wash exceeding the STV.

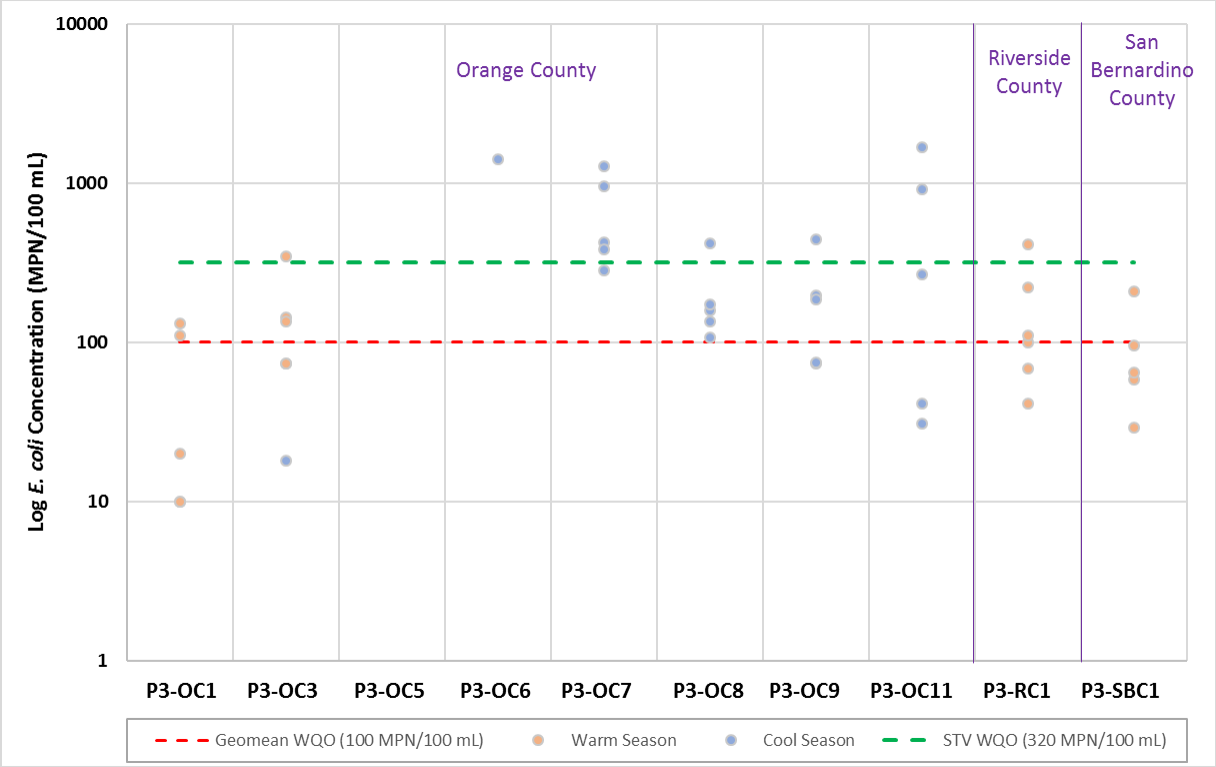

Figure 4-44
Distribution of *E. coli* Concentrations at Priority 3 Sites

Figure 4-45 and Table 4-9 summarize the distribution of historical *E. coli* concentrations from waterbodies monitored under Priority 3 of the RMP. These historical data were used as part of the 303(d) listing process for Priority 3 sites.[24] Note that the historical data are not collected from the same sites as Priority 3 sites in this RMP and that the data reflect results from samples collected from multiple sites within the waterbody. Historical *E. coli* data were not available for Los Trancos Creek and are not included in Figure 4-45 and Table 4-8. When compared with 2018 dry weather data, key observations include:

- Borrego Creek (P3-OC2) was dry in 2018; historical data show a three-order magnitude range of *E. coli* concentrations.
- Dry weather *E. coli* geomeans from 2018 are more than an order of magnitude lower than the upper range of historical data at all sites.
- Dry weather *E. coli* geomeans from 2018 are generally similar to geomeans from 2016 and 2017. While the 2017 geomeans at Bolsa Chica Channel and Serrano Creek were notably higher than geomeans in 2016, the 2018 geomeans are lower and similar to 2016 geomeans.

[24] https://www.waterboards.ca.gov/water_issues/programs/tmdl/2014_16state_ir_reports/category5_report.shtml

- The 2018 geomean at Morning Canyon Creek is notably higher than 2016 and 2017 geomeans at that site. However, this geomean is calculated based on 5 samples over a period of 7 weeks overlapping the wet season.

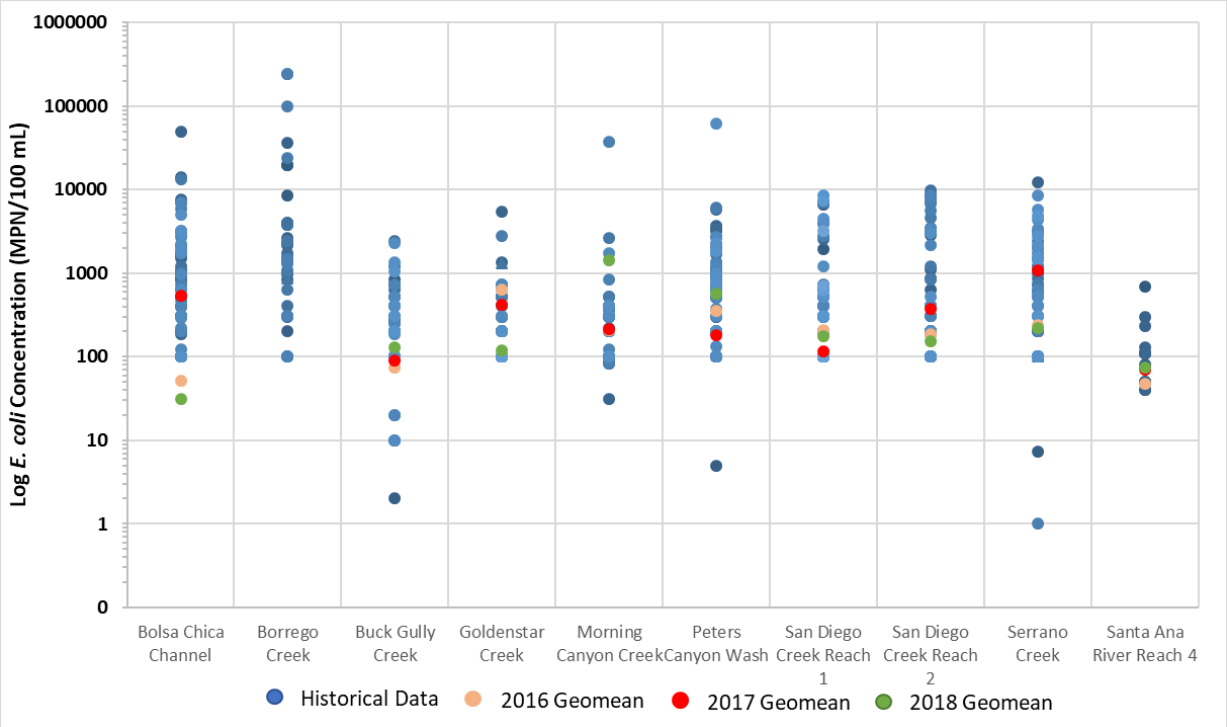

Figure 4-45
Distribution of Historical *E. coli* Concentrations at Priority 3 Waterbodies
Table 4-8 Summary of Historical *E. coli* Concentrations (MPN/100 mL) at Priority 3 Waterbodies

Waterbody	Range of Historical SSV *E. coli* Concentration[1]	Historical Sample Collection Period[3]	Historical Sample Size	Geomean[2]		
				2016	2017	2018
Bolsa Chica Channel	100 – 48,840	03/2004 – 03/2006	65	51	534	31
Borrego Creek	BDL to 241,920	03/2004 – 03/2006	43	Dry	Dry	dry
Buck Gully Creek	2 – 2,427	03/2004 – 04/2006	68	74	89	130
Morning Canyon Creek	31 – 37,840	03/2004 – 04/2006	61	633	212	1414 [4]
Peters Canyon Wash	BDL – 61,310	03/2004 – 03/2006	66	206	183	562
San Diego Creek Reach 1	10 – 8,420	10/2002 – 06/2004	84	349	116	176
San Diego Creek Reach 2	100 – 9,880	10/2002 – 06/2004	64	208	373	155
Serrano Creek	BDL – 12,230	03/2004 – 03/2006	69	121	1,080	221
Goldenstar Creek	BDL – 5,480	10/2002 – 06/2004	79	242	417	118
Santa Ana River Reach 4	7 – 700	10/2011 – 08/2018	14	48	70	74

[1] Historical refers to pre-2016 data collected before the RMP (SSV: single sample value)
[2] Samples used to calculate the geomean are from 5 consecutive weeks monitored during the dry season and are collected from sites that are different than the historical sites
[3] Sample size and range of concentrations from 'historical monitoring' served as the basis for original impairment decisions, which included samples collected year-round and from multiple stations in the same waterbody. No geomean is calculated from the historical data set for comparison with RMP data since the frequency and locations of

data are not the same
[4] The 2018 Morning Canyon Creek geomean is based on 6 samples collected over 7 weeks

Results of the *E. coli* geomeans were compared to the Statewide Bacteria Provision geomean WQO of 100 organisms/100 mL for a 5-sample/6-week geomean, described in Section 1.2.1, to assess whether the WQO were attained at these sites. Geometric means were calculated only when at least five sample results were available from the 6-week period. As each site was limited to five samples, WQO attainment is assessed based on only one geomean. Seven out of eleven Priority 3 sites did not meet the WQO (Table 4-8).

Table 4-9 *E. coli* Geometric Means for Priority 3 Sites

Site ID	Site	2016 Geometric Mean (MPN/100 mL)[1]	2017 Geometric Mean (MPN/100 mL)[1]	2018 Geometric Mean (MPN/100 mL)[1]	2018 WQO Attainment?
P3-OC1	Bolsa Chica Channel	51	534	31	Yes
P3-OC2	Borrego Creek	Dry	Dry	NA (dry)	Yes
P3-OC3	Buck Gully Creek	74	89	130	No
P3-OC5	Los Trancos Creek	457	658	NA (dry)	Yes
P3-OC6	Morning Canyon Creek	633	212	NA [2]	NA
P3-OC7	Peters Canyon Wash	206	183	562	No
P3-OC8	San Diego Creek Reach 1	349	116	176	No
P3-OC9	San Diego Creek Reach 2	208	373	155	No
P3-OC11	Serrano Creek	121	1080	221	No
P3-RC1	Goldenstar Creek	242	417	118	No
P3-SBC1	Santa Ana River Reach 4	48	70	74	Yes

[1] Samples used to calculate the geomean are from 5 consecutive weeks during the dry season and are different 5-week periods each year
[2] The 2018 Morning Canyon Creek samples were collected over 7 weeks and not the required 6-week period

4.3.2.1 Conductivity Analysis

The Statewide Bacteria Provisions uses salinity to indicate the appropriate indicator bacteria for a waterbody, as described in Section 1.1.2. A review of the conductivity results collected from 2016 to 2018, converted to salinity, suggests that Enterococci may be the more appropriate indicator bacteria at many of the Priority 3 sites (Figure 4-46). At all Priority 3 sites except Borrego Creek (dry) and SAR Reach 4, at least 70 percent of the measured conductivities suggest greater than the 1 ppth salinity threshold. This suggests that Enterococci should also be analyzed at these sites.

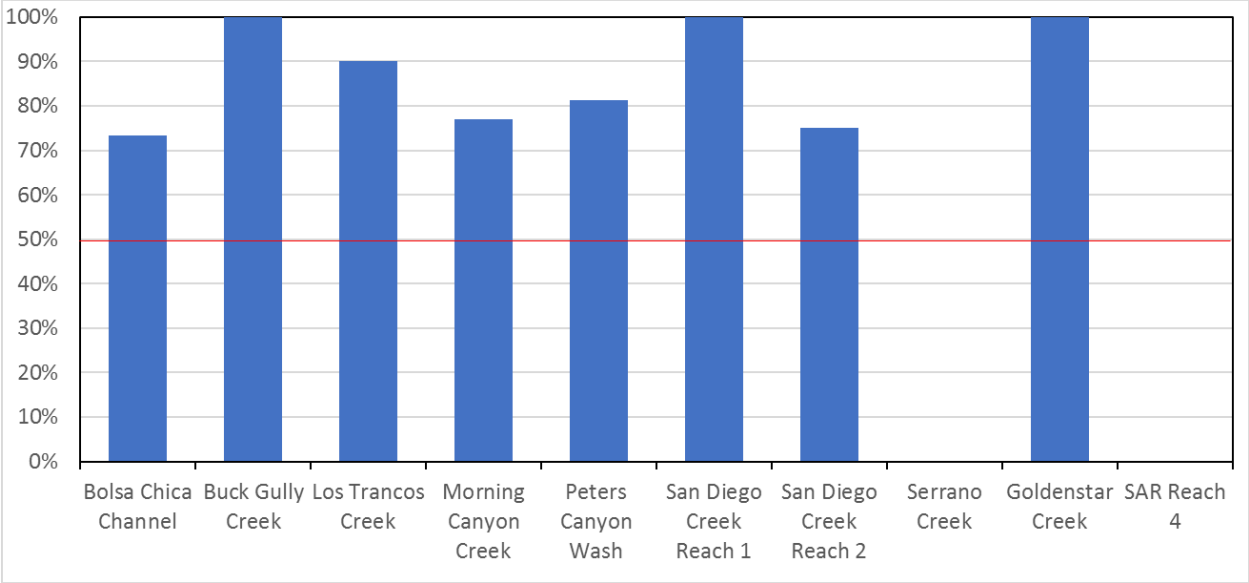

Figure 4-46 Fraction of 2016-2018 Measurements Greater than 1 ppth Salinity

4.4 Priority 4

4.4.1 Water Quality Observations

Each Priority 4 site (Table 4-10) is sampled once each year to evaluate compliance with the antidegradation target established for each waterbody. Table 4-12 summarizes the water quality observations from each site in 2018.

Table 4-11 Priority 4 Monitoring Sites

Site ID	Site Description	County
P4-RC1	Temescal Creek at Lincoln Avenue	Riverside
P4-OC1	Santa Ana Delhi Channel Upstream of Irvine Avenue	Orange
P4-OC2	Santa Ana Delhi Channel in Tidal Prism	Orange
P4-OC3	Greenville-Banning Channel in Tidal Prism	Orange
P4-SBC1	Cucamonga Creek at Hellman Avenue	San Bernardino

Table 4-12 Summary of Water Quality Data Collected from Priority 4 Sites

Parameter	Santa Ana Delhi Channel (P4-OC1)	Santa Ana Delhi Channel in Tidal Prism (P4-OC2)	Greenville-Banning Channel (P4-OC3)	Temescal Creek at Lincoln Avenue (P4-RC2)	Cucamonga Creek at Hellman Avenue (P4-SBC1)
Sample Date	9/13/2018	9/13/2018	9/13/2018	6/21/2018	6/21/2018
pH	8.3	7.8	7.8	8.5	8.2
Water Temperature (°C)	24.3	26.0	25.0	23.8	18.1
Dissolved Oxygen (mg/L)	12.2	4.0	0.2	5.2	9.6
Conductivity (µS/cm)	1483	47128	49238	1297	833
Turbidity (NTU)	1.9	NA	4.1	2.8	2.9
TSS (mg/L)	5	10	10	39 [1]	2 [1]
Flow (cfs)	1.6	NA	0	1.7	1.1

[1] EPA hold time exceeded

4.4.2 Bacteria Characterization

Priority 4 water quality sample results were compared to site-specific single sample antidegradation targets (Figure 4-47, Table 4-13). For all sites, indicator bacteria results did not exceed the antidegradation target and monitoring at these sites was considered complete for the monitoring year.

Table 4-13 Antidegradation Targets for Priority 4 Sites

Site ID	Site Description	Single Sample Antidegradation Target	Sample Date	Sample Result
P4-OC1	Santa Ana Delhi Channel Upstream of Irvine Avenue	*E. coli*: 1,067 MPN/100 mL	9/13/2018	252
P4-OC2	Santa Ana Delhi Channel in Tidal Prism	Enterococci: 464 MPN/100 mL	9/13/2018	5
P4-OC3	Greenville-Banning Channel in Tidal Prism	Enterococci: 64 MPN/100 mL	9/13/2018	BDL
P4-RC2	Temescal Creek at Lincoln Avenue	*E. coli*: 725 MPN/100 mL	6/21/2018	240
P4-SBC1	Cucamonga Creek at Hellman Avenue	*E. coli*: 1,385 MPN/100 mL	6/21/2018	330

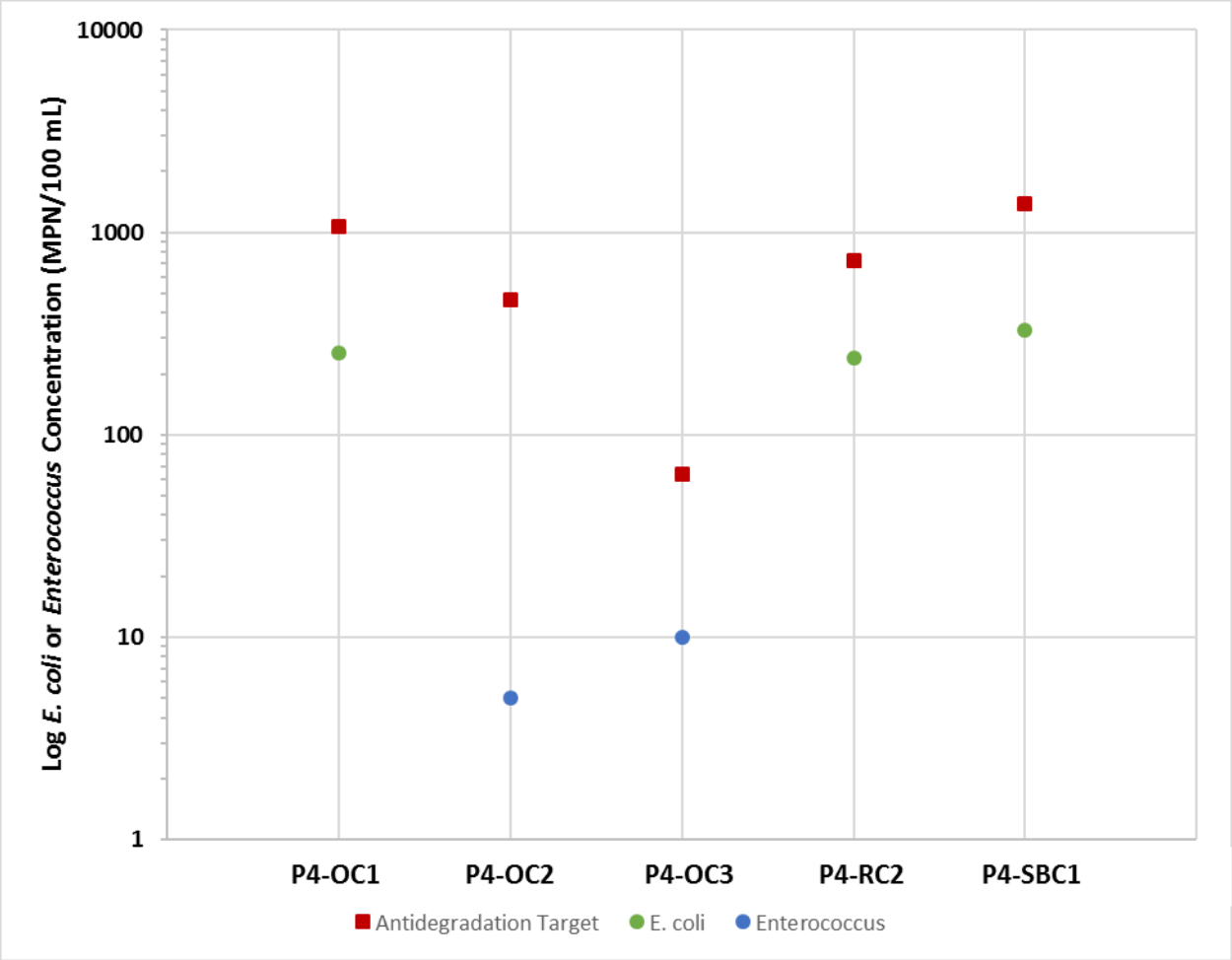

Figure 4-47
Monitoring Results and Antidegradation Targets for Priority 4 Sites

4.5 Correlation Analysis

Table 4-14 summarizes the results of correlation analyses between *E. coli* and field parameters for all 2018 dry weather samples. For this dataset the only correlation observed was a weak positive correlation between pH and *E. coli* concentrations. Table 4-15 summarizes the results of correlation analyses between *E. coli* and field parameters from all samples collected from the 2018-2019 storm event. Based on all samples including storm samples, *E. coli* concentrations were not significantly correlated with any of the tested variables and are consistent with the results presented in the 2017-2018 annual monitoring report. This analysis will continue to be completed in future iterations of the annual monitoring report to assess what relationships, if any, are consistently seen over time.

Table 4-14 Correlation Analysis Between *E. coli* and Field Parameters for 2018 Dry Weather Samples

Data Subset/Comparison	Pearson's r coefficient	Degrees of freedom (n-2)	Student t-statistic	p-value	Significant?[1]
Conductivity	-0.01	318	-0.12643	0.8995	No
Dissolved Oxygen	-0.07	318	-1.29907	0.1949	No
pH	-0.20	318	-3.63500	0.0003	Yes+
Total Suspended Solids	-0.03	318	-0.47875	0.6324	No
Temperature	-0.07	318	-1.23435	0.2180	No
Turbidity	-0.02	318	-0.39386	0.6939	No

[1]Significance determined by a p-value less than 0.05

Table 4-15 Correlation Analysis Between *E. coli* and Field Parameters for 2018-2019 Wet Weather Samples

Data Subset/Comparison	Pearson's r coefficient	Degrees of freedom (n-2)	Student t-statistic	p-value	Significant?[1]
Conductivity	0.06	18	0.26	0.7943	No
Dissolved Oxygen	-0.03	18	-0.14	0.8908	No
pH	0.28	18	1.22	0.2391	No
Total Suspended Solids	-0.13	18	-0.57	0.5727	No
Temperature	-0.14	18	-0.60	0.5558	No
Turbidity	-0.10	18	-0.42	0.6787	No

[1] Significance determined by a p-value less than 0.05

4.6 Summary

Key findings from the 2018-2019 monitoring year are summarized as follows:

- Priority 1: Priority 1 sites, except the two SAR sites with dual designations, were 100 percent compliant with the Statewide Bacteria Provisions geomean WQO of 100 MPN/100 mL. For the SAR sites, 100 percent and 94 percent of the geomeans from SAR at MWD Crossing and SAR at Pedley Avenue, respectively, exceeded the geomean WQO. Additionally, the STV WQO was exceeded by more than 10 percent of samples during the month of July at SAR at MWD Crossing and during the months of May through August at SAR at Pedley Avenue.

- Priority 2: *E. coli* geomean concentrations at the Priority 2 sites frequently exceeded the MSAR Bacteria TMDL geomean numeric target of 113 MPN/100 mL. Generally, geomeans were within the range observed in prior years. However, geomeans at Mill-Cucamonga Creek below the wetlands have shown consistent improvement each year since 2016. 2018 geomeans at Prado Park Lake also met the TMDL geomean target but this excludes five geomeans due to insufficient samples required to calculate the geomean.

- Priority 3: One geomean was calculated for each of the Priority 3 sites during the dry season. The geomean of samples collected at six (out of 11) sites were above the Statewide Bacteria Provisions geomean WQO of 100 MPN/100 mL. For the 2018 dry season, Borrego Creek (P3-OC2) was dry during all monitoring events so no data were collected. Los

Trancos Creek was dry during all but one monitoring event. Samples from Morning Canyon Creek were collected over a 7-week period, which exceeds the 6-week requirement for geomean calculation. As such, geomean WQO attainment could not be assessed for this site. The STV WQO was met at Borrego Creek, Bolsa Chica Channel, and SAR Reach 4.

- Priority 4: Indicator bacteria concentrations from all Priority 4 met the site-specific antidegradation targets.

Section 5
Recommendations for 2019-2020

This section describes recommended updates to the Monitoring Plan for the 2019-2020 monitoring year.

- To streamline monitoring efficiency between this RMP and existing monitoring programs conducted by OCPW, several Priority 3 sites can be removed from the RMP. This includes Bolsa Chica Channel (P3-OC1), Buck Gully Creek (P3-OC3), Peters Canyon Wash (P3-OC7), San Diego Creek Reach 1 (P3-OC8), and San Diego Creek Reach 2 (P3-OC9). The OCPW core monitoring programs collect a large volume of bacteria samples at these sites and analyze for Enterococci, which is the appropriate indicator bacteria based on salinity levels at these sites.
- Based on a review of conductivity measurements collected as part of the RMP from 2016 through 2018, several sites should use Enterococci as the appropriate indicator bacteria based on the Statewide Bacteria Provisions salinity threshold of 1 ppth. For sites where 50 percent or more of the measurements exceed the 1 ppth salinity threshold, bacteria samples should be analyzed for both *E. coli* and Enterococci. After streamlining sites mentioned above, this would include Lake Elsinore (P1-2), Los Trancos Creek (P3-OC5), Morning Canyon Creek (P3-OC6), and Goldenstar Creek (P3-RC1).
- To develop an updated dataset to support potential delisting as well as characterize a site with non-MS4 inputs to support TMDL revision, monitoring at SAR Reach 4 (P3-SBC1) should be increased to weekly during the dry season to obtain a minimum of 26 geomeans.
- Sites newly listed in the 2014/16 303(d) List of Impaired Waters should be added to the RMP. This includes Warm Creek and San Timoteo Creek Reaches 1A, 2, and 3.

These proposed changes have been included in the 2019 Draft Monitoring Plan and QAPP (Versions 2.0) and submitted for review.

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Appendix A
Data Summary

Tables A-1 through A-34 summarize the water quality results obtained for *E. coli*, TSS, and field measurements from Priority 1, Priority 2, and Priority 3 sites during 2018 dry weather sampling activities and 2018-2019 storm event. Data from Priority 4 sites are included in Section 4.4 and are not reproduced in this appendix. Tables A-35 through A-37 summarize the daily mean flow measured at key USGS gages in the SAR watershed.

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Table A-1. *E. coli* (MPN/100 mL) concentrations observed at Priority 1 lake sites during the 2018 dry season (geometric mean based on previous five weekly samples; if reported value has a < or > qualifier, the actual value was used to calculate the geomean; BDL: below detection limit)

Week Beginning Date	Canyon Lake (P1-1)		Lake Elsinore (P1-2)		Lake Perris (P1-3)		Big Bear Lake (P1-4)	
	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomeans
5/6/2018	3.1	--	70	--	55	--	4.1	--
5/13/2018	1	--	20	--	5.2	--	BDL	--
5/20/2018	BDL	--	2	--	16	--	3.1	--
527/2018	2	--	BDL	--	11	--	11	--
6/3/2018	2	--	BDL	--	34	--	BDL	--
6/10/2018	5.2	1.8	2	3.3	3.1	13	BDL	1.6
6/17/2018	3	1.8	1	1.6	3.1	8.2	BDL	1.1
6/24/2018	3.1	2.1	BDL	0.9	17	10.0	BDL	1.1
7/1/2018	1	2.4	260	2.0	8.6	9.0	BDL	0.8
7/8/2018	3	2.6	5.2	3.0	9.7	8.8	BDL	0.5
7/15/2018	BDL	2.0	1	3.3	1	4.9	BDL	0.5
7/22/018	BDL	1.4	BDL	2.6	36	7.4	BDL	0.5
7/29/2018	6.3	1.6	2	3.0	19	9.9	BDL	0.5
8/5/2018	1	1.3	3	4.0	1	6.2	4.1	0.7
8/12/2018	BDL	1.2	14	2.5	8.6	6.2	1	0.8
8/19/2018	BDL	0.9	3.1	2.3	1	4.2	BDL	0.8
8/26/2018	2	1.1	20	3.7	7.4	5.9	1	0.9
9/2/2018	BDL	1.1	2	4.7	1.1	3.3	BDL	0.9
9/9/2018	BDL	0.7	11	6.2	11	3.0	BDL	0.9
9/16/2018	4.1	0.9	2	5.8	BDL	2.7	1	0.7
10/28/2018	9	--	16	--	10	--	280	--
11/5/2018	2	--	8.4	--	11	--	26	--
11/11/2018	2	--	14	--	9.7	--	9.8	--
11/18/2018	15	--	34	--	14	--	7.4	--
11/25/2018	19	6.3	12	15	39	14	2	16

Table A-2. *E. coli* (MPN/100 mL) concentrations observed at Priority 1 stream sites during the 2018 dry season (geometric mean based on previous five weekly samples; if reported value has a < or > qualifier, the actual value was used to calculate the geomean; BDL = below detection limit)

Week Beginning Date	Mill Creek Reach 2 (P1-5)		Lytle Creek (P1-6)		SAR @ MWD Crossing (WW-S1)		SAR @ Pedley Avenue (WW-S4)	
	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomean
5/6/2018	3.1	--	2	--	610	--	41	--
5/13/2018	3.1	--	45	--	160	--	140	--
5/20/2018	1	--	11	--	330	--	86	--
527/2018	1	--	100	--	320	--	140	--
6/3/2018	7.4	--	17	--	170	--	170	--
6/10/2018	4.1	2.6	6.3	15	480	307	150	110
6/17/2018	BDL	1.9	3.1	16	270	268	86	124
6/24/2018	1	1.6	20	14	270	293	60	108
7/1/2018	6.2	2.1	56	18	390	301	110	112
7/8/2018	82	4.4	16 [1]	13	260	291	110	108
7/15/2018	9.8	4.7	5.2	11	370	331	150	106
7/22/018	BDL	3.3	17	13	200	286	120	102
7/29/2018	37	6.7	17	17	1200	367	380	131
8/5/2018	22	11	50	20	340	381	160	154
8/12/2018	44	16	23	17	230	349	74	144
8/19/2018	17	12	26	19	410	376	85	138
8/26/2018	7.4	11	26	25	180	334	150	138
9/2/2018	71	26	110	34	230	342	140	142
9/9/2018	9.7	21	82	44	160	244	140	120
9/16/2018	6.3	17	34	41	260	234	130	116
10/28/2018	1	--	36	--	190	--	120	--
11/5/2018	BDL	--	16	--	200	--	85	--
11/11/2018	BDL	--	34	--	160	--	150	--
11/18/2018	BDL	--	34	--	84	--	63	--
11/25/2018	BDL	0.6	43	31	190	158	63	91

[1] EPA hold time exceeded

Table A-3. *E. coli* (MPN/100 mL) concentrations observed at Priority 2 sites during the 2018 dry season (geometric mean based on previous five weekly samples; if reported value has a < or > qualifier, the actual value was used to calculate the geomean)

Week Beginning Date	Prado Park Lake Outlet (WW-C3)		Chino Creek @ Central Avenue (WW-C7)		Mill-Cucamonga Creek Below Wetlands (WW-M6)		SAR @ MWD Crossing (WW-S1)		SAR @ Pedley Avenue (WW-S4)	
	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomean
5/6/2018	250	--	1300	--	75	--	610	--	41	--
5/13/2018	52	--	160	--	150	--	160	--	140	--
5/20/2018	210	--	300	--	420	--	330	--	86	--
527/2018	4900	--	1900	--	210	--	320	--	140	--
6/3/2018	Dry	340	310	516	180	178	170	281	170	103
6/10/2018	63	241	150	335	120	196	480	268	150	134
6/17/2018	160	319	310	383	120	187	270	297	86	121
6/24/2018	41	212	290	380	310	176	270	286	60	113
7/1/2018	580	124	2100	388	260	184	390	297	110	108
7/8/2018	31	94	500	427	230	193	260	324	110	99
7/15/2018	97	103	1900	709	140	199	370	307	150	99
7/22/018	85	91	620	815	75	181	200	289	120	105
7/29/2018	20 [1]	78	690 [1]	969	710	214	1200	390	380	153
8/5/2018	150	60	840	807	180	199	340	379	160	164
8/12/2018	31	60	270	713	75	159	230	370	74	152
8/19/2018	31	48	140	423	260	180	410	378	85	136
8/26/2018	52	43	290	364	63	173	180	370	150	142
9/2/2018	31	47	200	284	110	119	230	266	140	116
9/9/2018	10	27	41	155	210	123	160	229	140	113
9/16/2018	74	33	52	112	170	145	260	234	130	127
10/28/2018	20	--	370	--	170	--	190	--	120	--
11/5/2018	98	--	120	--	110	--	200	--	85	--
11/11/2018	710	--	140	--	300	--	160	--	150	--
11/18/2018	85	--	380	--	150	--	84	--	63	--
11/25/2018	10	65	240	224	390	201	190	158	63	91

[1] EPA hold time exceeded

Table A-4. *E. coli* (MPN/100 mL) concentrations observed at Priority 3 Orange County sites during the 2018 dry season (geometric mean based on previous five weekly samples ["SSV"]; if reported value has a < or > qualifier, the actual value was used to calculate the geomean ["GM"]) (Note: Borrego Creek was dry during all sample events)

Week Beginning Date	Bolsa Chica Channel (P3-OC1)		Buck Gully Creek (P3-OC3)		Los Trancos Creek (P3-OC5)		Morning Canyon Creek (P3-OC6)		Peters Canyon Wash (P3-OC7)		San Diego Creek Reach 1 (P3-OC8)		San Diego Creek Reach 2 (P3-OC9)		Serrano Creek (P3-OC11)	
	SSV	GM	SSV	GM	SSV	GM	SSV	GM	SSV	GM	SSV	GM	SSV	GM	SSV	GM
5/6/2018	--	--	144	--	--	--	--	--	--	--	--	--	--	--	--	--
5/13/2018	--	--	345	--	--	--	--	--	--	--	--	--	--	--	--	--
5/20/2018	--	--	135	--	--	--	--	--	--	--	--	--	--	--	--	--
527/2018	--	--	74	--	--	--	--	--	--	--	--	--	--	--	--	--
6/3/2018	--	--	74	130	--	--	--	--	--	--	--	--	--	--	--	--
8/19/2018	20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
8/26/2018	10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9/2/2018	132	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9/9/2018	< 10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9/16/2018	110	41	--	--	--	--	--	--	--	--	--	--	--	--	--	--
10/28/2018	--	--	--	--	--	--	--	--	426	--	135	--	74	--	269	--
11/5/2018	--	--	--	--	--	--	--	--	281	--	158	--	75	--	31	--
11/11/2018	--	--	--	--	--	--	--	--	384	--	108	--	197	--	41	--
11/18/2018	--	--	--	--	--	--	--	--	1274	--	173	--	441	--	1674	--
11/25/2018	--	--	--	--	--	--	--	--	959	562	420	176	187	155	912	221
12/9/2018	--	--	28	--	Dry	--	> 2420	--	--	--	--	--	--	--	--	--
12/16/2018	--	--	13	--	Dry	--	> 2420	--	--	--	--	--	--	--	--	--
12/30/2018	--	--	9	--	Dry	--	2420	--	--	--	--	--	--	--	--	--
1/6/2019	--	--	22	--	NA	--	252	--	--	--	--	--	--	--	--	--
1/20/2019	--	--	18	--	Dry	--	1414	--	--	--	--	--	--	--	--	--
1/27/2019	--	--	49	18	Dry	NA	79	1414	--	--	--	--	--	--	--	--

Table A-5. *E. coli* (MPN/100 mL) concentrations observed at Priority 3 Riverside County and San Bernardino County sites during the 2018 dry season (geometric mean based on previous five weekly samples; if reported value has a < or > qualifier, the actual value was used to calculate the geomean)

Week Beginning Date	SAR Reach 4 (P3-SBC1)		Goldenstar Creek (P3-RC1)	
	Result	Geomeans	Result	Geomeans
6/10/2018	29	--	--	--
6/17/2018	96	--	--	--
6/24/2018	58	--	--	--
7/1/2018	210	--	--	--
7/8/2018	65	74	--	--
7/15/2018	--	--	68	--
7/22/018	--	--	220	--
7/29/2018	--	--	100	--
8/5/2018	--	--	410	--
8/12/2018	--	--	41	--
8/19/2018	--	--	110	118

Table A-6. Total suspended solids (mg/L) concentrations observed at Priority 1 sites during the 2018 dry season (BDL: below detection limit)

Week Beginning Date	Canyon Lake (P1-1)	Lake Elsinore (P1-2)	Lake Perris (P1-3)	Big Bear Lake (P1-4)	Mill Creek Reach 2 (P1-5)	Lytle Creek (P1-6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/6/2018	4	40	18	4	4	3	18	18
5/13/2018	8	65	40	2	BDL	BDL	11	12
5/20/2018	7	32	15	15	2	2	10	10
527/2018	10	48	6	210	6	4	10	9
6/3/2018	6	32	3	14	2	2	11	10
6/10/2018	7	34	BDL	12	BDL	BDL	5	6
6/17/2018	7 [1]	40 [1]	2 [1]	8	2	BDL	6	11
6/24/2018	7	29	3	6	BDL	BDL	8	8
7/1/2018	10	33	7	5	BDL	2	5	10
7/8/2018	9	30	3	8	32	BDL	4	8
7/15/2018	9	30	2	4	18	BDL	8	8
7/22/018	4	26	6	8	19	2	28	8
7/29/2018	6	21	2	14	130	BDL	9	7
8/5/2018	5 [1]	18 [1]	BDL [1]	12	22	BDL	10	9
8/12/2018	2	52	4	20	25	BDL	7	6
8/19/2018	3	37	2	22	20	BDL	17	4
8/26/2018	18	7200	BDL	710	41	BDL	5	2
9/2/2018	5	52	BDL	14	49	2	8	10
9/9/2018	2	66	4	26	9	2	6	6
9/16/2018	4	61	6	12	8	2	4	2
10/28/2018	5	32	2	30	2	BDL	8	5
11/5/2018	3	29	9	14	2	BDL	2	2
11/11/2018	4	58	13	47	BDL	BDL	2	2
11/18/2018	4	36	2	7	2	BDL	4	2
11/25/2018	4	24	9	6	20	BDL	27	6

[1] EPA hold time exceeded

Table A-7. Total suspended solids (mg/L) concentrations observed at Priority 2 sites during the 2018 dry season (BDL: below detection limit)

Week Beginning Date	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek Below Wetlands (WW-M6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/6/2018	21	2	BDL	8	9
5/13/2018	16	2	2	11	8
5/20/2018	10	BDL	BDL	8	4
5/27/2018	6	4	3	6	6
6/3/2018	Dry	4	4	4	14
6/10/2018	51	2	BDL	3	3
6/17/2018	12	4	BDL	4	4
6/24/2018	5	12	6	3	BDL
7/1/2018	14	BDL	2	6	4
7/8/2018	20	3	6	4	2
7/15/2018	16	10	2	8	8
7/22/2018	13	7	3	BDL	4
7/29/2018	30	6	6	6	10
8/5/2018	28	14	2	7	4
8/12/2018	11	2	4	5	4
8/19/2018	18	3	6	6	5
8/26/2018	43	2	BDL	8	6
9/2/2018	31	3	4	6	6
9/9/2018	22	BDL	7	6	2
9/16/2018	20	2	2	3	4
10/28/2018	36	3	2	4	4
11/5/2018	14	BDL	2	4	6
11/11/2018	28	BDL	BDL	2	2
11/18/2018	18	BDL	4	4	6
11/25/2018	18	2	BDL	4	4

Table A-7. Total suspended solids (mg/L) concentrations observed at Priority 3 sites in Orange County during the 2018 dry season (Note: Borrego Creek was dry during all sample events)

Week Beginning Date	Bolsa Chica Channel (P3-OC1)	Borrego Creek (P3-OC2)	Buck Gully Creek (P3-OC3)	Los Trancos Creek (P3-OC5)	Morning Canyon Creek (P3-OC6)	Peters Canyon Wash (P3-OC7)	San Diego Creek Reach 1 (P3-OC8)	San Diego Creek Reach 1 (P3-OC9)	Serrano Creek (P3-OC11)
5/6/2018	--	--	ND	--	--	--	--	--	--
5/13/2018	--	--	ND	--	--	--	--	--	--
5/20/2018	--	--	5	--	--	--	--	--	--
5/27/2018	--	--	ND	--	--	--	--	--	--
6/3/2018	--	--	7	--	--	--	--	--	--
8/19/2018	70	--	--	--	--	--	--	--	--
8/26/2018	BDL	--	--	--	--	--	--	--	--
9/2/2018	7	--	--	--	--	--	--	--	--
9/9/2018	BDL	--	--	--	--	--	--	--	--
9/16/2018	5	--	--	--	--	--	--	--	--
10/28/2018	--	--	--	--	--	4.6	12.3	1.5	5.7
11/4/2018	--	--	--	--	--	7.8	5.6	1.6	1.4
11/11/2018	--	--	--	--	--	10.6	14.3	3.1	19.2
11/18/2018	--	--	--	--	--	17.9	16.8	4.4	1.9
11/25/2018	--	--	--	--	--	9.4	23	1.7	1.2
12/9/2018	--	--	9	Dry	10	--	--	--	--
12/16/2018	--	--	BDL	Dry	BDL	--	--	--	--
12/30/2018	--	--	9	Dry	13	--	--	--	--
1/6/2019	--	--	BDL	NA	7	--	--	--	--
1/20/2019	--	--	5	Dry	7	--	--	--	--
1/27/2019	--	--	23	Dry	18	--	--	--	--

Table A-9. Total suspended solids (mg/L) concentrations observed at Priority 3 sites in Riverside County and San Bernardino County during the 2018 dry season

Week Beginning Date	SAR Reach 4 (P3-SBC1)	Goldenstar Creek (P3-RC1)
5/6/2018		
5/13/2018		
5/20/2018		
5/27/2018		
6/3/2018		
6/10/2018	2	
6/17/2018	5 [1]	
6/24/2018	2	
7/1/2018	2	
7/8/2018	2	
7/15/2018		BDL
7/22/2018		BDL
7/29/2018		6
8/5/2018		BDL [1]
8/12/2018		BDL
8/19/2018		2
8/26/2018		
9/2/2018		
9/9/2018		
9/16/2018		

[1] EPA hold time exceeded

Table A-10. Dissolved oxygen (mg/L) concentrations observed at Priority 1 sites during the 2018 dry season

Week Beginning Date	Canyon Lake (P1-1)	Lake Elsinore (P1-2)	Lake Perris (P1-3)	Big Bear Lake (P1-4)	Mill Creek Reach 2 (P1-5)	Lytle Creek (P1-6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/6/2018	10.3	8.2	10.7	8.2	7.8	9.4	8.2	8.3
5/13/2018	10.6	6.8	9.6	8.7	8.7	9.6	8.8	8.7
5/20/2018	10.0	7.7	9.7	8.1	8.0	9.5	8.6	8.5
5/27/2018	9.6	4.4	8.9	6.5	8.1	9.5	8.5	8.4
6/3/2018	9.6	7.0	9.0	18.0	7.6	9.4	8.2	8.1
6/10/2018	9.3	6.9	8.5	16.1	7.4	9.2	8.0	7.9
6/17/2018	9.8	8.4	8.6	9.8	8.4	9.5	8.3	8.1
6/24/2018	10.5	3.5	9.0	12.8	7.5	9.4	7.8	7.6
7/1/2018	9.2	5.6	9.0	11.4	7.6	9.2	8.1	8.0
7/8/2018	9.3	7.0	8.7	13.4	8.3	9.4	7.5	7.2
7/15/2018	9.1	4.2	7.8	8.7	7.6	9.3	8.1	7.8
7/22/2018	9.9	9.6	8.4	14.5	7.1	9.2	7.7	7.4
7/29/2018	7.7	4.4	8.5	8.1	7.6	9.4	7.9	7.5
8/5/2018	6.4	1.6	8.0	5.7	7.7	9.3	8.2	7.9
8/12/2018	6.2	9.1	7.5	13.7	7.1	9.1	7.9	7.6
8/19/2018	6.5	5.6	7.6	11.8	7.3	9.2	7.8	7.7
8/26/2018	6.4	10.8	7.8	13.0	7.7	9.2	7.8	7.5
9/2/2018	7.0	5.7	7.1	10.7	7.6	9.3	8.0	7.8
9/9/2018	6.0	6.1	7.8	11.1	7.8	9.4	8.0	7.9
9/16/2018	7.2	6.0	7.7	11.8	7.9	9.5	8.3	8.0
10/28/2018	6.4	4.2	7.4	5.1	9.2	9.3	8.3	8.4
11/5/2018	8.3	6.0	8.1	7.2	8.4	9.3	8.0	8.0
11/11/2018	3.3	10.6	8.7	9.1	9.2	9.7	8.3	8.4
11/18/2018	2.1	10.7	8.2	8.9	9.4	9.7	8.6	8.7
11/25/2018	2.0	9.3	9.3	9.9	9.0	9.9	8.5	8.6

Table A-11. Dissolved oxygen (mg/L) concentrations observed at Priority 2 sites during the 2018 dry season

Week Beginning Date	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek Below Wetlands (WW-M6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/7/2017	Dry	7.3	7.1	8.1	8.1
5/14/2017	Dry	7.3	6.8	8.0	8.0
5/21/2017	Dry	6.3	7.1	8.6	8.3
5/28/2017	Dry	4.9	6.6	8.6	8.3
6/4/2017	Dry	5.3	6.6	8.5	8.2
6/11/2017	Dry	6.2	7.2	8.4	8.1
6/18/2017	Dry	4.8	6.5	7.5	7.0
6/25/2017	Dry	6.5	7.3	8.3	8.1
7/2/2017	Dry	7.2	7.9	9.4	9.1
7/9/2017	Dry	5.0	6.1	7.8	7.6
7/16/2017	Dry	4.7	7.2	7.9	7.5
7/23/2017	Dry	6.1	6.7	8.1	7.9
7/30/2017	Dry	NA	NA	7.4	7.3
8/6/2017	Dry	3.9	6.3	8.1	7.7
8/13/2017	Dry	3.9	6.8	8.1	7.9
8/20/2017	Dry	3.6	6.6	8.1	7.9
8/27/2017	Dry	3.4	6.2	8.0	7.6
9/3/2017	Dry	2.4	5.3	8.0	7.7
9/10/2017	8.8	4.9	7.6	8.1	7.7
9/17/2017	7.1	3.0	6.4	8.2	8.1
10/29/2017	7.3	6.5	7.0	8.2	8.2
11/6/2017	8.3	7.2	7.9	8.6	8.4
11/12/2017	9.5	7.4	8.2	8.7	8.6
11/19/2017	9.6	7.8	8.0	9.0	8.8
11/26/2017	10.3	8.3	8.8	8.8	8.8

Table A-12. Dissolved oxygen (mg/L) concentrations observed at Priority 3 sites in Orange County during the 2018 dry season (Note: Borrego Creek was dry during all sample events)

Week Beginning Date	Bolsa Chica Channel (P3-OC1)	Buck Gully Creek (P3-OC3)	Los Trancos Creek (P3-OC5)	Morning Canyon Creek (P3-OC6)	Peters Canyon Wash (P3-OC7)	San Diego Creek Reach 1 (P3-OC8)	San Diego Creek Reach 2 (P3-OC9)	Serrano Creek (P3-OC11)
5/6/2018	--	8.6	--	--	--	--	--	--
5/13/2018	--	8.1	--	--	--	--	--	--
5/20/2018	--	7.0	--	--	--	--	--	--
5/27/2018	--	8.0	--	--	--	--	--	--
6/3/2018	--	8.1	--	--	--	--	--	--
8/19/2018	18.0	--	--	--	--	--	--	--
8/26/2018	18.8	--	--	--	--	--	--	--
9/2/2018	2.8	--	--	--	--	--	--	--
9/9/2018	5.6	--	--	--	--	--	--	--
9/16/2018	5.6	--	--	--	--	--	--	--
10/28/2018	--	--	--	--	9.1	6.2	15.7	14.7
11/4/2018	--	--	--	--	12.2	6.0	17.3	8.6
11/11/2018	--	--	--	--	12.8	8.8	16.6	9.2
11/18/2018	--	--	--	--	10.1	13.6	15.9	11.1
11/25/2018	--	--	--	--	11.5	9.6	15.3	11.0
12/9/2018	--	10.4	Dry	9.1	--	--	--	--
12/16/2018	--	11.2	Dry	8.2	--	--	--	--
12/30/2018	--	13.4	Dry	10.5	--	--	--	--
1/6/2019	--	11.2	NA	9.5	--	--	--	--
1/20/2019	--	10.9	Dry	10.6	--	--	--	--

Table A-13. Dissolved oxygen (mg/L) concentrations observed at Priority 3 sites in Riverside County and San Bernardino County during the 2018 dry season

Week Beginning Date	SAR Reach 4 (P3-SBC1)	Goldenstar Creek (P3-RC1)
6/10/2018	8.5	
6/17/2018	8.5	
6/24/2018	8.3	
7/1/2018	8.1	
7/8/2018	7.9	
7/15/2018		8.3
7/22/2018		8.1
7/29/2018		8.3
8/5/2018		8.4
8/12/2018		8.5
8/19/2018		8.4

Table A-14. pH (standard units) observed at Priority 1 sites during the 2018 dry season

Week Beginning Date	Canyon Lake (P1-1)	Lake Elsinore (P1-2)	Lake Perris (P1-3)	Big Bear Lake (P1-4)	Mill Creek Reach 2 (P1-5)	Lytle Creek (P1-6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/6/2018	8.7	8.7	9.2	8.5	8.4	8.1	8.2	8.1
5/13/2018	9.0	8.9	8.6	8.6	8.5	8.1	8.2	8.2
5/20/2018	9.4	9.1	9.9	9.0	8.5	8.3	8.5	8.5
5/27/2018	9.4	8.0	8.8	8.7	9.3	8.6	8.4	8.1
6/3/2018	8.6	8.6	8.5	9.6	8.8	8.1	8.1	8.0
6/10/2018	8.9	8.6	8.6	10.5	8.7	8.3	8.0	8.2
6/17/2018	8.9	8.5	8.5	8.8	8.8	8.1	8.0	8.1
6/24/2018	8.9	8.6	8.6	10.6	9.0	8.0	8.0	7.9
7/1/2018	8.8	8.6	8.7	10.4	8.8	8.0	8.1	8.1
7/8/2018	9.4	8.3	8.8	10.3	8.3	8.5	8.2	8.3
7/15/2018	8.9	8.7	8.7	9.8	8.6	8.3	8.3	8.3
7/22/2018	9.2	8.7	8.9	10.3	9.0	8.4	8.2	8.2
7/29/2018	8.8	8.6	8.5	9.4	8.5	8.3	8.0	8.1
8/5/2018	8.4	8.4	8.4	9.7	8.2	8.0	7.9	8.0
8/12/2018	8.5	8.8	8.4	9.9	8.0	8.3	8.1	8.1
8/19/2018	8.5	8.6	8.3	10.0	8.9	8.3	7.9	8.0
8/26/2018	8.1	9.0	8.4	10.0	8.4	8.2	8.3	8.1
9/2/2018	8.3	8.7	8.1	9.4	8.5	8.0	8.1	8.2
9/9/2018	8.2	8.6	8.3	9.1	8.3	8.4	7.9	8.1
9/16/2018	8.4	8.8	7.9	9.8	8.9	8.1	8.2	8.2
10/28/2018	7.9	8.9	8.0	8.7	8.4	8.4	8.1	8.2
11/5/2018	8.2	8.9	8.2	8.5	8.4	8.3	8.1	8.2
11/11/2018	9.0	11.2	8.9	9.8	8.9	9.7	8.1	8.3
11/18/2018	7.5	9.0	7.9	4.6	6.9	9.2	8.0	8.1
11/25/2018	7.5	9.0	8.2	8.7	8.4	8.4	8.1	8.3

Table A-15. pH (standard units) observed at Priority 2 sites during the 2018 dry season

Week Beginning Date	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek Below Wetlands (WW-M6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/6/2018	8.54	8.2	8.5	8.2	8.1
5/13/2018	7.76	7.6	7.8	8.2	8.2
5/20/2018	8.34	8.4	7.9	8.5	8.5
5/27/2018	7.86	7.5	8.1	8.4	8.1
6/3/2018	Dry	7.6	7.6	8.1	8.0
6/10/2018	9.27	7.3	7.9	8.0	8.2
6/17/2018	8.93	8.0	7.9	8.0	8.1
6/24/2018	9.22	7.4	8.4	8.0	7.9
7/1/2018	7.85	7.5	7.7	8.1	8.1
7/8/2018	9.06	7.6	7.9	8.2	8.3
7/15/2018	8.21	8.3	8.0	8.3	8.3
7/22/2018	9.07	7.9	8.3	8.2	8.2
7/29/2018	9.36	7.6	7.7	8.0	8.1
8/5/2018	9.08	7.6	7.7	7.9	8.0
8/12/2018	9.62	7.5	7.7	8.1	8.1
8/19/2018	9.23	7.6	8.0	7.9	8.0
8/26/2018	9.4	7.8	8.0	8.3	8.1
9/2/2018	9.56	7.5	7.9	8.1	8.2
9/9/2018	9.5	7.3	7.8	7.9	8.1
9/16/2018	9.1	7.6	8.7	8.2	8.2
10/28/2018	10.1	7.7	7.8	8.1	8.2
11/5/2018	9.8	7.7	7.7	8.1	8.2
11/11/2018	9.3	8.5	8.6	8.1	8.3
11/18/2018	9.6	7.7	7.7	8.0	8.1
11/25/2018	9.2	8.1	7.7	8.1	8.3

Table A-16. pH (standard units) observed at Priority 3 sites in Orange County during the 2018 dry season (Note: Borrego Creek was dry during all sample events)

Week Beginning Date	Bolsa Chica Channel (P3-OC1)	Buck Gully Creek (P3-OC3)	Los Trancos Creek (P3-OC5)	Morning Canyon Creek (P3-OC6)	Peters Canyon Wash (P3-OC7)	San Diego Creek Reach 1 (P3-OC8)	San Diego Creek Reach 2 (P3-OC9)	Serrano Creek (P3-OC11)
5/6/2018	--	7.9	--	--	--	--	--	--
5/13/2018	--	7.9	--	--	--	--	--	--
5/20/2018	--	7.4	--	--	--	--	--	--
5/27/2018	--	7.9	--	--	--	--	--	--
6/3/2018	--	7.9	--	--	--	--	--	--
8/19/2018	8.8	--	--	--	--	--	--	--
8/26/2018	8.7	--	--	--	--	--	--	--
9/2/2018	7.8	--	--	--	--	--	--	--
9/9/2018	8.1	--	--	--	--	--	--	--
9/16/2018	8.0	--	--	--	--	--	--	--
10/28/2018	--	--	--	--	8.0	8.0	8.1	10.0
11/4/2018	--	--	--	--	8.3	8.3	8.4	8.7
11/11/2018	--	--	--	--	8.1	8.3	8.3	8.7
11/18/2018	--	--	--	--	8.3	8.9	8.3	9.2
11/25/2018	--	--	--	--	8.3	8.8	8.5	9.3
12/9/2018	--	7.8	Dry	7.6	--	--	--	--
12/16/2018	--	7.7	Dry	7.4	--	--	--	--
12/30/2018	--	7.7	Dry	7.2	--	--	--	--
1/6/2019	--	7.8	NA	7.6	--	--	--	--
1/20/2019	--	7.8	Dry	7.5	--	--	--	--

Table A-17. pH (standard units) observed at Priority 3 sites in Riverside County and San Bernardino County during the 2018 dry season

Week Beginning Date	SAR Reach 4 (P3-SBC1)	Goldenstar Creek (P3-RC1)
6/10/2018	7.8	
6/17/2018	7.7	
6/24/2018	7.8	
7/1/2018	7.8	
7/8/2018	8.1	
7/15/2018		8.3
7/22/2018		8.3
7/29/2018		8.1
8/5/2018		7.9
8/12/2018		8.1
8/19/2018		8.0

Table A-18. Turbidity (NTU) observed at Priority 1 sites during the 2018 dry season

Week Beginning Date	Canyon Lake (P1-1)	Lake Elsinore (P1-2)	Lake Perris (P1-3)	Big Bear Lake (P1-4)	Mill Creek Reach 2 (P1-5)	Lytle Creek (P1-6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/6/2018	1.3	62	20.4	6.3	0.2	1.7	2.2	2.6
5/13/2018	2.1	56	5.7	6.0	2.2	0.8	2.3	2.3
5/20/2018	2.6	79	9.1	9	1.2	0.3	1.9	3.0
5/27/2018	3.0	38	4.2	32.6	2.0	0.4	3.0	3.3
6/3/2018	2.4	45	3.4	9	0.4	0.1	2.2	2.1
6/10/2018	2.7	48	0.2	5	1.4	0.2	2.3	1.8
6/17/2018	2.9	65	2.1	4.0	0.5	0.2	1.9	1.9
6/24/2018	3.8	41	0.9	6	0.2	0.2	2.0	1.8
7/1/2018	3.1	77	2.6	2.8	0.1	0.4	3.0	1.6
7/8/2018	4.0	31	1.9	3	17.5	0.1	2.0	1.7
7/15/2018	4.7	17	0.2	7	7	0.5	2.7	1.1
7/22/2018	3.6	30	1.9	11	3.9	0.4	1.7	1.1
7/29/2018	2.9	25	0.9	14	35.3	0.3	2.3	2.6
8/5/2018	1.8	30	0.4	6	6.7	0.2	3.0	1.8
8/12/2018	1.4	66	2.2	11	2.6	0.0	3.0	1.4
8/19/2018	1.1	48	0.9	9.0	6.6	0.1	2.1	1.7
8/26/2018	1.3	25510	1.8	83.8	4.3	0.1	1.8	1.6
9/2/2018	0.8	71	0.1	22.2	3.9	0.9	1.1	0.8
9/9/2018	1.0	144	2.3	39.3	1.5	0.1	1.2	0.5
9/16/2018	0.5	101	0.6	9	0.5	0.2	0.2	0.1
10/28/2018	2.7	48	0.9	23.3	1.6	0.3	2.8	3.3
11/5/2018	1.9	52	1.3	14.2	0.9	0.4	1.8	2.5
11/11/2018	0.6	52	5.1	3.3	0.1	0.0	0.3	0.6
11/18/2018	2.7	47	1.0	3	1.4	0.7	1.8	3.1
11/25/2018	2.7	31	3.8	4	6.3	0.8	3.5	2.6

Table A-19. Turbidity (NTU) observed at Priority 2 sites during the 2018 dry season

Week Beginning Date	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek Below Wetlands (WW-M6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/6/2018	12	0.5	1.0	2.2	2.6
5/13/2018	5.2	0.6	0.2	2.3	2.3
5/20/2018	6.3	0.9	1.0	1.9	3.0
5/27/2018	4.2	1.7	1.3	3.0	3.3
6/3/2018	Dry	1.6	1.2	2.2	2.1
6/10/2018	18	1.0	1.6	2.3	1.8
6/17/2018	10.1	1.6	0.8	1.9	1.9
6/24/2018	12.4	2.7	2.0	2.0	1.8
7/1/2018	6.8	1.7	1.6	3.0	1.6
7/8/2018	11.1	1.7	1.0	2.0	1.7
7/15/2018	8.9	4.8	0.4	2.7	1.1
7/22/2018	15.4	2.5	1.0	1.7	1.1
7/29/2018	32.8	2.3	2.2	2.3	2.6
8/5/2018	18.6	5.5	1.0	3.0	1.8
8/12/2018	17.2	1.9	1.4	3.0	1.4
8/19/2018	11.6	1.6	1.6	2.1	1.7
8/26/2018	43.4	1.1	0.5	1.8	1.6
9/2/2018	29.1	0.5	0.9	1.1	0.8
9/9/2018	13.5	1.0	1.5	1.2	0.5
9/16/2018	18.3	0.2	0.3	0.2	0.1
10/28/2018	53.2	2.8	1.2	2.8	3.3
11/5/2018	16.2	0.6	0.8	1.8	2.5
11/11/2018	9.0	0.1	0.1	0.3	0.6
11/18/2018	15.4	0.9	1.4	1.8	3.1
11/25/2018	10.2	1.4	1.9	3.5	2.6

Table A-20. Turbidity (NTU) observed at Priority 3 sites in Orange County during the 2018 dry season (Note: Borrego Creek was dry during all sample events)

Week Beginning Date	Bolsa Chica Channel (P3-OC1)	Buck Gully Creek (P3-OC3)	Los Trancos Creek (P3-OC5)	Morning Canyon Creek (P3-OC6)	Peters Canyon Wash (P3-OC7)	San Diego Creek Reach 1 (P3-OC8)	San Diego Creek Reach 2 (P3-OC9)	Serrano Creek (P3-OC11)
5/6/2018	--	1.9	--	--	--	--	--	--
5/13/2018	--	2.4	--	--	--	--	--	--
5/20/2018	--	1.6	--	--	--	--	--	--
5/27/2018	--	1.6	--	--	--	--	--	--
6/3/2018	--	2.0	--	--	--	--	--	--
8/19/2018	8.2	--	--	--	--	--	--	--
8/26/2018	13.1	--	--	--	--	--	--	--
9/2/2018	6.6	--	--	--	--	--	--	--
9/9/2018	18.4	--	--	--	--	--	--	--
9/16/2018	19.0	--	--	--	--	--	--	--
10/28/2018	--	--	--	--	1.2	10.7	1.1	3.5
11/4/2018	--	--	--	--	9.5	4.9	0.6	0.6
11/11/2018	--	--	--	--	10.0	7.6	0.9	5.4
11/18/2018	--	--	--	--	11.2	13.3	8.5	4.0
11/25/2018	--	--	--	--	8.5	20.1	2.2	3.8
12/9/2018	--	1.6	Dry	2.6	--	--	--	--
12/16/2018	--	1.4	Dry	2.2	--	--	--	--
12/30/2018	--	1.4	Dry	7.4	--	--	--	--
1/6/2019	--	1.6	NA	4.8	--	--	--	--
1/20/2019	--	2.1	Dry	1.7	--	--	--	--

Table A-21. Turbidity (NTU) observed at Priority 3 sites in Riverside County and San Bernardino County during the 2018 dry season

Week Beginning Date	SAR Reach 4 (P3-SBC1)	Goldenstar Creek (P3-RC1)
6/10/2018	0.1	
6/17/2018	0.4	
6/24/2018	0.4	
7/1/2018	0.4	
7/8/2018	0.4	
7/15/2018		0.2
7/22/2018		0.2
7/29/2018		0.9
8/5/2018		0.4
8/12/2018		0.1
8/19/2018		0.5

Table A-22. Water temperature (°C) concentrations observed at Priority 1 sites during the 2018 dry season

Week Beginning Date	Canyon Lake (P1-1)	Lake Elsinore (P1-2)	Lake Perris (P1-3)	Big Bear Lake (P1-4)	Mill Creek Reach 2 (P1-5)	Lytle Creek (P1-6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/6/2018	24.8	21.6	22.4	21.7	19.2	13.0	24.3	24.1
5/13/2018	21.3	20.4	18.5	15.3	14.3	13.0	20.1	20.6
5/20/2018	22.5	20.6	20.4	16.5	17.4	12.8	20.9	21.8
5/27/2018	22.4	21.2	19.4	18.4	17.7	13.5	20.3	21.3
6/3/2018	24.1	23.1	23.8	19.4	21.4	14.0	23.9	22.9
6/10/2018	25.9	23.8	26.3	22.8	22.2	16.6	25.1	25.3
6/17/2018	26.8	23.7	24.5	16.6	15.9	12.8	22.3	22.8
6/24/2018	26.6	24.6	25.7	22.5	21.3	13.5	26.3	26.8
7/1/2018	27.2	25.3	27.0	22.4	21.1	14.7	23.6	23.8
7/8/2018	27.2	26.8	25.4	21.1	17.0	14.0	27.4	30.0
7/15/2018	27.8	24.5	25.5	19.6	20.6	13.6	23.6	25.2
7/22/2018	32.0	30.0	29.2	24.1	24.4	14.2	27.6	28.8
7/29/2018	29.7	27.7	26.4	21.0	21.3	14.6	26.4	27.5
8/5/2018	28.7	26.9	26.9	17.4	20.1	13.4	23.0	24.0
8/12/2018	28.2	26.7	26.5	21.7	23.8	14.7	24.7	25.7
8/19/2018	28.0	26.0	26.2	20.7	22.8	14.1	25.1	26.6
8/26/2018	27.5	26.0	27.3	18.2	20.2	14.2	25.9	26.8
9/2/2018	26.5	24.6	25.1	17.8	21.5	14.6	23.6	24.5
9/9/2018	25.6	23.2	25.3	18.1	19.1	13.5	23.2	24.1
9/16/2018	25.2	23.0	25.4	15.8	18.6	12.5	22.2	23.6
10/28/2018	20.0	17.6	20.5	6.5	10.3	11.7	18.0	16.7
11/5/2018	19.7	18.3	20.4	12.3	14.6	13.0	20.2	20.8
11/11/2018	18.3	16.9	20.7	8.7	11.8	12.0	19.8	20.5
11/18/2018	16.1	14.6	14.6	5.9	10.3	11.6	18.6	19.4
11/25/2018	16.1	14.1	16.8	7.8	12.7	12.1	19.6	20.2

Table A-23. Water temperature (°C) concentrations observed at Priority 2 sites during the 2018 dry season

Week Beginning Date	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek Below Wetlands (WW-M6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/6/2018	22	19.7	18.7	24.3	24.1
5/13/2018	20.1	18.1	17.3	20.1	20.6
5/20/2018	20.8	16.5	18.4	20.9	21.8
5/27/2018	19.6	18.8	20.3	20.3	21.3
6/3/2018	Dry	19.5	21.1	23.9	22.9
6/10/2018	25.2	21.2	20.7	25.1	25.3
6/17/2018	23.1	19.4	19.3	22.3	22.8
6/24/2018	25.3	19.2	21.0	26.3	26.8
7/1/2018	21.5	20.9	21.5	23.6	23.8
7/8/2018	26	22.6	23.3	27.4	30.0
7/15/2018	25.9	19.8	22.1	23.6	25.2
7/22/2018	27.9	21.9	23.7	27.6	28.8
7/29/2018	27.2	21.6	23.6	26.4	27.5
8/5/2018	25.4	20.2	22.0	23.0	24.0
8/12/2018	26.2	21.9	22.8	24.7	25.7
8/19/2018	26.5	23.7	22.8	25.1	26.6
8/26/2018	25.8	21.7	21.0	25.9	26.8
9/2/2018	24.6	21.4	21.8	23.6	24.5
9/9/2018	24.0	21.3	20.7	23.2	24.1
9/16/2018	23.1	19.3	18.3	22.2	23.6
10/28/2018	18.9	17.7	18.3	18.0	16.7
11/5/2018	19.5	18.1	18.5	20.2	20.8
11/11/2018	16.3	14.4	14.5	19.8	20.5
11/18/2018	14.4	14.4	14.2	18.6	19.4
11/25/2018	16.3	18.8	16.0	19.6	20.2

Table A-24. Water temperature (°C) concentrations observed at Priority 3 sites in Orange County during the 2018 dry season (Note: Borrego Creek was dry during all sample events)

Week Beginning Date	Bolsa Chica Channel (P3-OC1)	Buck Gully Creek (P3-OC3)	Los Trancos Creek (P3-OC5)	Morning Canyon Creek (P3-OC6)	Peters Canyon Wash (P3-OC7)	San Diego Creek Reach 1 (P3-OC8)	San Diego Creek Reach 2 (P3-OC9)	Serrano Creek (P3-OC11)
5/6/2018	--	16.51	--	--	--	--	--	--
5/13/2018	--	19.79	--	--	--	--	--	--
5/20/2018	--	19	--	--	--	--	--	--
5/27/2018	--	18.18	--	--	--	--	--	--
6/3/2018	--	18.88	--	--	--	--	--	--
8/19/2018	32.15	--	--	--	--	--	--	--
8/26/2018	26.18	--	--	--	--	--	--	--
9/2/2018	22.3	--	--	--	--	--	--	--
9/9/2018	24.08	--	--	--	--	--	--	--
9/16/2018	20.04	--	--	--	--	--	--	--
10/28/2018	--	--	--	--	19.6	22.4	23.1	20.7
11/4/2018	--	--	--	--	19.85	20.97	21.28	22.4
11/11/2018	--	--	--	--	12.42	18.88	19.14	18.6
11/18/2018	--	--	--	--	14.67	18.43	16.55	16.3
11/25/2018	--	--	--	--	16.21	17.82	19.07	18.03
12/9/2018	--	13.3	Dry	13.7	--	--	--	--
12/16/2018	--	13.3	Dry	14.4	--	--	--	--
12/30/2018	--	9.7	Dry	10.5	--	--	--	--
1/6/2019	--	12.8	NA	13.1	--	--	--	--
1/20/2019	--	12	Dry	12	--	--	--	--

Table A-25. Water temperature (°C) concentrations observed at Priority 3 sites in Riverside County and San Bernardino County during the 2018 dry season

Week Beginning Date	SAR Reach 4 (P3-SBC1)	Goldenstar Creek (P3-RC1)
6/10/2018	25.5	
6/17/2018	25.7	
6/24/2018	26.2	
7/1/2018	27.5	
7/8/2018	26.5	
7/15/2018		21.4
7/22/2018		22.9
7/29/2018		21.4
8/5/2018		20.4
8/12/2018		20.8
8/19/2018		21.2

Table A-26. Conductivity (µS/cm) observed at Priority 1 sites during the 2018 dry season

Week Beginning Date	Canyon Lake (P1-1)	Lake Elsinore (P1-2)	Lake Perris (P1-3)	Big Bear Lake (P1-4)	Mill Creek Reach 2 (P1-5)	Lytle Creek (P1-6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/6/2018	870	4359	534	479	191	271	1024	1061
5/13/2018	858	4400	526	441	183	266	1042	1050
5/20/2018	867	4443	529	434	188	268	1032	1048
5/27/2018	871	4480	529	398	189	269	1031	1046
6/3/2018	870	4527	536	412	194	269	1040	1057
6/10/2018	899	4647	554	433	198	279	1051	1087
6/17/2018	888	4593	538	396	190	268	1036	1066
6/24/2018	871	4591	533	435	194	265	1014	1010
7/1/2018	900	4712	544	463	198	272	1028	1053
7/8/2018	899	4750	542	439	175	272	1036	1082
7/15/2018	906	4816	551	444	194	274	1047	1082
7/22/2018	923	4910	555	447	196	274	1051	1050
7/29/2018	933	4933	546	433	197	274	1037	1076
8/5/2018	956	5000	500	455	198	275	1034	1078
8/12/2018	974	5034	552	423	198	282	1025	1077
8/19/2018	980	5066	551	474	186	276	1031	1045
8/26/2018	990	5089	557	452	189	275	1036	1055
9/2/2018	993	5125	550	424	189	274	1023	1037
9/9/2018	986	5131	552	441	189	275	1014	1039
9/16/2018	969	5184	553	451	188	275	1008	1036
10/28/2018	940	5207	534	591	174	274	990	1017
11/5/2018	937	5205	533	523	174	275	981	1005
11/11/2018	1031	5679	586	555	182	298	1080	1103
11/18/2018	957	5276	534	514	167	275	995	1017
11/25/2018	951	5245	531	500	165	273	979	995

Table A-27. Conductivity (µS/cm) observed at Priority 2 sites during the 2018 dry season

Week Beginning Date	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek Below Wetlands (WW-M6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/6/2018	1064	1034	1451	1024	1061
5/13/2018	1373	1070	1340	1042	1050
5/20/2018	932	931	1054	1032	1048
5/27/2018	1729	1291	1060	1031	1046
6/3/2018	Dry	1342	1036	1040	1057
6/10/2018	956	1456	1690	1051	1087
6/17/2018	999	1387	1642	1036	1066
6/24/2018	986	1127	801	1014	1010
7/1/2018	1475	1342	1135	1028	1053
7/8/2018	1000	1387	1523	1036	1082
7/15/2018	1103	786	1948	1047	1082
7/22/2018	1021	782	1625	1051	1050
7/29/2018	908	882	1270	1037	1076
8/5/2018	1068	820	1501	1034	1078
8/12/2018	929	1003	1219	1025	1077
8/19/2018	987	1981	1165	1031	1045
8/26/2018	974	1021	1458	1036	1055
9/2/2018	928	983	1160	1023	1037
9/9/2018	937	1243	1097	1014	1039
9/16/2018	984	1202	1200	1008	1036
10/28/2018	889	1242	973	990	1017
11/5/2018	890	1060	1034	981	1005
11/11/2018	1399	1151	1166	1080	1103
11/18/2018	999	1089	998	995	1017
11/25/2018	1173	538	963	979	995

Table A-28. Conductivity (µS/cm) observed at Priority 3 sites in Orange County during the 2018 dry season (Note: Borrego Creek was dry during all sample events)

Week Beginning Date	Bolsa Chica Channel (P3-OC1)	Buck Gully Creek (P3-OC3)	Los Trancos Creek (P3-OC5)	Morning Canyon Creek (P3-OC6)	Peters Canyon Wash (P3-OC7)	San Diego Creek Reach 1 (P3-OC8)	San Diego Creek Reach 2 (P3-OC9)	Serrano Creek (P3-OC11)
5/6/2018	--	5873	--	--	--	--	--	--
5/13/2018	--	5445	--	--	--	--	--	--
5/20/2018	--	5514	--	--	--	--	--	--
5/27/2018	--	5668	--	--	--	--	--	--
6/3/2018	--	5286	--	--	--	--	--	--
8/19/2018	2315	--	--	--	--	--	--	--
8/26/2018	1756	--	--	--	--	--	--	--
9/2/2018	2092	--	--	--	--	--	--	--
9/9/2018	2275	--	--	--	--	--	--	--
9/16/2018	2346	--	--	--	--	--	--	--
10/28/2018	--	--	--	--	2760	2893	2540	1493
11/4/2018	--	--	--	--	2546	2699	2289	894
11/11/2018	--	--	--	--	2139	2741	2208	804
11/18/2018	--	--	--	--	1890	2722	2061	2092
11/25/2018	--	--	--	--	1857	2747	1815	1072
12/9/2018	--	5264	Dry	7085	--	--	--	--
12/16/2018	--	5856	Dry	8088	--	--	--	--
12/30/2018	--	6045	Dry	6632	--	--	--	--
1/6/2019	--	4928	NA	6830	--	--	--	--
1/20/2019	--	5264	Dry	7325	--	--	--	--

Table A-29. Conductivity (µS/cm) observed at Priority 3 sites in Riverside County and San Bernardino County during the 2018 dry season

Week Beginning Date	SAR Reach 4 (P3-SBC1)	Goldenstar Creek (P3-RC1)
6/10/2018	892	
6/17/2018	863	
6/24/2018	822	
7/1/2018	852	
7/8/2018	850	
7/15/2018		2194
7/22/2018		2248
7/29/2018		2260
8/5/2018		2272
8/12/2018		2243
8/19/2018		2207

Table A-30. Flow (cfs) observed at Priority 1 sites during the 2018 dry season

Week Beginning Date	Canyon Lake (P1-1)	Lake Elsinore (P1-2)	Lake Perris (P1-3)	Big Bear Lake (P1-4)	Mill Creek Reach 2 (P1-5)	Lytle Creek (P1-6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/6/2018	--	--	--	--	2.6	6.3	21	82
5/13/2018	--	--	--	--	4.1	6.0	78	104
5/20/2018	--	--	--	--	4.0	6.8	45	94
5/27/2018	--	--	--	--	3.7	4.7	55	96
6/3/2018	--	--	--	--	7.4	4.9	115	125
6/10/2018	--	--	--	--	7.4	1.8	70	105
6/17/2018	--	--	--	--	2.7	1.3	31	94
6/24/2018	--	--	--	--	2.7	5.0	39	116
7/1/2018	--	--	--	--	3.2	4.3	89	58
7/8/2018	--	--	--	--	4.5	1.8	29	117
7/15/2018	--	--	--	--	2.5	1.9	45	116
7/22/2018	--	--	--	--	3.3	5.7	61	103
7/29/2018	--	--	--	--	7.2	2.1	59	106
8/5/2018	--	--	--	--	3.2	2.7	56	160
8/12/2018	--	--	--	--	7.1	3.5	48	66
8/19/2018	--	--	--	--	2.6	2.9	51	72
8/26/2018	--	--	--	--	2.0	3.0	92	112
9/2/2018	--	--	--	--	4.6	1.6	54	59
9/9/2018	--	--	--	--	2.9	4.3	46	47
9/16/2018	--	--	--	--	2.8	2.0	46	74
10/28/2018	--	--	--	--	1.6	2.9	82	70
11/5/2018	--	--	--	--	3.8	4.0	107	230
11/11/2018	--	--	--	--	3.8	3.6	89	112
11/18/2018	--	--	--	--	3.1	2.3	64	195
11/25/2018	--	--	--	--	2.1	2.0	150	131

Table A-31. Flow (cfs) observed at Priority 2 sites during the 2018 dry season

Week Beginning Date	Prado Park Lake Outlet (WW-C3)	Chino Creek @ Central Avenue (WW-C7)	Mill-Cucamonga Creek Below Wetlands (WW-M6)	SAR @ MWD Crossing (WW-S1)	SAR @ Pedley Avenue (WW-S4)
5/6/2018	3.3	2.3	6.1	21	82
5/13/2018	3.5	7.3	2.9	78	104
5/20/2018	2.6	5.2	8.8	45	94
5/27/2018	0.2	7.4	12	55	96
6/3/2018	Dry	2.0	11	115	125
6/10/2018	2.4	3	4.6	70	105
6/17/2018	1.3	2.9	1.0	31	94
6/24/2018	2.2	5.1	22	39	116
7/1/2018	0.2	7.1	4.6	89	58
7/8/2018	4.2	2.8	7.3	29	117
7/15/2018	3.5	27	3.1	45	116
7/22/2018	3.4	33	4.5	61	103
7/29/2018	2.4	4.2	4.6	59	106
8/5/2018	3.2	25	3.8	56	160
8/12/2018	2.4	6.1	7.3	48	66
8/19/2018	3.5	11	11	51	72
8/26/2018	5.2	5.3	3.2	92	112
9/2/2018	2.0	4.8	5.0	54	59
9/9/2018	1.5	4.5	15.3	46	47
9/16/2018	5.8	6.6	5.0	46	74
10/28/2018	3.5	6.1	11	82	70
11/5/2018	3.7	4.6	13	107	230
11/11/2018	2.6	5.5	14	89	112
11/18/2018	1.4	7.6	18	64	195
11/25/2018	3.2	6.8	35	150	131

Table A-32. Flow (cfs) observed at Priority 3 sites in Orange County during the 2018 dry season (Note: Borrego Creek was dry during all sample events)

Week Beginning Date	Bolsa Chica Channel (P3-OC1)	Buck Gully Creek (P3-OC3)	Los Trancos Creek (P3-OC5)	Morning Canyon Creek (P3-OC6)	Peters Canyon Wash (P3-OC7)	San Diego Creek Reach 1 (P3-OC8)	San Diego Creek Reach 2 (P3-OC9)	Serrano Creek (P3-OC11)
5/6/2018	--	0.3	--	--	--	--	--	--
5/13/2018	--	0.3	--	--	--	--	--	--
5/20/2018	--	0.2	--	--	--	--	--	--
5/27/2018	--	0.2	--	--	--	--	--	--
6/3/2018	--	0.6	--	--	--	--	--	--
8/19/2018	0.4	--	--	--	--	--	--	--
8/26/2018	0.4	--	--	--	--	--	--	--
9/2/2018	0.5	--	--	--	--	--	--	--
9/9/2018	0.6	--	--	--	--	--	--	--
9/16/2018	0.4	--	--	--	--	--	--	--
10/28/2018	--	--	--	--	1.3	3.3	0.1	0.1
11/4/2018	--	--	--	--	1.0	6.4	0.2	0.3
11/11/2018	--	--	--	--	0.9	0.2	0.1	1.4
11/18/2018	--	--	--	--	1.3	2.6	0.3	0.1
11/25/2018	--	--	--	--	1.0	4.1	0.3	0.1
12/9/2018	--	0.9	Dry	0.4	--	--	--	--
12/16/2018	--	0.8	Dry	0.3	--	--	--	--
12/30/2018	--	0.5	Dry	0.2	--	--	--	--
1/6/2019	--	NA	NA	0.4	--	--	--	--
1/20/2019	--	0.7	Dry	0.5	--	--	--	--

Table A-33. Flow (cfs) observed at Priority 3 sites in Riverside County and San Bernardino County during the 2018 dry season

Week Beginning Date	SAR Reach 4 (P3-SBC1)	Goldenstar Creek (P3-RC1)
6/10/2018	49	
6/17/2018	19	
6/24/2018	53	
7/1/2018	35	
7/8/2018	54	
7/15/2018		2.4
7/22/2018		1.6
7/29/2018		0.4
8/5/2018		0.5
8/12/2018		1.3
8/19/2018		0.5

Table A-34. Water Quality Data from Priority 2 Sites during the 2018-2019 Storm Event

Date	*E. coli* (MPN/100 mL)	TSS (mg/L)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Flow (cfs)	pH	Water Temperature (°C)	Turbidity (NTU)
Prado Park Lake (WW-C3)								
2/1/2019	110	13	874	11.4	3.0	9.2	13.5	7
2/3/2019	24000	19	767	9.5	11.0	8.6	13.0	13
2/4/2019	460	13	891	7.4	NA	7.4	12.7	12
2/5/2019	14000	16	748	9.4	8.0	8.3	12.8	14
Chino Creek at Central Avenue (WW-C7)								
2/1/2019	2100	2	820	9.5	7.0	7.8	14.4	2
2/3/2019	5200	6	663	10.5	NA	8.0	12.1	9
2/4/2019	340	24	130	10.6	7.0	7.9	12.1	11
2/5/2019	4400	12	368	10.7	NA	7.8	11.8	15
Mill-Cucamonga Creek below Treatment Wetlands (WW-M6)								
2/1/2019	4900	7	706	8.7	NA	7.9	15.0	6
2/3/2019	3900	28	335	9.7	NA	7.8	13.6	24
2/4/2019	440	56	277	9.8	NA	7.7	13.9	12
2/5/2019	24000	24	227	10.2	NA	7.9	12.2	25
SAR at MWD Crossing (WW-S1)								
2/1/2019	2800	90	703	8.9	125	7.9	14.9	51
2/3/2019	6500	1000	325	9.8	NA	7.9	12.8	713
2/4/2019	370	490	347	9.9	NA	7.8	13.0	262
2/5/2019	2900	270	230	10.7	NA	7.9	10.7	377
SAR at Pedley Avenue (WW-S4)								
2/1/2019	4400	200	617	9.2	294	7.9	14.6	109
2/3/2019	5500	1400	313	9.7	NA	7.9	12.5	893
2/4/2019	550	510	313	10.0	NA	7.8	13.0	287
2/5/2019	4100	580	248	10.6	NA	7.9	11.4	326

Table A-35. 2018 Daily mean flow (cfs), Chino Creek at Schaeffer Avenue, as measured by the USGS (Data are provisional)

Date	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	0.4	0.5	0.3	0.3	0.3	0.4	0.3	0.5	0.4	0.6	0.6	0.8
2	0.3	0.4	7.8	0.3	1.8	0.4	0.4	0.6	0.4	0.6	0.6	1.3
3	0.3	0.4	0.9	0.3	0.5	0.4	0.4	1.8	0.5	4.2	0.5	0.8
4	0.4	0.4	0.5	0.3	0.5	0.4	0.4	1.2	0.7	4.5	0.6	0.7
5	0.4	0.4	0.3	0.3	0.5	0.4	0.4	1.4	0.5	0.7	0.6	13
6	0.4	0.4	0.3	0.3	0.5	0.4	0.4	2.3	0.4	0.8	0.6	482
7	0.3	0.4	0.3	0.4	0.5	0.4	0.6	2.1	0.4	1.6	0.6	3.6
8	17	0.4	0.3	0.4	0.5	0.4	0.3	1.9	0.4	0.8	0.6	0.6
9	341	0.3	0.3	0.4	0.5	0.5	0.4	0.4	0.4	0.7	0.6	0.5
10	1.2	0.3	47	0.4	0.5	0.3	0.4	0.5	0.4	0.7	0.5	0.4
11	0.6	0.3	12	0.3	0.4	0.3	0.4	0.4	0.4	0.6	0.5	0.4
12	0.4	0.5	0.5	0.3	0.4	0.3	0.4	0.9	0.7	77	0.6	0.4
13	0.4	0.6	3.2	0.3	0.6	0.4	0.4	0.6	0.4	51	0.6	0.4
14	0.4	0.3	16	0.3	0.5	0.4	0.4	0.7	0.5	1.1	0.6	0.4
15	0.4	0.3	15	0.3	0.5	0.4	0.4	0.8	0.4	0.7	0.7	0.4
16	0.4	0.3	5.6	0.3	0.5	0.3	0.4	0.4	0.4	0.7	0.7	0.4
17	0.4	0.2	25	0.3	0.5	0.3	0.4	0.4	0.4	0.6	0.7	0.4
18	0.4	0.3	0.5	0.3	0.4	0.3	0.4	0.4	0.4	0.6	0.7	0.4
19	1.6	0.3	0.4	0.3	0.5	0.3	0.8	0.3	0.4	0.6	0.7	0.4
20	2.1	0.2	0.3	0.3	1.1	0.4	2.8	0.5	0.4	0.6	1.4	0.4
21	0.4	0.2	14	0.3	0.6	0.4	2.5	0.4	0.4	0.6	0.6	0.4
22	0.4	0.3	47	0.3	0.5	0.4	3.0	0.3	0.4	0.6	54	0.4
23	0.4	0.3	4.4	0.3	0.5	0.3	1.8	0.3	0.4	0.6	0.9	0.4
24	0.4	0.2	0.6	0.3	0.6	0.3	2.7	0.3	0.4	1.0	0.7	0.4
25	0.4	0.3	0.6	0.3	0.5	0.4	3.2	0.4	0.4	0.6	0.6	2.5
26	0.5	3.2	0.4	0.3	0.4	0.4	2.7	0.4	0.4	0.6	0.6	0.4
27	0.4	43	0.3	0.3	0.5	0.3	2.7	0.4	0.5	0.6	0.8	0.4
28	0.5	0.4	0.3	0.3	0.5	0.3	2.6	0.8	0.5	0.7	0.6	0.3
29	0.5		0.3	0.3	0.5	0.3	1.8	0.4	0.6	0.6	227	0.2
30	0.4		0.3	0.4	0.6	0.3	1.1	0.4	0.5	0.6	3.4	0.2
31	0.4		0.3		0.5		1.2	0.4		0.7		0.3
COUNT	31	28	31	30	31	30	31	31	30	31	30	31
MAX	341	43	47	0	2	0	3.2	2	1	77	227	482
MIN	0	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.4	1	0.5	0

Table A-36. 2018 Daily mean flow (cfs), Cucamonga Creek near Mira Loma, as measured by the USGS (Data are provisional)

Date	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	26	30	51	7.3	22	22	2.8	2.4	8.2	58	20	28
2	27	29	62	5.6	27	17	2.3	1.1	15	65	27	25
3	22	19	57	11	3.7	23	1.6	0.7	11	93	12	31
4	28	24	48	8.8	1.6	20	2.0	2.5	9.1	88	31	34
5	41	22	32	7.6	4.1	11	1.4	4.0	5.1	42	24	56
6	54	18	13	5.3	11	15	1.7	1.2	8.4	40	20	855
7	83	21	9.0	9.0	9.3	9.9	4.2	0.4	11	45	20	80
8	98	16	26	12	5.2	0.6	2.6	1.0	10	46	17	51
9	670	7.1	40	9.2	3.1	1.1	1.6	0.5	13	49	38	48
10	58	11	105	4.1	2.8	2.5	1.6	0.3	12	37	25	48
11	44	42	64	1.8	5.5	1.6	2.2	1.4	8.1	38	38	46
12	42	50	28	1.8	14	2.6	2.1	2.5	12	94	33	47
13	39	36	34	2.5	15	0.9	3.0	1.3	4.3	173	22	48
14	39	25	64	5.5	11	1.0	3.4	1.3	5.7	26	7.8	48
15	42	14	153	6.9	6	0.9	3.8	0.7	17	71	14	45
16	43	10	35	5.3	5.0	3.0	2.7	0.6	21	62	14	46
17	43	27	90	3.5	4.1	3.7	2.7	1.2	26	44	18	48
18	42	49	31	8.4	3.8	1.1	2.7	2.5	13	27	20	50
19	44	75	35	9.1	5.9	1.3	0.9	3.7	13	16	25	49
20	53	44	37	6.2	14	1.7	0.5	4.0	9.3	16	43	51
21	44	40	96	8.9	20	3.8	0.7	3.9	11	27	58	51
22	45	27	157	12	22	3.6	2.4	6.9	15	31	102	56
23	45	22	48	7.2	22	9.5	1.1	6.4	20	34	8.8	63
24	42	34	37	2.6	21	10	0.6	4.8	31	29	7.4	63
25	40	46	38	3.4	19	11	0.9	10	29	41	8.2	68
26	38	83	47	4.4	31	8.0	0.6	13	29	35	17.7	49
27	36	100	32	4.1	35	7.7	0.5	7.0	26	30	31	42
28	34	34	35	7.1	33	6.9	0.6	3.9	21	35	32	29
29	34		22	12	35	3.5	0.8	3.1	24	38	451	31
30	15		11	12	35	2.3	2.0	5.3	52	34	46	33
31	22		8.9		27.0		2.3	6.3		25		38
COUNT	31	28	31	30	31	30	31	31	30	31	30	31
MAX	670	100	157	12	35	23	4.2	13	52	173	451	855
MIN	15	7.1	8.9	1.8	1.6	0.6	0.5	0.3	4.3	16	7.4	25

Table A-37. 2018 Daily mean flow (cfs), Santa Ana River at MWD Crossing, as measured by the USGS (Data are provisional)

Date	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1	39	38	48	51	40	33	35	24	31	26	41	82
2	39	39	47	52	57	32	36	24	32	25	41	50
3	39	37	68	52	51	32	36	25	31	26	40	37
4	39	40	53	50	47	31	36	28	32	45	40	29
5	39	39	51	52	46	32	33	26	32	35	42	30
6	39	40	47	52	42	32	33	27	32	35	43	1830
7	53	40	45	51	43	33	34	25	32	37	44	545
8	186	41	47	51	40	33	32	27	31	38	43	135
9	2270	43	46	49	38	32	31	27	31	38	42	83
10	467	41	153	48	37	31	32	27	32	40	42	68
11	110	43	251	48	39	31	31	26	32	39	40	61
12	43	45	61	48	39	29	31	27	33	39	41	57
13	33	44	49	47	38	28	32	25	33	325	42	54
14	32	46	48	43	38	29	31	24	31	70	40	51
15	36	45	167	42	39	30	32	29	30	56	42	50
16	43	47	71	43	36	30	32	30	29	50	40	49
17	50	45	225	42	36	29	31	32	29	48	40	50
18	52	46	73	40	37	29	31	31	28	44	42	51
19	50	46	66	41	35	31	28	33	29	43	41	51
20	63	49	67	40	34	33	24	32	29	40	41	50
21	59	47	62	40	35	27	24	34	29	41	42	48
22	60	49	199	39	36	31	26	35	29	41	47	47
23	54	51	185	37	35	32	28	35	30	41	45	48
24	50	49	71	36	35	32	29	34	30	40	46	48
25	51	50	56	35	36	33	27	34	30	41	41	64
26	47	48	58	38	35	32	27	36	30	40	43	51
27	47	103	53	36	32	33	28	34	29	39	39	50
28	45	54	52	35	32	37	28	35	29	40	27	49
29	42		56	36	34	33	26	32	28	42	605	49
30	43		52	38	35	36	24	31	28	42	481	49
31	41		52		35		23	31		41		50
COUNT	31	28	31	30	31	30	31	31	30	31	30	31
MAX	2270	103	251	52	57	37	36.3	36	33	325	605	1830
MIN	32	37	45	35	32	27	23	24	28	25	27	29

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Appendix B
QA/QC Summary

Introduction

This section provides the Quality Assurance/Quality Control (QA/QC) evaluation for samples and data collected during the period covered by this report, which includes the 2018 dry weather monitoring and 2018-2019 storm monitoring. The basis for this evaluation is the approved QAPP.[25]

Field measurements were made for the following constituents: conductivity, dissolved oxygen, pH, turbidity, water temperature, and flow. Field data were checked to ensure that all required data were gathered and recorded. This check included a data review to ensure correct units of measurements were reported and that reported values were within expected ranges.

Laboratory analyses were conducted for three constituents: *E. coli*, *Enterococcus*, and TSS. Data validation included a check to ensure that samples were delivered to laboratories within required holding times and that all sample handling and custody protocols were followed. Field/equipment blank and duplicate results were evaluated against various reporting requirements and data were checked to ensure correct units of measurement were reported.

The following sections summarize the results of the QA/QC evaluation for the period covered by this report.

Field Measured Parameters

Completeness

Table B-1 shows number of the dry weather field measurements collected for 2017. Completeness is summarized as follows:

- Prado Park Lake was dry during one monitoring event. As such, no field measurements or water quality samples were collected during that event and resulted in 1 uncollected measurement for each parameter.
- Due to dry conditions at Borrego Creek during the monitoring events, no field measurements or water quality samples were collected, resulting in 5 uncollected measurements for each parameter.
- Los Trancos Creek was dry for five of the six monitoring events, during which no field measurements and water quality samples were collected. The diversion at Los Trancos Creek was turned off during one monitoring event, resulting in flow at the monitoring site. However due to time constraints, field measurements and water quality samples were not

[25] SAR RMP QAPP, Version 1.0, February 2016

collected during that monitoring event. This resulted in 5 uncollected measurements for each parameter.

- There are fewer planned flow measurements as flow is measured in stream sites only. As four Priority 1 sites are located in lakes and two Priority 4 sites are located in the tidal zone, there are 238 planned flow measurements (97 less than other field parameters). Ten flow measurements were not collected due to dry conditions. One measurement was not collected due to tidal influence and one was not collected due to time constraints.
- An additional six samples were collected from Buck Gully Creek under dry conditions during the wet season as part of the increased monitoring effort approved by the Santa Ana Water Board to develop a new dataset to support future potential delisting. This resulted in an additional 6 measurements for each parameter.

Table B-1. Dry weather field parameter completeness summary

Parameter	Planned[1]	Collected	% Complete
Conductivity	335	331	98.8%
Dissolved Oxygen	335	331	98.8%
Flow[2]	238	228	97.9%
pH	335	331	98.8%
Temperature	335	331	98.8%
Turbidity	335	329	98.2%

[1] Planned represents the number of samples planned based on SAR RMP Monitoring Plan and does not include special investigations that arise based on results of the routine monitoring program.
[2] Flow is not measured at lake sites and sites located in tides.

Accuracy and Precision

Field staff used a Horiba multi-parameter probe (or equivalent) to collect in situ field measurements for conductivity, dissolved oxygen, pH, and water temperature at all sample locations during each sample event. Turbidity and flow were measured with a Hach Turbidity meter and Marsh-McBirney Flo-Mate meter with top-setting rod, respectively. Field staff calibrated each of the water quality meters prior to each sample event to ensure accuracy and precision of the measurements. Table B-2 summarizes the accuracy and repeatability associated with the use of each meter.

Table B-2. Summary of accuracy and repeatability expectations for field measurement meters

Water Quality Constituent	Accuracy	Repeatability
Dissolved Oxygen	± 0.2 mg/L	± 0.1 mg/L
pH	± 0.1 units	± 0.05 units
Conductivity	± 1%	± 0.05%
Water Temperature	± 0.3 °C	±0.1 °C
Turbidity	± 2%	± 1%
Flow	± 2%	N/A

Laboratory Constituents

Table B-3 describes the number of grab water samples planned versus actual samples collected. During the 2018 dry weather season, 25 weeks of sampling at eight Priority 1 sites and five Priority 2 sites was planned from the week of May 6, 2018, through the week of November 25, 2018. During the same period, 5 weeks of sampling at eleven Priority 3 sites and one week of sampling at five Priority 4 sites are also planned. This results in 335 dry weather samples. This Annual Report also encompasses monitoring of a wet weather storm events at the five Priority 2 sites. This results in 20 wet weather samples (5 sites/event and 4 samples per site) for a total of 355 samples during the entire monitoring period covered in this 2018-2019Annual Report.

As previously discussed, five additional samples were collected from Buck Gully Creek as part of an approved RMP change to develop a new dataset for potential delisting.

Holding time requirements for TSS (7 days) and *E. coli* (6 hours) were exceeded on four occasions, affecting fifteen samples. This includes:

- Six TSS samples collected from P1-1, P1-2, P1-3, P3-SBC1, P4-RC2, and P4-SB1 during the week of June 17, 2018;
- Six TSS samples collected from P1-1, P1-2, P1-3, P3-RC1, field blank and field duplicate during the week of August 5, 2018;
- One *E. coli* sample collected from P1-6 during the week of July 8, 2018; and
- Two *E. coli* samples collected from WW-C3 and WW-C7 during the week of July 29, 2018.

Field/Equipment Blanks

The QAPP calls for a field/equipment blank to be collected during each sample event. A sample event is defined as one week for dry weather sampling, during which multiple days of sampling may occur. One field/equipment blank sample is also required during each storm event. Accordingly, the QAPP requires a total of 26 field/equipment blanks, however, 41 field/equipment blanks were collected as multiple blanks were collected during some

weeks. This results in a frequency of 12 percent, well above the typically required frequency. Per the QAPP, the reporting target limits for TSS and bacterial indicators were 1.0 mg/L and 10 MPN/100 mL, respectively. These method sensitivity guidelines were met. Field/equipment blank results were all below detectable counts (< 10 MPN/100 mL) for *E. coli*. For TSS, all but one field/equipment blank results were reported below the target reporting limit. The one blank was 4 mg/L while the target reporting limit is 2 mg/L.

Field Duplicates

The QAPP requires the collection of a field duplicate at a minimum frequency of at least 5 percent of the total samples collected. Field staff collected at least one field duplicate during each sample event for a total of 42 TSS field duplicates and 42 indicator bacteria field duplicates (41 *E. coli* and 1 *Enterococcus*). As a result, the frequency of field duplicate collection was 12 percent, well above the required frequency.

Table B-3. Summary of grab sample collection activity for dry and wet weather sample events and regularly sampled sites

Sample ID	Sample Location	Planned	Collected	Missed
P1-1	Canyon Lake at Holiday Harbor	25	25	0
P1-2	Lake Elsinore	25	25	0
P1-3	Lake Perris	25	25	0
P1-4	Big Bear Lake at Swim Beach	25	25	0
P1-5	Mill Creek Reach 2	25	25	0
P1-6	Lytle Creek (Middle Fork)	25	25	0
WW-M6	Mil-Cucamonga Creek below Wetlands	29	29	0
WW-C7 [1]	Chino Creek at Central Avenue	29	29	0
WW-C3	Prado Park Lake	29	28	1
WW-S1	Santa Ana River Reach 3 at MWD Crossing	29	29	0
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	29	29	0
P3-OC1	Bolsa Chica Channel	5	5	0
P3-OC2 [2]	Borrego Creek	5	0	5
P3-OC3 [3]	Buck Gully Creek	5	10	0
P3-OC5 [4]	Los Trancos Creek	5	0	5
P3-OC6	Morning Canyon Creek	5	5	0
P3-OC7	Peters Canyon Wash	5	5	0
P3-OC8	San Diego Creek Reach 1	5	5	0
P3-OC9	San Diego Creek Reach 1	5	5	0
P3-OC11	Serrano Creek	5	5	0
P3-RC1	Goldenstar Creek	5	5	0
P3-SBC1	Santa Ana River Reach 4	5	5	0
P4-RC2	Temescal Creek at Lincoln Avenue	1	1	0
P4-OC1	Santa Ana Delhi Channel Upstream of Irvine Avenue	1	1	0
P4-OC2	Santa Ana Delhi Channel in Tidal Prism	1	1	0
P4-OC3	Greenville-Banning Channel in Tidal Prism	1	1	0
P4-SBC1	Cucamonga Creek at Hellman Avenue	1	1	0
Total		355	349	11

[1] Prado Park Lake was dry during one sample event.
[2] Borrego Creek was dry during all five sample events.
[3] Additional samples were collected at Buck Gully Creek as part of a Santa Ana Water Board approved RMP amendment.
[4] Los Trancos Creek was dry during four out of five sample events. During the remaining event, samples were not collected due to time constraints.

Each duplicate sample was analyzed for the same parameters as its paired field sample. Results of the field duplicate analyses can be used to assess adherence to field sampling collection protocols and laboratory precision. Table B-4 summarizes the field duplicate analysis results for TSS. Twelve duplicate pairs exceeded the QAPP's relative percent difference (RPD) goal of ± 25 percent. Two pairs of duplicate samples, collected at Big Bear Lake during the week of May 17, 2018 and Mill Creek Reach 2 during the week of August 19, 2018, have a significant RPD resulting from a large difference in concentrations (38 mg/L vs 210 mg/L and 20 mg/L vs 92 mg/L, respectively). This is 5 percent of all QA/QC samples and is within a normal frequency. Eight pairs with RPD exceeding ± 25 percent are due to low TSS values; maximum TSS concentration in those pairs is 12 mg/L and the maximum difference in the eight pairs is 12 mg/L. Dividing by the low TSS values artificially results in high RPD values. Two pairs have higher TSS concentrations with a maximum TSS concentration of 65 mg/L, the difference in the pair is 15 mg/L.

To determine the precision of the duplicate analysis for each bacterial indicator the following method was used:[26]

- Calculate the logarithm of each sample and associated duplicate ("laboratory pair")
- Determine the range for each laboratory pair (R_{log})
- Calculate the mean of the ranges (Mean R_{log})
- Calculate the precision criterion, where the precision criteria = 3.27 * Mean R_{log}
- Compare R_{log} for each duplicate pair with the calculated precision criterion for the data set to determine if R_{log} is less than the precision criterion.

Tables B-5 summarizes the field duplicate analysis results for *E. coli*, respectively. One duplicate pair for *E. coli*, collected from Prado Park Lake on the week of September 2, 2018, exceeded the calculated precision criterion. This is 2 percent of the QA/QC pairs and is comparable with historical data. The duplicate concentration is approximately four times the sample concentration (120 MPN/100 mL vs 31 MPN/100 mL). Approximately one order of magnitude difference in replicate bacteria samples is common and within reason.

[26] Standard Methods, Section 9020B, 18th, 19th, or 20th Editions

Table B-4. Results of field duplicate analysis for TSS

Week Beginning Date	Site ID	Site Location	Duplicate Result (mg/L)	Sample Result (mg/L)	RPD (%)
5/6/2018	P1-1	Canyon Lake	< 2	4	67%
5/13/2018	P1-2	Lake Elsinore	50	65	26%
5/20/2018	P1-3	Lake Perris	13	15	14%
5/27/2018	P1-4	Big Bear Lake	38	210	139%
6/3/2018	P1-5	Mill Creek Reach 2	2	2	0%
6/10/2018	P1-6	Lytle Creek	< 2	< 2	0%
6/17/2018	WW-S1	SAR @ MWD Crossing	5	4	22%
6/24/2018	WW-S4	SAR @ Pedley Avenue	12	< 2	143%
7/1/2018	WW-M6	Mill-Cucamonga Creek	< 2	2	0%
7/8/2018	P3-SBC1	SAR Reach 4	< 2	2	0%
7/15/2018	WW-C3	Prado Park Lake	14	16	13%
7/22/2018	P1-1	Canyon Lake	6	4	40%
7/29/2018	P1-2	Lake Elsinore	21	21	0%
8/5/2018	P3-RC1	Goldenstar Creek	< 2	< 2	0%
8/12/2018	P1-6	Lytle Creek	< 2	< 2	0%
8/19/2018	P1-5	Mill Creek Reach 2	92	20	129%
8/26/2018	P1-6	Lytle Creek	< 2	< 2	0%
9/2/2018	WW-C3	Prado Park Lake	2	31	176%
9/9/2018	WW-S4	SAR @ Pedley Avenue	3	2	40%
9/16/2018	WW-C3	Prado Park Lake	24	20	18%
10/28/2018	WW-S1	SAR @ MWD Crossing	4	4	0%
11/4/2018	WW-S4	SAR @ Pedley Avenue	< 2	6	100%
11/11/2018	WW-M6	Mill-Cucamonga Creek	< 2	< 2	0%
11/18/2018	WW-C7	Chino Creek	< 2	< 2	0%
11/25/2018	WW-S1	SAR @ MWD Crossing	4	4	0%
12/9/2018	P3-OC6	Morning Canyon Creek	11	10	10%
5/6/2018	P3-OC3	Buck Gully Creek	< 5	< 5	0%
5/13/2018	P3-OC3	Buck Gully Creek	< 5	< 5	0%
5/20/2018	P3-OC3	Buck Gully Creek	6	6	0%
5/27/2018	P3-OC3	Buck Gully Creek	< 5	< 5	0%
6/3/2018	P3-OC3	Buck Gully Creek	7	7	0%
8/19/2018	P3-OC1	Bolsa Chica Channel	7	10	35%
8/26/2018	P3-OC1	Bolsa Chica Channel	< 5	< 5	0%
9/2/2018	P3-OC1	Bolsa Chica Channel	6	7	15%
9/9/2018	P3-OC1	Bolsa Chica Channel	< 5	< 5	0%
9/16/2018	P3-OC1	Bolsa Chica Channel	< 5	5	0%
9/9/2018	P4-OC3	Greenville-Banning Channel	12	10	18%
10/28/2018	P3-OC11	Serrano Creek	5.1	5.7	11%
11/4/2018	P3-OC9	San Diego Creek Reach 2	2.3	1.6	36%
11/11/2018	P3-OC7	Peters Canyon Wash	9.3	10.6	13%
11/18/2018	P3-OC8	San Diego Creek Reach 1	13.8	16.8	20%
11/25/2018	P3-OC11	Serrano Creek	2.2	1.2	59%

Note: Values with a "<" qualifier reflect results that are below detection limits. For calculation purposes, the value was represented by the detection limit.

Table B-5. Results of field duplicate analysis for *E. coli*

Week Beginning Date	Site ID	Site Location	Duplicate Result (cfu/100 mL)	Sample Result (cfu/100 mL)	Log of Duplicate Result (L_1)	Log of Sample Result (L_2)	Range of Logs (L_1 - L_2) or (R_{log})
5/6/2018	P1-1	Canyon Lake	4.1	3.1	0.6128	0.4914	0.1214
5/13/2018	P1-2	Lake Elsinore	28	20	1.4472	1.3010	0.1461
5/20/2018	P1-3	Lake Perris	19	16	1.2788	1.2041	0.0746
5/27/2018	P1-4	Big Bear Lake	15	11	1.1761	1.0414	0.1347
6/3/2018	P1-5	Mill Creek Reach 2	8.6	7.4	0.9345	0.8692	0.0653
6/10/2018	P1-6	Lytle Creek	6.3	6.3	0.7993	0.7993	0.0000
6/17/2018	WW-S1	SAR @ MWD Crossing	410	270	2.6128	2.4314	0.1814
6/24/2018	WW-S4	SAR @ Pedley Avenue	100	60	2.0000	1.7782	0.2218
7/1/2018	WW-M6	Mill-Cucamonga Creek	200	260	2.3010	2.4150	0.1139
7/8/2018	P3-SBC1	SAR Reach 4	59	65	1.7709	1.8129	0.0421
7/15/2018	WW-C3	Prado Park Lake	85	97	1.9294	1.9868	0.0574
7/22/2018	P1-1	Canyon Lake	1	BDL	0.0000	0.0000	0.0000
7/29/2018	P1-2	Lake Elsinore	1	2	0.0000	0.3010	0.3010
8/5/2018	P3-RC1	Goldenstar Creek	440	410	2.6435	2.6128	0.0307
8/12/2018	P1-6	Lytle Creek	26	23	1.4150	1.3617	0.0532
8/19/2018	P1-5	Mill Creek Reach 2	7.4	17	0.8692	1.2304	0.3612
8/26/2018	P1-6	Lytle Creek	28	26	1.4472	1.4150	0.0322
9/2/2018	WW-C3	Prado Park Lake	120	31	2.0792	1.4914	0.5878
9/9/2018	WW-S4	SAR @ Pedley Avenue	85	140	1.9294	2.1461	0.2167
9/16/2018	WW-C3	Prado Park Lake	110	74	2.0414	1.8692	0.1722
10/28/2018	WW-S1	SAR @ MWD Crossing	180	190	2.2553	2.2788	0.0235
11/4/2018	WW-S4	SAR @ Pedley Avenue	86	85	1.9345	1.9294	0.0051
11/11/2018	WW-M6	Mill-Cucamonga Creek	240	300	2.3802	2.4771	0.0969
11/18/2018	WW-C7	Chino Creek	340	380	2.5315	2.5798	0.0483
11/25/2018	WW-S1	SAR @ MWD Crossing	140	190	2.1461	2.2788	0.1326
12/9/2018	P3-OC6	Morning Canyon Creek	2420	2420	3.3838	3.3838	0.0000
5/6/2018	P3-OC3	Buck Gully Creek	121	144	2.0828	2.1584	0.0756
5/13/2018	P3-OC3	Buck Gully Creek	331	345	2.5198	2.5378	0.0180
5/20/2018	P3-OC3	Buck Gully Creek	160	135	2.2041	2.1303	0.0738
5/27/2018	P3-OC3	Buck Gully Creek	74	74	1.8692	1.8692	0.0000
6/3/2018	P3-OC3	Buck Gully Creek	52	74	1.7160	1.8692	0.1532
8/19/2018	P3-OC1	Bolsa Chica Channel	10	20	1.0000	1.3010	0.3010
8/26/2018	P3-OC1	Bolsa Chica Channel	10	10	1.0000	1.0000	0.0000
9/2/2018	P3-OC1	Bolsa Chica Channel	63	132	1.7993	2.1206	0.3212

Week Beginning Date	Site ID	Site Location	Duplicate Result (cfu/100 mL)	Sample Result (cfu/100 mL)	Log of Duplicate Result (L_1)	Log of Sample Result (L_2)	Range of Logs (L_1 - L_2) or (R_{log})
9/9/2018	P3-OC1	Bolsa Chica Channel	10	10	1.0000	1.0000	0.0000
9/16/2018	P3-OC1	Bolsa Chica Channel	135	110	2.1303	2.0414	0.0889
9/9/2018	P4-OC3	Greenville-Banning Channel	10	10	1.0000	1.0000	0.0000
10/28/2018	P3-OC11	Serrano Creek	373	269	2.5717	2.4298	0.1420
11/4/2018	P3-OC9	San Diego Creek Reach 2	120	75	2.0792	1.8751	0.2041
11/11/2018	P3-OC7	Peters Canyon Wash	341	384	2.5328	2.5843	0.0516
11/18/2018	P3-OC8	San Diego Creek Reach 1	173	173	2.2380	2.2380	0.0000
11/25/2018	P3-OC11	Serrano Creek	768	912	2.8854	2.9600	0.0746
						Sum of R_{log}	4.7243
						Mean R_{log}	0.1125
						Precision Criterion (3.27*Mean R_{log})	0.3678

[1] For data values with > qualifier, the data values shown were used for duplicate precision calculations.

Appendix C

Laboratory QA/QC Reports

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Quality Assurance / Certification Statement

CDM Smith – SAR Monitoring Program

There were a total of 337 samples submitted, which includes 287 site samples, 25 field duplicate samples and 25 field blanks. Samples were analyzed for Total Suspended Solids, Total Coliform and *E. coli*. The sampling period spanned May 2018 through November 2018.

All samples were received in good condition, meeting temperature guidelines of <10 °C for bacteria testing, <6 °C for solids testing, or having been sampled and placed on ice immediately for transport and received within 6 hours.

All samples were received within acceptable holding times for the analyses requested.

The samples received under this project were analyzed with Good Laboratory Practices. The following items listed pertain to all samples submitted to our laboratory.

1) The method specified QC was performed on all batches containing project samples.
2) All sample parameters requested were reported, unless otherwise notified.
3) All batch acceptance criteria was met prior to reporting results, except as noted below.

Exceptions to Standard Quality Control Procedures

This report is organized into three sections:

Section I details Batch QC failures. An analytical batch includes the analysis of Method Blanks and Blank Spikes as applicable, also knowns as Laboratory Control Samples. If a batch has been qualified due to this type of failure, the end user should weigh the results associated with the batch according to its intended use. Often, the presence of trace contamination will have little to no effect on the usefulness of the reported result. Failed Blank Spikes are flagged with "Data Suspect".

Section II lists the qualifiers associated with samples that have been fortified with known quantities of target and/or non-target surrogate compounds, whose purpose is to monitor analyte recovery in "real-world' samples and to note any matrix interference. Also included in this section is precision information provided by duplicate analyses and/or fortified-sample duplicate analyses. Since the information included in this section is unique to each individual sample, the acceptance of the analytical batch is not controlled by the results of these bias and precision parameters.

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Section III of the report identifies individual samples that have been qualified for various reasons. Missed holding times, improper sample preservation, etc. must carefully be evaluated using professional judgement regarding the acceptability of the data for its intended use.

Section 1

All Method Blanks and Laboratory Control Samples analyzed for Total Suspended Solids were within acceptance criteria. All Method Blanks analyzed for Total Coliform and *E. coli* were within acceptance criteria.

Section II

All project source samples used for duplicates met acceptance criteria for precision.

Field Blanks

The following field blank samples were above the detection limit for the associated analytical method:

SAMPLE NAME	LAB Sample ID	Sampled Date	Analysis	Result
20180510SAWPAFB	B8E1249-05	05/10/2018 11:00:00	Solids-Total Suspend	4
20180518SAWPAFB	B8E1904-04	05/17/2018 07:45:00	Solids-Total Suspend	2
20180529SAWPAFB	B8E2821-04	05/29/2018 10:00:00	Solids-Total Suspend	2
20180605SAWPAFB	B8F0346-04	06/05/2018 11:30:00	Solids-Total Suspend	2
20180612SAWPAFB	B8F1138-04	06/12/2018 08:30:00	Solids-Total Suspend	2
20180627SAWPAFB	B8F2738-05	06/27/2018 11:15:00	Solids-Total Suspend	4
20180518SAWPAFB	B8G3275-04	07/26/2018 11:30:00	Total Coliform	13
20180809SAWPAFB	B8H1651-04	08/14/2018 08:00:00	Total Coliform	5.2
20181031SAWPAFB	B8J4328-06	10/31/2018 09:40:00	Solids-Total Suspend	2

Field Duplicates

Field duplicate precision was not calculated, due to source samples not identified.

Section III

All sample holding times were met, with the following exceptions listed in the table below. All samples were received with proper preservation. No other sample or data qualifiers were necessary for project samples.

Missed holding times:

SAMPLE NAME	LAB Sample ID	Sampled Date	Analysis
P1-2	B8F2158-01	06/21/2018 08:20:00	Solids-Total Suspend
P1-1	B8F2158-02	06/21/2018 09:05:00	Solids-Total Suspend
P1-3	B8F2158-03	06/21/2018 09:50:00	Solids-Total Suspend
P4-RC2	B8F2158-04	06/21/2018 07:25:00	Solids-Total Suspend
P3-SBC1	B8F2158-05	06/21/2018 10:55:00	Solids-Total Suspend
P4-SBC1	B8F2158-06	06/21/2018 06:45:00	Solids-Total Suspend
P1-6	B8G1412-01	07/12/2018 07:45:00	BT-MMUG-QT2000
P1-6	B8G1412-01	07/12/2018 07:45:00	BT-MMUG-QT2000
WW-C7	B8H0044-01	08/01/2018 07:15:00	BT-MMUG-QT2000
WW-C7	B8H0044-01	08/01/2018 07:15:00	BT-MMUG-QT2000
WW-C3	B8H0044-02	08/01/2018 07:50:00	BT-MMUG-QT2000
WW-C3	B8H0044-02	08/01/2018 07:50:00	BT-MMUG-QT2000
P1-2	B8H1172-01	08/09/2018 07:15:00	Solids-Total Suspend
P1-1	B8H1172-02	08/09/2018 07:50:00	Solids-Total Suspend
P1-3	B8H1172-03	08/09/2018 08:35:00	Solids-Total Suspend
P3-RC1	B8H1172-04	08/09/2018 09:15:00	Solids-Total Suspend
20180809SAWPAFB	B8H1172-05	08/09/2018 09:00:00	Solids-Total Suspend
20180809SAWPADup	B8H1172-06	08/09/2018 09:00:00	Solids-Total Suspend

Note:

The qualifiers contained in the reported results are for informational use. The results associated have been evaluated and believed to be useful in the decision-making process.

All reports were prepared, and all analyses were performed in accordance with a system designed to assure that qualified personnel perform the analyses, use specified EPA approved methods and review the data before it is reported.

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Date: **April 23, 2019**

To: **Orange County Public Works – OC Watersheds**

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Subject: **SAR Watershed-wide Monitoring**
QA/QC *E. coli* and Enterococcus analysis
Season: May 2018 – November 2018

There were 16 sampling events for the 2018 SAR monitoring. A total of 65 water samples were submitted, including 33 site samples (31 for *E. coli* and 2 for Enterococcus), 16 field blanks, and 16 field replicates.

I. Cooler Temperature during sample transport

Acceptable transport temperature for this monitoring program per QAPP is <4°C for each sampling event, although Standard Methods 9060 B allows <10°C for transport.

Transport temperatures were noted on the chain of custody (COC) form at the time samples were received in the laboratory. All documented transport temperatures were below 10°C, meeting the Standard Methods criteria, so all samples were analyzed. For the 05/22/18 and 09/18/18 sampling events, transport temperatures were recorded as 9°C and 7.1°C respectively, which is above the QAPP criteria of < 4°C. Project managers will need to decide on the acceptability of the data for those samples that did not meet the QAPP criteria.

II. Transport times

Samples for regulatory monitoring should be submitted to the lab within 6 hours of collection.

The time the samples were received in the lab was noted on the COC form for each sampling event. All documented transport times were within the allotted 6 hour transport time.

III. Method Blanks

A. Field/Equipment Blanks: 16 field blanks were collected for the SAR Watershed-wide monitoring. One blank was collected for each sampling Event.
18 field blanks were tested for other monitoring programs on the same days that SAR Watershed-wide samples were tested.

B. Laboratory Blanks: 152 blank samples were tested on the days that SAR samples were tested. The lab ran blank samples at a rate of 21% (152/727) during SAR sampling events.

For *E. coli* and Enterococcus, the 16 field blanks that were collected for SAR monitoring all showed no growth with results reported below the reporting limit of <10 MPN/100ml for SM 9223B and SM 9230D methods. The 18 field blanks collected for other monitoring programs also showed no growth for all bacterial indicators tested. Results for all 152 laboratory blanks showed no growth or <1 CFU/100ml which met the established acceptance criteria.

IV. Field Replicates/Lab Duplicates:

A. Field Replicates

Field replicates for the SAR sampling were collected at a frequency of 48% (15/31) for E. coli and 50% (1/2) for Enterococcus. The replicate samples were analyzed for the same parameters as its paired field sample. 13 field replicate analysis for other monitoring programs were submitted on the same days that SAR samples were tested. Results of the field replicate analyses can be used to assess field adherence to sample collection protocols. Also, laboratory precision can be assessed by examining the results from the field sample and its replicate pair. Precision of replicate analysis was determined using Standard Methods, 20th Ed. 9020 B section 8.

1. For field replicate samples submitted for *E. coli* by SM 9223B analysis (Colilert-18), a precision criteria of 0.3074 (3.27 x 0.0940) was established. Of the 15 replicate samples included, 14 samples were within the established precision criteria.

The imprecision for the one sample outside of the precision criteria was determined to be acceptable as the results for the sample and its paired replicate were within the 95% confidence level for the test method.

2. Only one replicate sample was submitted for Enterococcus by SM 9230D analysis (Enterolert).

Precision criteria was not calculated as there were too few replicates submitted, but the results from the replicate results for the one sample submitted was within the 95% confidence level for the test method.

3. For the 13 field replicates submitted for other monitoring programs, a precision criteria of 0.4506 (3.27 x 0.1378) was established. Three samples was above the precision criteria. See Table 1 for summary of samples not meeting precision.

The imprecision is determined to be acceptable due to low count samples where there was only a 1 to 3 colony difference between the sample and the replicate.

B. Laboratory Duplicates

Laboratory duplicates were analyzed on 13% (91/727) of total samples received on the days SAR samples were tested. The results of duplicate analyses are used to assess laboratory precision during analysis. Precision of duplicate analysis was determined using Standard Methods, 20th Ed. 9020 B section 8.

1. For the 91 laboratory duplicates tested, a precision criteria of 0.4222 (3.27 x 0.1291) was established. Seven samples had a difference in results outside the established precision criteria.

Although there were 7 laboratory duplicates outside the established precision criteria value, the imprecision is determined to be acceptable. The imprecision represented low count samples where there was only a 1 to 3 colony difference between the sample and the duplicate.

V. Laboratory Control Samples:

A. *E. coli* with Colilert-18 media (SM 9223B)

2 lots of Idexx Colilert-18 media were used during the SAR monitoring. There are 4 parameters tested for with each new lot:
1 – Escherichia coli culture is used as a positive control with positive reactions for both yellow color production and apple green fluorescence.
2 – Klebsiella pneumoniae culture is used as a positive control for yellow color production, but negative control for apple green fluorescence.
3 – Psuedomonas aeruginosa culture used as a negative control, for both yellow color production and apple green fluorescence.
4 – 1 packet per new lot of media is set up as a sterility control and to check for auto fluorescence.

3 lots of sterile 90ml dilution blank water were used to test for E. coli by SM 9223B. There are 3 parameters tested for with each new lot:

1 – 8 ml of the water blank is inoculated into TSB and incubated to check for sterility.
2 – the entire contents of the dilution blank is poured into a calibrated graduated cylinder to check that the 90ml aliquot is accurate.
3- pH is checked to make sure it is within specifications.

2 lots of sterile Quanti-tray 2000 trays were used to test for E. coli by SM 9223B. Each new lot is checked for sterility.

B. Enterococcus with Enterolert media (SM 9230D)

1 lot of Idexx Enterolert media was used during the SAR monitoring. There are 4 parameters tested for with each new lot:
1 – Enterococcus faecalis culture is used as a positive control with positive reaction for blue fluorescence.
2 – Aerococcus viridans culture is used as a negative control for blue fluorescence.
3 – Serratia marcescens culture is used as a negative control for blue fluorescence.
4 – 1 packet per new lot of media is set up as a sterility control and to check for auto fluorescence.

1 lot of sterile 90ml dilution blank water was used to test for Enterococcus by SM 9230D. There are 3 parameters tested for with each new lot:

1 – 8 ml of the water blank is inoculated into TSB and incubated to check for sterility.
2 – the entire contents of the dilution blank is poured into a calibrated graduated cylinder to check that the 90ml aliquot is accurate.
3- pH is checked to make sure it is within specifications.

1 lot of sterile Quanti-tray 2000 trays was used to test for Enterococcus by SM 9230D. Each new lot is checked for sterility.

All lots of Colilert-18 media, Enterolert media, sterile 90ml dilution water, and Quanti-tray 2000 trays used for the SAR monitoring had acceptable quality control results for all parameters tested. QC records are available.

VI. Laboratory Equipment/Calibration

Temperatures for the 35°C and 41°C incubators were recorded twice daily on temperature charts. Both incubators were calibrated by a contracted vendor every 6 months and documentation is available for review.
The Quanti-Tray sealer used to seal the Quanti-tray 2000 trays for E. coli and Enterococcus had routine monthly maintenance performed and documentation is available for review.

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Summary of Orange County TSS QA/QC

A total of 81 Total Suspended Solids (TSS) samples were submitted during the 2018 dry season, including 33 field quality assurance/quality control (QA/QC) samples. Out of the QA/QC Samples, 10 TSS samples were submitted to and processed by Enthalpy Analytical, 22 were submitted to and processed by Weck Labs, and 1 was submitted to and processed by American Environmental Testing Laboratory (AETL). A summary of the QA/QC samples is provided in Table 1.

I. Cooler Temperature

Cooler temperatures were documented on the chain of custody (COC) form or a laboratory sample receiving checklist at the time samples were received by the laboratories. All temperatures were less than 6°C.

II. Transport times

The time the samples were received by the labs was noted on the COC or checklist for each sampling event. All samples were received within 6 hours of sample collection.

III. Method Blanks

- Field Blanks: 16 field replicates were collected during the 2018 dry season at a rate of 20% (16/81). Of the 17 samples, 11 were tested by Weck Labs and 5 by Enthalpy Analytical.

IV. Field Replicates:

- Field Replicates: 17 field replicates were collected during the 2018 dry season at a rate of 21% (17/81). Of the 17 samples, 11 were tested by Weck Labs, 5 by Enthalpy Analytical, and 1 by AETL.

Table 1 Field QA/QC Samples

Sample Date	Sample Time	Site ID	Sample Type	Result	Units	Lab
5/7/2018	9:49	P3-OC3	Duplicate	BDL	mg/L	Weck
	9:44	P3-OC3	Blank	BDL	mg/L	Weck
5/14/2018	12:20	P3-OC3	Duplicate	BDL	mg/L	Weck
	12:21	P3-OC3	Blank	BDL	mg/L	Weck
5/22/2018	11:20	P3-OC3	Duplicate	6	mg/L	Weck
	11:20	P3-OC3	Blank	BDL	mg/L	Weck
5/31/2018	11:26	P3-OC3	Duplicate	BDL	mg/L	Weck
	12:30	P3-OC3	Blank	BDL	mg/L	Weck
6/6/2018	10:16	P3-OC3	Duplicate	7	mg/L	Weck
	10:46	P3-OC3	Blank	BDL	mg/L	Weck
8/23/2018	11:50	P3-OC1	Duplicate	7	mg/L	Weck
	12:50	P3-OC1	Blank	BDL	mg/L	Weck
8/28/2018	12:13	P3-OC1	Duplicate	BDL	mg/L	Weck
	13:04	P3-OC1	Blank	BDL	mg/L	Weck
9/5/2018	8:52	P3-OC1	Duplicate	6	mg/L	Weck
	9:28	P3-OC1	Blank	BDL	mg/L	Weck
9/10/2018	10:09	P3-OC1	Duplicate	BDL	mg/L	Weck
	10:14	P3-OC1	Blank	BDL	mg/L	Weck
9/18/2018	09:41	P3-OC1	Duplicate	BDL	mg/L	Weck
	11:27	P3-OC1	Blank	BDL	mg/L	Weck
9/13/2018	10:05	P4-OC3	Duplicate	12	mg/L	Weck
	11:55	P4-OC3	Blank	BDL	mg/L	Weck
10/29/2018	10:57	P3-OC11	Duplicate	5.1	mg/L	Enthalpy
	12:35	P3-OC11	Blank	BDL	mg/L	Enthalpy
11/7/2018	11:01	P3-OC9	Duplicate	2.3	mg/L	Enthalpy
	13:16	P3-OC9	Blank	BDL	mg/L	Enthalpy
11/13/2018	10:16	P3-OC7	Duplicate	9.3	mg/L	Enthalpy
	12:56	P3-OC7	Blank	BDL	mg/L	Enthalpy
11/20/2018	11:35	P3-OC8	Duplicate	13.8	mg/L	Enthalpy
	12:04	P3-OC8	Blank	BDL	mg/L	Enthalpy
11/27/2018	11:31	P3-OC11	Duplicate	2.2	mg/L	Enthalpy
	12:38	P3-OC11	Blank	BDL	mg/L	Enthalpy
12/12/2018	10:38	P3-OC6	Duplicate	11	mg/L	AETL

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