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Santa Ana Watershed Project Authority

Santa Ana River Regional Bacteria Monitoring Program Annual Report: 2021-2022

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Acronyms and Abbreviations

AgSEP	Agricultural Source Evaluation Plan
Babcock	Babcock Laboratories, Inc.
Basin Plan	Santa Ana Region Basin Plan
BMP	Best Management Practice
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
IDDE	Illicit Discharge Detection and Elimination
mgd	Million Gallons Per Day
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
RBMP	Regional Bacteria 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
STV	Statistical Threshold Value
State Water Board	State Water Resources Control Board
SWAMP	California's Surface Water 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

Executive Summary

The Stormwater Quality Standards Study (SQSS) Task Force was formed in 2002 to embark upon a deliberate and measured approach to protect recreational uses in inland surface waters in the Santa Ana Basin. At the time, there were few examples of such a group including water quality regulators and watershed stakeholders spread across three counties, and encompassing a mix of MS4s, agricultural groups, state lands, and POTWs coalescing together for common values. The SQSS Task Force collaborated on a Basin Plan Amendment (BPA) that pulled from 17 recreational use surveys, six use attainability analyses (UAAs), economic feasibility assessments, hydrologic analysis, CEQA analysis, and many other special studies. Changes to the Basin Plan were approved by EPA Region 9 in April 2015 and allowed for the watershed stakeholders to focus resources on areas of highest priority to protect public health. The BPA required development and implementation of a Regional Bacteria Monitoring Program (RBMP). The SQSS Task Force was sunsetted and a new Task Force was formed to oversee the RBMP: a program of routine bacteriological data needed to meet key objectives of the BPA, as follows:

Priority 1: Monitor fecal bacteria conditions in the areas of greatest risk of exposure including lakes and streams with designated beaches and active recreational use to ensure water quality objectives (WQOs) are being met or actively addressed

Priority 2: Evaluate effectiveness of implementation actions taken to comply with the Middle Santa Ana River (MSAR) bacteria TMDL

Priority 3: Collect data to evaluate status and trends in other bacteria impaired waters throughout the Santa Ana Basin

Priority 4: Ensure that waters re-designated as 'REC2 Only' meet anti-degradation requirements in the absence of a numeric WQO

For each of these priority categories, data is synthesized at a summary level and key interpretive findings from this 2021-22 annual report are highlighted in the following sections.

Priority 1 – Waterbody Segments with Greatest Risk of Exposure

Fecal bacteria conditions in Priority 1 waters remain generally low and support recreational use with the exceptions of Lake Elsinore at Elm Grove Beach (P1-2-ELM) and the two SAR sites (WW-S1 and WW-S4) during both warm and cool seasons (Figure ES-1). In 2019, enterococcus was included the list of lab analytes for Lake Elsinore samples based on Statewide Bacteria Provisions (Section 1.1.2), which indicate enterococcus as the primary metric for bacteriological water quality in waters with typical salinities greater than 1 ppth. The results are shown in Figure ES-2, which indicate the 2021 dry season was of particular concern.

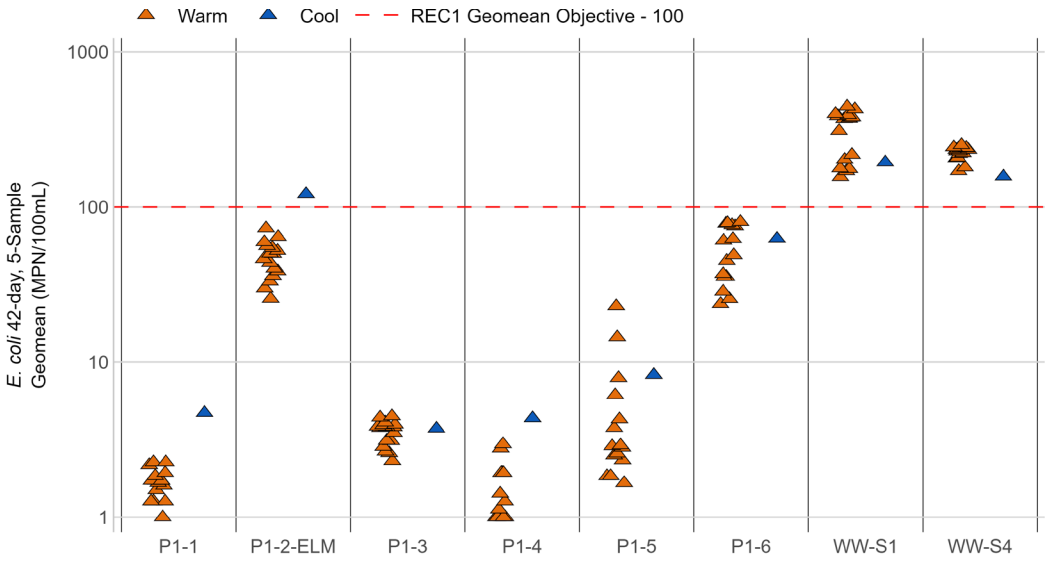

Figure ES-1. *E. coli* Concentrations during Dry Weather in Warm (20 consecutive weeks) and Cool (5 consecutive weeks) Seasons in 2021-2022

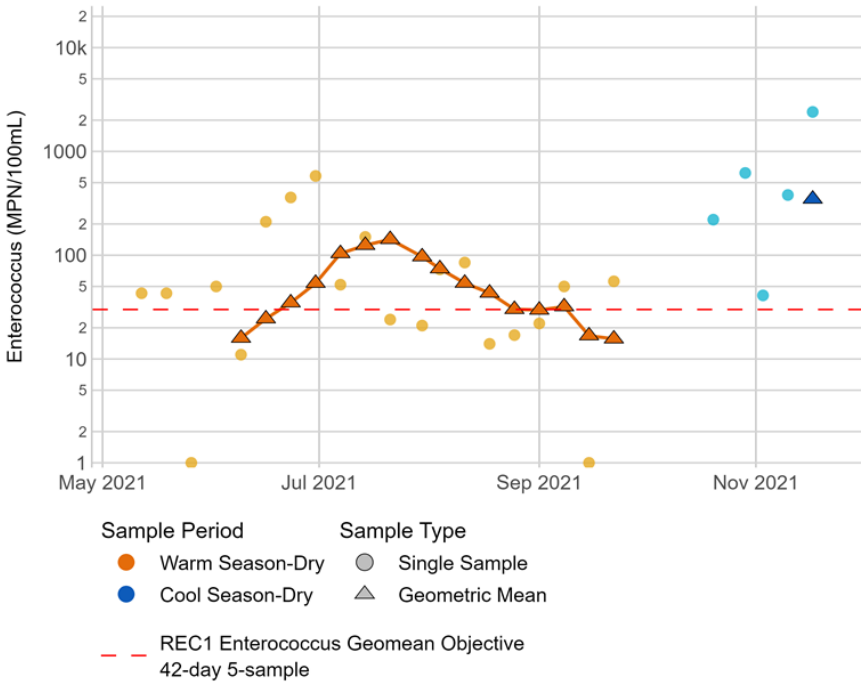

Figure ES-2. Enterococcus Concentrations at Lake Elsinore at Elm Grove Beach (P1-2-ELM) during Dry Weather in Warm (20 consecutive weeks) and Cool (5 consecutive weeks) Seasons in 2021-2022

The Lake Elsinore sampling location was changed to focus sample collection at Elm Grove Beach in 2021 from the previous sampling location at the Boat Launch after coordination with the City of Lake Elsinore. This was done to achieve the Priority 1 goal of monitoring locations with the greatest risk of exposure. Enterococcus concentrations at the boat launch site in Lake Elsinore

had shown to be low in 2019 and 2020 with a few exceptions. As shown in Figure ES-2, enterococcus measurements began and remained relatively high throughout the 2021 dry season at Elm Grove Beach. This data was shared with the City of Lake Elsinore staff and the city initiated a source identification study. The ultimate goal of the source identification study is to find and mitigate or eliminate the source. Possible bacteria sources at Elm Grove Beach include swimmers, unhoused population, leaking septic systems, urban dry weather flow, wildlife, and the East Valley Municipal Water District (EVMWD) wastewater treatment plant outlet. As of April 2022, the City of Lake Elsinore is conducting a HF183 source identification study and will share results with the RBMP team as Elm Grove Beach continues to be monitored in the 2022 dry season.

Priority 2 – Waters Subject to an Existing TMDL

This RBMP annual report characterizes fecal bacteria conditions within the MSAR TMDL waters: Santa Ana River Reach 3, Mill-Cucamonga Creek, and Chino Creek. Figure ES-3 shows the calculated geomean concentrations for both the warm and cool 2021 dry season. In 2021, no site was in compliance with the TMDL WLA for the entirety of the dry season, with rolling geomeans compliance percentages of 75, 12, 12, 0 and 0, at Prado Park Lake, Chino Creek, Mill-Cucamonga Creek, SAR at MWD Crossing, and SAR at Pedley Avenue, respectively. The Task Force has been busy with source investigations in the past year with a key focus on assessing the role of MS4 sources on general fecal bacteria concentrations within the TMDL waters. Several notable findings and ongoing special studies are presented below.

The Task Force has collaborated with the SAWPA-led special study to assess the impacts of homeless encampments on water quality within the mainstem of the SAR. The study included four sampling events during dry weather in the cool season at six locations; upstream and downstream of the Market Street, Mission Avenue, and Van Buren Boulevard Bridge crossings. Results from the first two sampling events showed human associated Bacteroides HF183 below detection at all sites, suggesting that direct open defecation by people within the river bottom is not an important source of fecal bacteria. The study was adapted to add additional DNA markers for dogs and pigs in the final two sampling events. Results of qPCR analysis showed elevated levels of the Pig2Bac marker during the final two sampling events at all three sites downstream of the Mission Avenue Bridge. This same location within the SAR Reach 3 is where the RBMP has often seen a sharp rise in general *E. coli* concentration since the addition of the WW-MISSION site in 2019 (Figure ES-4). In 2021, the five week *E. coli* geomean increased from 20 to 287 mpn/100mL between the Riverside Drive and Mission Avenue. Feral pigs may be a significant in-stream contributor to general *E. coli* loads within Reach 3 of the Santa Ana River. Additional data collection is recommended within the SAR as well as Mill-Cucamonga Creek to assess whether a correlation between the Pig2Bac DNA marker (measured as gene copies per 100mL) and general *E. coli* concentration exists; which would present a strong case that defecation by feral pigs within the large riparian corridor causes the impairment of recreational water quality standards. Given that feral pigs are an uncontrollable wildlife source, such a finding would make attainment of REC1 WQOs through implementation of the CBRP or any future MS4 watershed plan, technically infeasible. Thus, it is paramount to better understand the impact of this source of fecal bacteria prior to any determinations with regard to the effectiveness of the CBRP, reasonable assurance analysis of future watershed plans, and assessment of TMDL compliance status of the MS4s within the MSAR watershed.

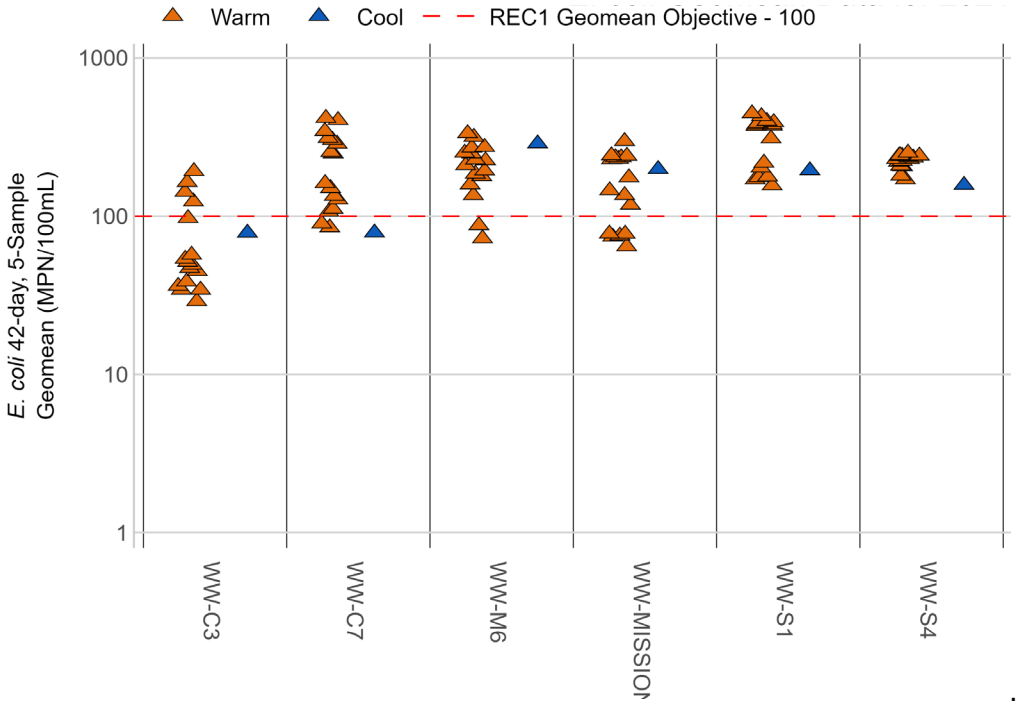

Figure ES-3. *E. coli* (MPN/100 mL) and Geomeans for Priority 2 Waters in 2021-2022

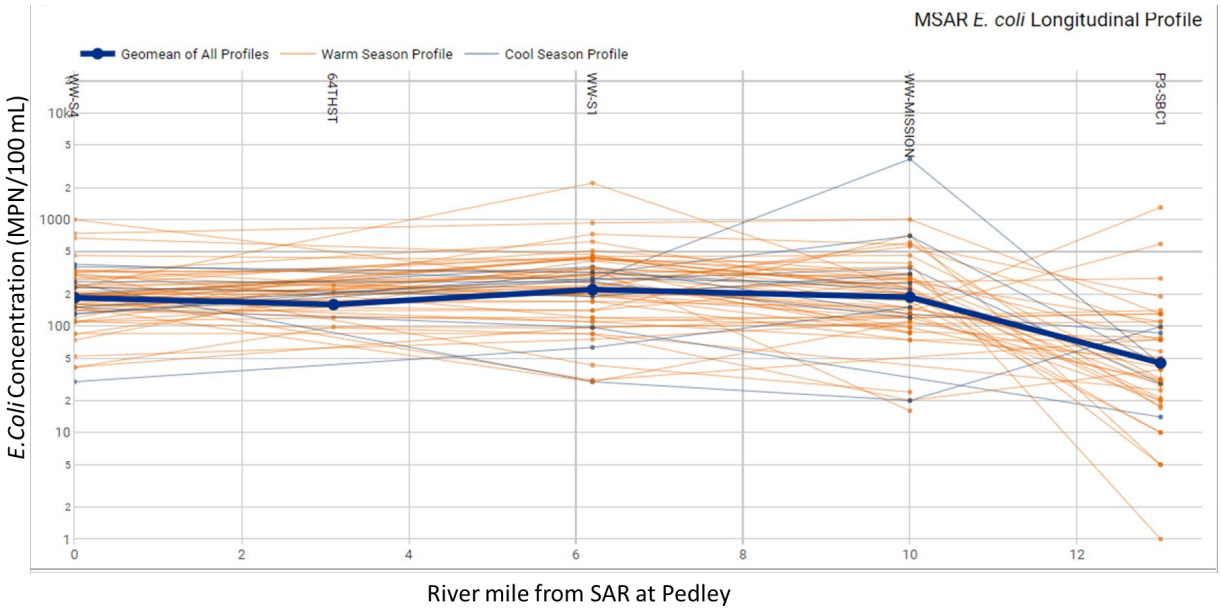

Figure ES-4. *E. coli* (MPN/100 mL) Longitudinal Plot of Mainstem Santa Ana River

Starting in 2005, extensive efforts have been taken by the MSAR bacteria TMDL Task Force to meet the TMDL requirements, including development and ongoing implementation of watershed control plans for urban and agricultural sources. The MSAR bacteria TMDL Task Force conducted comprehensive bacteria loading analyses in 2007, 2012, and 2019 that have shown inflows of *E. coli* to the TMDL waters have declined since the TMDL was adopted. However, there has not been

a proportional reduction of *E. coli* concentrations within the TMDL waters to meet numeric targets at the compliance monitoring locations. This condition is most apparent by interpretation of 44 paired samples at Mill-Cucamonga Creek (WW-M6) and Cucamonga Creek at Hellman Avenue (P4-SBC1). Nearly all of the MS4 drainage area upstream of the Mill-Cucamonga Creek TMDL compliance monitoring location is upstream of Cucamonga Creek at Hellman Avenue, where the channel transitions from concrete lined to a natural watercourse. Thus, it would be reasonable to expect the bacteria load at P4-SBC1 would be closely related to the nearby downstream site WW-M6. Surprisingly, there is no evidence of any correlation between the two datasets (Figure ES-5). This could indicate that fecal bacteria from collective inputs from all MS4s to Cucamonga Creek are not causing TMDL impairment in Mill-Cucamonga Creek. The Mill Creek Wetland stormwater BMP diverts a portion of the flow from the Hellman Avenue location for treatment and releases back to Mill-Cucamonga Creek just upstream of the TMDL compliance monitoring location. Comprehensive analysis of the 2017-2022 data collected by SBCFCD along a longitudinal profile in Cucamonga Creek (referred to as the 10-week study) is recommended to evaluate the role of the Mill Creek Wetlands on fecal bacteria within the downstream TMDL waterbody.

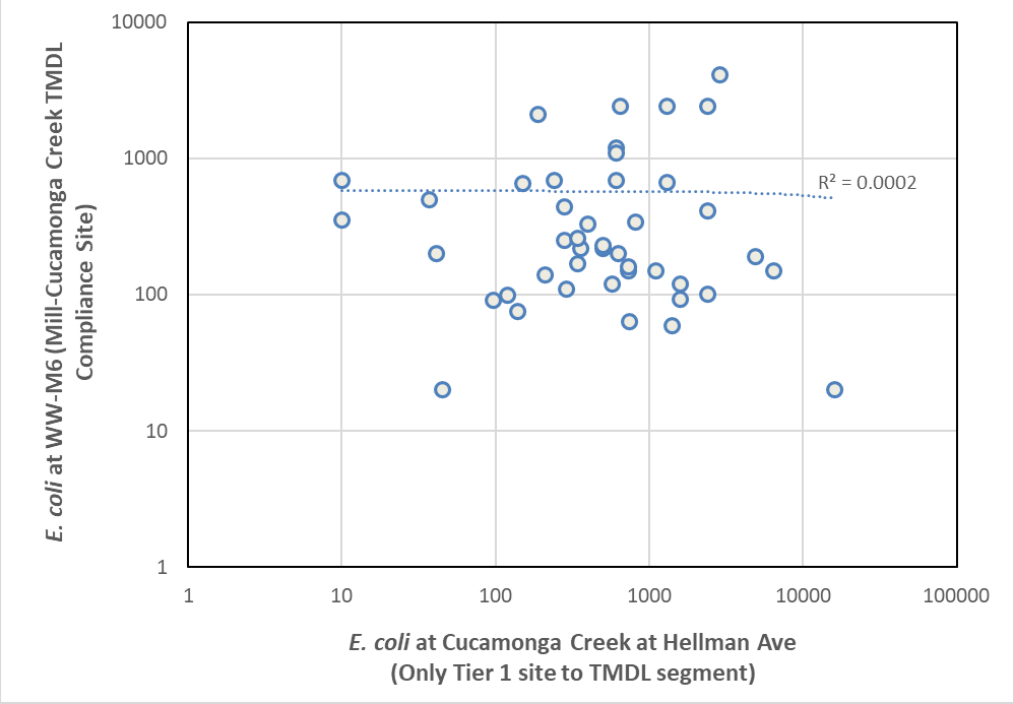

Figure ES-5. *E. coli* Concentrations (MPN/100 mL): Correlation between Mill-Cucamonga Creek (WW-M6) and Cucamonga Creek at Hellman Ave (P4-SBC1)

Priority 3 – Bacteria Impaired Waters Without an Existing TMDL

The Task Force has collaborated with the Regional Board to collect five consecutive-week samples each dry season to characterize current fecal bacteria concentrations in waters that were added to the 303(d) list but do not have a TMDL. In some cases, the basis for original 303(d) listing involved data collected over 15 years ago and new monitoring data collected through this RBMP has provided updated information.

In 2020, it was determined that an appropriately sized database had been collected for many of the Priority 3 sampling locations included in the RBMP and many of these sites would be transitioned to site-specific source investigations to determine and eliminate the source of the waterbody impairment. For 2021, this left the continued sampling of six sites: Goldenstar Creek (P3-RC1), Santa Ana River Reach 4 (P3-SBC1), Warm Creek (P3-SBC4), and three San Timoteo reaches 1-3 sites (P3-SBC2, P3-SBC3, and P3-RC3).

Figure ES-6 shows the results from the 2021 dry season sampling. Three sites along San Timoteo Creek have been added to the RBMP, allowing for assessment of the water quality from the furthest upstream (P3-RC3) to the downstream end just prior to entry to the mainstem SAR (P3-SBC2). Bacteria concentrations rise sharply in Reach 1A, which may be attributed in part to the variation in flows, which are the highest in Reach 3 prior with inputs from agricultural/rural lands as well as the City of Beaumont's wastewater treatment plant. Reach 2 contains the San Timoteo groundwater recharge basin which reduces the flows prior to reaching San Timoteo Creek Reach 2 sampling point (P3-SBC3). The results indicate the potential sources of the bacteria impairment are both upstream of San Timoteo Reach 3 and from urban flows to Reach 1A.

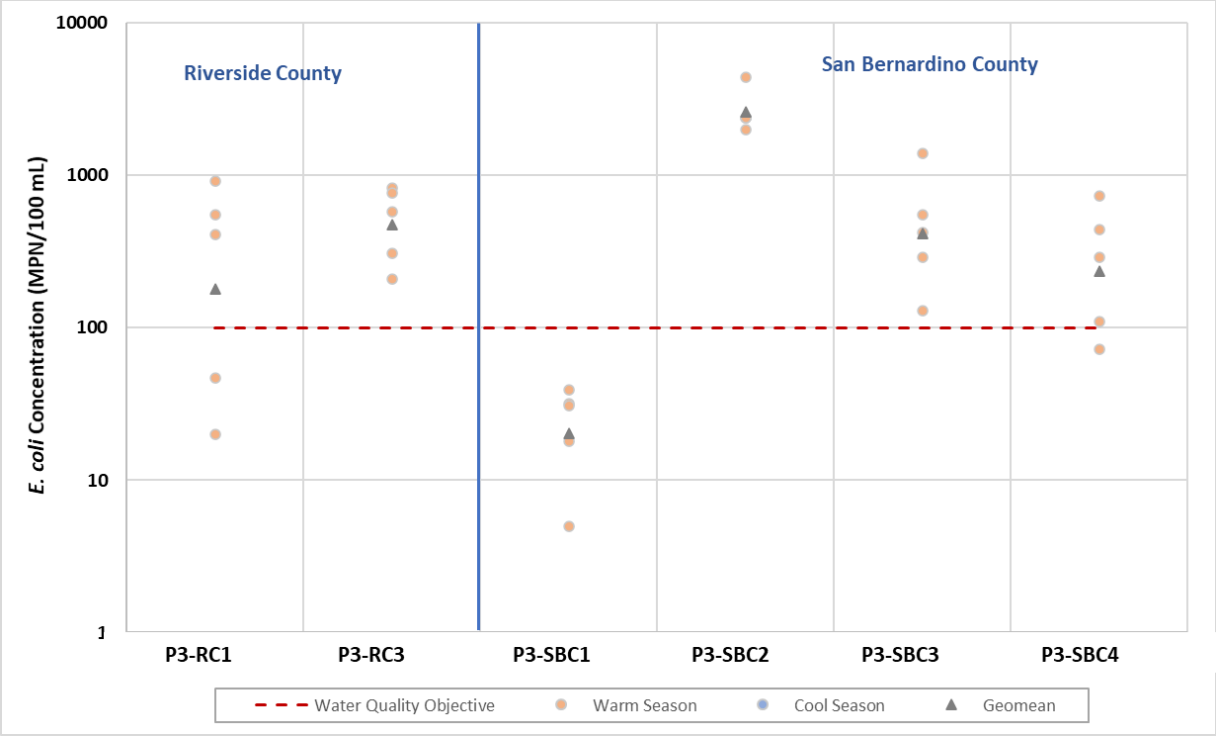

Figure ES-6 Distribution of *E. Coli* Concentration Measurements at Priority 3 Sites

Priority 4 – Waters Re-Designated as REC2 Only

A key component to the 2012 BPA involved the completion of six use attainability analyses (UAAs) that served as the basis for EPA approval of changes to the beneficial use from REC1 and REC2 to REC2 Only in eight waterbodies: Cucamonga Creek Reach 1, Temescal Creek Reach 1a and 1b, Santa Ana Delhi Channel Reaches 1 and 2, Greenville-Banning Channel Reach 1, and tidal prisms for Greenville-Banning and Santa Ana Delhi Channels.

The Basin Plan describes REC2 Only waters as having "…relatively brief incidental or accidental water contact that is limited primarily to the body extremities (e.g., hands or feet) is generally deemed REC 2 because ingestion is not considered reasonably possible." Numeric water quality objectives included in the Basin Plan for REC2-Only waters serve to meet antidegradation policy requirements. Statistical analysis of historical datasets on the re-designated waters was performed to derive an anti-degradation target as a statistical threshold value set at the 75th percentile of the data distribution. Each year, the RBMP collects a single sample in these waters to be compared with the site-specific thresholds. If there is an exceedance, follow-up samples are collected to assess if the event falls within the natural variability of the historical data (i.e., there is a 1 in 4 chance that a sample may exceed the 75th percentile without indicating any antidegradation is occurring).

In 2021-2022 monitoring period, the threshold value was exceeded at both Greenville Banning Channel and Cucamonga Creek at Hellman Avenue. Three follow-up samples were collected at both sites. At Greenville-Banning channel, Orange County is continuing sampling monthly.

Data at Cucamonga Creek at Hellman Avenue was combined with data collected by San Bernardino's 10-week study, which has been collecting weekly bacteria samples throughout Cucamonga Creek Reach 1 since 2016. Section 4.5.2 provides more information on the Cucamonga Creek 10-week study. The 10-week study is a Tier 2 source investigation and will provide the data to support identification and elimination of upstream sources.

Retrospective

The Regional Monitoring Program Task Force is continuing to collaborate on common objectives to protect recreational use in the region's inland surface waters. We have used collective understanding of the watershed and scientific advancements to address fecal bacteria impairments and used the tools afforded in the Clean Water Act to prioritize use of resources to protect public health. The addition of the RBMP digital dashboard in 2021 has provided a platform for collaboration and transparency between the Task Force and the general public as well as regulators and other governmental agencies. In addition, the Task Force has continued to stay at the forefront of environmental science and technology through the implementation of innovative studies using bacterial DNA sampling to determine or eliminate causes for degraded water quality. As an example, evidence from the Homelessness Encampment study performed by GEI (2022) has led to the addition of pig DNA samples within the mainstem SAR sampling sites to the 2022-2023 RBMP. This may lead to the discovery of an uncontrollable bacteria source within the SAR while utilizing the established monitoring program to manage costs associated with the sampling. It is apparent that the approach is working; evidenced by improving water quality conditions in most of the SAR basin's inland surface waters and continuing significant investments in studies and implementation projects in the waters with the highest risk of exposure.

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Section 1
Introduction

The Santa Ana River (SAR) Watershed Bacteria Monitoring Program (RBMP) was developed to achieve the following objectives through bacteria monitoring:

- 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 RBMP 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 RBMP 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

- Revision of 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 the BPA in collaboration with the Stormwater Quality Standards Task Force (SWQSTF), composed 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 RBMP 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/100 mL, 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.
- Enterococcus: For all waters where the salinity is greater than 1 ppth 5 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, except for cases involving a site-specific standard or if an existing TMDL was developed with targets based on prior regional Basin Plan REC1 WQOs (such as the MSAR Bacteria TMDL). **Section 2.1.1** describes the MSAR Bacteria TMDL and associated numeric targets, which differ from those included in the Statewide Bacteria Provisions. This comprehensive monitoring program was developed to facilitate data collection needed to

[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

evaluate both TMDL numeric targets and Statewide Bacteria Provisions WQOs for the TMDL waters. Compliance metrics, however, are 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 composed 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 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 75thpercentile of the fitted lognormal distribution was selected as the antidegradation target when relying on a single sample result. Table 1-1 summarizes the antidegradation targets for the REC2 waterbodies included in the SAR RBMP.

Table 1-1. Antidegradation 75th Percentile Targets for Waterbodies with a REC2 Only Designation in the SAR RBMP

Waterbody	*E. coli* (MPN/100 ML)	Enterococcus (MPN/100 ML)
Temescal Creek Reach 1a/1b	725 MPN/100 mL	
Santa Ana Delhi Channel Reach 1/2	1,067 MPN/100 mL	
Santa Ana Delhi Channel in Tidal Prism[1]		464 MPN/100 mL
Greenville-Banning Channel in Tidal Prism[1]		64 MPN/100 mL
Cucamonga Creek Reach 1	1,385 MPN/100 mL	

[1] Salinity at site is greater than 1 ppth 95 percent or more of the time

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.

This risk-based approach, which is designed to guide all aspects of protecting water contact recreation, provides the foundation for this RBMP. 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 RBMP is structured to direct water quality monitoring resources to the highest priority waterbodies.

1.2.1 Priority Designation

Basin Plan requirements for an RBMP 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 waterbodies 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.
- 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 RBMP, which prioritizes waterbodies as follows:

- *Priority 1*: 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:* 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 in these waters focuses on evaluating progress toward attainment with the water quality standard for these impaired waters.
- *Priority 3:* Monitor 303(d)-listed or impaired waterbodies where a TMDL has not yet been developed. For these Priority 3 sites, the RBMP includes periodic sample collection for 5 consecutive weeks on an annual basis. Data from Priority 3 sites are used to evaluate compliance with the Santa Ana region *E. coli* water quality objective.
- *Priority 4*: 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 are used to evaluate compliance with the site-specific antidegradation targets (Table 1-1).

1.2.2 Monitoring Plan and Quality Assurance Project Plan

To support the watershed-wide SAR RBMP, 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 RBMP Monitoring Plan and QAPP[9] to support this monitoring program. The monitoring documents were last updated in 2022.

1.2.3 Annual Report

This Annual Report summarizes the results of the 2021-2022 monitoring efforts. Annual Reports summarizing monitoring efforts from 2016-2021 are available from SAWPA.[8] Previous seasonal water quality reports prepared only for the sites subject to the MSAR Bacteria TMDL (2007 – 2015) are also available.[9]

[8] SAR RBMP Annual Monitoring Reports 2016-2020: https://sawpa.org/task-forces/regional-water-quality-monitoring-task-force/#geographic-setting
[9] 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 2021-2022 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 for nearly 100 miles from its headwaters to the Pacific Ocean.

2.1.1 MSAR Bacteria TMDL

Currently, one bacteria TMDL has been adopted for inland freshwater streams in the Santa Ana River Watershed: the MSAR Bacteria TMDL, which was adopted by Santa Ana Water Board in 2005[10] and became effective when approved by the EPA 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 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.

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

Per the TMDL, the above compliance targets for fecal coliform become ineffective upon EPA approval of the BPA.[11]

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.[12] 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.[13] This TMDL monitoring program has been incorporated into the SAR RBMP.

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.[14]

2.1.2 Major Geographic Subareas

The Santa Ana River watershed can be divided into 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.

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

[12] Page 6 of 15, Table 5-9 of Attachment A to Santa Ana Water Board Resolution R8-2005-0001

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

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

- 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.

2.1.3 Middle Santa Ana River Watershed

The MSAR watershed exists within the region Santa Ana River above Prado Dam and Chino Basin Region and covers approximately 488 square miles. The MSAR watershed 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).

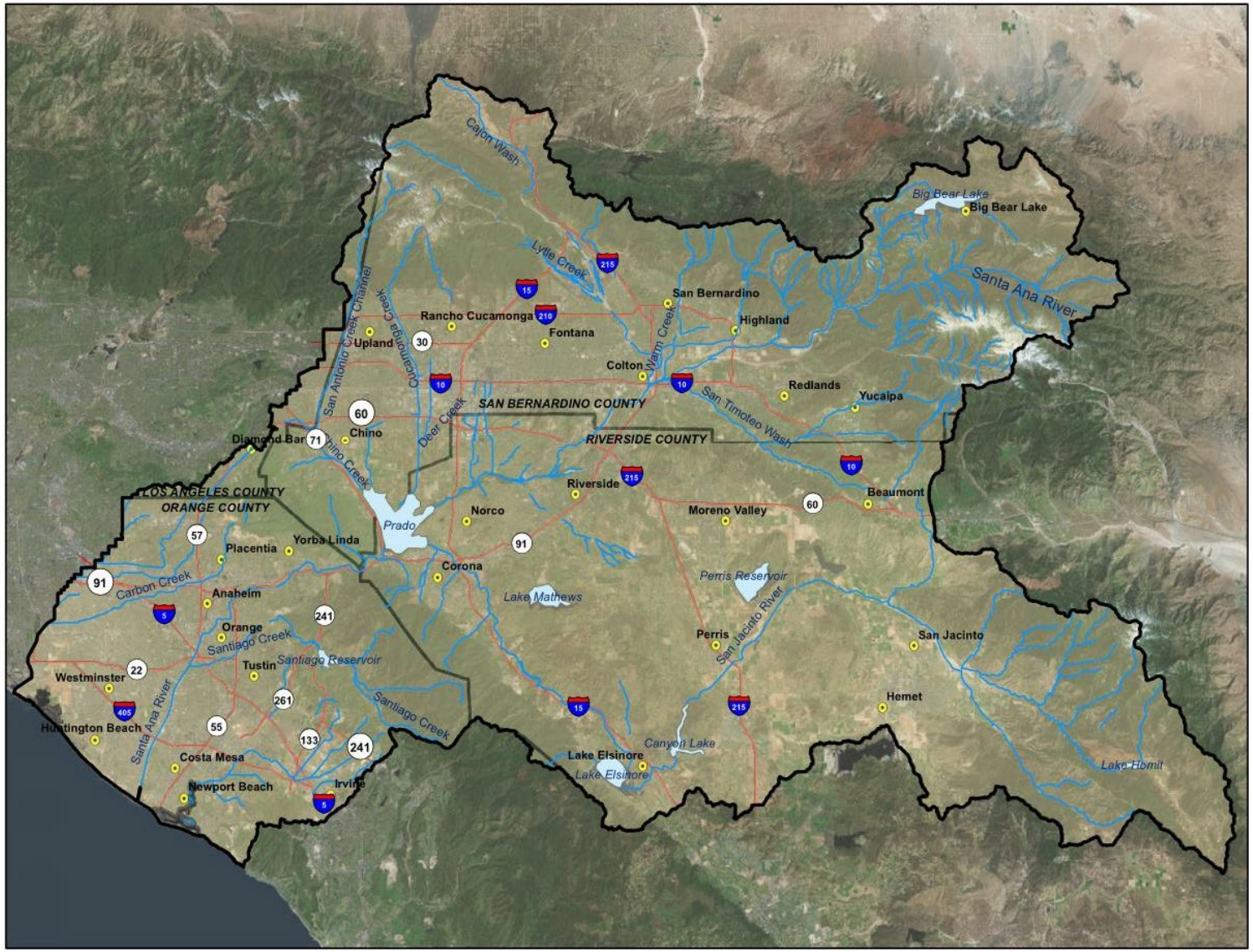

Figure 2-1. Santa Ana River Watershed and Location of Orange, Riverside and San Bernardino Counties (Source: SAWPA)

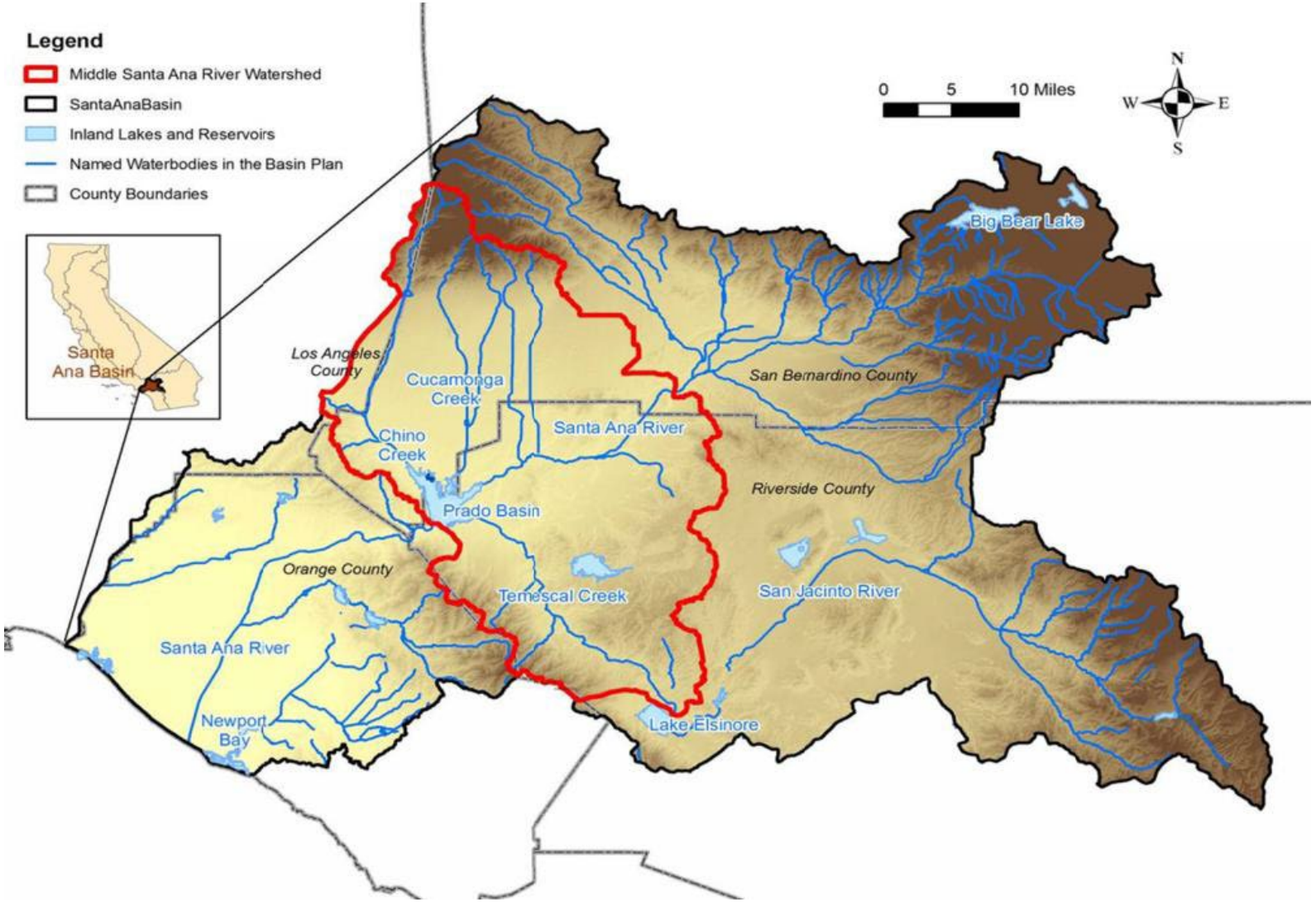

Figure 2-2. Middle Santa Ana River Watershed

Land uses in the MSAR watershed include urban, agriculture, and open space. Although originally developed as an agricultural area, the watershed continues to urbanize rapidly. 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.

2.1.4 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[15] and Table 2-2 summarizes the total monthly rainfall data from each location for the 2021-2022 monitoring 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

[15] 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 2021 at Key Rainfall Gages

Station No.	Rainfall Gage	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
178	Riverside North	2.09	0.02	1.29	0.00	0.00	0.00	0.22	0.00	0.01	0.57	0.00	4.86	9.06
179	Riverside South	1.46	0.02	1.29	0.00	0.00	0.00	0.11	0.05	0.02	0.49	0.00	3.90	7.34
35	Corona	1.91	0.07	1.39	0.00	0.00	0.00	0.06	0.00	0.01	0.59	0.00	7.46	11.49
131	Norco	1.59	0.02	1.37	0.00	0.00	0.00	0.08	0.00	0.01	0.21	0.02	4.24	7.54
67	Elsinore	1.52	0.04	1.30	0.00	0.00	0.01	0.13	0.00	0.00	0.46	0.01	3.60	7.07
90	Idyllwild	3.99	0.44	3.12	0.32	0.02	0.02	2.36	0.02	0.49	1.40	0.00	10.1	22.28
9022	Fawnskin	0.36	0.00	4.96	3.11	0.04	0.00	0.00	0.75	0.00	0.00	0.86	0.44	10.52
2965	Lytle Creek Canyon	5.39	1.81	0.87	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.51	0.00	17.40
2808	Highland Plunge Creek	5.31	1.54	2.16	0.28	0.12	0.08	0.51	0.04	0.00	0.55	0.00	0.00	10.59
61	Tustin-Irvine Ranch	2.14	0.09	1.83	0.05	0.03	0.00	0.04	0.01	0.28	0.90	0.00	6.5	11.87
169	Corona del Mar	2.14	0.04	1.45	0.06	0.14	0.02	0.03	0.00	0.02	1.06	0.01	4.35	9.32
219	Costa Mesa Water District	1.92	0.12	1.18	0.01	0.22	0.00	0.03	0.04	0.03	0.71	0.00	4.56	8.82
163	Yorba Reservoir	1.97	0.08	1.2	0.01	0.01	0.00	0.15	0.00	0.00	0.43	0.00	5.15	9.00
5	Buena Park	1.68	0.2	1.26	0.00	0.12	0.00	0.09	0.01	0.00	0.42	0.00	5.12	8.90

During the 2021 monitoring season, rainfall varied throughout the watershed with heavier precipitation recorded in the upper watershed and during winter months. While smaller storms occurred during the summer months, all dry weather monitoring adhered to the dry weather condition established in the Monitoring Plan, which states that dry weather samples be collected only if there is no measurable rainfall in the preceding 72-hour period.

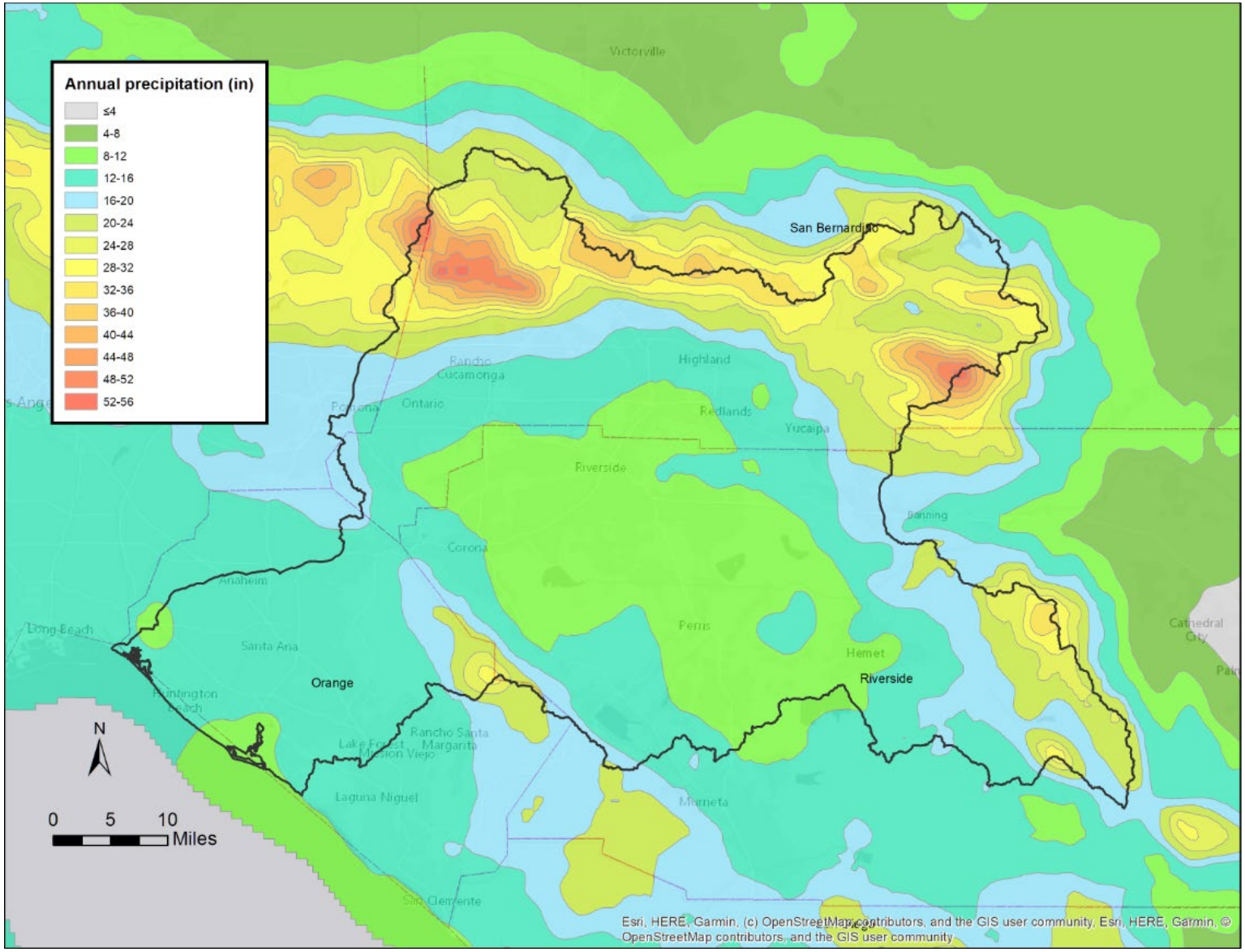

Figure 2-3. Historical Average Annual Rainfall in the Santa Ana River Watershed from 1980-2019

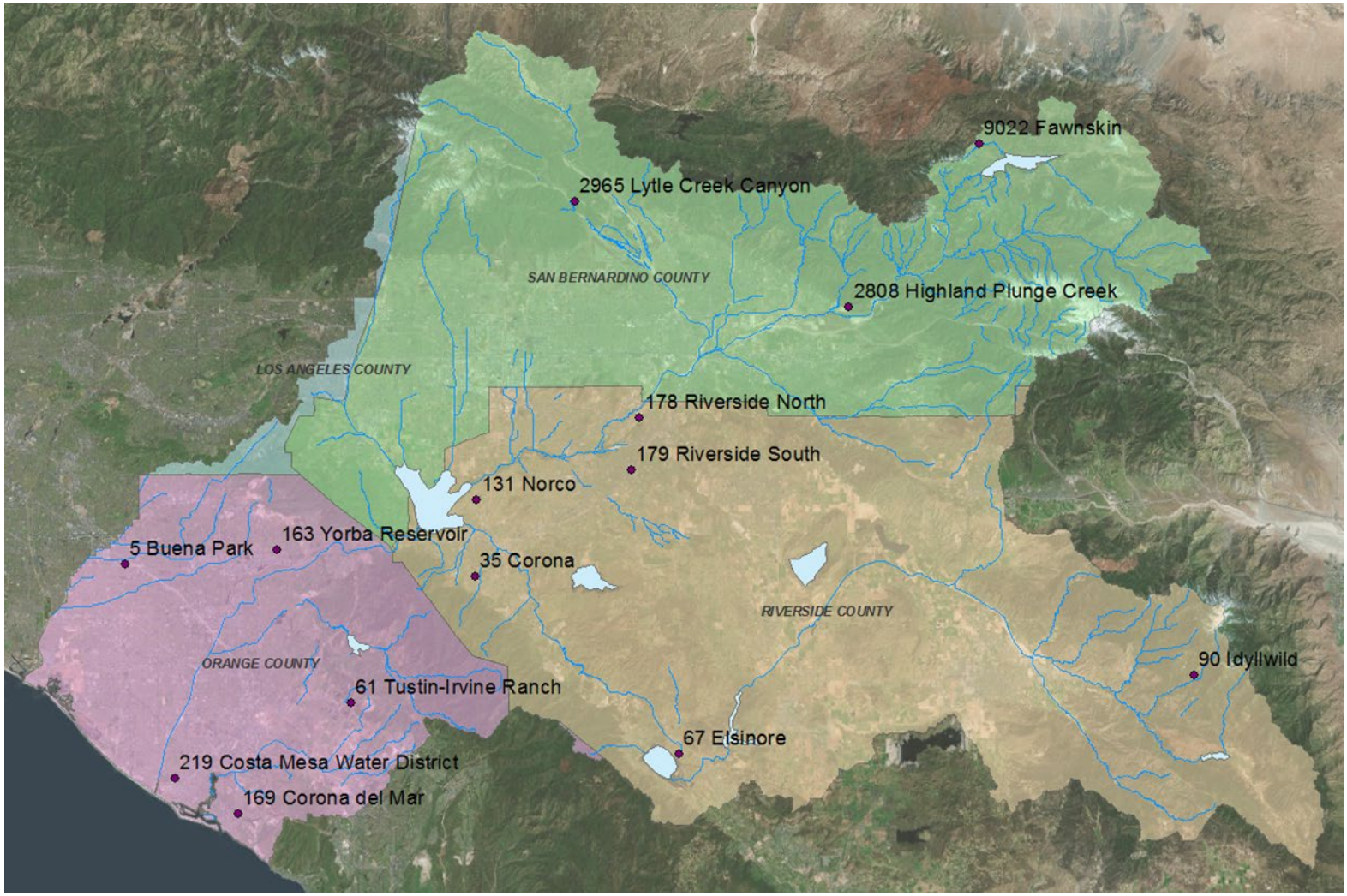

Figure 2-4. Key Rainfall Gages

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 in Riverside County and three sites are in San Bernardino County (Table 2-3, Figure 2-5).

Because 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 are also 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-ELM	Lake Elsinore[1]	Riverside	33.6664	-117.3356
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

[1]In 2021, the sampling location for Lake Elsinore was changed from the boat ramp to Elm Grove Beach

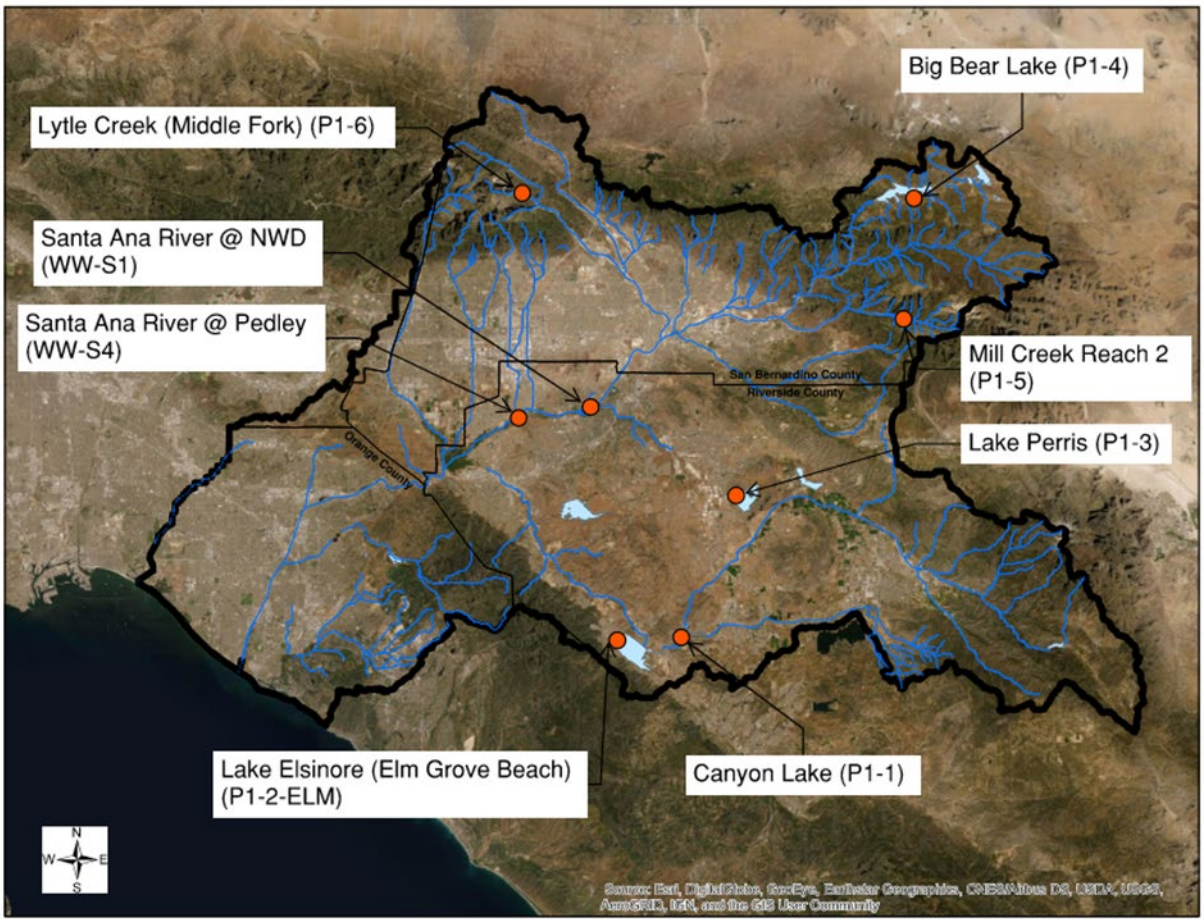

Figure 2-5. Priority 1 Monitoring Sites

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[16] (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.

[16] See Section 4.1.1 in the Monitoring Plan for the original basis for the selection of these monitoring 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
MISSION	Santa Ana River at Mission Blvd. Bridge	Riverside	33.9906	-117.3951

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 for which no TMDL has been adopted. Eight waterbodies were not included in the original RBMP for reasons described in Section 3.3.3.2 of the Monitoring Plan. Of the fifteen waterbodies that are monitored in the RBMP in 2021-2022, nine are in Orange County, two are in Riverside County, and four are in San Bernardino County (Figure 2-7). San Timoteo Creek Reach 3 (P3-RC3) was added in the 2020-2021 sampling season based on the 2014/16

303(d) listing. 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
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-RC3	San Timoteo Creek Reach 3	Riverside	34.0025	-117.1645
P3-SBC1	Santa Ana River Reach 4 above S. Riverside Avenue Bridge	San Bernardino	34.0248	-117.3628
P3-SBC2	San Timoteo Creek Reach 1A at Anderson St.	San Bernardino	34.0615	-117.2629
P3-SBC3	San Timoteo Creek Reach 2 at San Timoteo Canyon Rd.	San Bernardino	34.0615	-117.2629
P3-SBC4	Warm Creek below Fairway Dr.	San Bernardino	34.0646	-117.3072

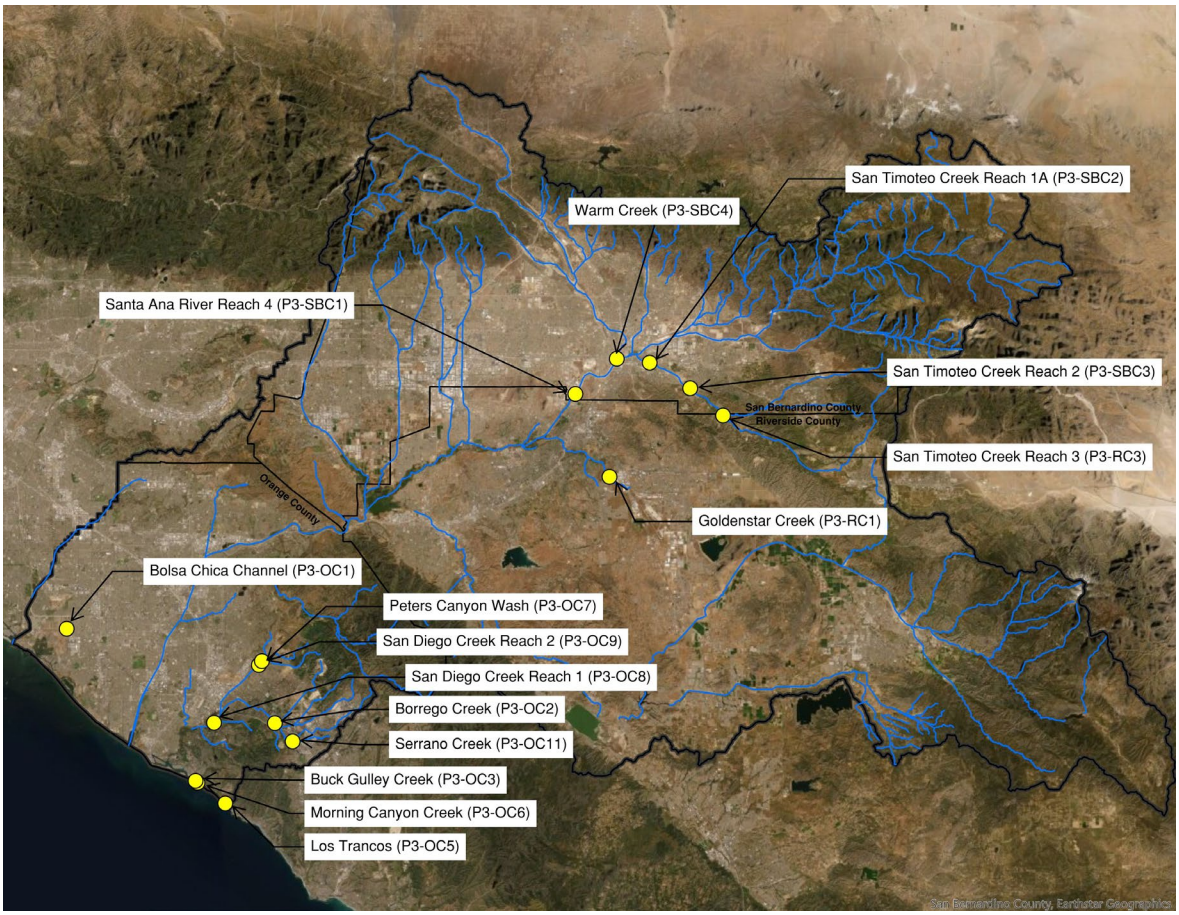

Figure 2-7. Priority 3 Monitoring Sites

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. The remaining two Priority 4 waterbodies are 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 were 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

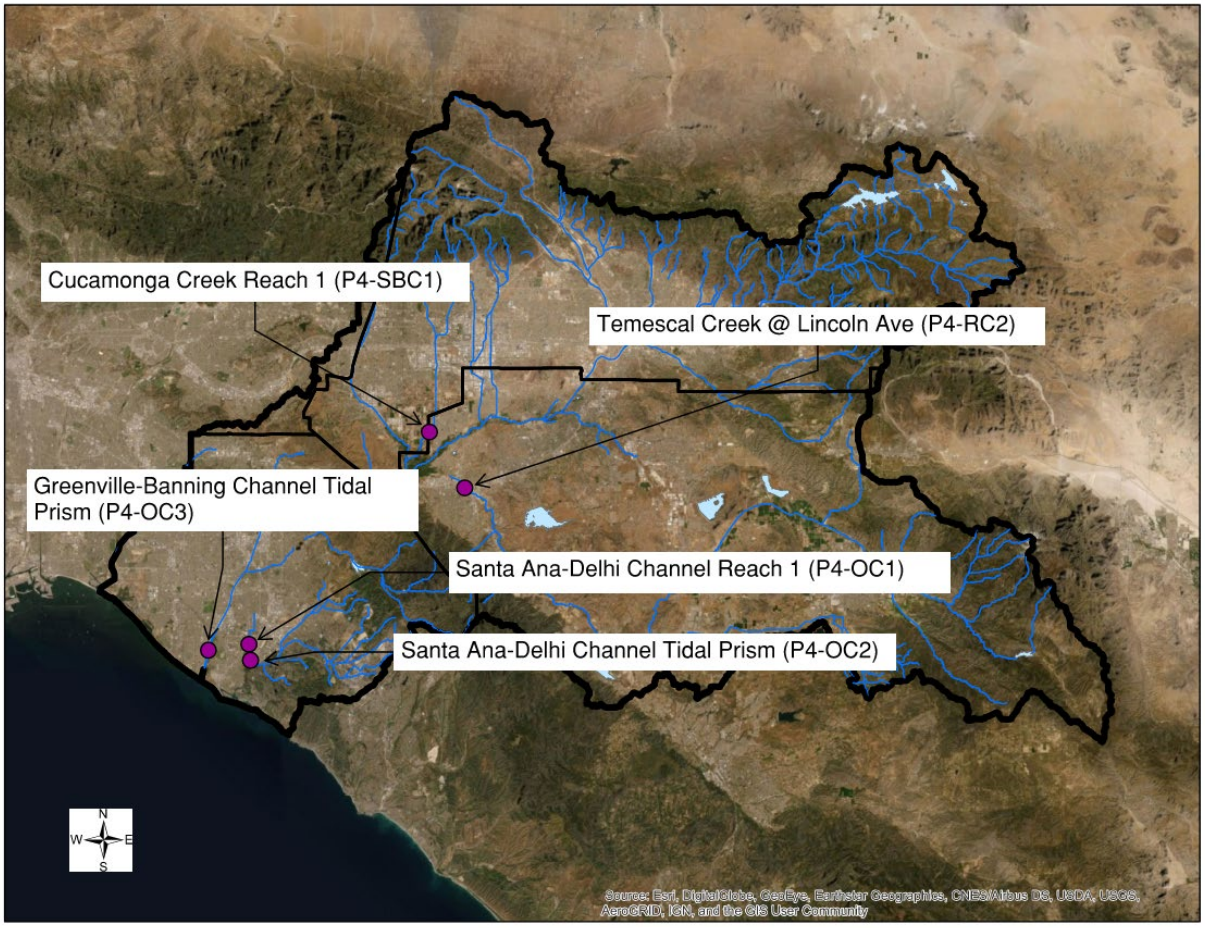

Figure 2-8. Priority 4 Monitoring Sites (top: Riverside County and San Bernardino County; bottom: Orange County)

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Section 3
Methods

The RBMP 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 – September 30) and cool, dry (October 1 – November 30) season periods. Target sample 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 9 through September 20, 2021. Dry weather, cool season monitoring occurred over a five-week period from October 17, through November 22, 2021. 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 20 consecutive weeks during the warm, dry season and for five consecutive weeks during the cool, dry season.

Priority 3 sites were monitored weekly for five consecutive weeks during the warm or cool, dry seasons. The fifteen 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 21. Cucamonga Creek at Hellman Avenue (P4-SBC1) and Greenville Banning Channel (P4-OC3) did not meet the site-specific antidegradation target in 2021and required three monthly follow-up samples. All other Priority 4 sites met their antidegradation targets in 2021 and did not require additional sampling.

3.1.2 Wet Weather

Wet weather sample collection occurs during the wet season (November 1 – March 31). Per the MSAR Bacteria TMDL, wet weather monitoring is conducted for one storm event per wet season. For that storm event, samples are collected from Priority 2 sites on the day of the storm event as well as 24, 48, and 72 hours after the onset of the storm; this is a change from previous monitoring seasons when the samples were collected the day of the event and 48, 72, and 96 hours after the onset of the storm. The sampling protocol was changed to be able to better track the decline in bacteria concentrations following events.

During the 2021-2022 wet season, the March 29, 2022 storm was monitored with samples collected on March 29, 30, 31, and April 01, 2022.

3.1.3 Summary of Sample Collection Effort

In general, the 2021-2022 monitoring program was successful in meeting the requirements except for some events where site conditions could not accommodate sampling. Differences between planned and executed sampling events are summarized in Table 3-1 and described as follows:

Samples were not collected at Bolsa Chica Channel (P3-OC1) as Orange County is developing a source tracking strategy and will begin sampling in 2022.

Additional samples were collected at Cucamonga Creek at Hellman Avenue (P4-SBC1) and Greenville-Banning Channel (P4-OC3) due to an exceedance of the anti-degradation targets in the initial sample; per sampling protocol, an additional three monthly samples were collected.

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	150	20
	Collected	150	20
Priority 3	Planned	35	0
	Collected	30[1]	0
Priority 4	Planned	5	0
	Collected	11[2]	0

[1] Five samples were not collected at Bolsa Chica Channel (P3-OC1) due to the development of a source tracking study by Orange County.
[2] Three additional samples were collected at Cucamonga Creek at Hellman Avenue (P4-SBC1) and at Greenville Banning Channel (P4-OC3) due to an exceedance of the antidegradation targets.

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. 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 three sites in this Regional Monitoring Program where enterococcus is collected instead
- Enterococcus is quantified at Lake Elsinore (P1-2) and two Orange County sites, Santa Ana Delhi Channel in Tidal Prism (P4-OC2) and Greenville-Banning Channel in Tidal Prism (P4-OC3) due to persistence of salinities greater than 1ppt.

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. Appendix C includes a 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.[17] Accordingly, prior to conducting statistical analyses, the bacterial indicator data were log transformed.

[17] 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 of the 2021-2022 dataset, which includes the 2021 dry season and the 2021-2022 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 are summarized and compliance is assessed using water quality standards or antidegradation targets established by the BPA 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:

The water quality objective (WQO) for pH established in the Santa Ana Basin Plan allows pH to range between 6.5 and 8.5. Figure 4-1 shows that no sites had any measurements below the allowable range, with all exceedances measured at a value greater than 8.5. The highest exceedance percentage was seen at Lake Elsinore at Elm Grove Beach (P1-2-ELM) where 100 percent of the samples were greater than the allowable limit. The largest range and highest values were seen at Big Bear Lake (P1-4) with pH reaching 10.1 in the middle of the warm, dry season. Elevated pH values in lakes are typically correlated with high concentrations of algae. In contrast, the four riverine Priority 1 sites were within or just slight over the allowable pH range.

Figure 4-2 shows distribution of water temperature by station demonstrating that water temperature has a direct relationship with cooler ambient air temperatures (median less than 20°C) at higher elevations and higher ambient air temperatures (median greater than 23°C) 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 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.[18] These standards were met at all Priority 1 sites except for 20 percent of measurements taken at Canyon Lake and 10 percent of measurements taken at Big Bear Lake.

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

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

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). Flow in waterbodies in the upper watershed generally consist of rain and snow melt, while flow in waterbodies in the lower watershed also include groundwater baseflow and runoff (and in some instances treated wastewater), which commonly have higher salt concentrations. Lake Elsinore exhibits particularly high conductivity (3,001 to 3,820 µS/cm), which is not unusual for a terminal lake with ongoing evapo-concentration.

Turbidity at six of the eight sites were generally low to moderate with values ranging between 0 and 22 NTU. The remaining stations Lake Elsinore at Elm Grove Beach and Big Bear Lake at Swim Beach generally had high and variable turbidity throughout the year were Lake Elsinore (13 NTU to 212 NTU) and Big Bear Lake (1 NTU to 101 NTU). Seasonal variability is higher in the lake monitoring sites as the warm samples typically result in higher values corresponding to high algal presence than the cool samples. Values at Elm Grove Beach at Lake Elsinore were typically higher than seen previous years at the previous sampling location. This could be caused by swimmers, wind- or boat wake-driven waves, and/or eutrophication.

TSS at the eight sites were generally follow those of turbidity, where TSS had the highest values and greatest variability at Lake Elsinore and Big Bear Lake (4 to 460 mg/L).

Flow is lower at the upstream sites, Mill Creek Reach 2 (0 to 6 cubic feet per second [cfs]) and Lytle Creek (0 to 27 cfs). Flow is greatest in the SAR which is fed by POTW effluent (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-ELM	Lake Elsinore at Elm Grove Beach	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

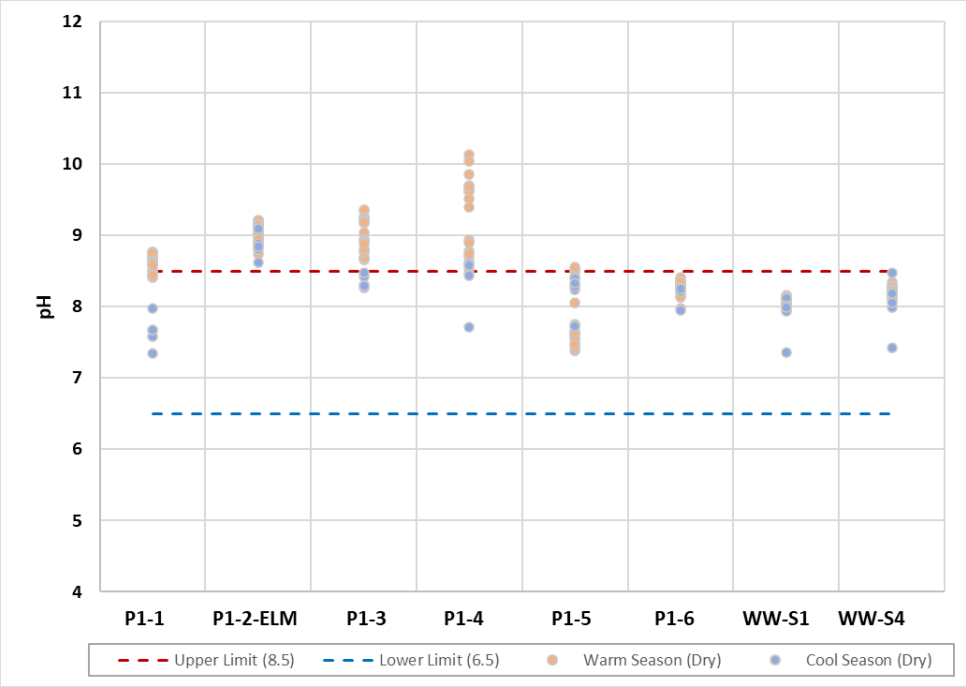

Figure 4-1. Distribution of pH Measurements at Priority 1 Sites

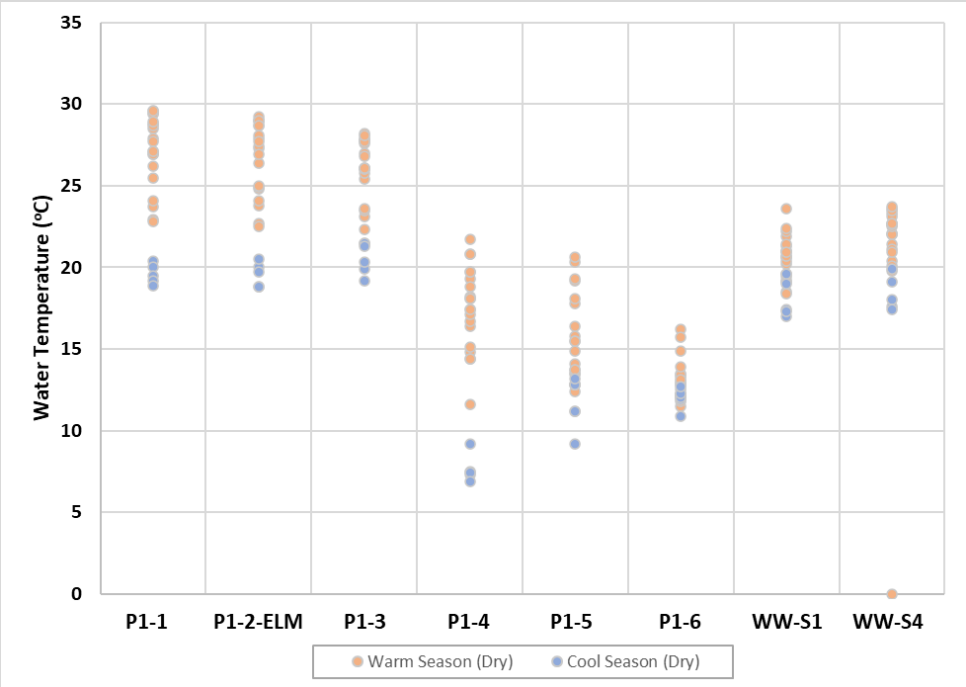

Figure 4-2. Distribution of Water Temperature Measurements at Priority 1 Sites

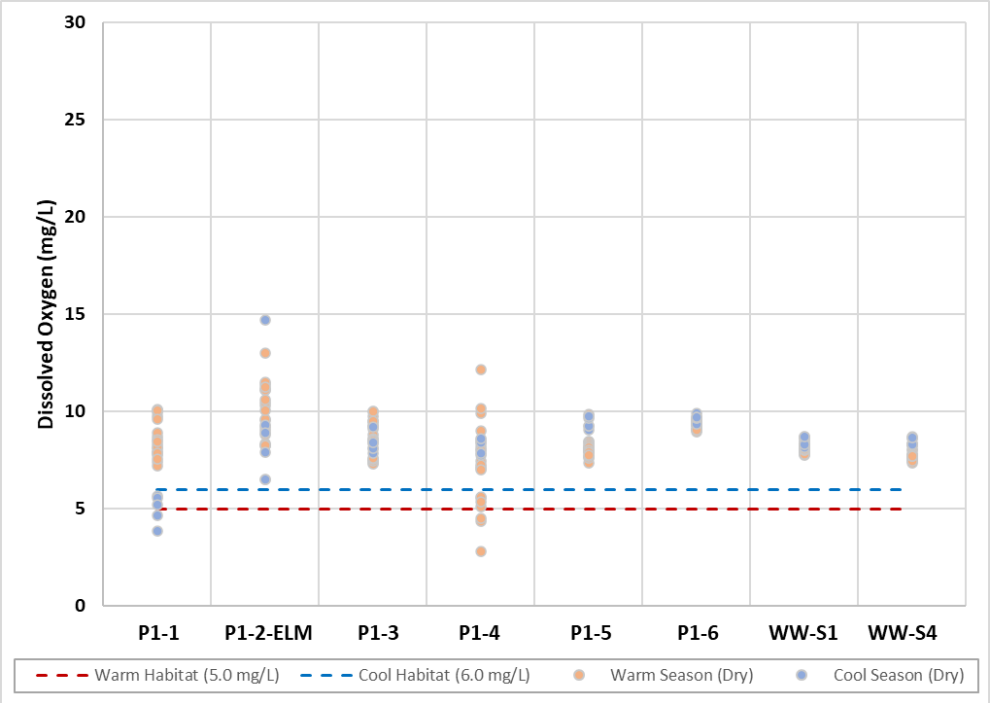

Figure 4-3. Distribution of Dissolved Oxygen Measurements at Priority 1 Sites

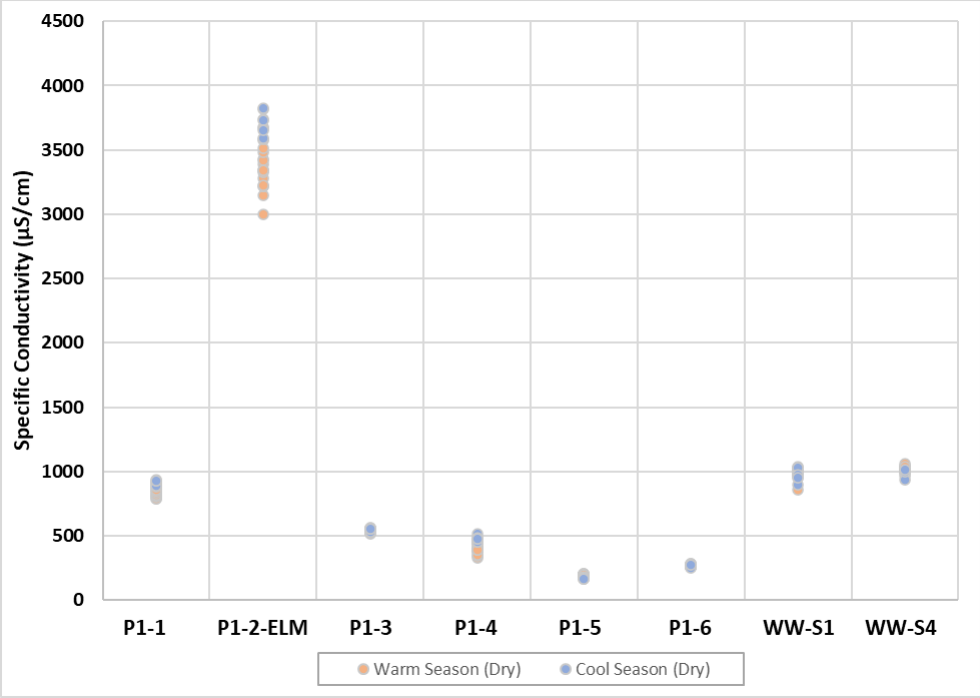

Figure 4-4. Distribution of Specific Conductivity Measurements at Priority 1 Sites

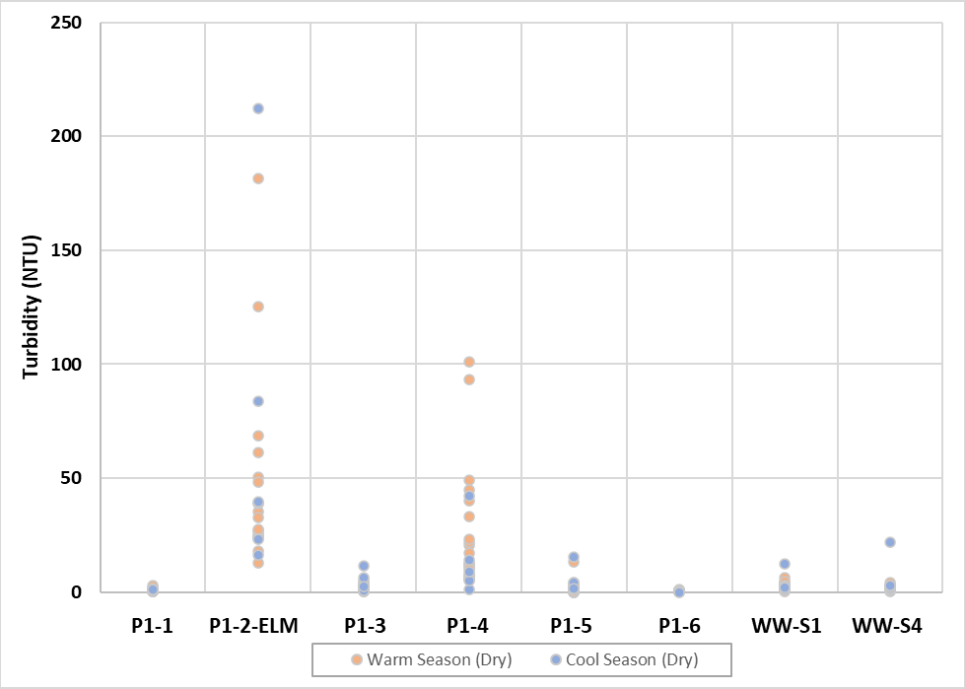

Figure 4-5. Distribution of Turbidity Measurements at Priority 1 Sites

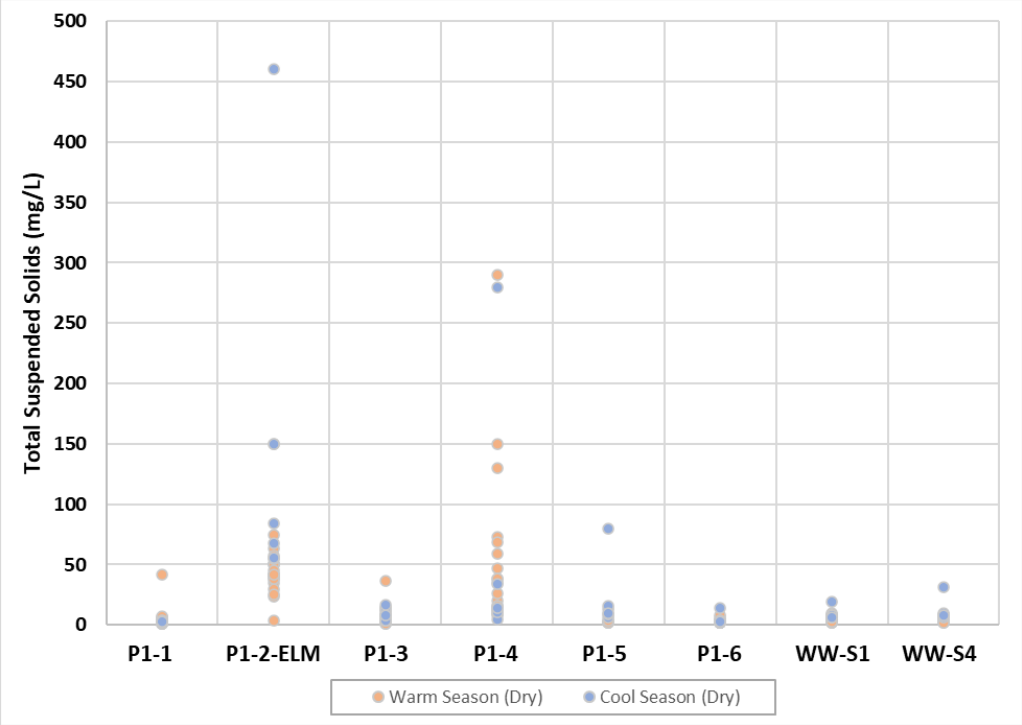

Figure 4-6. Distribution of TSS Measurements at Priority 1 Sites

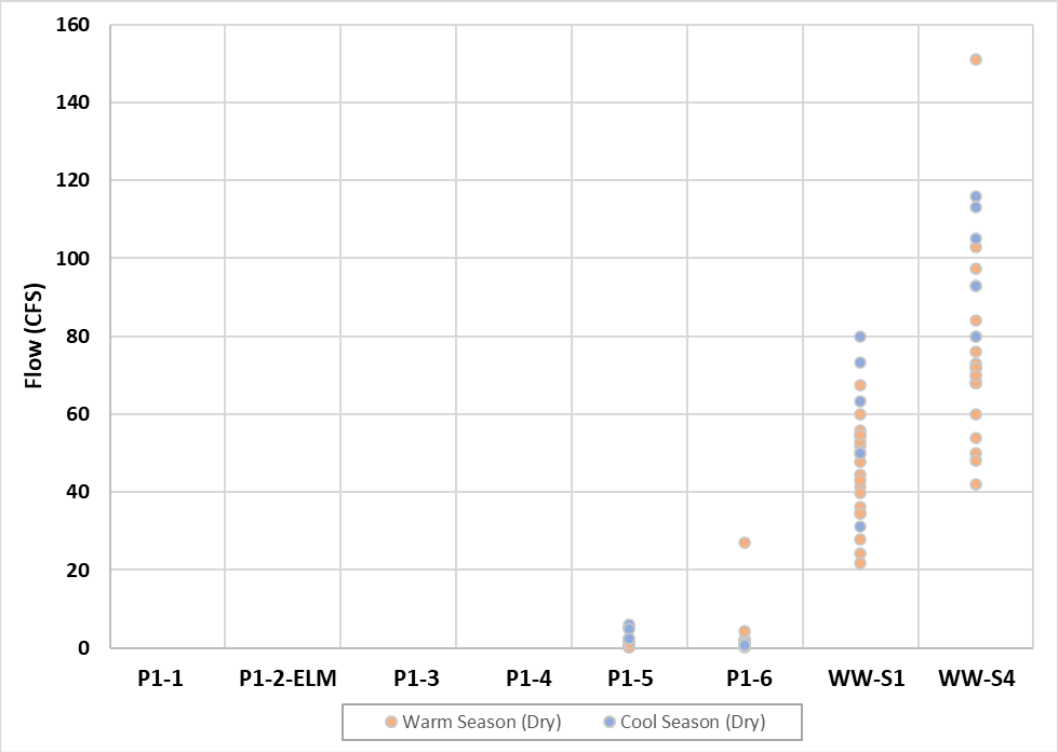

Figure 4-7. Distribution of Flow Measurements at Priority 1 Sites
**Note that lake sites are not monitored for flow*

4.1.2 Bacteria Characterization

This section presents the bacteria data from the Priority 1 sites. Accompanying figures also include the bacteria WQOs; bacteria compliance analysis against the WQOs is presented in Section 4.1.3.

Figure 4-8 presents the distribution of the 5-sample rolling geomeans of *E. coli* concentrations observed at Priority 1 sites during the warm, dry and cool, dry seasons. Geomeans from the warm, dry season are 6-week rolling geomeans while the geomean from the cool, dry season is a single 5-week geomean. When sample concentrations were below the laboratory detection limit, one-half of that detection limit was used to calculate the geometric mean. All of the SAR site (WW-S1 and WW-S4) geomean data were above the REC1 objective of 100 MPN/100 mL, as was the cool season geomean at Lake Elsinore's Elm Grove Beach (P1-2-ELM) station.

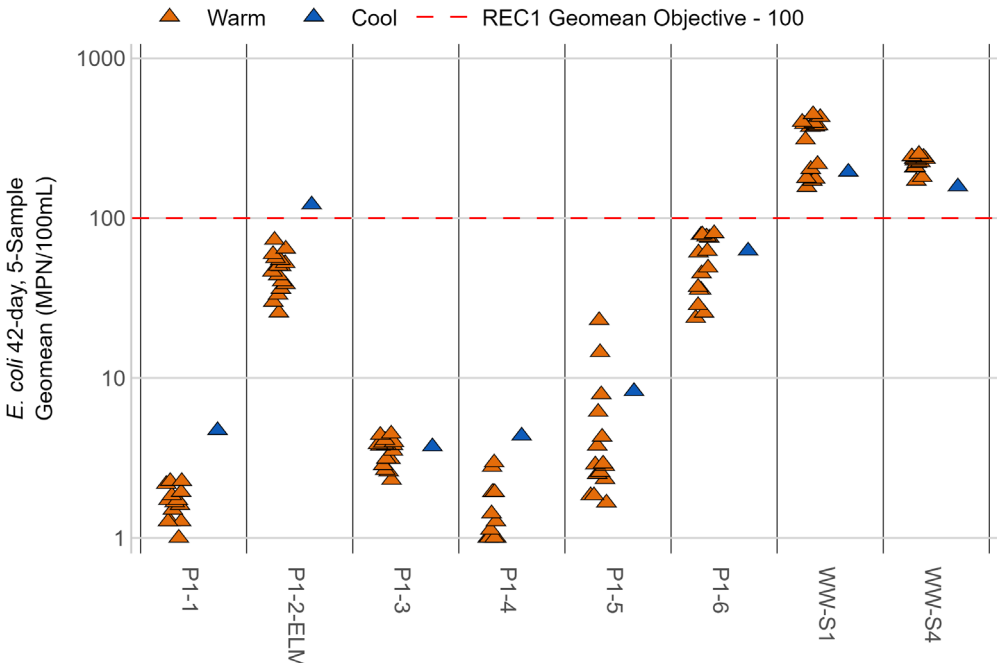

Figure 4-8. Distribution of *E. coli Geomean* Concentrations at Priority 1 Sites

Figures 4-9 and 4-10 and 4-12 through 4-16 show the individual and geomean *E. coli* concentrations for each Priority 1 site; Figure 4-11 presents the individual and geomean enterococcus concentrations at Lake Elsinore.

Key observations from the Priority 1 site data include:

Bacteria levels were consistently very low at several sites. All but two samples were less than 10 CFU/100 mL at Canyon Lake (P1-1) and those two were just above 10 MPN/100 mL in the cool season. Lake Perris (P1-3) and Big Bear Lake (P1-4) also had consistently low bacteria levels, with each only having a handful of samples between 10 and 100 MPN/100 mL.

Both Mill Creek Ranch (P1-5) and Lytle Creek (P1-6) had very low *E. coli* values at the start of the warm, dry season which increased steadily rising to their highest levels in September. Individual values and all geomean values were less than 100 MPN/100 mL. Cool, dry season samples were variable at Mill Creek Ranch but again remained under 100 MPN/100 mL, while at Lytle Creek the cool, dry season values tended toward the higher end of the warm, dry season range.

At the lake sites (P1-1 to P1-4) sites, the cool, dry season samples had slightly higher *E. coli* concentrations than in the warm, dry season. Seasonal bacteria levels at the riverine sites were comparable.

Enterococcus values at Lake Elsinore at Elm Grove Beach were higher than values typically seen at Lake Elsinore at the previous sampling location at the boat ramp (2 of 50 samples exceeded STV threshold of 110 mpn/100mL in 2019 and 2020). In 2021, 65 percent of the 42-day calculated geomean concentrations were above the REC1 WQO. The pattern in the enterococcus geomean concentrations also differed from those for *E. coli* during the warm, dry season; the E. *coli* concentrations tended to be steady through that season, while the enterococcus

concentrations peaked above the REC1 WQO in late July. The shape of the enterococcus geomean trend is driven by three consecutive high values in June; the *E. coli* concentrations during that period were somewhat higher but not high enough to cause the *E. coli* geomean values to exceed the REC1 WQO.

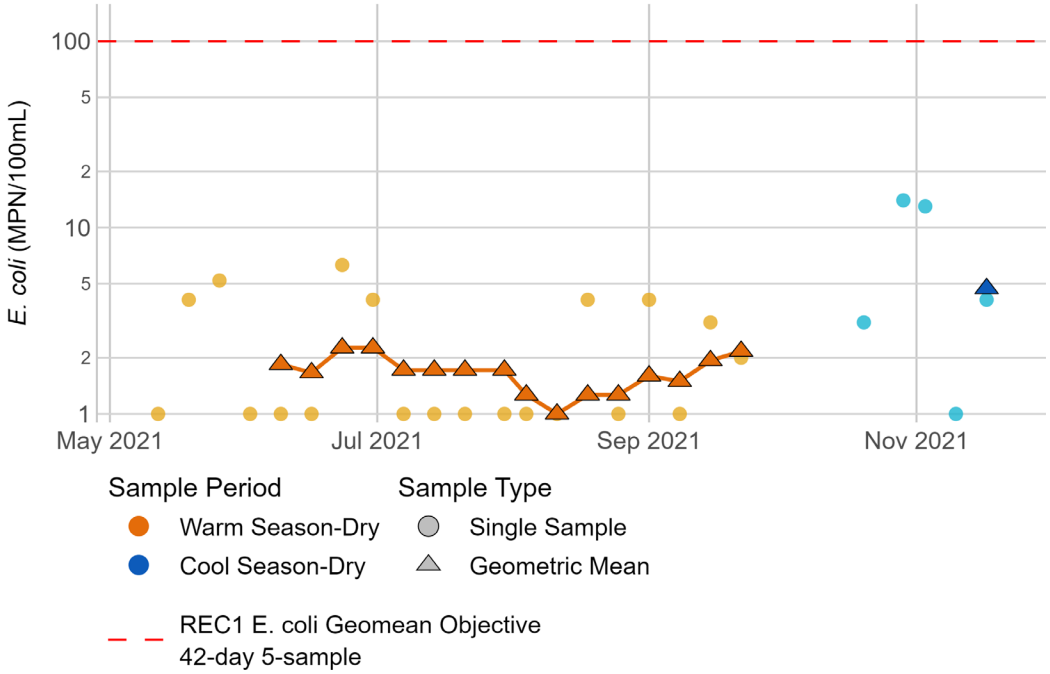

Figure 4-9. *E. coli* Concentrations and Geomeans at Canyon Lake at Holiday Harbor (P1-1)

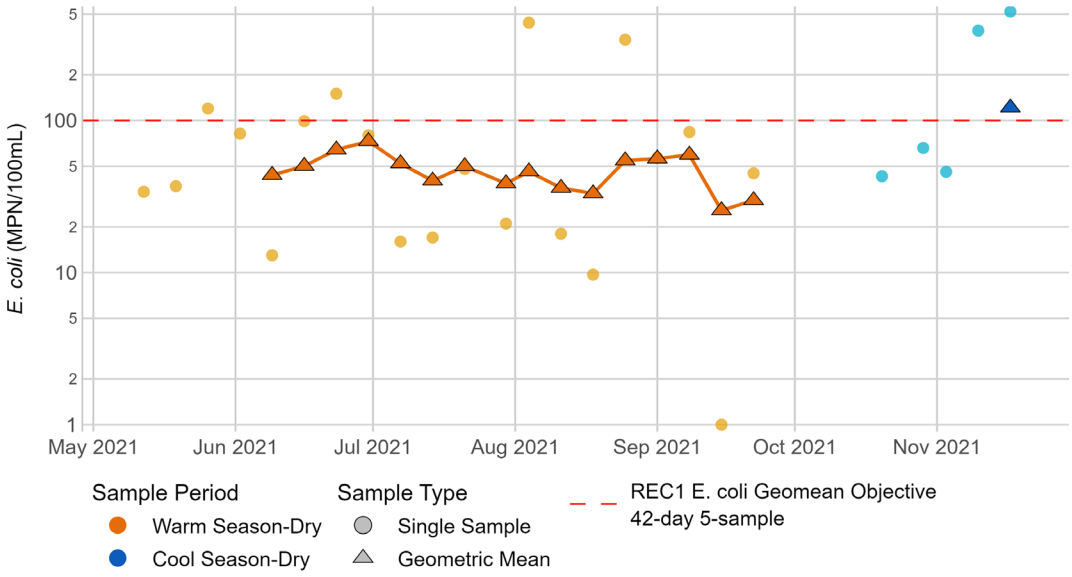

Figure 4-10. *E. coli* Concentrations and Geomeans at Lake Elsinore at Elm Grove Beach (P1-2-ELM)

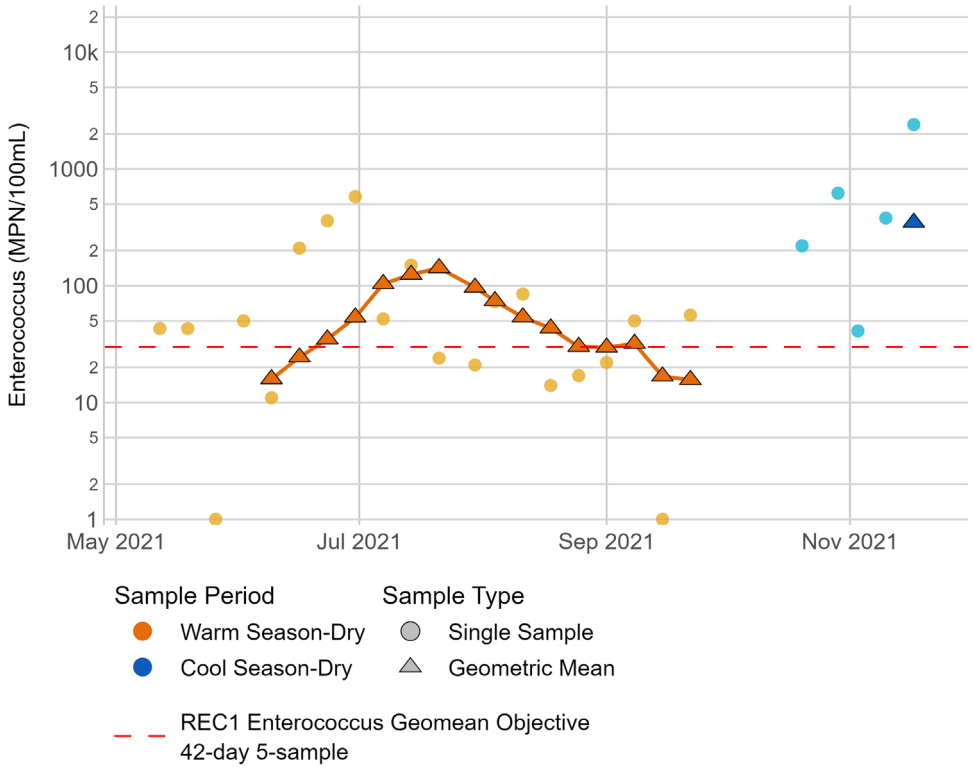

Figure 4-11. *Enterococci* Concentrations and Geomeans at Lake Elsinore at Elm Grove Beach (P1-2-ELM)

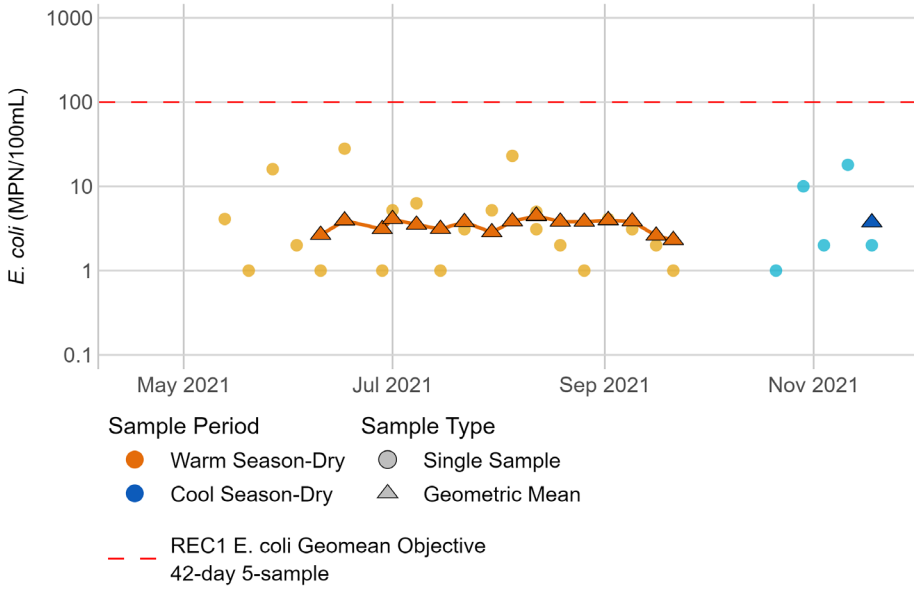

Figure 4-12. *E. coli* Concentrations and Geomeans at Lake Perris (P1-3)

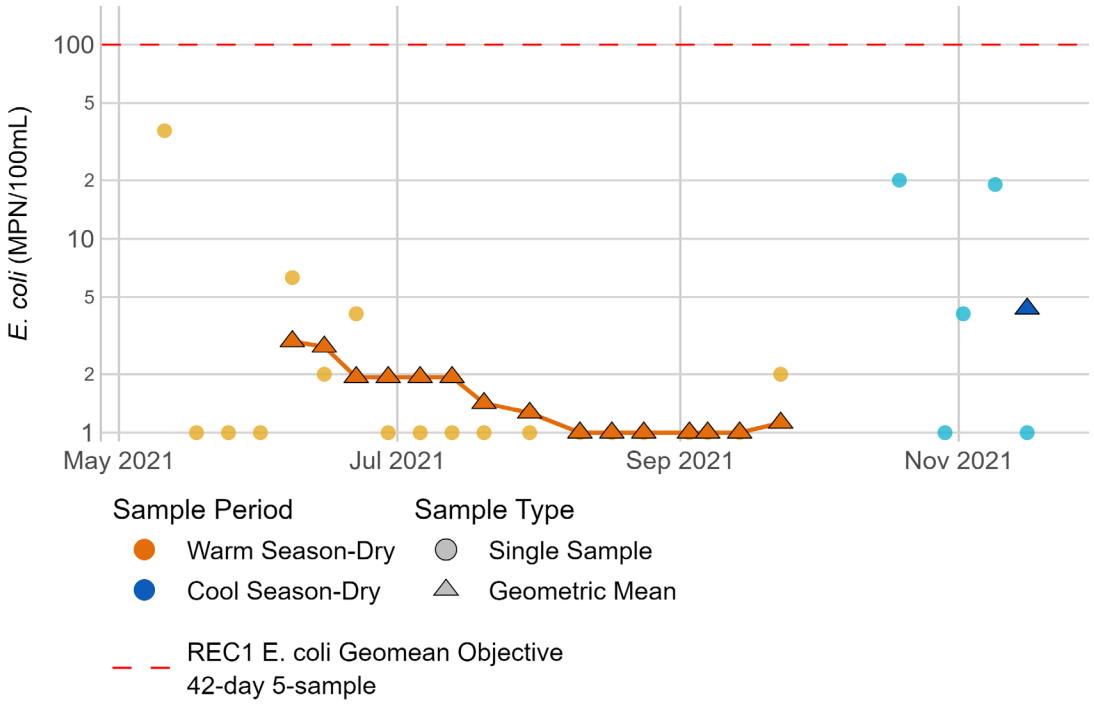

Figure 4-13. *E. coli* Concentrations and Geomeans at Big Bear Lake (P1-4)

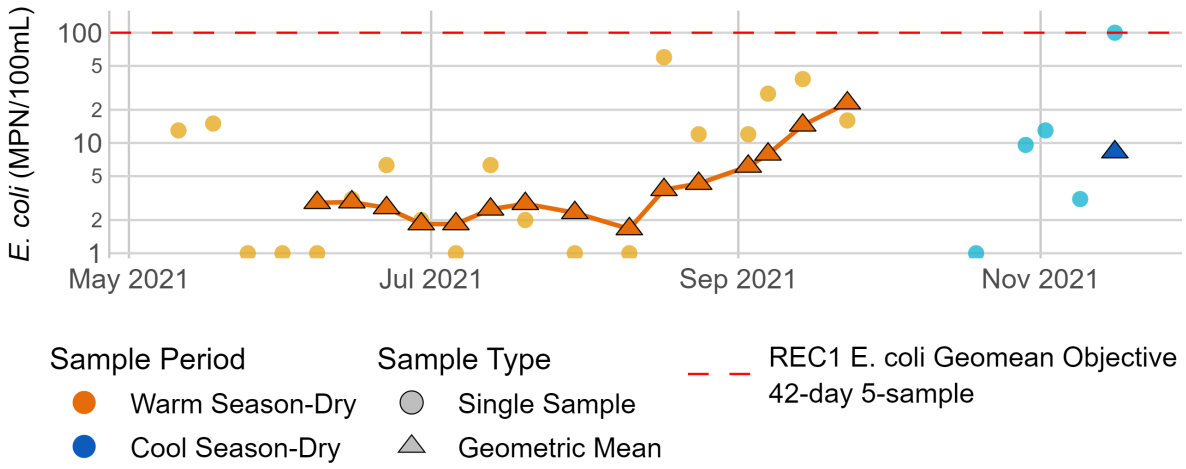

Figure 4-14. *E. coli* Concentrations and Geomeans at Mill Creek Reach 2 (P1-5)

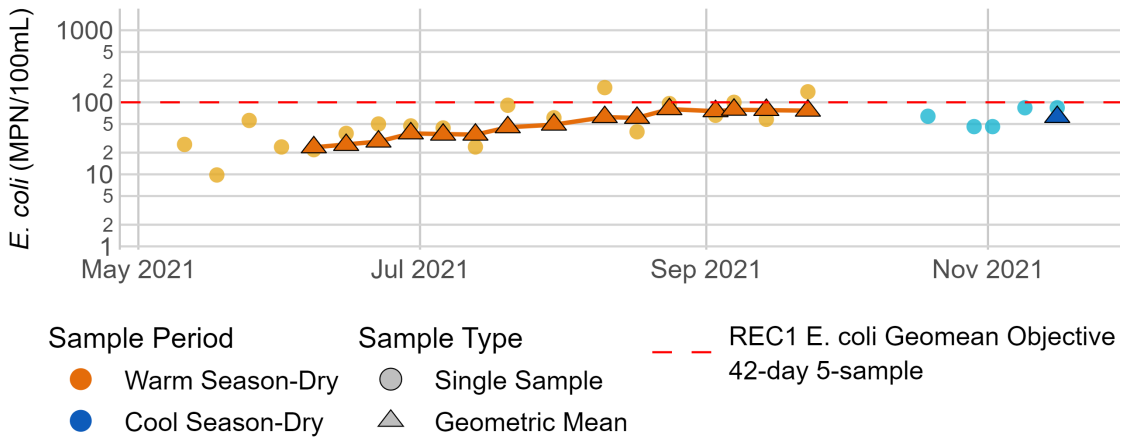

Figure 4-15. *E. coli* Concentrations and Geomeans at Lytle Creek (P1-6)

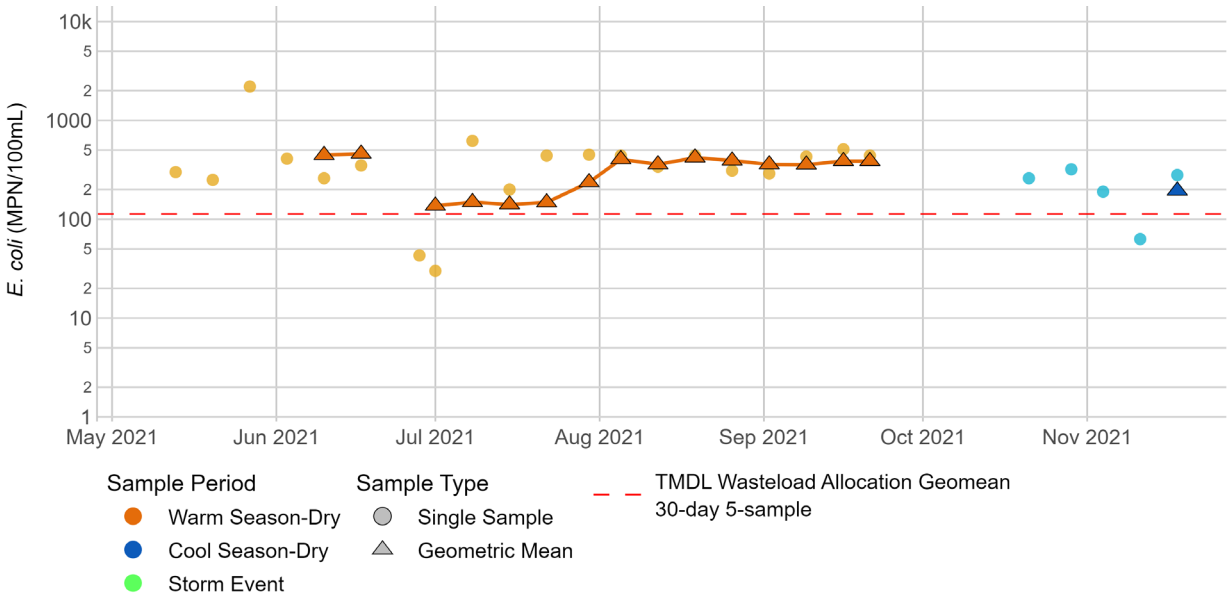

Figure 4-16. *E. coli* Concentrations and Geomeans at Santa Ana River at MWD Crossing (WW-S1)

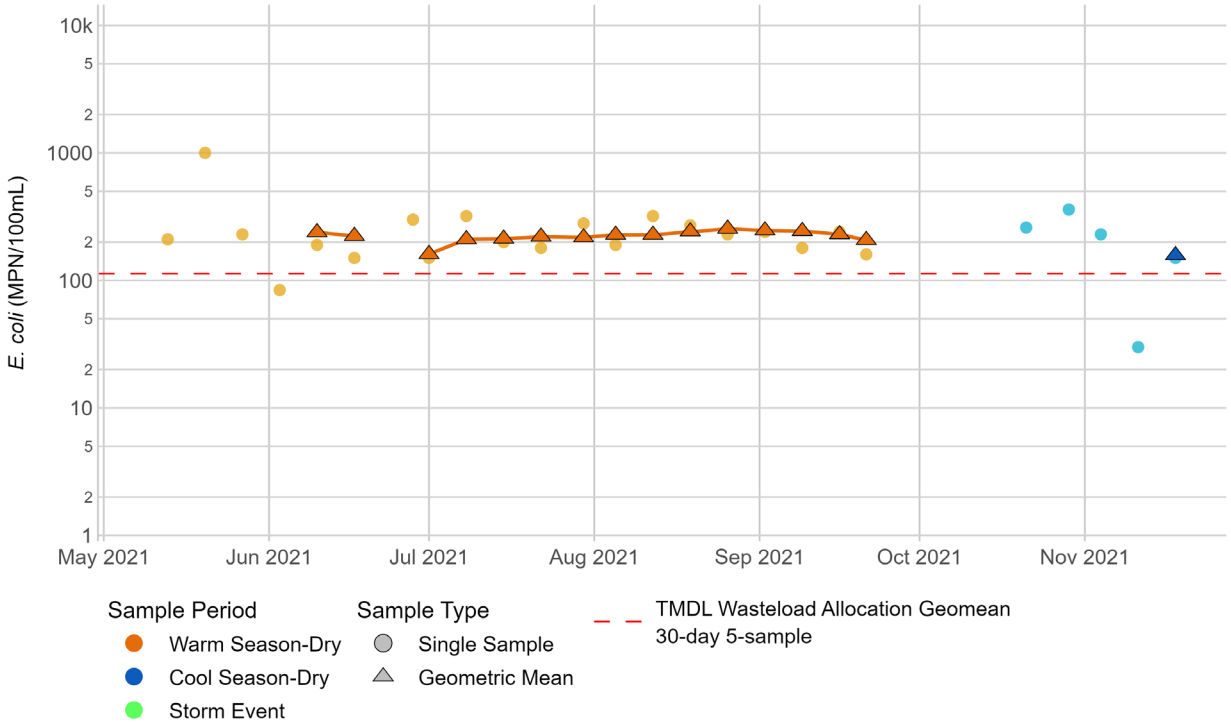

Figure 4-17. *E. coli* Concentrations and Geomeans at Santa Ana River at Pedley Avenue (WW-S4)

4.1.3 Bacteria Compliance Analysis

The compliance analysis compared the Statewide Bacteria Provisions for REC-1 waters: for *E. coli* the geomean WQO is 100 MPN/100 mL, while the single statistical threshold value (STV) is 320 MPN/100 mL for that cannot be exceeded by more than 10 percent of samples in any calendar month.

Aside from the SAR sites and Lake Elsinore, Priority 1 *E. coli* concentrations continue to consistently meet water quality objectives. Five out of eight Priority 1 sites had no geomean nor STV exceedances (Table 4-2). The three sites that exceeded the geomean WQO were Lake Elsinore at Elm Grove Beach (P1-2-ELM) with 65 percent exceedance frequency, SAR at MWD Crossing (WW-S1), and SAR at Pedley Avenue (WW-S4) with 100 percent exceedance frequencies.

The same three sites also had individual samples that exceeded the STV. Nine samples at SAR at MWD Crossing (WW-S1) and three samples at SAR at Pedley Avenue (WW-S4) exceeded the 90th percentile STV. The percentage of samples exceeding the STV per month is shown in Table 4-3.

In addition, six samples at Lake Elsinore at Elm Grove Beach exceeded the enterococcus single sample STV criteria of 110 MPN/100 mL.

Table 4-2. 2021-2022 Monitoring Season Frequency of Exceedance with *E. coli* Geomean (100 MPN/100 mL) and STV (320 MPN/100 mL) or Enterococcus Geomean (30 MPN/100 mL) and STV (110 MPN/100 mL) Water Quality Objective During the 2021 Dry Weather Samples

Site ID	Site	Geometric Mean Criterion Exceedance Frequency (%)	STV Criterion Exceedance Frequency (%)
P1-1	Canyon Lake	0	0
P1-2-ELM	Lake Elsinore at Elm Grove Beach	65	32
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	44
WW-S4	Santa Ana River Reach 3 at Pedley Avenue	100	8

Table 4-3. Monthly Frequency of Exceedance of STV (320 MPN/100 mL) Water Quality Objective During the 2021 Dry Weather Samples for the Santa Ana River Sites

Month	Number of Samples Collected	STV Criterion Exceedance Frequency (%)	
		SAR @ MWD Crossing	SAR @ Pedley Avenue
May	3	33	33
June	4	50	0
July	5	60	0
August	4	75	0
September	4	75	0
October	2	0	50
November	3	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 4-18 through 4-24. Key observations are summarized as follows:

Figure 4-18 shows that all the pH measurements were above the lower allowable limit of 6.5, however, 100 percent of measurements taken at Prado Park Lake Outlet exceeded the upper limit of 8.5; Prado Park Lake measurements ranged from 8.8 to 9.7.

Water temperatures are generally similar among Priority 2 sites and are slightly lower during the cold, dry season than the dry, warm season (Figure 4-19).

All 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 three SAR sites, and Prado Park Lake, are greater than 5 mg/L (Figure 4-20), while 15 dry weather samples from Chino Creek and two samples from Mill Cucamonga Creek were below 5 mg/L.

Specific conductivity (Figure 4-21) is similar at the two SAR sites ranging from 793 µS/cm to 1058 µS/cm. Specific conductivity in Prado Park Lake, Chino Creek, and Mill Cucamonga Creek rose during the summer months as a result of evapo-concentration.

Turbidity (Figure 4-22) and TSS (Figure 4-23) are similar with low to moderate ranges for most of the sites except at Prado Park Lake and Chino Creek. Prado Park Lake showed the largest variations with turbidity ranges from 3.3 to 13.2 NTU and total suspended solids from 10 to 43 mg/L. All three mainstem SAR sites experienced elevated turbidity and TSS the week of 10/24/2021 due to wet weather conditions four days prior to sampling.

Flow is lowest at Prado Park Lake (spill from the lake) with rates ranging from 2.2 to 8.1 cfs. Chino and Cucamonga Creeks had slightly higher but similar ranges of flow (3.9 to 18.3 cfs and 3.7 to 30.6 cfs, respectively). Flow is higher in the SAR and highest at the most downstream site SAR at Pedley Avenue (Figure 4-24). Maximum flow at SAR at Pedley Avenue (151 cfs) is approximately 90 percent higher than the maximum flow at SAR at MWD Crossing (80 cfs) due to effluent discharge from Riverside WQCP.

Table 4-4. Priority 2 Monitoring Sites

Site ID	Site Description	County
WW-C3	Prado Park Lake	San Bernardino
WW-C7	Chino Creek at Central Avenue	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
MISSION	Santa Ana River at Mission Blvd. Bridge	Riverside

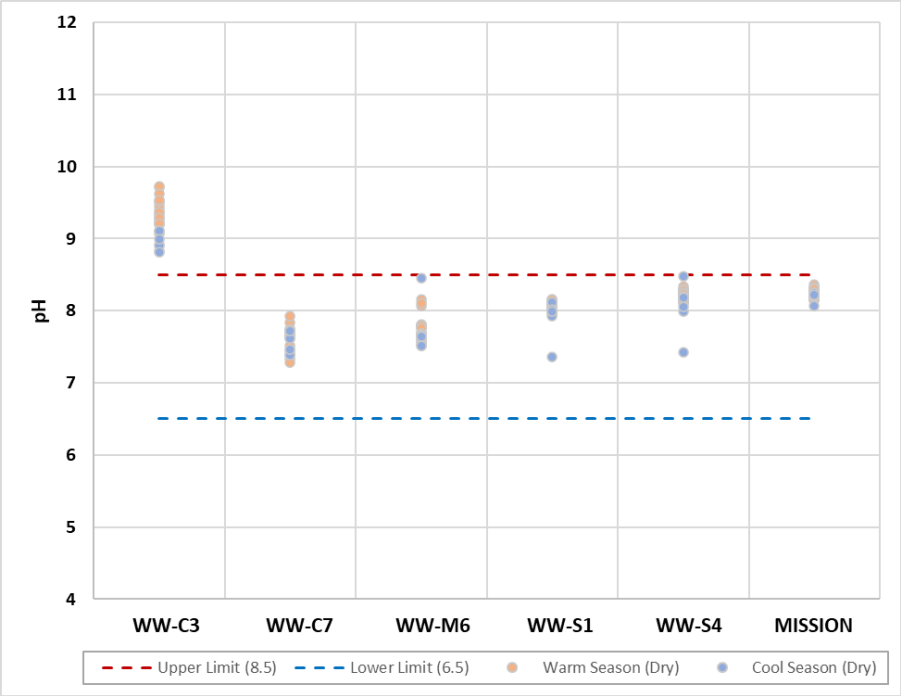

Figure 4-18. Distribution of pH Measurements at Priority 2 Sites

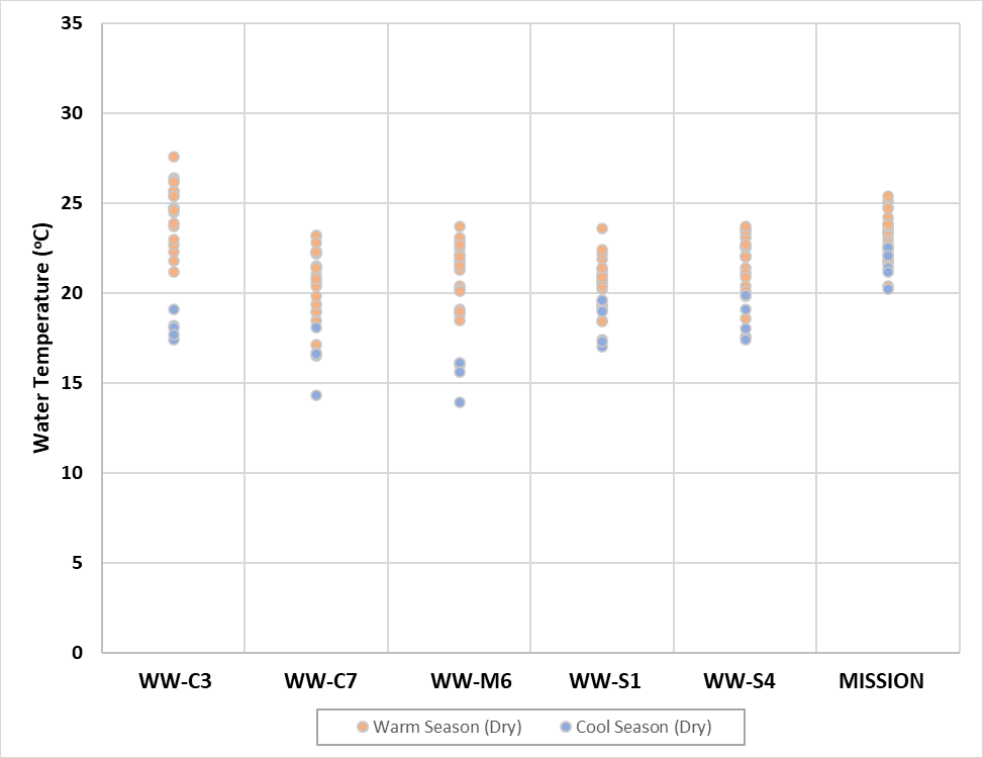

Figure 4-19. Distribution of Water Temperature Measurements at Priority 2 Sites

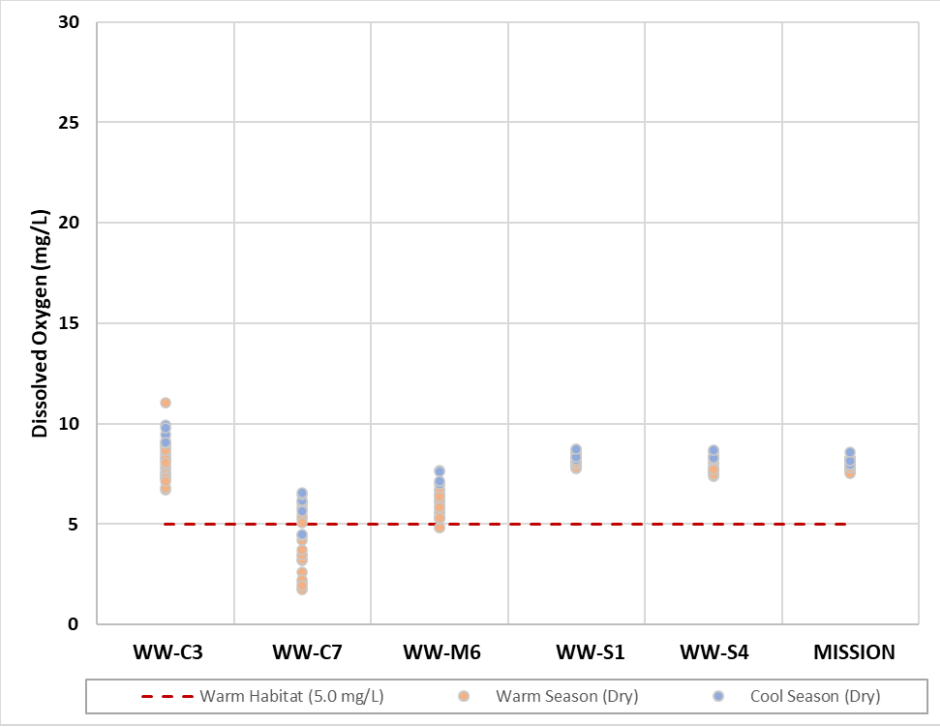

Figure 4-20. Distribution of Dissolved Oxygen Measurements at Priority 2 Sites

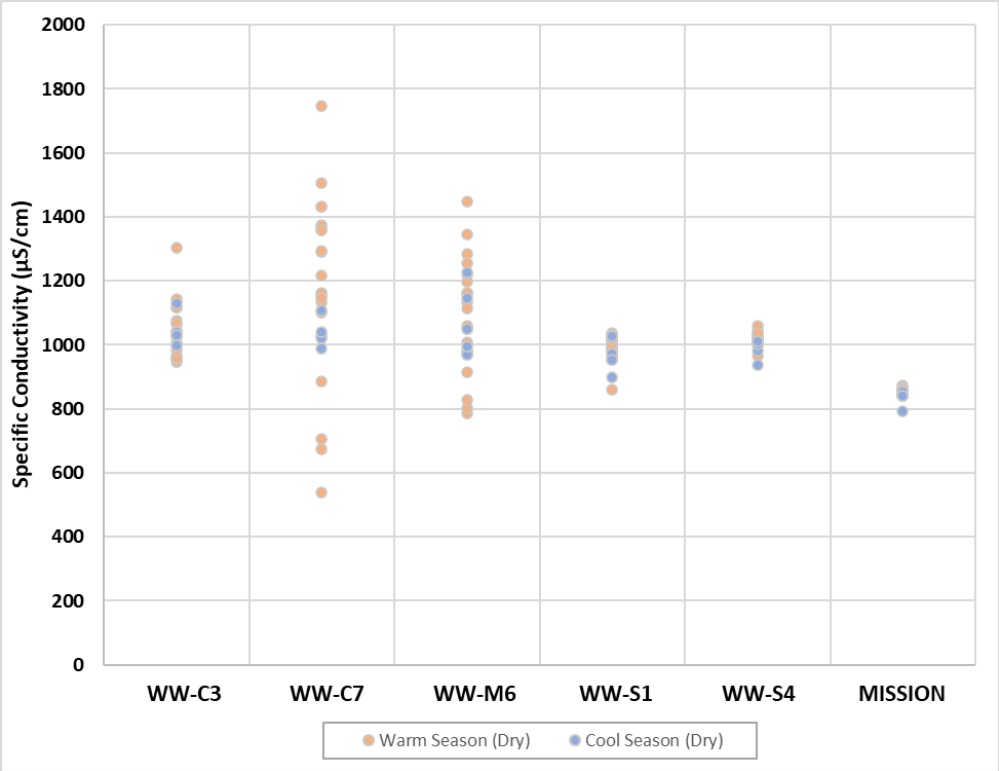

Figure 4-21. Distribution of Specific Conductivity Measurements at Priority 2 Sites

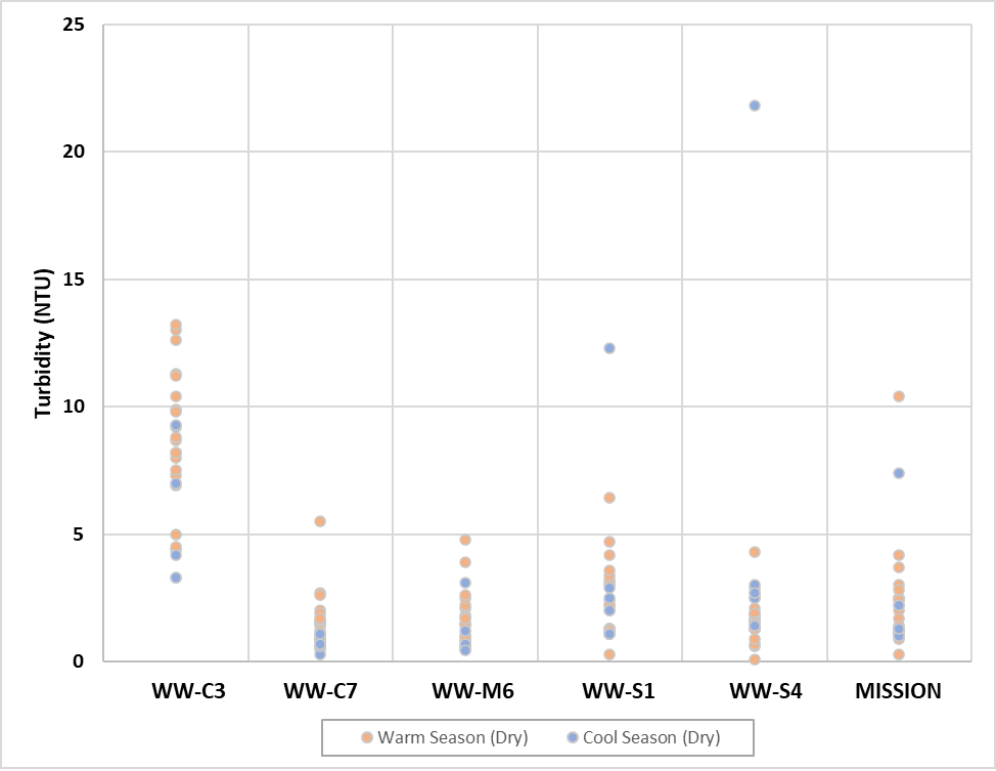

Figure 4-22. Distribution of Turbidity Measurements at Priority 2 Sites

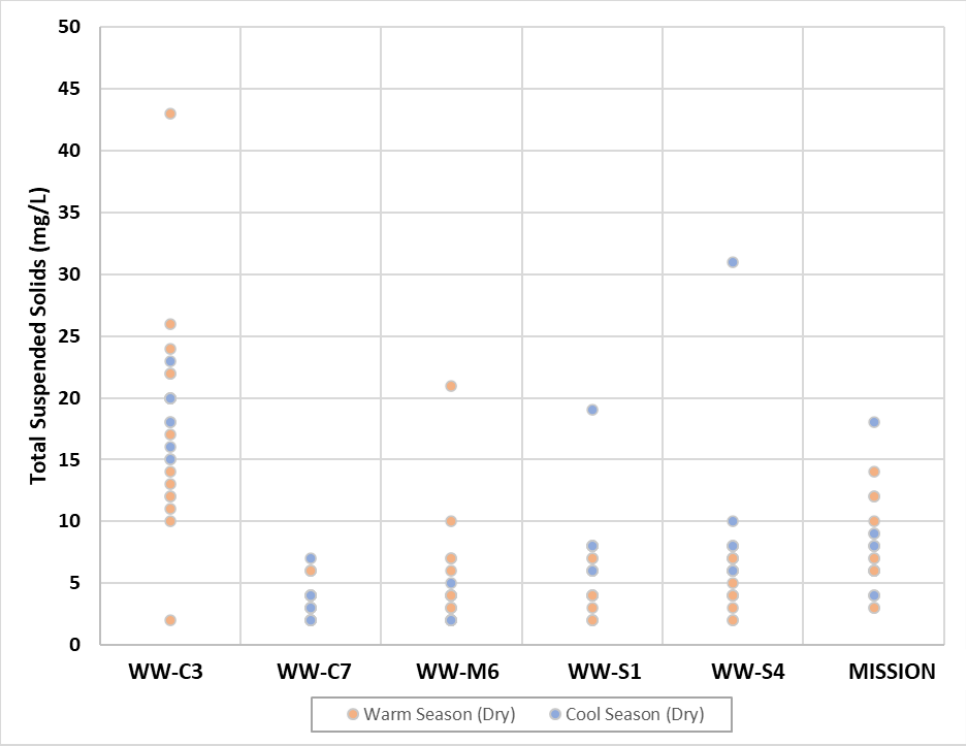

Figure 4-23. Distribution of TSS Measurements at Priority 2 Sites

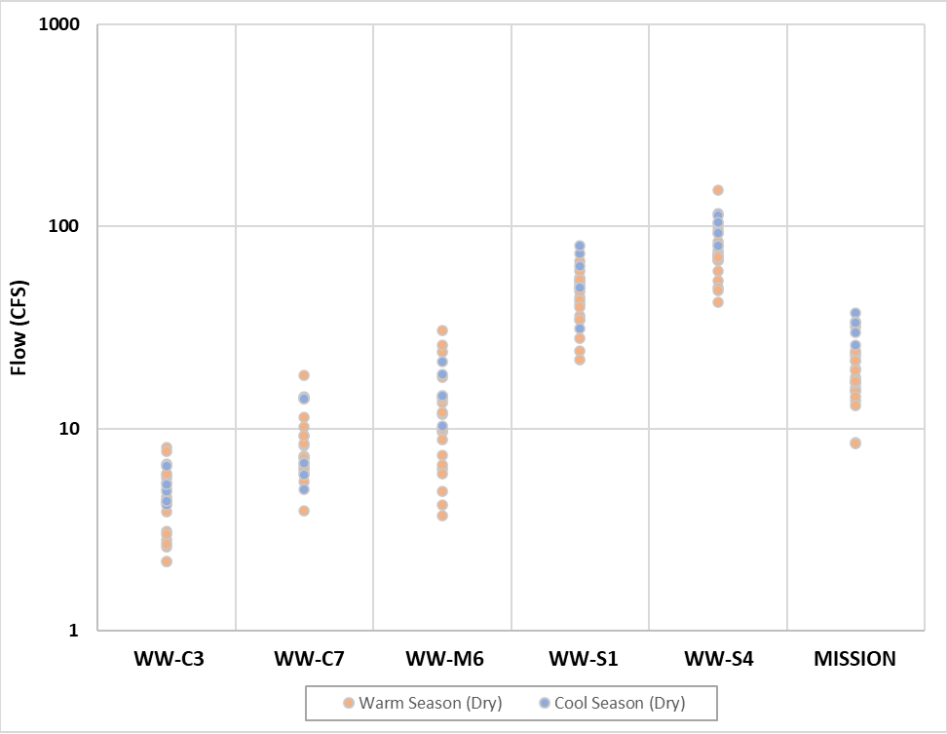

Figure 4-24. Distribution of Flow Measurements at Priority 2 Sites

4.2.2 Bacteria Characterization

Figure 4-25 summarizes the distribution of the geomeans of *E. coli* concentrations observed at Priority 2 sites during the warm, dry and cool, dry seasons. Figures 4-26 through 4-31 show the individual and rolling geomean *E. coli* concentrations during the 2021-2022 monitoring period.

The figures include geomeans that were calculated using a five-sample minimum, 30-day geomean per the 2005 TMDL requirements. Please note that there is a discontinuation in the geomean calculation for all sites in mid-June due to a wet weather event causing the delay of weekly sampling. Make-up samples were collected the following week and the geomean calculation was able to continue in July.

4.2.2.1 Dry Weather

Figure 4-25 shows the distribution of the calculated geomeans throughout the warm, dry season. All sites had geomeans calculated above 113 MPN/ 100 mL WLA, with the two Santa Ana River sites having all their geomean values above that threshold. All sites except Prado Park Lake Outlet (WW-C3) and Chino Creek (WW-C7) were above the WLA during the cool, dry season.

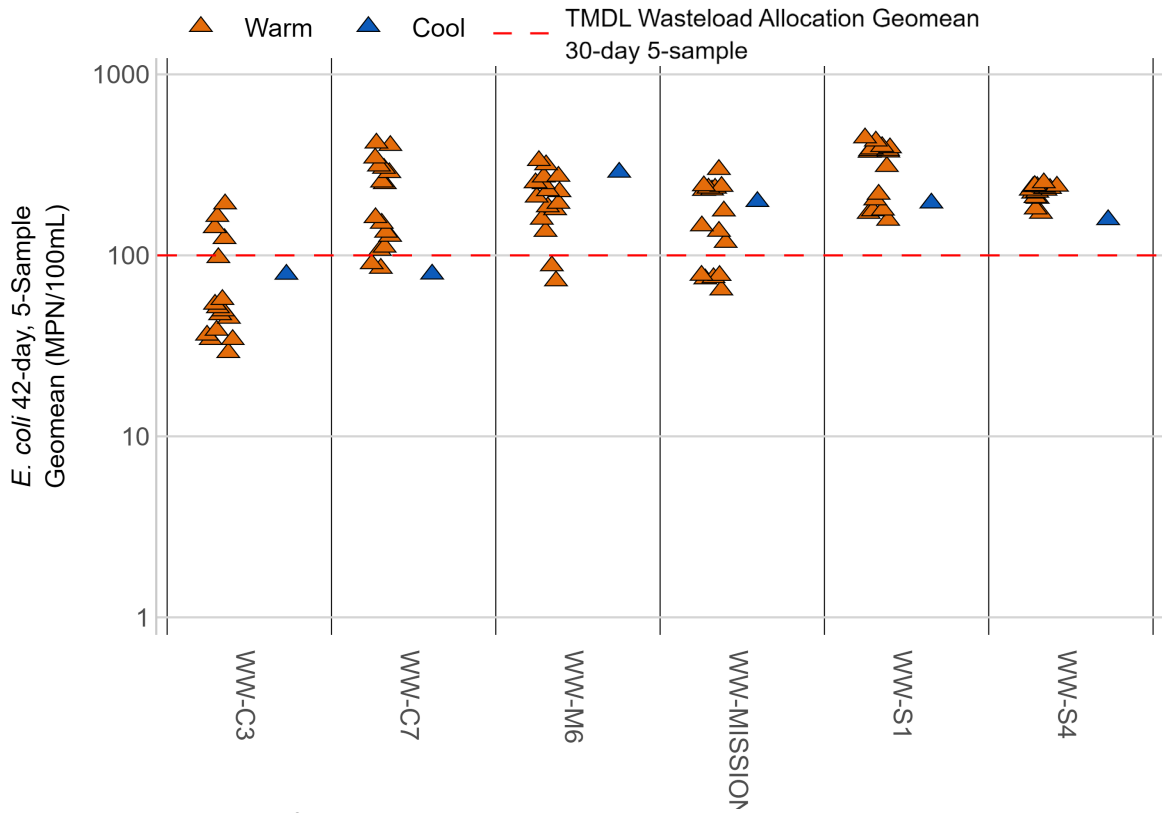

Figure 4-25. Distribution of *E. coli* Concentrations at Priority 2 Sites

SAR @ MWD Crossing had the highest single sample observed E. coli concentration of 2,200 MPN/100 mL, which was observed during the 2021 warm, dry season.

E. coli concentrations at Prado Park Lake ranged from 5 to 470 MPN/100 mL (Figure 4-26). Bacteria concentrations were elevated in the early weeks of the warm, dry season causing the

initial three geomean concentrations to be above the TMDL WLA. In June 2021, bacteria concentrations fell below the WLA where they mostly remained for the remainder of the warm, dry season and the entirety of the cool, dry season.

For the Santa Ana River monitoring sites (Figure 4-29 through 4-30), *E. coli* concentrations exceed the geometric mean criteria by a relatively small margin (30-day rolling geomeans ranged from 137 to 387 MPN/100 mL), continuing a result from previous sampling periods. The 2019 dry season Synoptic Study found that uncontrollable sources that are not conveyed through the MS4 account for the majority (77%) of the total bacteria load in Reach 3 of the Santa Ana River. The 2019 study also showed no relationship between *E. coli* concentration and presence of human HF 183 marker within the receiving waters. This finding strongly suggests that the *E. coli* observed in the Santa Ana River is coming from natural or uncontrollable sources (e.g., sediment releases, wildlife, feral pigs) than controllable sources (e.g., MS4 discharges). The reader is referred to the Middle Santa Ana River Synoptic Study and TMDL Triennial Report for more detail on this source analysis.

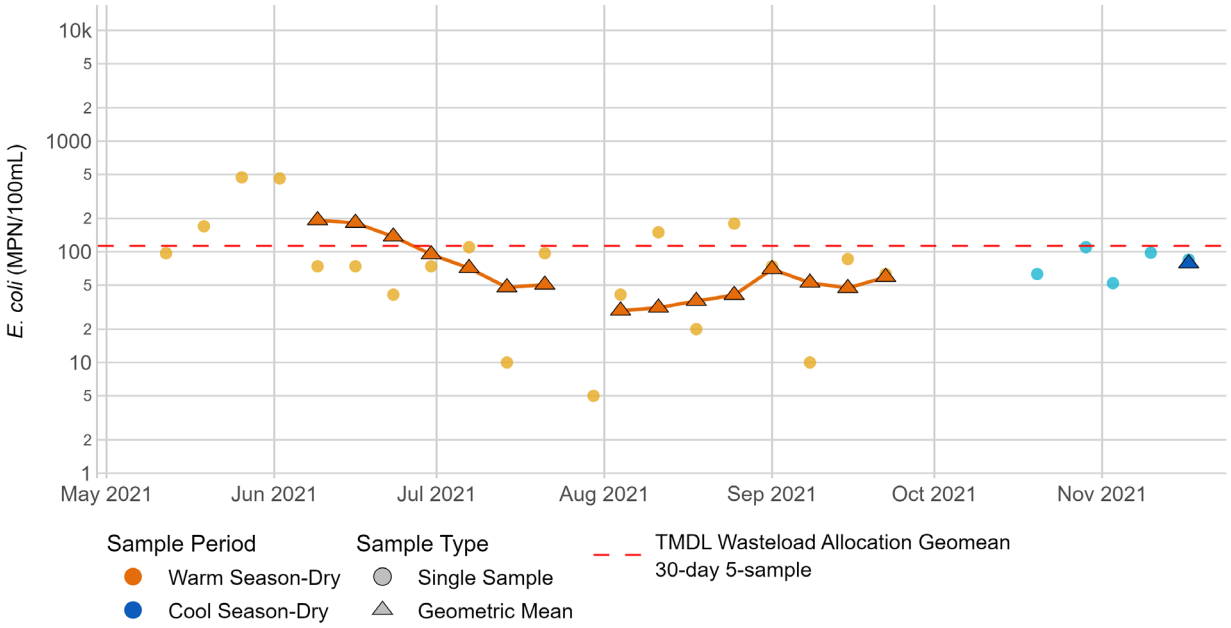

Figure 4-26. *E. coli* Concentrations and Geomeans at Prado Park Lake (WW-C3)

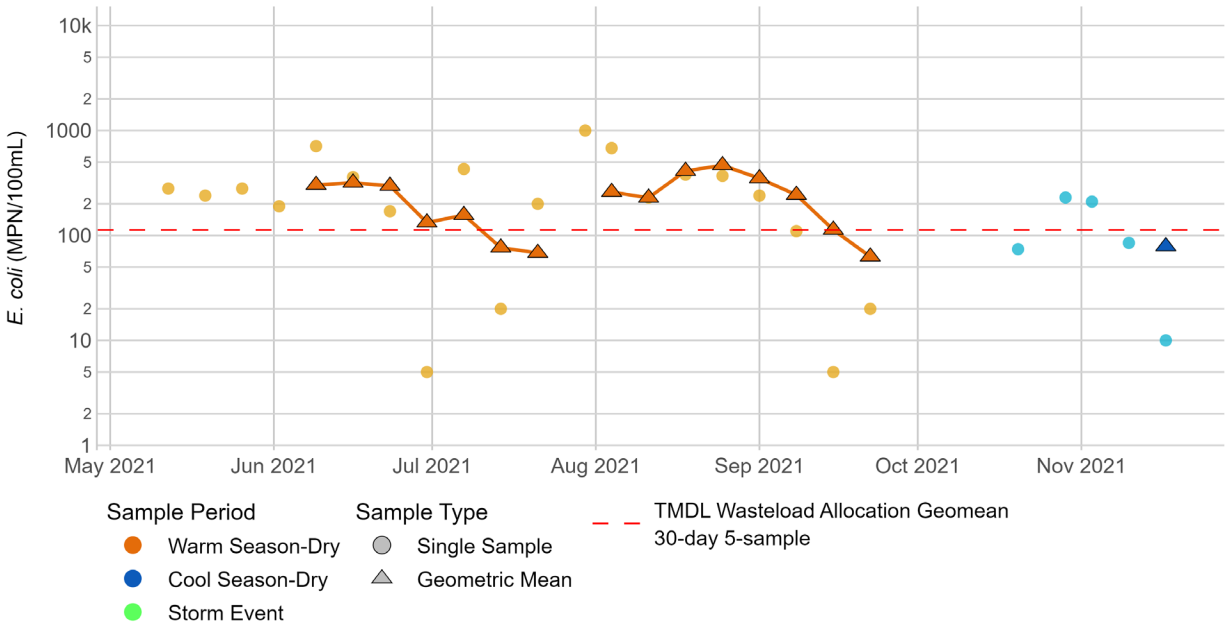

Figure 4-27. *E. coli* Concentrations and Geomeans at Chino Creek at Central Avenue (WW-C7)

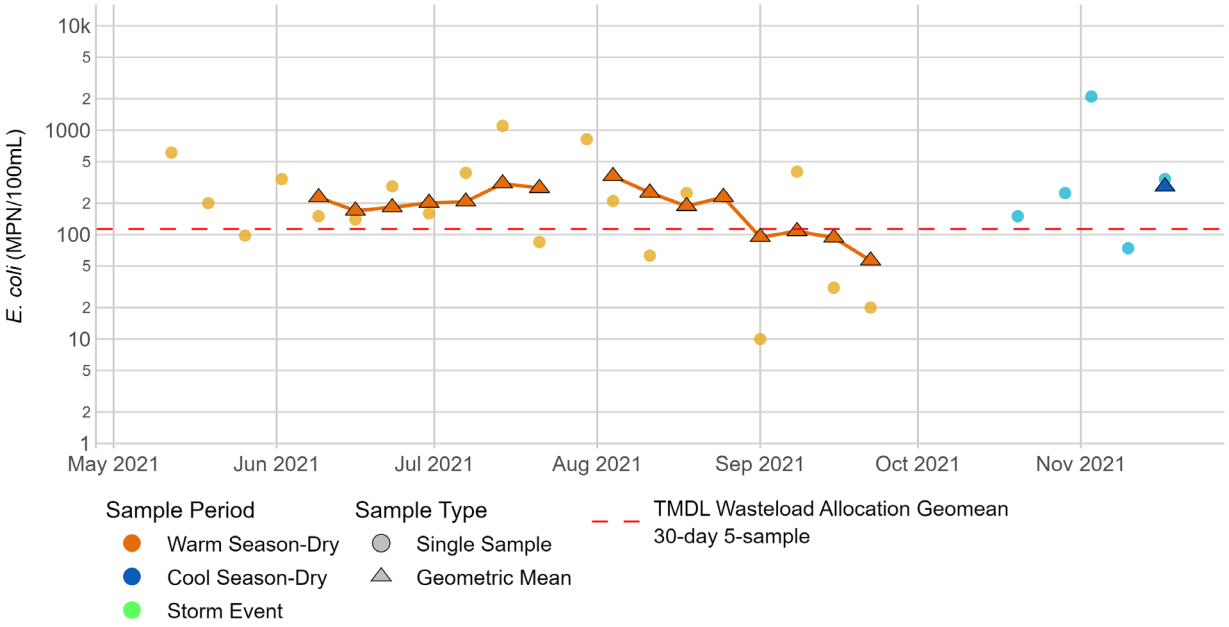

Figure 4-28. *E. coli* Concentrations and Geomeans at Mill-Cucamonga Creek Below Wetlands (WW-M6)

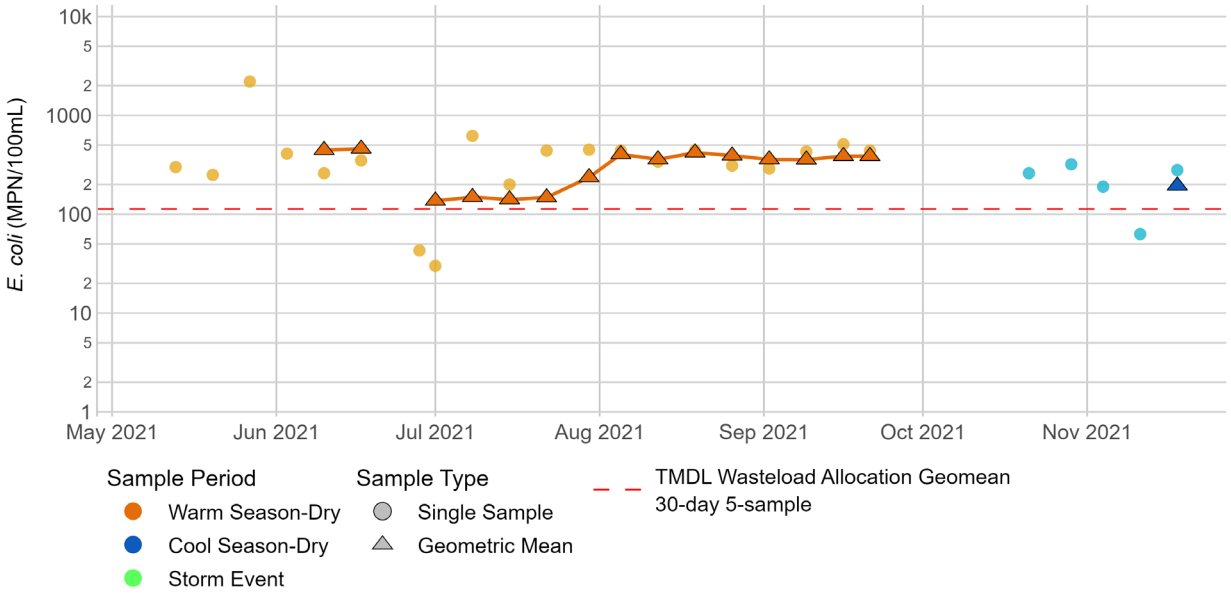

Figure 4-29. *E. coli* Concentrations and Geomeans at Santa Ana River at MWD Crossing (WW-S1)

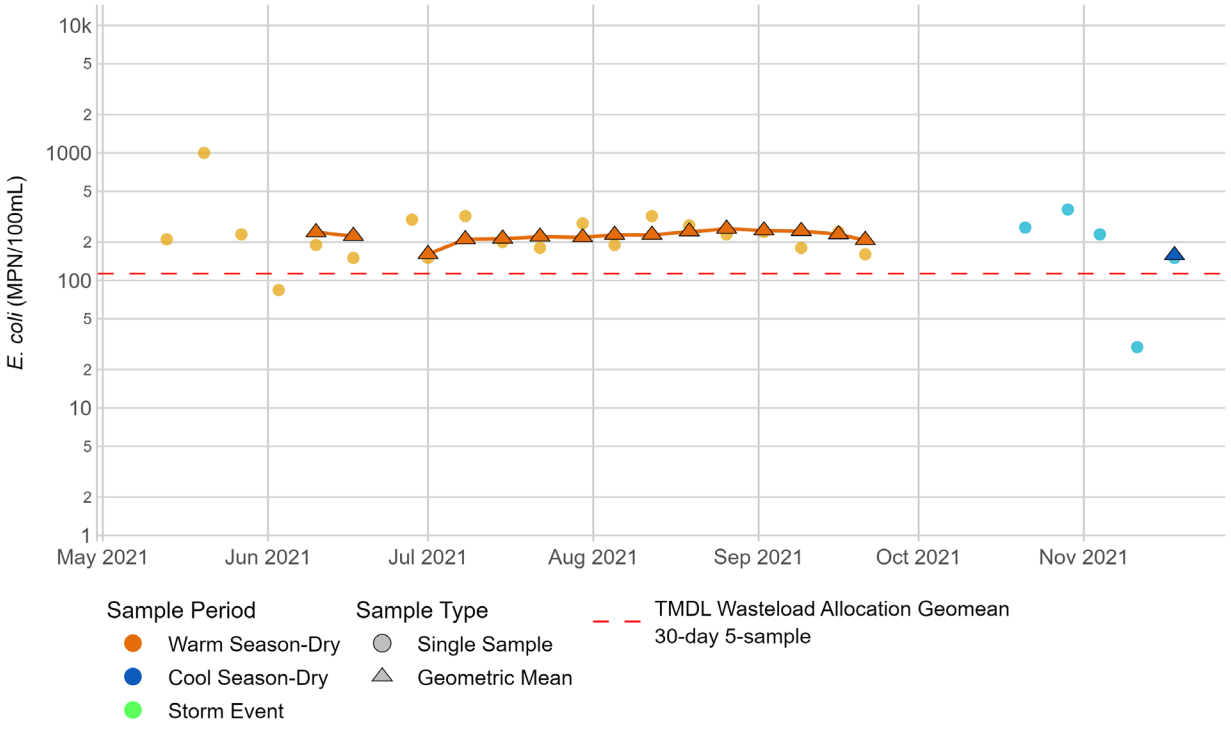

Figure 4-30. *E. coli* Concentrations and Geomeans at Santa Ana River at Pedley Avenue (WW-S4)

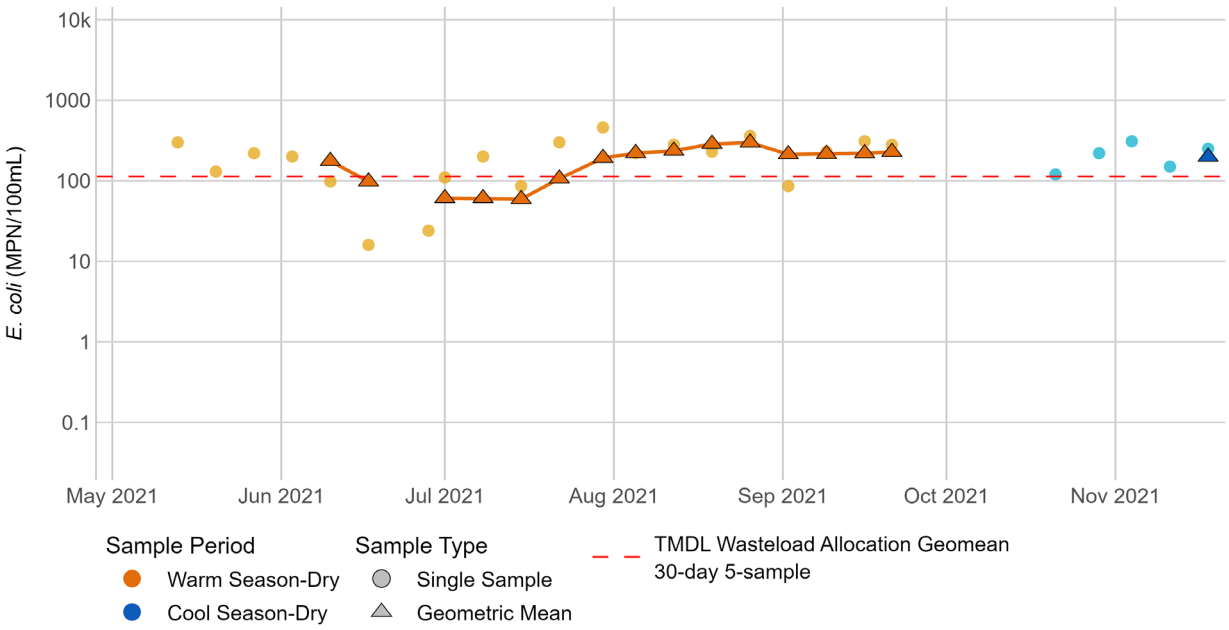

Figure 4-31. *E. coli* Concentrations and Geomeans at Santa Ana River at Mission Avenue (MISSION)

Forty-four paired samples were analyzed to assess if there is a correlation between bacteria *E. coli* concentrations at Mill-Cucamonga Creek (WW-M6) and concentrations at Cucamonga Creek at Hellman Avenue (P4-SBC1) which represents all of the MS4 dry weather inflow to the TMDL segment (Figure 4-32). No correlation between the two datasets can be seen, suggesting that the water quality from the MS4 inputs to Cucamonga Creek is not the cause of the TMDL impairment, and is instead caused by another in-stream source.

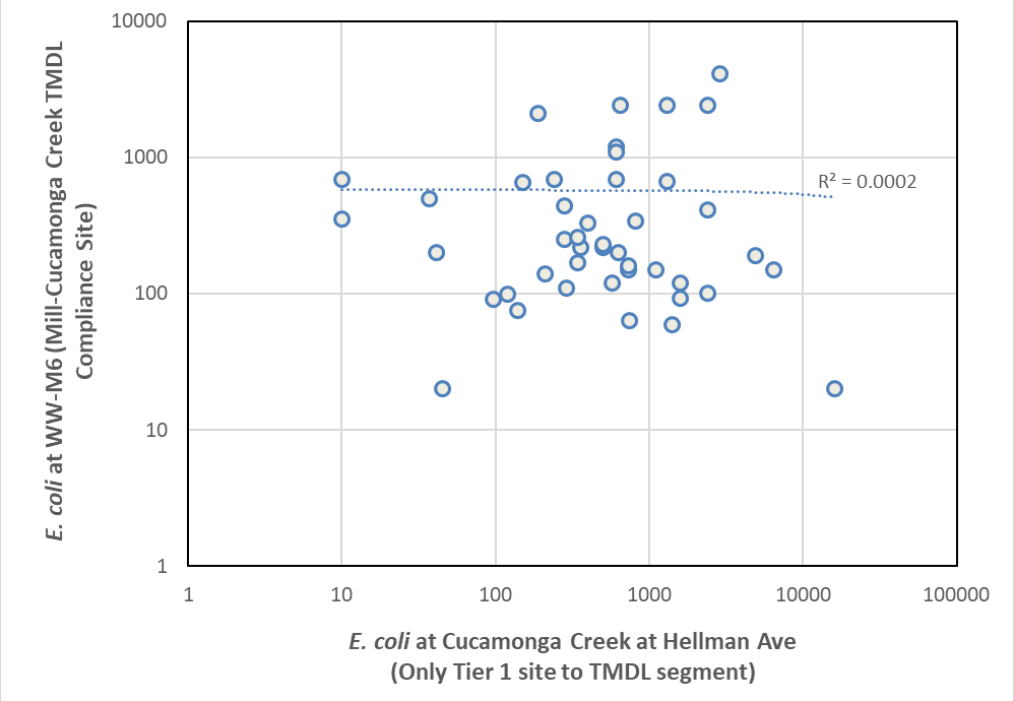

Figure 4-32. *E. coli* Concentrations Correlation between Mill-Cucamonga Creek (WW-M6) and Cucamonga Creek at Hellman Ave (P4-SBC1)

4.2.2.2 Wet Weather 2021-2022 Event

Samples collected for the March 29, 2022 storm event are summarized in Table 4-5. Figures 4-33 and 4-34 display changing *E. coli* concentrations at two stations over the sampling period. Historical wet weather analysis showed that bacteria levels in the MSAR waterbodies return to pre-event levels 24-48 hours following a returning to dry weather flow conditions, see Figure 4-35.

To provide better understanding of post-storm bacteria characterization and to better support data analysis for future wet weather CBRP implementation, the wet weather sampling procedure was adjusted from samples being taken every 0, 48, 72, and 96 hours to 0, 24, 48, and 72 hours. This provides greater definition for bacteria levels immediately after the storm and reduces likelihood of a follow-up event interfering with scheduled post storm sampling. For the March 29, 2022 event, the highest bacteria concentrations were observed during the 0 hour sampling event followed by gradual reduction of bacteria concentrations with the exception of Prado Park Lake which saw an increase in bacteria concentrations following the storm. This could be the result of a reduction in recreational activities during the storm event, a reduction in wildlife activities during the storm event, and a possible flushing/dilution effect caused by the storm. This will continue to be monitored in future wet weather events.

Table 4-5 *E. coli* Concentrations (MPN/100 mL) Observed During the 2021-2022 Storm Event

Site	3/29/2022 During Storm	3/30/2022 24 hours after storm start	3/31/2022 48 hours after storm start	4/01/2022 72 hours after storm start
Prado Park Lake (WW-C3)	41	41	62	150
Chino Creek at Central Avenue (WW-C7)	8700	960	490	74
Mill-Cucamonga Creek below Wetlands (WW-M6)	8200	710	230	200
SAR Reach 3 at MWD Crossing (WW-S1)	16000	420	280	130
SAR Reach 3 at Pedley Avenue (WW-S4)	16000	1000	260	140

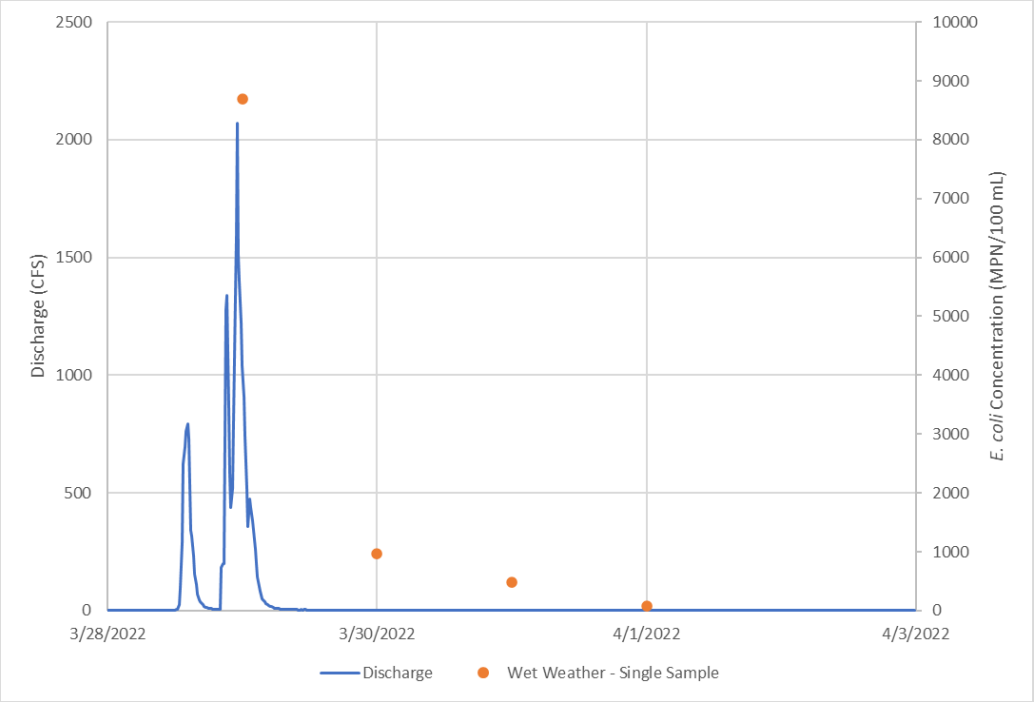

Figure 4-33. *E. coli* Concentrations Observed at Chino Creek During and After the March 29, 2022 Storm Event

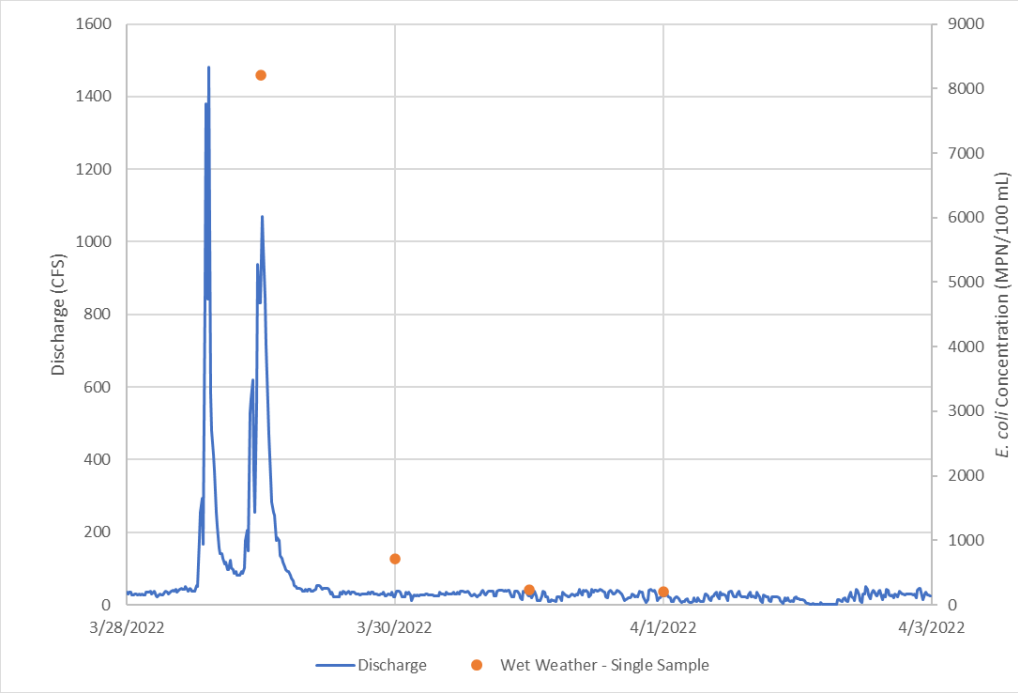

Figure 4-34. *E. coli* Concentrations Observed at Mill-Cucamonga Creek During and After the March 19, 2022 Storm Event

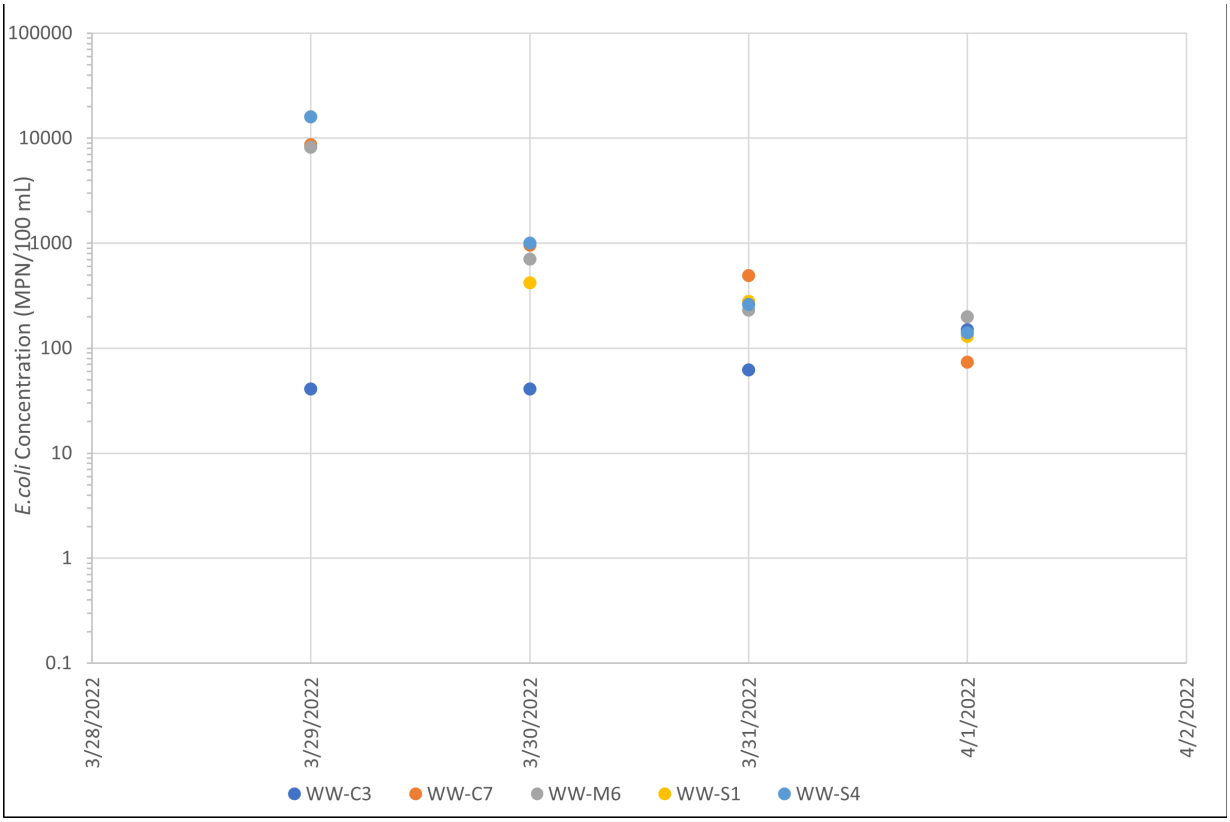

Figure 4-35. Post-storm Event *E. coli* Sample Concentrations from MSAR TMDL Waters

4.2.3 Compliance Analysis

The compliance analysis compares the *E. coli* geomeans to the MSAR Bacteria TMDL geomean WLAs/LAs of 113 organisms/100 mL for a 5-sample/30-day geomean (Section 1.2.1). Geometric means were calculated only when at least five sample results were available from the previous 30-day period.

Most of the Priority 2 geomeans exceeded the MSAR TMDL WLAs/LAs, with all geomeans calculated at the SAR sites exceeding the goal. At Prado Park Lake, only the cool, dry season sample exceeded the goal. All geomeans calculated during the cool, dry season except for SAR at MWD Crossing exceeded the TMDL WLAs/LAs. Table 4-6 shows the exceedance frequencies at each TMDL site.

Table 4-6. Frequency of Exceedance with MSAR TMDL WLAs/LAs for *E. coli* (113 MPN/100 mL) for the 2021 Dry Weather Samples

Site ID	Site	Warm, Dry Season Geomean WLA/LA Exceedance Frequency (%) (n=16)	Cool, Dry Season Geomean WLA/LA Exceedance Frequency (%) (n=1)
WW-C3	Prado Park Lake	25%	0%
WW-C7	Chino Creek at Central Avenue	88%	0%
WW-M6	Mill-Cucamonga Creek	88%	100%
WW-S1	Santa Ana River at MWD Crossing	100%	100%
WW-S4	Santa Ana River at Pedley Avenue	100%	100%

4.3 Priority 3

In the 2021-2022 sampling seasons, samples were collected, as planned, at 6 of 15 Priority 3 sites. Samples and measurements were not collected from Borrego Creek (P3-OC2), Buck Gully (P3-OC3), Los Trancos Creek (P3-OC5), Morning Canyon (P3-OC6), Peters Canyon Wash (P3-OC7), San Diego Creek Reach 1 (P3-OC8), San Diego Creek (Reach 2), Serrano Creek (P3-OC11) based on the determination of utilizing source investigation studies determine and eliminate cause of impairment. Bolsa Chica Channel (P3-OC1) was not sampled during the 2021-2022 sampling season as Orange County was working to establish the source investigation study methodology by continuing sampling program but determining new sampling locations further up the reach each year. Sampling at Bolsa Chica will begin in 2022.

4.3.1 Water Quality Observations

Figures 4-36 through 4-42 summarize water quality field observations at Priority 3 sites (Table 4-7). Sites where no samples were collected during the 2021-2022 dry season are not included on the figures. Key observations are summarized below.

Figure 4-36 presents pH measurements. During the dry, warm sampling period, pH observations were generally within the allowable range (6.5 to 8.5) with the exception of San Timoteo creek which saw increasing pH as flow moved down the reach prior to entering the mainstem of the SAR.

Figure 4-37 shows water temperatures generally range from 15°C to 27°C with the highest temperatures (26 to 27°C) observed at Santa Ana River Reach 4 (P3-SBC1).

Figure 4-38 shows that DO levels at all sites met the WQO for a minimum of 5 mg/L for WARM use.

Conductivity ranged from 500 to 1,312 µS/cm at the San Timoteo Creek sites and SAR Reach 4 (P3-SBC1). Conductivity ranged between 2,100 and 2,250 µS/cm at Goldenstar Creek.

Figure 4-40 shows that turbidity levels are generally low with 85 percent of measurements all measurements being less than 10 NTU except at San Timoteo Creek Reach 1A (P3-SBC2) where three samples ranged from 21 to 49 NTU.

Similar to turbidity, Figure 4-40 shows that TSS is generally low at all sites except at San Timoteo Creek Reach 1A (P3-SBC2) where three samples ranged from 40 to 180 mg/L.

Figure 4-42 shows that flow was low at all of the Priority 3 sites (less than 10 cfs) except for SAR Reach 4 (P3-SBC1) and San Timoteo Creek Reach 3 (P3-RC3).

Table 4-7. Priority 3 Monitoring Sites

Site ID	Site Description	County	Sampled in 2021-2022 by RMBP Program
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	yes
P3-RC3	San Timoteo Creek Reach 3	Riverside	yes
P3-SBC1	Santa Ana River Reach 4 above S. Riverside Avenue Bridge	San Bernardino	yes
P3-SBC2	San Timoteo Creek Reach 1A at Anderson St.	San Bernardino	yes
P3-SBC3	San Timoteo Creek Reach 2 at San Timoteo Canyon Rd.	San Bernardino	yes
P3-SBC4	Warm Creek below Fairway Dr.	San Bernardino	yes

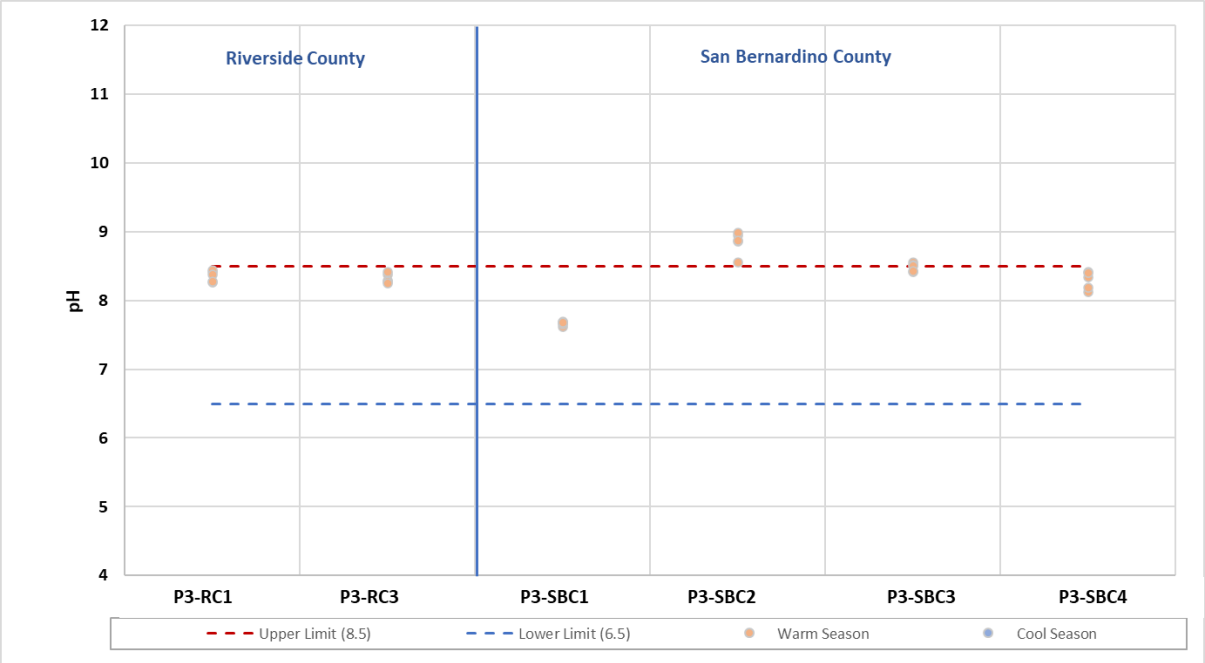

Figure 4-36. Distribution of pH Measurements at Priority 3 Sites

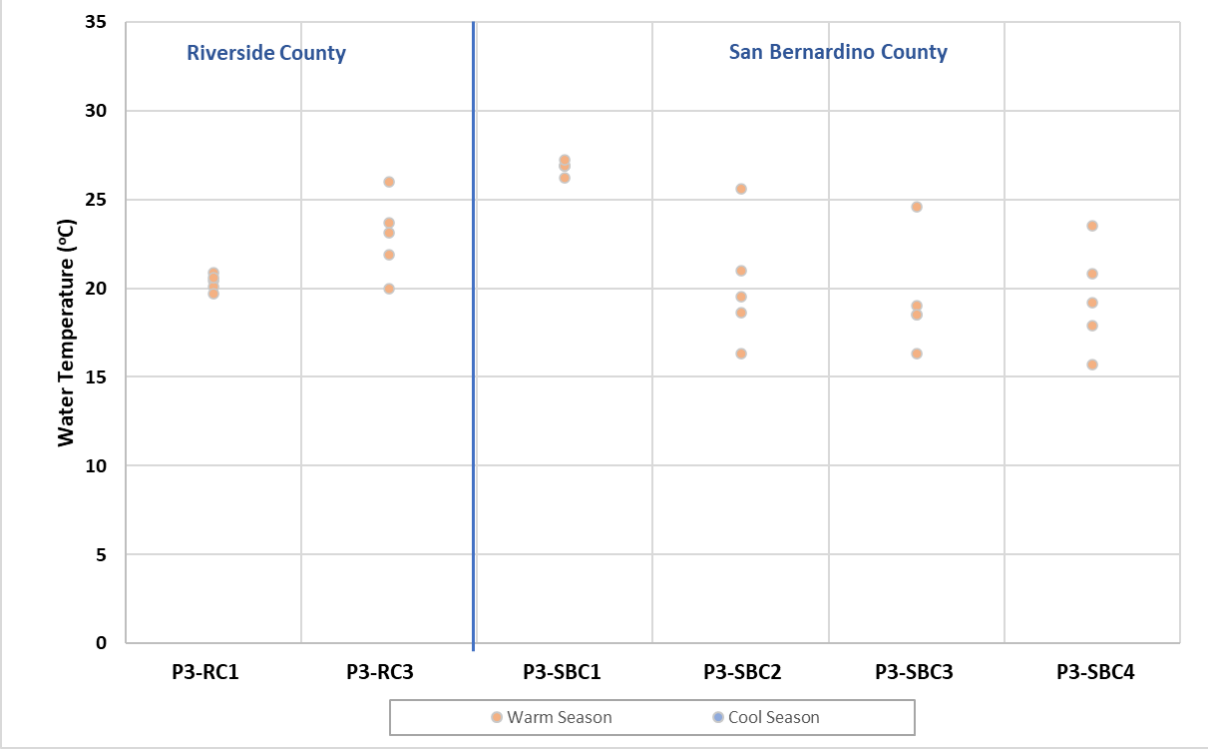

Figure 4-37. Distribution of Water Temperature Measurements at Priority 3 Sites

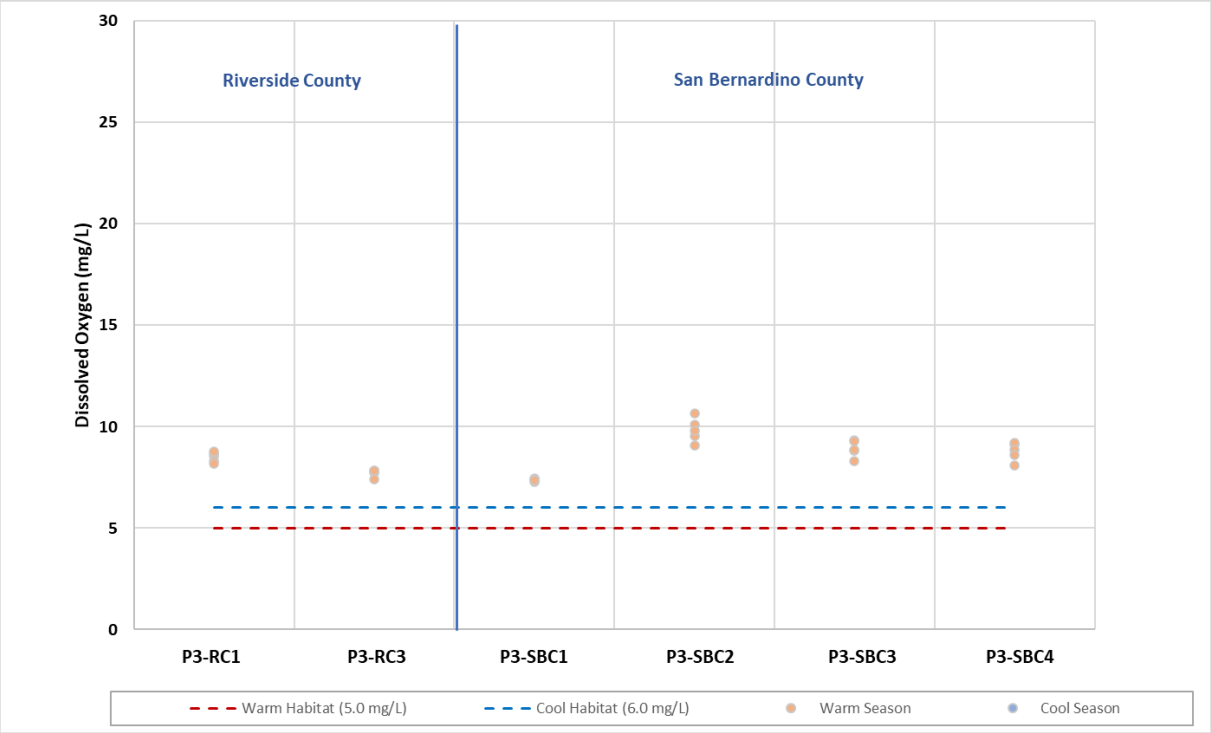

Figure 4-38. Distribution of Dissolved Oxygen Measurements at Priority 3 Sites

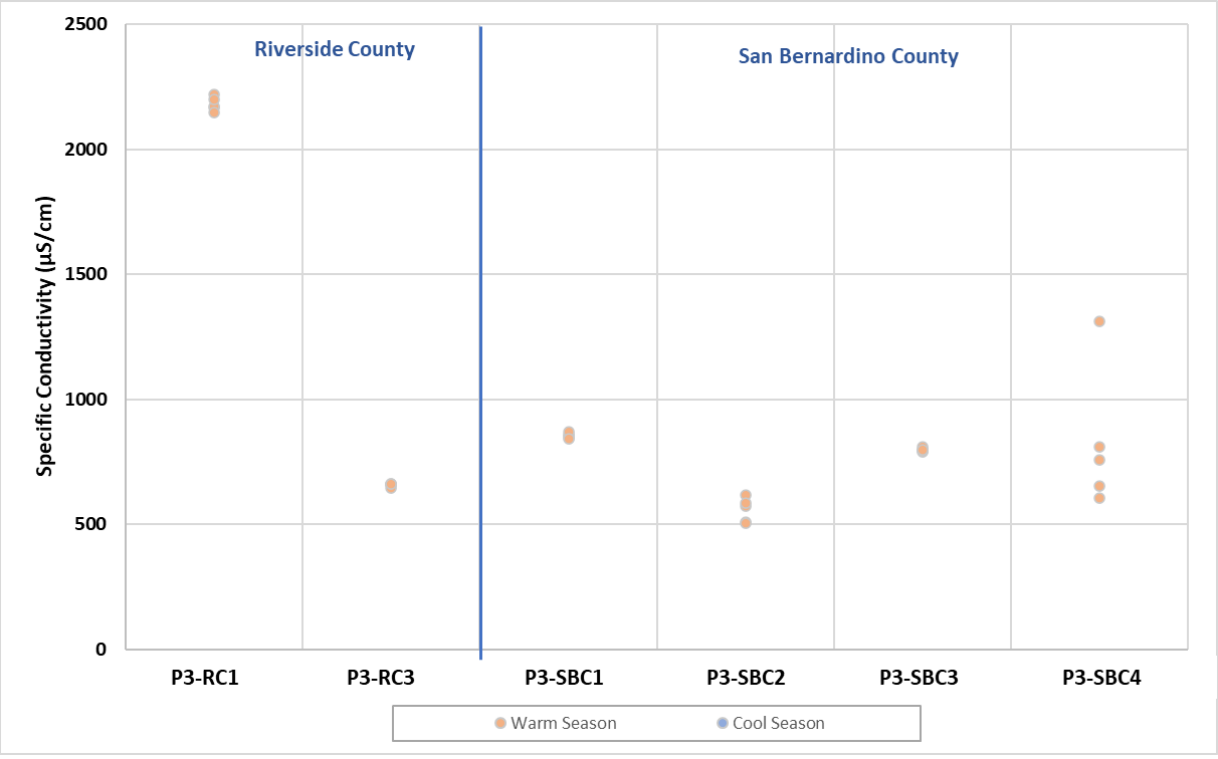

Figure 4-39. Distribution of Specific Conductivity Measurements at Priority 3d Sites

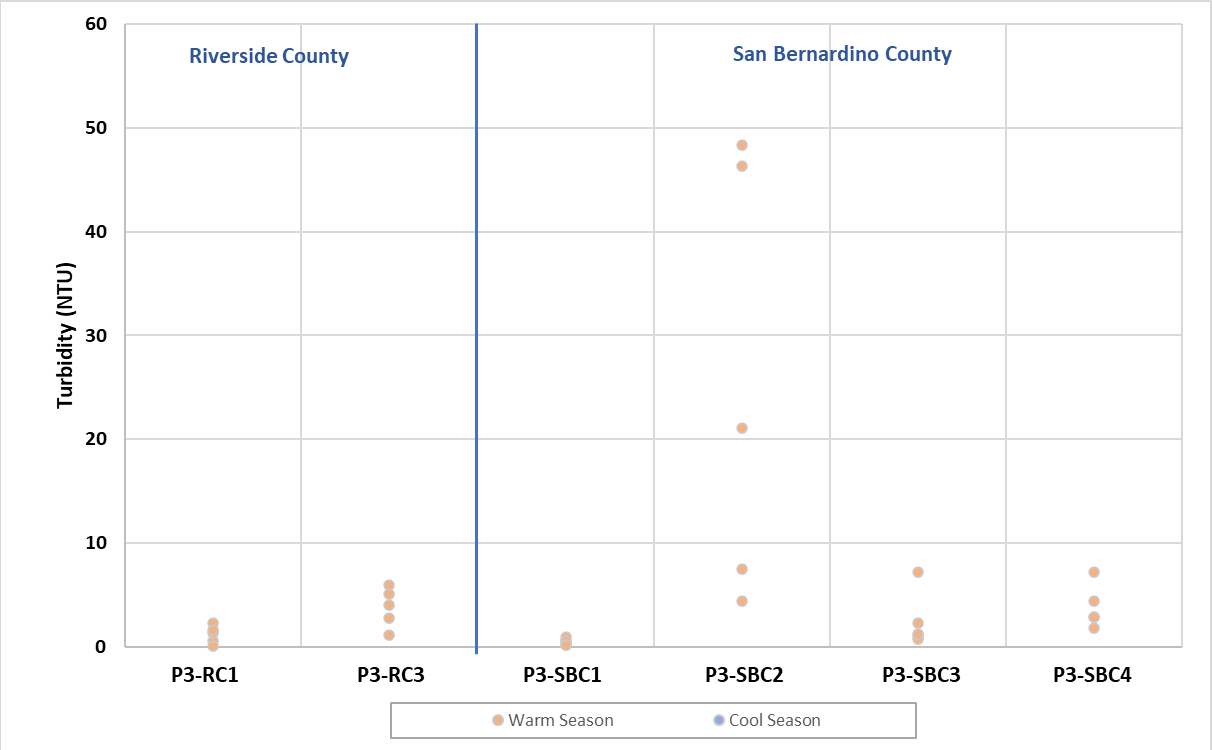

Figure 4-40. Distribution of Turbidity Measurements at Priority 3 Sites

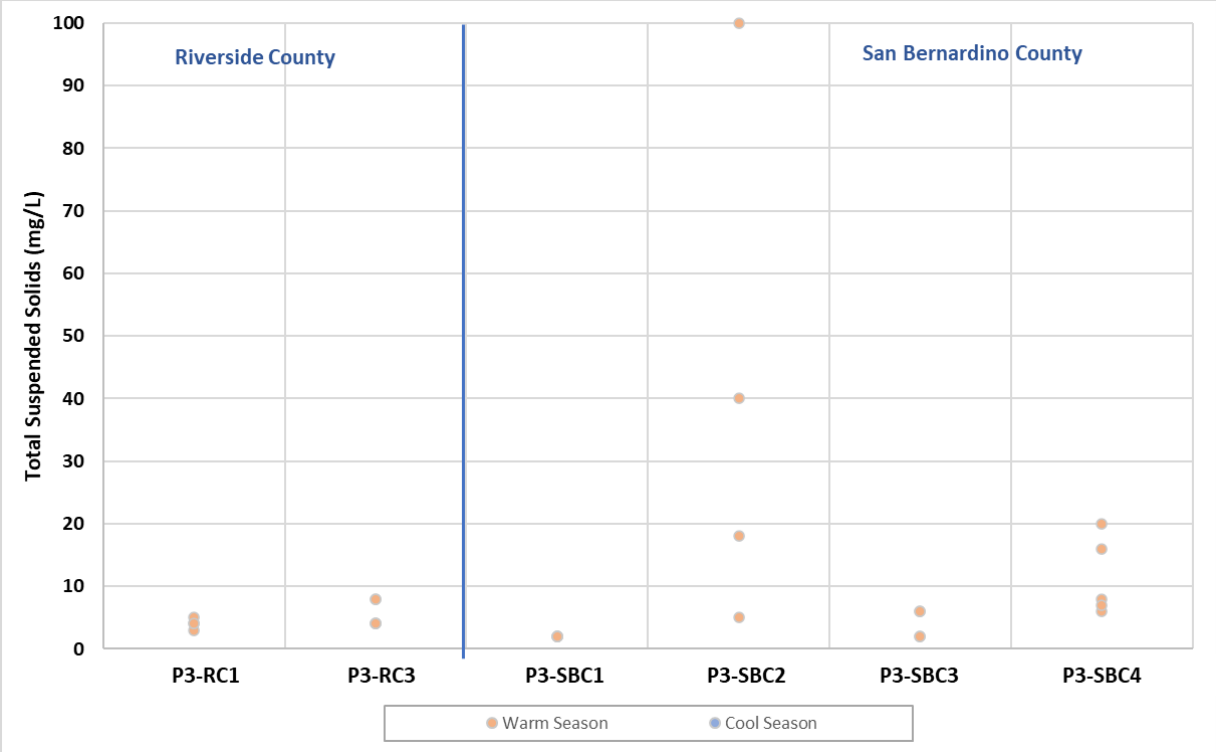

Figure 4-41. Distribution of TSS Measurements at Priority 3 Sites

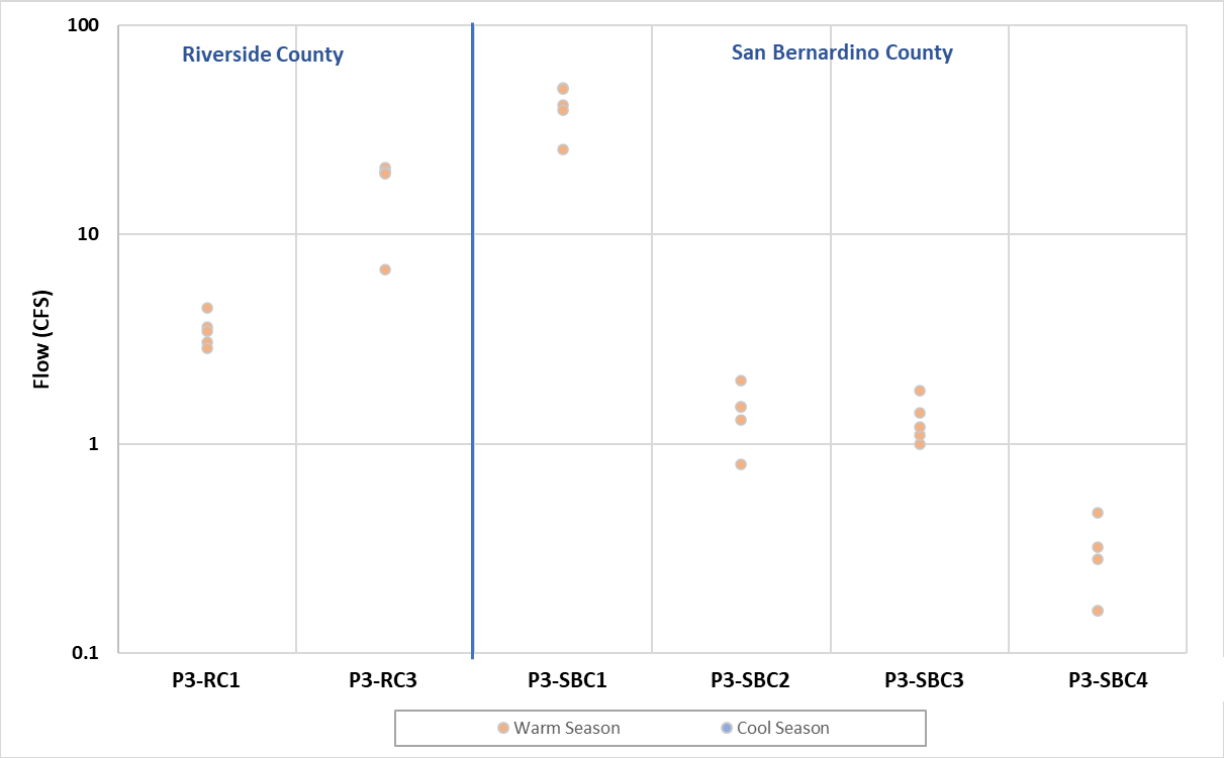

Figure 4-42. Distribution of Flow Measurements at Priority 3 Sites

4.3.2 Bacteria Characterization

Figure 4-43 displays the 2021 5-week geomeans and individual *E. coli* concentrations at Priority 3 sites during dry weather. The figure shows that five Priority 3 sites were higher than the Statewide Bacteria Provision geomean WQO of 100 organisms/100 mL: Goldenstar Creek (P3-RC1) and San Timoteo Creek Reach 1A (P3-SBC2), San Timoteo Creek Reach 2 (P3-SBC3), San Timoteo Creek Reach 3 (P3-RC3), and Warm Creek (P3-SBC4). Only Santa Ana River Reach 3 (P3-SBC1) that met the standard.

Bacteria levels were relatively similar for San Timoteo Creek reaches 2 and 3 ranging from 130 to 1,400 MPN/100 mL. Concentrations were typically higher at the furthest downstream San Timoteo site (P3-SBC2) ranging from 2000 to 4,400 MPN/100 mL.

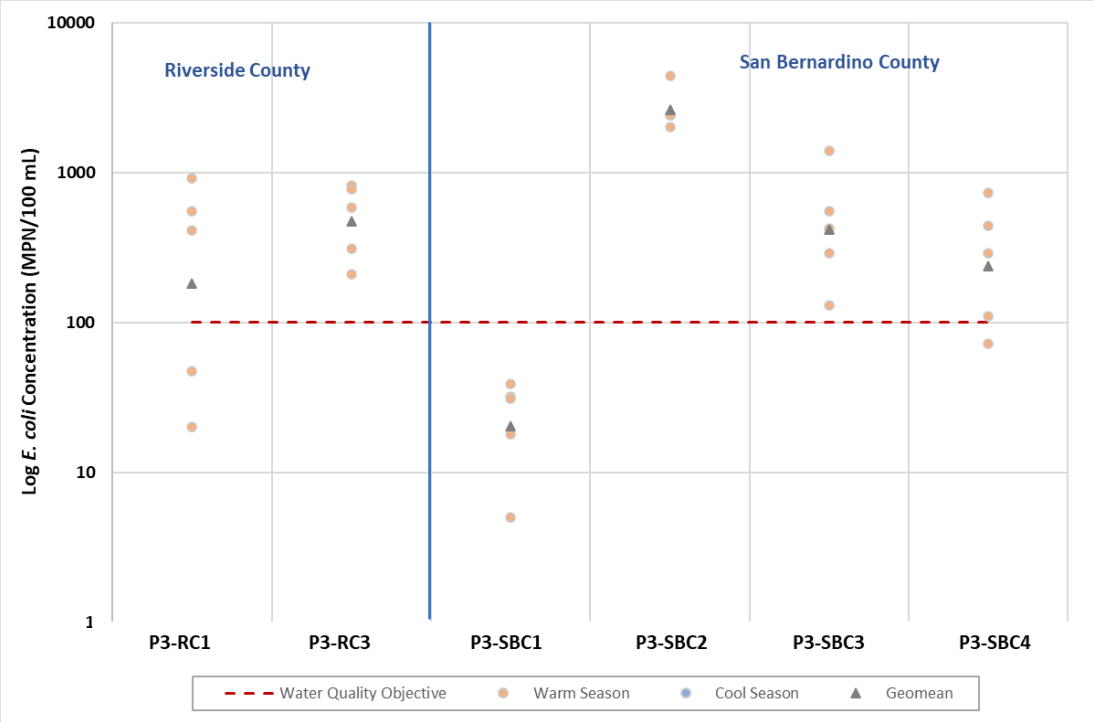

Figure 4-43. Distribution of *E. Coli* Concentration Measurements at Priority 3 Sites

4.4 Priority 4

The 2015 Basin Plan Amendment includes provisions applicable to waters with completed use attainability analyses (UAAs) supporting change of beneficial use from REC1 to REC2 Only to assure bacteria water quality conditions do not degrade from baseline levels as a result of controllable factors.[19] A statistical analysis of historical data (2002-2011) was completed to estimate a baseline of bacterial water quality including geometric mean, median, standard deviation, coefficient-of-variation, maximum value, and 75th percentile density. The 75th percentile density serves as the antidegradation target, meaning that 3 of 4 samples in data collected after the 2015 BPA must fall below these values to infer no degradation.

4.4.1 Water Quality Observations

Each Priority 4 site (Table 4-8) is sampled once each year to evaluate compliance with the antidegradation target established for each waterbody. Table 4-9 summarizes the water quality field parameters from each site in 2021.

[19] https://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/recreational_standards.html

Table 4-8. Priority 4 Monitoring Sites

Site ID	Site Description	County
P4-RC2	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 4-9. 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 in Tidal Prism (P4-OC3)	Temescal Creek at Lincoln Avenue (P4-RC2)	Cucamonga Creek at Hellman Avenue (P4-SBC1)
Sample Date	8/19/2021	8/19/2021	8/19/2021	7/23/2021	7/22/2021
pH	8.2	8.0	8.0	8.9	10.01
Water Temperature (°C)	24.0	25.9	25.2	26.5	27.2
Dissolved Oxygen (mg/L)	10.0	4.3	2.4	10.9	12.64
Conductivity (µS/cm)	2,237	45,600	47,752	1,346	662
Turbidity (NTU)	0.8	2.9	4.11	3.2	5.7
TSS (mg/L)	0.7	2.7	2.6	8	28
Flow (cfs)				4.7	3.5

4.4.2 Bacteria Characterization

Priority 4 water quality sample results were compared to site-specific single sample antidegradation targets (Table 4-10, Figure 4-44). Greenville-Banning Channel in Tidal Prism (P4-OC2) and Cucamonga Creek at Hellman Avenue (P4-SBC1) exceeded their antidegradation targets of 64 and 1,346 MPN/100mL respectively. The other three Priority 4 sites met their antidegradation targets.

As shown in Tables 4-11 and 4-12, the two of the three required monthly follow-up samples also exceeded the antidegradation targets. Orange County is continuing to do monthly samples at Greenville-Banning Channel in Tidal Prism and will continue until bacteria concentrations fall below antidegradation target. Data at Cucamonga Creek at Hellman Avenue was combined with data collected by San Bernardino's 10-week Study; they have been collecting weekly bacteria samples throughout Cucamonga Creek Reach 1 since 2016. Analysis revealed highly variable bacteria and flow conditions with elevated bacteria conditions extending further up the reach beyond the Inland Empire Utilities Agencies RP1 Recycled Water Pump Station. Section 4.5.2 provides more information on the Cucamonga Creek 10-week Study. This data was used as the beginning of a source investigation study and should be examined with other data such as dissolved organic carbon (DOC) as part of further source investigation study for Cucamonga Creek.

Table 4-10. Antidegradation Targets for Priority 4 Sites

Site ID	Site Description	Single Sample Antidegradation Target (MPN/100 mL)	*E.coli* Sample Result	*Enterococcus* Sample Result	Sample Date
P4-OC1	Santa Ana Delhi Channel Upstream of Irvine Avenue	1067	122		8/19/2021
P4-OC2	Santa Ana Delhi Channel in Tidal Prism	464		109	8/19/2021
P4-OC3[1]	Greenville-Banning Channel in Tidal Prism	64		98	8/19/2021
P4-RC2	Temescal Creek at Lincoln Avenue	725	7.48		7/23/2021
P4-SBC1[2]	Cucamonga Creek at Hellman Avenue	1385	1500		

[1] This sample exceeded the anti-degradation target for Greenville-Banning Channel in Tidal Prism of 64 MPN/100mL and resulted in three monthly follow-up samples. Results are shown in Table 4-11.
Cucamonga Creek at Hellman Avenue exceeded the anti-degradation target of 1,385 MPN/100 mL and resulted in three monthly follow-up samples. Results are shown in table 4-12.

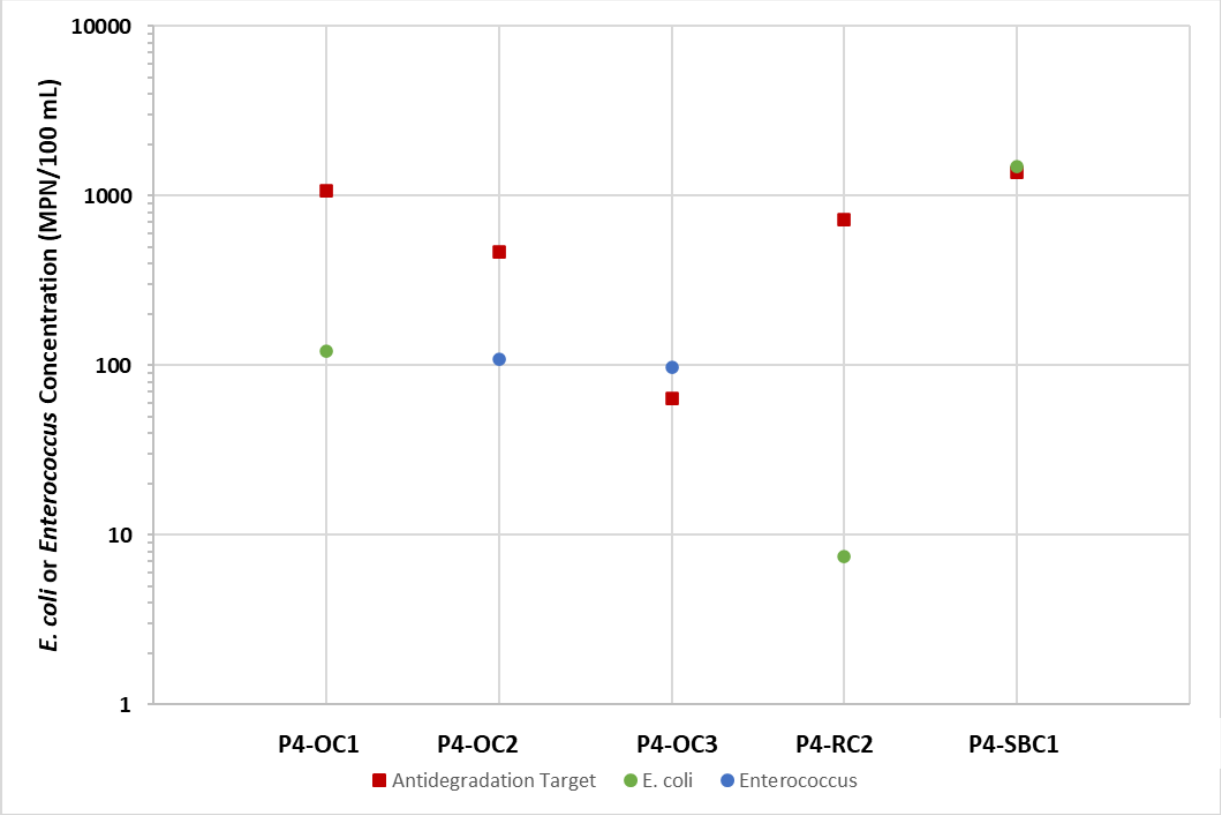

Figure 4-44. Monitoring Results and Antidegradation Targets for Priority 4 Sites

Table 4-11. Monthly Follow-Up Sampling at Greenville Banning Channel in Tidal Prism (P4-OC3)

Sample Requirement	Sample Date	*Enterococcus* Concentration (MPN/100 mL)
Original Annual Sample	8/19/2021	98[1]
Required Monthly Follow-up Samples	09/21/2021	132
	10/28/2021	882
	11/29/2021	20

[1] This sample exceeded the anti-degradation target for Greenville-Banning Channel in Tidal Prism of 64 MPN/100mL

Table 4-12. Monthly Follow-Up Sampling at Cucamonga Creek at Hellman Avenue (P4-SBC1)

Sample Requirement	Sample Date	*E. Coli* Concentration (MPN/100 mL)
Original Annual Sample	7/23/2021	1,500[1]
Required Monthly Follow-up Samples	8/25/2021	500
	9/22/2021	16,000
	10/20/2021	6,500

[1] This sample exceeded the anti-degradation target for Cucamonga Creek at Hellman Ave. of 1385 MPN/100mL

4.5 Related Study Results

In the 2021-2022 RBMP sampling year, two studies were performed that provide useful data for interpreting the RBMP results and setting future sampling direction. They are summarized briefly below.

4.5.1 Homeless Encampment Phase 1A Study

The Phase 1A Homeless Encampment study (GEI, CEI and CDM Smith, 2022) included data collection of water samples, field parameter measurements, and a rapid trash assessment.

Four rounds of dry weather samples were collected between September 2021 and January 2022. In the September and October sampling rounds, water samples were analyzed for total suspended solids, *E. coli*, and the human bacteria marker HF183. The final sampling rounds (November and January) included analysis for the bacteria markers for dogs (DG37) and pigs (Pig2Bac). Samples were collected on the upstream and downstream sides of three bridges on stretch of the Santa Ana River Reach at three areas of concentrated homeless encampments activity: Market Street Bridge, Mission Blvd. Bridge, and Van Buren Bridge.

The findings of the bacteria samples are presented in Table 4-13 and found that much of the bacteria was typed to the presence of feral pigs and not to the presence of humans or dogs. This finding along with anecdotal reports of a large herd of feral pigs in the vicinity warrant further investigation into the extent of pig-related bacteria impacts in this stretch of the Santa Ana River. Further study of the presence of pig DNA was approved for the 2022-2023 monitoring program along a slightly larger stretch of river than sampled in the Phase 1A of the Homeless Encampment Study; proposed sampling locations are shown in Figure 4-45.

Table 4-13. Results of Phase 1A of Homeless Encampment Study Bacteria Monitoring on the Santa Ana River

Sample Date	Bacteria or Marker		Market Street Bridge		Mission Blvd Bridge		Van Buren Bridge	
			MSB-1	MSB-2	MBB-1	MBB-2	VBB-1	VBB-2
9/21/2021	*E. coli*		20	170	140	110	310	280
	Human	Result	ND	ND	BDL	ND	ND	BDL
		Quantity	---	---	51	---	---	35 / Dup = 47
10/21/2021	*E. coli*		44	88	56	140	110	2,000
	Human	Result	ND	ND	ND	ND	ND	ND
		Quantity	---	---	---	---	---	---
11/18/2021	*E. coli*		130	230	84	440	150	430
	Human	Result	ND	ND	ND	BDL	ND	BDL
		Quantity	---	---	---	33	Dup = ND	64
	Dog	Result	ND	BDL	ND	ND	ND	ND
		Quantity	---	33	---	---	Dup = ND	---
	Pig	Result	ND	ND	ND	Detect	Detect	Detect
		Quantity	---	---	---	945	1,924 / Dup=1,734	26,915
1/6/2022	*E. coli*		31	60	59	59	99	93
	Human	Result	ND	ND	ND	ND	BDL	BDL
		Quantity	---	---	---	---	34	31
	Dog	Result	ND	ND	ND	ND	ND	ND
		Quantity	---	---	---	---	---	---
	Pig	Result	ND	ND	BDL	Detect	Detect	Detect
		Quantity	---	---	66	102	102	1,919

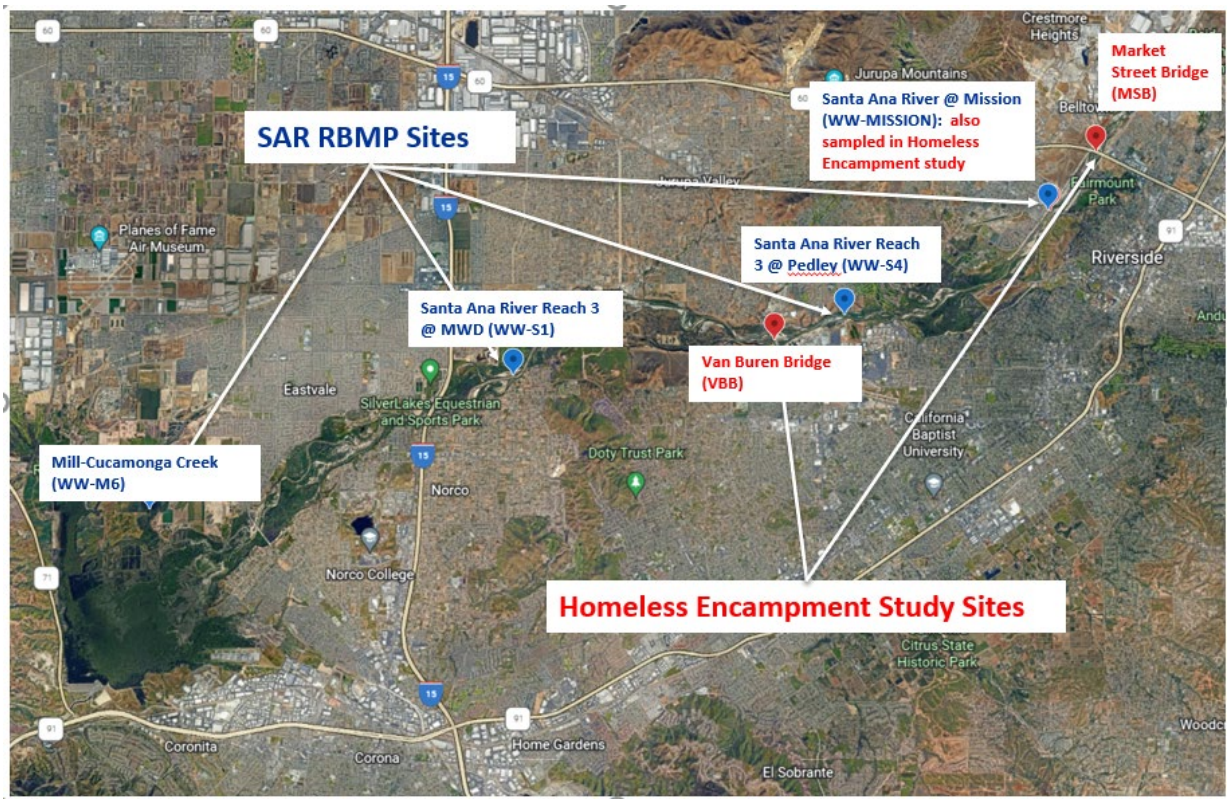

Figure 4-45. Sampling Locations for the Proposed SAR RBMP 2022-2023 Study and the Phase 1A Homeless Encampment Study

4.5.2 10-week Cucamonga Creek Study

Since 2016, San Bernardino County has been collecting bacteria data various locations ranging from the outlet of the Mill-Creek Wetlands to North of the Inland Empire Utilities Agencies RP1 Recycled Water Pump Station, see Figure 4-46. Bacteria data from this study was uploaded to the digital dashboard to allow for trend analysis in conjunction with the data collected by the RBMP at Cucamonga Creek at Hellman Avenue.

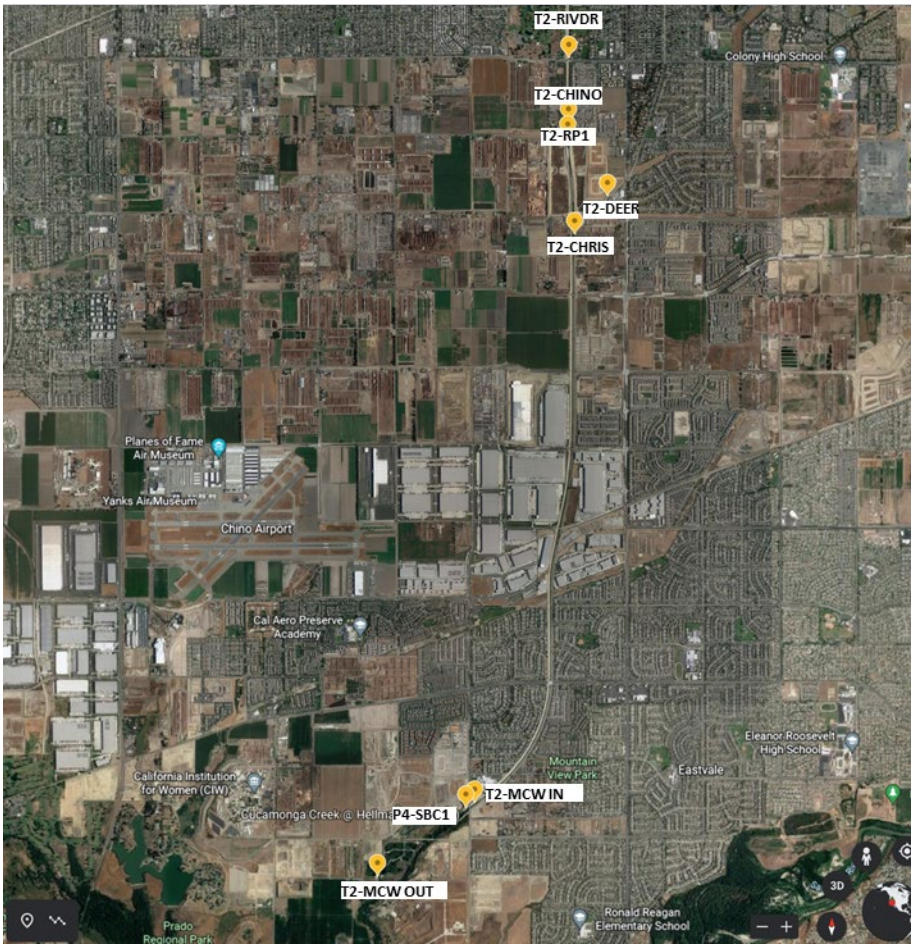

Figure 4-46. Cucamonga Creek 10-Week study Sampling Locations

Section 5

Recommendations for 2022-2023 Monitoring Program

This section describes recommended updates to the Monitoring Plan for the 2022-2023 monitoring year.

- Collect additional Pig qPCR samples at Santa Ana River at MISSION (WW-MISSION), Santa Ana River Reach 3 at Pedley (WW-S4), Santa Ana River Reach 3 at MWD (WW-S1) and Mill-Cucamonga Creek (WW-M6) to assess correlation between feral pig population and bacteria concentration in the SAR. This plan was presented in Section 4.5.1.
- Review of Tier 2 data collection in Cucamonga Creek with additional dissolved organic carbon (DOC) data as part of source analysis for Cucamonga creek.
- City of Lake Elsinore to conduct HF183 source investigation study in the vicinity of Elm Grove Beach to determine and eliminate potential causes for increased bacteria levels seen at this site in Lake Elsinore throughout the 2021 dry season sampling effort.

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Appendix A
Data Summary

Tables A-1 through A-27 summarize the water quality results obtained for *E. coli*, enterococci, TSS, and field measurements from Priority 1, Priority 2, and Priority 3 sites during 2021 dry weather sampling activities and 2021-2022 storm event. Data from Priority 4 sites are included in Section 4.4 and are not reproduced in this appendix. Tables A-28 through A-30 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 2021 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
5/9/2021	BDL	--	34	--	4.1	--	36	--
5/16/2021	4.1	--	37	--	BDL	--	BDL	--
5/23/2021	5.2	--	120	--	16	--	BDL	--
5/30/2021	BDL	--	82	--	2	--	BDL	--
6/6/2021	BDL	1.2	13	44	1	1.4	6.3	2.0
6/13/2021	BDL	1.2	99	54	28	2.3	2	1.1
6/20/2021	6.3	1.3	150	72	BDL	2.3	4.1	1.7
6/27/2021	4.1	1.3	80	66	5.2	2.7	BDL	1.7
7/4/2021	BDL	1.3	16	48	6.3	3.4	BDL	1.7
7/11/2021	1.0	1.5	17	50	1	3.4	BDL	1.0
7/18/2021	BDL	1.5	48	44	3.1	2.2	1	0.9
7/25/2021	BDL	0.9	21	29	5.2	3.5	1	0.7
8/1/2021	BDL	0.6	440	41	23	4.7	4.1	1.0
8/8/2021	BDL	0.6	18	42	3.1	4.1	1	1.2
8/15/2021	4.1	0.8	9.7	38	2	4.7	BDL	1.2
8/22/2021	BDL	0.8	340	56	1	3.7	BDL	1.0
8/29/2021	4.1	1.2	57	68	4.1	3.6	1	1.0
9/5/2021	1.0	1.3	84	49	3.1	2.4	BDL	0.7
9/12/2021	3.1	1.9	1	28	2	2.2	BDL	0.6
9/19/2021	2.0	1.7	45	37	BDL	1.7	2	0.8
10/17/2021	3.1	--	43	--	1	--	20	--
10/24/2021	14.0	--	66	--	10	--	BDL	--
10/31/2021	13.0	--	46	--	2	--	4.1	--
11/7/2021	BDL	--	390	--	18	--	19	--
11/14/2021	4.1	4.1	520	121	2	4	BDL	3

[1] Field blank collected at this site had a detectable value

Table A-2. *E. coli* (MPN/100 mL) Concentrations Observed at Priority 1 Stream Sites during the 2021 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
5/9/2021	13	--	26	--	300	--	210	--
5/16/2021	15	--	9.8	--	250	--	1000	--
5/23/2021	1	--	56	--	2200	--	230	--
5/30/2021	BDL	--	24	--	410	--	84	--
6/6/2021	BDL	2.2	22	23.7	260	445.7	190	238.4
6/13/2021	3.1	1.6	37	25.9	350	459.7	150	222.9
6/20/2021	6.3	1.4	50	38.9	43	323.3	300	175.2
6/27/2021	2	1.6	47	37.2	30	136.9	150	160.9
7/4/2021	1	1.8	44	38.5	620	148.7	320	210.2
7/11/2021	6.3	3.0	24	39	200	141.1	200	212.4
7/18/2021	2	2.8	91	47	440	147.7	180	220.3
7/25/2021	BDL	1.7	61	49	450	236.3	280	217.2
8/1/2021	BDL	1.3	18	40	440	404.3	190	227.8
8/8/2021	BDL	1.1	160	52.1	340	358.5	320	227.8
8/15/2021	60	1.7	39	57.4	440	419.8	270	241.8
8/22/2021	12	2.5	96	58.0	310	391.4	230	254.0
8/29/2021	12	4.6	66	58.9	290	358.5	240	246.3
9/5/2021	28	10.4	100	83.1	430	356.8	180	243.6
9/12/2021	38	24.7	58	67.8	510	386.9	240	230.0
9/19/2021	16	19.0	140	87.6	440	386.9	160	207.2
10/17/2021	1	--	64	--	260	--	260	--
10/24/2021	9.6	--	46	--	320	--	360	--
10/31/2021	13	--	46	--	190	--	230	--
11/7/2021	3.1	--	84	--	63	--	30	--
11/14/2021	100	8.3	84	62.5	280	194.6	150	157.5

[1] Field blank collected at this site had a detectable value

Table A-3. *E. coli* (MPN/100 mL) Concentrations Observed at Priority 2 Sites during the 2021 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)		SAR @ Mission Avenue (MISSION)	
	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomean	Result	Geomean
5/9/2021	97	--	280	--	610	--	300	--	210	--	300	--
5/16/2021	170	--	240	--	200	--	250	--	1000	--	130	--
5/23/2021	470	--	280	--	98	--	2200	--	230	--	220	--
5/30/2021	460	--	190	--	340	--	410	--	84	--	200	--
6/6/2021	74	192.4	710	302.6	150	227.5	260	446	190	238	98	176
6/13/2021	74	182.3	360	318.2	140	169.5	350	460	150	223	16	98
6/20/2021	41	137.2	170	297.0	290	182.6	43	323	300	175	24	70
6/27/2021	74	94.8	BDL	132.8	160	201.4	30	137	150	161	110	61
7/4/2021	110	71.2	430	156.3	390	207.0	620	149	320	210	200	61
7/11/2021	10	47.7	20	76.6	1100	308.3	200	141	200	212	86	59
7/18/2021	97	50.4	200	68.1	85	279.0	440	148	180	220	300	106
7/25/2021	BDL	33.1	1000	97.0	820	343.5	450	236	280	217	460	192
8/1/2021	41	29.4	680	259.2	210	362.7	440	404	190	228	220	221
8/8/2021	150	31.3	230	228.7	63	251.9	340	359	320	228	280	236
8/15/2021	20	35.9	380	412.1	250	187.3	440	420	270	242	230	287
8/22/2021	180	40.6	370	466.1	230	228.6	310	391	230	254	360	298
8/29/2021	74	69.6	240	350.3	10	94.7	290	358	240	246	86	213
9/5/2021	10	52.5	110	243.4	400	107.7	430	357	180	244	230	215
9/12/2021	86	47.0	BDL	113.2	31	93.5	510	387	240	230	310	219
9/19/2021	63	59.1	20	62.8	20	56.4	440	387	160	207	280	228
10/17/2021	63	--	74	--	150	--	260	--	260	--	120	--
10/24/2021	110	--	230	--	250	--	320	--	360	--	220	--
10/31/2021	52	--	210	--	2100	--	190	--	230	--	310	--
11/7/2021	98	--	85	--	74	--	63	--	30	--	150	--
11/14/2021	85	78.6	10	78.8	340	288.0	280	195	150	157	250	198

Table A-4. *E. coli* (MPN/100 mL) Concentrations Observed at Priority 3 Sites during the 2021 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"])

Week Beginning Date	Goldenstar Creek		San Timoteo Creek Reach 3		Santa Ana River Reach 3		San Timoteo Creek Reach 1A		San Timoteo Creek Reach 2		Warm Creek	
	(P3-RC1)		(P3-RC3)		(P3-SBC1)		(P3-SBC2)		(P3-SBC3)		(P3-SBC4)	
	SSV	GM	SSV	GM	SSV	GM	SSV	GM	SSV	GM	SSV	GM
5/9/2021	--	--	--	--	--	--	--	--	--	--	--	--
5/16/2021	--	--	--	--	--	--	--	--	--	--	--	--
5/23/2021	--	--	--	--	--	--	--	--	--	--	--	--
5/30/2021	--	--	--	--	--	--	--	--	--	--	--	--
6/6/2021	--	--	--	--	--	--	--	--	--	--	--	--
6/13/2021	--	--	--	--	--	--	--	--	--	--	--	--
6/20/2021	--	--	--	--	--	--	--	--	--	--	--	--
6/27/2021	--	--	--	--	--	--	--	--	--	--	--	--
7/4/2021	--	--	--	--	--	--	--	--	--	--	--	--
7/11/2021	--	--	--	--	--	--	--	--	--	--	--	--
7/18/2021	47	--	--	--	BDL	--	--	--	--	--	--	--
7/25/2021	910	--	--	--	32	--	--	--	--	--	--	--
8/1/2021	550	--	--	--	39	--	--	--	--	--	--	--
8/8/2021	410	--	--	--	31	--	--	--	--	--	--	--
8/15/2021	20	180.7	--	--	18	20.3	--	--	--	--	--	--
8/22/2021	--	--	310	--	--	--	2400	--	130	--	730	--
8/29/2021	--	--	820	--	--	--	2400	--	290	--	290	--
9/5/2021	--	--	580	--	--	--	2000	--	1400	--	440	--
9/12/2021	--	--	770	--	--	--	2400	--	550	--	72	--
9/19/2021	--	--	210	473.7	--	--	4400	2612.3	420	414.2	110	236.4
10/17/2021	--	--	--	--	--	--	--	--	--	--	--	--
10/24/2021	--	--	--	--	--	--	--	--	--	--	--	--
10/31/2021	--	--	--	--	--	--	--	--	--	--	--	--
11/7/2021	--	--	--	--	--	--	--	--	--	--	--	--
11/14/2021	--	--	--	--	--	--	--	--	--	--	--	--

Table A-5. *Enterococci* (MPN/100 mL) Concentrations Observed at Priority 1 Sites during the 2021 Dry Season

Week Beginning Date	Lake Elsinore at Elm Grove Beach (P1-2-ELM)	
	Results	Geomean
5/9/2021	43	--
5/16/2021	43	--
5/23/2021	0	--
5/30/2021	50	--
6/6/2021	11	16
6/13/2021	210	24
6/20/2021	360	35
6/27/2021	580	54
7/4/2021	52	104
7/11/2021	150	125
7/18/2021	24	142
7/25/2021	21	97
8/1/2021	73	74
8/8/2021	85	54
8/15/2021	14	43
8/22/2021	17	30
8/29/2021	22	30
9/5/2021	50	32
9/12/2021	1	17
9/19/2021	56	16
10/17/2021	220	--
10/24/2021	620	--
10/31/2021	41	--
11/7/2021	380	--
11/14/2021	2400	348

Table A-6. Total Suspended Solids (mg/L) Concentrations Observed at Priority 1 Sites during the 2021 Dry Season (BDL: below detection limit)

Week Beginning Date	Canyon Lake	Lake Elsinore	Lake Perris	Big Bear Lake	Mill Creek Reach 2	Lytle Creek	SAR @ MWD Crossing	SAR @ Pedley Avenue
	(P1-1)	(P1-2)	(P1-3)	(P1-4)	(P1-5)	(P1-6)	(WW-S1)	(WW-S4)
5/9/2021	BDL	35	8	10	BDL	BDL	8	7
5/16/2021	2	24	3	35	BDL	6	10	8
5/23/2021	BDL	30	37	20	BDL	4	2	4
5/30/2021	42	4	BDL	14	BDL	BDL	8	8
6/6/2021	4	42	8	38	BDL	4	BDL	6
6/13/2021	4	40	2	26	BDL	2	4	2
6/20/2021	2	42	10	8	BDL	8	7	7
6/27/2021	2	50	5	13	BDL	2	7	7
7/4/2021	3	50	2	10	2	2	6	5
7/11/2021	6	50	12	16	BDL	2	4	8
7/18/2021	3	38	4	290	BDL	2	6	6
7/25/2021	4	38	6	47	BDL	2	8	8
8/1/2021	5	63	2	38	BDL	BDL	8	7
8/8/2021	6	45	8	73	BDL	3	4	6
8/15/2021	7	42	12	59	13	2	4	4
8/22/2021	2	55	7	69	3	4	4	6
8/29/2021	2	25	4	150	2		2	4
9/5/2021	BDL	75	1	130	2	2	2	3
9/12/2021	BDL	57	4	16	2	2	4	4
9/19/2021	4	150	4	12	4	4	3	2
10/17/2021	2	68	4	34	6	2	6	6
10/24/2021	3	150	14	5	80	14	19	31
10/31/2021	4	84	14	11	16	BDL	8	10
11/7/2021	3	56	8	280	9	3	8	8
11/14/2021	3	460	17	14	10	BDL	6	8

[1] Field blank collected at this site had a detectable value

Table A-7. Total Suspended Solids (mg/L) Concentrations Observed at Priority 2 Sites during the 2021 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)	SAR @ Mission (WW-MISSION)
5/9/2021	20	4	7	8	7	7
5/16/2021	20	2		10	8	8
5/23/2021	20	2	2	2	4	4
5/30/2021	24	6	4	8	8	8
6/6/2021	26	4	3	BDL	6	6
6/13/2021	22	2	4	4	2	2
6/20/2021	20	4	2	7	7	7
6/27/2021	17	2	4	7	7	7
7/4/2021	43	6	4	6	5	5
7/11/2021	20	3	21	4	8	8
7/18/2021	14	6	4	6	6	6
7/25/2021	11	4	2	8	8	8
8/1/2021	20	BDL	3	8	7	7
8/8/2021	22	3	3	4	6	6
8/15/2021	15	3	4	4	4	4
8/22/2021	18	2	7	4	6	6
8/29/2021	12	4	2	2	4	4
9/5/2021	10	4	6	2	3	3
9/12/2021	13	2	BDL	4	4	4
9/19/2021	12	3	2	3	2	2
10/17/2021	23	3	2	6	6	6
10/24/2021	16	7	2	19	31	31
10/31/2021	15	4	2	8	10	10
11/7/2021	18	2	3	8	8	8
11/14/2021	20	BDL	5	6	8	8

[1] Field blank collected at this site had a detectable value

Table A-8. Total Suspended Solids (mg/L) Concentrations Observed at Priority 3 Sites during the 2021 Dry Season

Week Beginning Date	Goldenstar Creek	San Timoteo Creek Reach 3	Santa Ana River Reach 3	San Timoteo Creek Reach 1A	San Timoteo Creek Reach 2	Warm Creek
	(P3-RC1)	(P3-RC3)	(P3-SBC1)	(P3-SBC2)	(P3-SBC3)	(P3-SBC4)
5/9/2021	--	--	19	--	12	--
5/16/2021	--	--	18	--	12	--
5/23/2021	--	--	10	--	7	--
5/30/2021	--	--	9	--	10	--
6/6/2021	--	--	12	--	BDL	--
6/13/2021	--	--	--	--	--	--
6/20/2021	--	--	--	--	--	--
6/27/2021	--	--	--	--	--	--
7/4/2021	--	--	--	--	--	--
7/11/2021	--	--	--	--	--	--
7/18/2021	BDL	--	--	--	--	--
7/25/2021	BDL	--	--	--	--	--
8/1/2021	BDL	--	--	--	--	--
8/8/2021	BDL	--	--	--	--	--
8/15/2021	BDL	--	--	--	--	--
8/22/2021	--	--	--	--	--	15.3
8/29/2021	--	--	--	--	--	25.7
9/5/2021	--	--	--	--	--	19
9/12/2021	--	--	--	--	--	22.7
9/19/2021	--	--	--	--	--	41.8
10/17/2021	--	--	--	--	--	--
10/24/2021	--	--	--	--	--	--
10/31/2021	--	--	--	--	--	--
11/7/2021	--	--	--	--	--	--
11/14/2021	--	--	--	--	--	--

Table A-9. Dissolved Oxygen (mg/L) Concentrations Observed at Priority 1 Sites during the 2021 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)
5/9/2021	10.1	8.3	9.3	8.2	8.2	9.5	8.6	8.3
5/16/2021	10.0	11.1	9.3	8.1	8.0	9.3	8.3	8.1
5/23/2021	8.7	8.3	9.5	5.6	8.5	9.6	8.5	8.4
5/30/2021	10.1	13.0	9.5	7.1	8.5	9.5	8.3	8.0
6/6/2021	8.3	11.4	9.8	7.2	8.4	9.4	8.7	8.6
6/13/2021	9.8	11.5	10.0	8.4	8.1	9.1	8.0	7.8
6/20/2021	8.9	9.6	10.0	2.8	8.0	9.3	7.9	7.7
6/27/2021	8.1	9.1	9.5	9.9	8.0	9.2	8.0	7.8
7/4/2021	7.8	10.3	9.1	7.5	8.3	9.6	8.0	7.7
7/11/2021	7.9	9.6	8.8	5.6	8.1	9.4	8.1	7.8
7/18/2021	7.9	9.2	8.6	10.2	9.9	9.4	7.9	7.5
7/25/2021	8.2	8.4	8.6	4.4	8.2	9.5	8.0	7.7
8/1/2021	8.6	10.5	8.5	9.0	8.0	9.5	8.1	7.6
8/8/2021	10.1	10.6	8.1	12.2	7.7	9.4	8.1	7.6
8/15/2021	9.6	8.3	7.4	5.1	7.4	9.0	7.8	7.5
8/22/2021	8.5	11.1	7.5	5.3	8.0	9.5	8.0	7.7
8/29/2021	7.4	6.5	7.3	7.3	7.9	9.4	7.8	7.4
9/5/2021	7.9	10.1	7.5	4.5	7.6	9.1	7.8	7.5
9/12/2021	7.2	8.8	7.6	8.0	7.7	9.4	8.0	7.7
9/19/2021	7.6	11.3	7.6	7.0	7.8	9.1	8.1	7.7
10/17/2021	3.9	9.3	7.9	8.6	9.3	9.9	8.7	8.7
10/24/2021	5.7	14.7	8.4	8.4	9.1	9.4	8.2	8.3
10/31/2021	5.6	6.5	8.1	7.8	9.3	9.7	8.4	8.3
11/7/2021	5.2	7.9	8.4	8.6	9.7	9.7	8.3	8.3
11/14/2021	4.6	8.9	9.2	7.9	9.8	9.7	8.7	8.7

Table A-10. Dissolved Oxygen (mg/L) Concentrations Observed at Priority 2 Sites during the 2021 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)	SAR @ Mission (WW-MISSION)
5/9/2021	7.78	5.8	6.4	8.6	8.3	8.29
5/16/2021	8.52	6.0	6.7	8.3	8.1	7.92
5/23/2021	11.06	5.3	6.4	8.5	8.4	8.25
5/30/2021	8.93	4.4	5.9	8.3	8.0	8.05
6/6/2021	8.4	6.2	6.5	8.7	8.6	8.14
6/13/2021	9.11	4.2	5.7	8.0	7.8	7.75
6/20/2021	7.84	4.4	4.9	7.9	7.7	7.65
6/27/2021	8.21	3.5	5.5	8.0	7.8	7.86
7/4/2021	8.26	5.4	5.6	8.0	7.7	7.85
7/11/2021	7.56	3.2	6.1	8.1	7.8	7.93
7/18/2021	7.33	3.2	5.3	7.9	7.5	7.76
7/25/2021	8.81	1.8	4.8	8.0	7.7	7.63
8/1/2021	7.52	5.08	5.25	8.1	7.6	7.77
8/8/2021	8.66	3.5	5.3	8.1	7.6	7.9
8/15/2021	7.38	2.6	5.3	7.8	7.5	7.61
8/22/2021	7.27	2.1	6.1	8.0	7.7	7.71
8/29/2021	6.69	3.7	6.2	7.8	7.4	7.62
9/5/2021	6.81	1.7	5.8	7.8	7.5	7.52
9/12/2021	7.1	2.2	6.7	8.0	7.7	7.8
9/19/2021	8.1	2.0	6.4	8.1	7.7	7.82
10/17/2021	9.5	5.6	7.7	8.7	8.7	8.29
10/24/2021	9.9	4.5	7.1	8.2	8.3	7.98
10/31/2021	9.0	6.2	7.0	8.4	8.3	8.14
11/7/2021	9.8	6.5	7.2	8.3	8.3	8.14
11/14/2021	9.1	6.6	7.6	8.7	8.7	8.58

Table A-11. Dissolved Oxygen (mg/L) Concentrations Observed at Priority 3 Sites during the 2021 Dry Season

Week Beginning Date	Goldenstar Creek	San Timoteo Creek Reach 3	Santa Ana River Reach 3	San Timoteo Creek Reach 1A	San Timoteo Creek Reach 2	Warm Creek
	(P3-RC1)	(P3-RC3)	(P3-SBC1)	(P3-SBC2)	(P3-SBC3)	(P3-SBC4)
5/9/2021	--	--	--	--	--	--
5/16/2021	--	--	--	--	--	--
5/23/2021	--	--	--	--	--	--
5/30/2021	--	--	--	--	--	--
6/6/2021	--	--	--	--	--	--
6/13/2021	--	--	--	--	--	--
6/20/2021	--	--	--	--	--	--
6/27/2021	--	--	--	--	--	--
7/4/2021	--	--	--	--	--	--
7/11/2021	--	--	--	--	--	--
7/18/2021	8.57	--	7.29	--	--	--
7/25/2021	8.69	--	7.35	--	--	--
8/1/2021	8.76	--	7.46	--	--	--
8/8/2021	8.32	--	7.4	--	--	--
8/15/2021	8.16	--	7.36	--	--	--
8/22/2021	--	7.74	--	10.09	8.8	9.1
8/29/2021	--	7.77	--	9.55	8.85	9.22
9/5/2021	--	7.42	--	9.08	8.29	8.85
9/12/2021	--	7.84	--	9.8	9.31	8.11
9/19/2021	--	7.84	--	10.65	9.3	8.6
10/17/2021	--	--	--	--	--	--
10/24/2021	--	--	--	--	--	--
10/31/2021	--	--	--	--	--	--
11/7/2021	--	--	--	--	--	--
11/14/2021	--	--	--	--	--	--

Table A-12. pH (standard units) Observed at Priority 1 Sites during the 2021 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)	SAR @ MISSION (WW-MISSION)
5/9/2021	8.8	9.0	8.7	8.6	7.7	8.4
5/16/2021	8.8	9.0	8.7	8.6	7.7	8.3
5/23/2021	8.5	8.9	8.7	8.5	7.4	8.2
5/30/2021	8.8	9.2	8.8	8.7	7.5	8.3
6/6/2021	8.7	9.2	9.0	8.5	7.6	8.3
6/13/2021	8.7	9.2	9.3	8.9	7.8	8.3
6/20/2021	8.7	9.2	9.4	8.9	7.6	8.3
6/27/2021	8.7	9.1	9.4	9.6	7.4	8.4
7/4/2021	8.5	9.1	9.2	9.7	7.6	8.2
7/11/2021	8.5	9.1	9.3	9.6	7.7	8.4
7/18/2021	8.6	9.0	9.2	9.6	8.1	8.4
7/25/2021	8.6	9.0	9.2	10.1	7.5	8.3
8/1/2021	8.7	8.9	9.2	9.9	7.5	8.2
8/8/2021	8.8	9.2	9.2	9.7	7.7	8.4
8/15/2021	8.6	8.7	9.0	9.5	8.5	8.3
8/22/2021	8.6	9.0	8.9	10.0	8.4	8.2
8/29/2021	8.6	8.9	8.9	9.7	8.5	8.3
9/5/2021	8.4	9.0	8.8	9.4	8.5	8.0
9/12/2021	8.4	9.0	8.8	8.8	8.3	8.1
9/19/2021	8.4	9.2	8.9	8.7	8.6	8.4
10/17/2021	7.4	8.9	8.3	8.6	8.4	8.2
10/24/2021	7.6	9.1	8.4	8.6	8.2	8.2
10/31/2021	7.7	8.8	8.3	8.6	8.3	8.3
11/7/2021	7.7	8.8	8.3	8.4	8.3	8.3
11/14/2021	8.0	8.6	8.5	7.7	7.7	8.0

Table A-13. pH (standard units) Observed at Priority 2 Sites during the 2021 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)	SAR @ MISSION (WW-MISSION)
5/9/2021	7.78	5.8	6.4	8.6	8.3	8.29
5/16/2021	8.52	6.0	6.7	8.3	8.1	7.92
5/23/2021	11.06	5.3	6.4	8.5	8.4	8.25
5/30/2021	8.93	4.4	5.9	8.3	8.0	8.05
6/6/2021	8.4	6.2	6.5	8.7	8.6	8.14
6/13/2021	9.11	4.2	5.7	8.0	7.8	7.75
6/20/2021	7.84	4.4	4.9	7.9	7.7	7.65
6/27/2021	8.21	3.5	5.5	8.0	7.8	7.86
7/4/2021	8.26	5.4	5.6	8.0	7.7	7.85
7/11/2021	7.56	3.2	6.1	8.1	7.8	7.93
7/18/2021	7.33	3.2	5.3	7.9	7.5	7.76
7/25/2021	8.81	1.8	4.8	8.0	7.7	7.63
8/1/2021	7.52	5.08	5.25	8.1	7.6	7.77
8/8/2021	8.66	3.5	5.3	8.1	7.6	7.9
8/15/2021	7.38	2.6	5.3	7.8	7.5	7.61
8/22/2021	7.27	2.1	6.1	8.0	7.7	7.71
8/29/2021	6.69	3.7	6.2	7.8	7.4	7.62
9/5/2021	6.81	1.7	5.8	7.8	7.5	7.52
9/12/2021	7.1	2.2	6.7	8.0	7.7	7.8
9/19/2021	8.1	2.0	6.4	8.1	7.7	7.82
10/17/2021	9.5	5.6	7.7	8.7	8.7	8.29
10/24/2021	9.9	4.5	7.1	8.2	8.3	7.98
10/31/2021	9.0	6.2	7.0	8.4	8.3	8.14
11/7/2021	9.8	6.5	7.2	8.3	8.3	8.14
11/14/2021	9.1	6.6	7.6	8.7	8.7	8.58

Table A-14. pH (standard units) Observed at Priority 3 Sites during the 2021 Dry Season

Week Beginning Date	Goldenstar Creek	San Timoteo Creek Reach 3	Santa Ana River Reach 3	San Timoteo Creek Reach 1A	San Timoteo Creek Reach 2	Warm Creek
	(P3-RC1)	(P3-RC3)	(P3-SBC1)	(P3-SBC2)	(P3-SBC3)	(P3-SBC4)
5/9/2021	--	--	--	--	--	--
5/16/2021	--	--	--	--	--	--
5/23/2021	--	--	--	--	--	--
5/30/2021	--	--	--	--	--	--
6/6/2021	--	--	--	--	--	--
6/13/2021	--	--	--	--	--	--
6/20/2021	--	--	--	--	--	--
6/27/2021	--	--	--	--	--	--
7/4/2021	--	--	--	--	--	--
7/11/2021	--	--	--	--	--	--
7/18/2021	8.41	--	7.62	--	--	--
7/25/2021	8.44	--	7.69	--	--	--
8/1/2021	8.26	--	7.66	--	--	--
8/8/2021	8.38	--	7.68	--	--	--
8/15/2021	8.28	--	7.68	--	--	--
8/22/2021	--	8.38	--	8.95	8.55	8.34
8/29/2021	--	8.41	--	8.86	8.51	8.41
9/5/2021	--	8.29	--	8.99	8.5	8.4
9/12/2021	--	8.28	--	8.56	8.41	8.12
9/19/2021	--	8.25	--	8.87	8.43	8.18
10/17/2021	--	--	--	--	--	--
10/24/2021	--	--	--	--	--	--
10/31/2021	--	--	--	--	--	--
11/7/2021	--	--	--	--	--	--
11/14/2021	--	--	--	--	--	--

Table A-15. Turbidity (NTU) Observed at Priority 1 Sites during the 2021 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)
5/9/2021	0.3	18	4.3	6.2	0.3	0.8	3.0	2.7
5/16/2021	0.8	13	1.0	20.8	0.1	0.6	2.4	1.8
5/23/2021	0.7	27	1.9	13	0.1	0.3	2.2	2.1
5/30/2021	0.9	25	1.0	11.1	0.6	0.6	1.1	0.6
6/6/2021	1.2	27	2.8	12	0.1	0.2	1.1	1.6
6/13/2021	1.9	35	3.1	12	0.0	1.1	3.1	2.9
6/20/2021	2.9	24	2.3	7.0	0.1	0.2	3.2	1.7
6/27/2021	0.9	24	0.7	22	0.2	0.4	2.0	1.9
7/4/2021	0.6	24	2.5	6.1	0.5	0.1	2.2	1.6
7/11/2021	1.1	39	2.4	5	0.1	0.4	1.3	1.9
7/18/2021	0.6	24	5.0	33	0	0.6	6.5	1.6
7/25/2021	1.8	39	2.7	23	0.3	0.5	3.4	2.5
8/1/2021	0.9	33	0.6	10	0.2	0.3	3.6	4.3
8/8/2021	0.8	51	0.2	49	1.3	0.2	0.3	0.1
8/15/2021	1.0	48	0.2	45	13.1	0.1	1.3	0.7
8/22/2021	0.7	61	0.9	40.0	2.2	0.2	1.3	1.3
8/29/2021	0.7	27	1.3	101.0	2.0	0.1	4.2	1.3
9/5/2021	0.5	69	1.6	93.2	1.6	0.3	1.1	0.9
9/12/2021	0.7	125	0.7	17.1	1.8	0.5	4.7	1.5
9/19/2021	0.6	182	1.3	8	2.9	0.9	1.2	1.3
10/17/2021	0.6	23	3.4	14.2	3.8	0.2	1.1	1.4
10/24/2021	0.3	212	6.2	1.1	15.4	0.6	12.3	21.8
10/31/2021	0.4	16	0.6	5.1	4.2	0.2	2.9	3.0
11/7/2021	0.8	40	2.3	42	4.0	0.3	2.5	2.5
11/14/2021	1.3	84	11.4	9	1.5	0.1	2.0	2.7

Table A-16. Turbidity (NTU) Observed at Priority 2 Sites during the 2021 Dry Season

Week Beginning Date	Prado Park Lake Outlet	Chino Creek @ Central Avenue	Mill-Cucamonga Creek Below Wetlands	SAR @ MWD Crossing	SAR @ Pedley Avenue	SAR @ Mission Ave
	(WW-C3)	(WW-C7)	(WW-M6)	(WW-S1)	(WW-S4)	(MISSION)
5/9/2021	7.3	1.4	4.8	3.0	2.7	2.5
5/16/2021	8	1.5	2.1	2.4	1.8	3
5/23/2021	9.9	1.6	2.2	2.2	2.1	1.3
5/30/2021	10.4	0.5	1.8	1.1	0.6	1.2
6/6/2021	6.9	0.9	2.5	1.1	1.6	0.9
6/13/2021	9.8	2.7	1.4	3.1	2.9	10.4
6/20/2021	8.7	2.0	1.5	3.2	1.7	4.2
6/27/2021	8.2	1.0	1.5	2.0	1.9	2.5
7/4/2021	11.3	5.5	1.0	2.2	1.6	2
7/11/2021	13	1.6	3.9	1.3	1.9	1.7
7/18/2021	11.2	1.9	1.0	6.5	1.6	2.2
7/25/2021	12.6	1.2	1.8	3.4	2.5	3.7
8/1/2021	13.2	0.56	0.8	3.6	4.3	2.4
8/8/2021	8.8	0.8	0.5	0.3	0.1	0.3
8/15/2021	8.2	1.1	2.6	1.3	0.7	1.1
8/22/2021	7.5	2.6	0.6	1.3	1.3	1
8/29/2021	5	1.6	0.9	4.2	1.3	2.8
9/5/2021	3.3	1.7	1.7	1.1	0.9	1.1
9/12/2021	4.4	0.6	0.6	4.7	1.5	1.06
9/19/2021	4.5	0.9	0.5	1.2	1.3	1.4
10/17/2021	9.2	0.9	0.6	1.1	1.4	1.2
10/24/2021	3.3	0.3	3.1	12.3	21.8	7.4
10/31/2021	4.2	1.1	0.7	2.9	3.0	2.2
11/7/2021	7.0	0.6	0.5	2.5	2.5	1
11/14/2021	9.3	0.7	1.2	2.0	2.7	1.3

Table A-17. Turbidity (NTU) Observed at Priority 3 Sites during the 2021 Dry Season

Week Beginning Date	Goldenstar Creek	San Timoteo Creek Reach 3	Santa Ana River Reach 3	San Timoteo Creek Reach 1A	San Timoteo Creek Reach 2	Warm Creek
	(P3-RC1)	(P3-RC3)	(P3-SBC1)	(P3-SBC2)	(P3-SBC3)	(P3-SBC4)
5/9/2021	--	--	--	--	--	--
5/16/2021	--	--	--	--	--	--
5/23/2021	--	--	--	--	--	--
5/30/2021	--	--	--	--	--	--
6/6/2021	--	--	--	--	--	--
6/13/2021	--	--	--	--	--	--
6/20/2021	--	--	--	--	--	--
6/27/2021	--	--	--	--	--	--
7/4/2021	--	--	--	--	--	--
7/11/2021	--	--	--	--	--	--
7/18/2021	0.5	--	0.9	--	--	--
7/25/2021	2.3	--	0.5	--	--	--
8/1/2021	1.3	--	0.2	--	--	--
8/8/2021	1.6	--	0.5	--	--	--
8/15/2021	0.1	--	0.2	--	--	--
8/22/2021	--	5.9	--	46.3	1	2.9
8/29/2021	--	5.1	--	21.1	2.3	2.9
9/5/2021	--	4	--	48.3	7.2	1.8
9/12/2021	--	2.8	--	4.4	0.7	4.4
9/19/2021	--	1.1	--	7.5	1.2	7.2
10/17/2021	--	--	--	--	--	--
10/24/2021	--	--	--	--	--	--
10/31/2021	--	--	--	--	--	--
11/7/2021	--	--	--	--	--	--
11/14/2021	--	--	--	--	--	--

Table A-18. Water Temperature (°C) Concentrations Observed at Priority 1 Sites during the 2021 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)
5/9/2021	23.7	22.7	22.3	14.8	12.4	12.1	18.5	19.8
5/16/2021	22.9	22.5	21.5	16.4	12.8	12.2	19.4	20.4
5/23/2021	22.8	23.8	23.1	17.4	12.8	12.1	19.2	20.1
5/30/2021	25.5	24.8	23.5	19.3	13.5	12.9	20.2	21.4
6/6/2021	24.1	24.1	23.6	11.6	12.8	12.1	18.4	18..6
6/13/2021	28.8	29.0	25.4	18.2	13.5	16.2	20.6	22.0
6/20/2021	26.9	24.9	26.1	14.4	14.1	12.5	20.6	22.1
6/27/2021	28.5	27.3	25.8	18.8	13.7	13.3	20.4	22.0
7/4/2021	28.7	27.9	27.0	18.1	13.7	12.2	21.0	22.6
7/11/2021	29.4	29.0	27.8	19.7	15.8	13.5	23.6	23.6
7/18/2021	29.6	29.2	27.6	21.7	14.9	12.8	21.3	23.3
7/25/2021	29.4	28.7	27.9	16.7	15.5	13.4	21.9	23.1
8/1/2021	29.6	29.0	28.2	20.8	15.5	13.0	21.0	22.5
8/8/2021	28.9	28.1	27.8	20.8	20.3	14.9	20.7	22.6
8/15/2021	27.9	26.4	27.7	19.7	20.6	15.7	22.2	23.5
8/22/2021	27.1	27.4	26.8	14.4	16.4	11.5	21.4	22.7
8/29/2021	26.9	25.0	26.0	15.1	17.8	12.2	20.9	22.7
9/5/2021	27.7	28.7	28.1	17.1	19.2	13.1	22.4	23.7
9/12/2021	27.1	26.9	26.1	17.4	18.1	11.8	19.6	21.1
9/19/2021	26.2	27.7	26.1	18.1	19.3	13.9	19.1	20.9
10/17/2021	20.4	20.0	21.5	7.5	12.8	10.9	17.4	17.6
10/24/2021	20.0	20.5	21.3	9.2	11.2	11.9	19.0	19.1
10/31/2021	19.5	18.8	19.2	7.3	13.2	12.0	17.0	18.0
11/7/2021	19.2	18.8	19.9	7.4	9.2	12.3	19.6	19.9
11/14/2021	18.9	19.7	20.3	6.9	11.2	12.7	17.3	17.4

Table A-19. Water Temperature (°C) Concentrations Observed at Priority 2 Sites during the 2021 Dry Season

Week Beginning Date	Prado Park Lake Outlet	Chino Creek @ Central Avenue	Mill-Cucamonga Creek Below Wetlands	SAR @ MWD Crossing	SAR @ Pedley Avenue	SAR @ Mission Ave
	(WW-C3)	(WW-C7)	(WW-M6)	(WW-S1)	(WW-S4)	(MISSION)
5/9/2021	22.3	18.5	19.0	18.5	19.8	20.4
5/16/2021	21.2	17.1	18.8	19.4	20.4	21.6
5/23/2021	22.7	18.9	20.4	19.2	20.1	21.8
5/30/2021	23	19.0	20.2	20.2	21.4	22.2
6/6/2021	21.8	19.4	18.5	18.4	18.6	21.9
6/13/2021	24.7	21.5	21.6	20.6	22.0	23.3
6/20/2021	25.4	19.8	22.9	20.6	22.1	23
6/27/2021	25.7	20.6	21.8	20.4	22.0	22.7
7/4/2021	25.7	21.4	21.3	21.0	22.6	23.3
7/11/2021	27.6	22.2	23.1	23.6	23.6	24.2
7/18/2021	24.5	22.3	22.5	21.3	23.3	23.5
7/25/2021	26.4	23.2	22.0	21.9	23.1	25.1
8/1/2021	25.4	22.3	22.2	21.0	22.5	23.7
8/8/2021	26.3	23.2	22.7	20.7	22.6	23.8
8/15/2021	26.2	22.3	23.7	22.2	23.5	24.8
8/22/2021	23.7	21.0	20.1	21.4	22.7	24.7
8/29/2021	24.7	20.4	21.5	20.9	22.7	23.8
9/5/2021	24.7	22.8	22.0	22.4	23.7	25.4
9/12/2021	24.6	20.8	19.1	19.6	21.1	22.5
9/19/2021	23.9	21.4	19.0	19.1	20.9	22.4
10/17/2021	18.2	14.3	13.9	17.4	17.6	21.4
10/24/2021	18.1	18.1	16.0	19.0	19.1	22.5
10/31/2021	17.4	16.7	16.1	17.0	18.0	20.2
11/7/2021	19.1	16.5	16.1	19.6	19.9	22.1
11/14/2021	17.7	16.6	15.6	17.3	17.4	21.2

Table A-20. Water Temperature (°C) Concentrations Observed at Priority 3 Sites during the 2021 Dry Season

Week Beginning Date	Goldenstar Creek	San Timoteo Creek Reach 3	Santa Ana River Reach 3	San Timoteo Creek Reach 1A	San Timoteo Creek Reach 2	Warm Creek
	(P3-RC1)	(P3-RC3)	(P3-SBC1)	(P3-SBC2)	(P3-SBC3)	(P3-SBC4)
5/9/2021	--	--	--	--	--	--
5/16/2021	--	--	--	--	--	--
5/23/2021	--	--	--	--	--	--
5/30/2021	--	--	--	--	--	--
6/6/2021	--	--	--	--	--	--
6/13/2021	--	--	--	--	--	--
6/20/2021	--	--	--	--	--	--
6/27/2021	--	--	--	--	--	--
7/4/2021	--	--	--	--	--	--
7/11/2021	--	--	--	--	--	--
7/18/2021	20.4	--	26.2	--	--	--
7/25/2021	20.1	--	26.9	--	--	--
8/1/2021	19.7	--	26.9	--	--	--
8/8/2021	20.9	--	26.9	--	--	--
8/15/2021	20.6	--	27.2	--	--	--
8/22/2021	--	23.7	--	21	18.5	20.8
8/29/2021	--	23.1	--	19.5	19	19.2
9/5/2021	--	26	--	25.6	24.6	23.5
9/12/2021	--	20	--	16.3	16.3	15.7
9/19/2021	--	21.9	--	18.6	18.5	17.9
10/17/2021	--	--	--	--	--	--
10/24/2021	--	--	--	--	--	--
10/31/2021	--	--	--	--	--	--
11/7/2021	--	--	--	--	--	--
11/14/2021	--	--	--	--	--	--

Table A-21. Conductivity (µS/cm) Observed at Priority 1 Sites during the 2021 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)
5/9/2021	791	3278	522	451	197	259	993	1008
5/16/2021	789	3001	518	447	195	259	952	1037
5/23/2021	805	3148	526	449	198	262	999	1021
5/30/2021	812	3389	528	446	197	261	1002	1042
6/6/2021	810	3218	524	454	196	260	995	1001
6/13/2021	822	3342	525	426	195	283	983	1011
6/20/2021	821	3323	522	417	196	256	994	1011
6/27/2021	833	3425	521	380	195	270	978	1009
7/4/2021	849	3340	528	389	196	262	1001	1018
7/11/2021	849	3419	533	332	195	261	860	1011
7/18/2021	870	3217	538	377	199	264	1035	1019
7/25/2021	885	3484	537	343	202	262	985	1009
8/1/2021	885	3226	545	355	197	266	1012	1028
8/8/2021	879	3572	550	409	207	269	1030	1018
8/15/2021	859	3516	540	396	199	266	1005	1058
8/22/2021	881	3582	548	391	201	265	1005	1021
8/29/2021	887	3344	544	395	199	265	1000	1023
9/5/2021	902	3672	559	390	201	277	1023	967
9/12/2021	905	3735	556	450	200	267	997	1032
9/19/2021	908	3669	559	459	194	269	1018	1038
10/17/2021	916	3818	557	518	181	281	1027	981
10/24/2021	891	3594	529	453	162	251	898	938
10/31/2021	935	3820	558	478	172	281	965	1007
11/7/2021	929	3728	554	484	164	281	973	1001
11/14/2021	928	3654	553	480	167	275	953	1010

Table A-22. Conductivity (µS/cm) Observed at Priority 2 Sites during the 2021 Dry Season

Week Beginning Date	Prado Park Lake Outlet	Chino Creek @ Central Avenue	Mill-Cucamonga Creek Below Wetlands	SAR @ MWD Crossing	SAR @ Pedley Avenue	SAR @ Mission Ave
	(WW-C3)	(WW-C7)	(WW-M6)	(WW-S1)	(WW-S4)	(MISSION)
5/9/2021	967	1154.0	1049.0	993.0	1008.0	843
5/16/2021	1136	1134.0	978.0	952.0	1037.0	858
5/23/2021	1001	1291.0	968.0	999.0	1021.0	852
5/30/2021	1067	1745.0	1007.0	1002.0	1042.0	860
6/6/2021	1143	672.0	786.0	995.0	1001.0	847
6/13/2021	1004	1431.0	1285.0	983.0	1011.0	844
6/20/2021	948	1366.0	801.0	994.0	1011.0	850
6/27/2021	1074	1292.0	827.0	978.0	1009.0	841
7/4/2021	1116	706.0	1197.0	1001.0	1018.0	861
7/11/2021	957	1431.0	915.0	860.0	1011.0	860
7/18/2021	1303	1506.0	1255.0	1035.0	1018.7	860
7/25/2021	1000	1362.0	1163.0	985.0	1009.0	847
8/1/2021	1033	540	1059	1012.0	1028.0	858
8/8/2021	1067	1161.0	1132.0	1030.0	1018.0	873
8/15/2021	960	1101.0	982.0	1005.0	1058.0	842
8/22/2021	1025	1146.0	1219.0	1005.0	1021.0	853
8/29/2021	986	886.0	1163.0	1000.0	1023.0	856
9/5/2021	1042	1375.0	1113.0	1023.0	967.0	866
9/12/2021	1002.0	1359.0	1344.0	997.0	1032.0	855
9/19/2021	1118.0	1216.0	1448.0	1018.0	1038.0	861
10/17/2021	1040.0	1028.0	1145.0	1027.0	981.0	849
10/24/2021	997.0	1108.0	1049.0	898.0	938.0	793
10/31/2021	1131.0	1019.0	968.0	965.0	1007.0	849
11/7/2021	1030.0	1040.0	1226.0	973.0	1001.0	852
11/14/2021	1030.0	988.0	995.0	953.0	1010.0	840

Table A-23. Conductivity (µS/cm) Observed at Priority 3 Sites during the 2021 Dry Season

Week Beginning Date	Goldenstar Creek	San Timoteo Creek Reach 3	Santa Ana River Reach 3	San Timoteo Creek Reach 1A	San Timoteo Creek Reach 2	Warm Creek
	(P3-RC1)	(P3-RC3)	(P3-SBC1)	(P3-SBC2)	(P3-SBC3)	(P3-SBC4)
5/9/2021	--	--	--	--	--	--
5/16/2021	--	--	--	--	--	--
5/23/2021	--	--	--	--	--	--
5/30/2021	--	--	--	--	--	--
6/6/2021	--	--	--	--	--	--
6/13/2021	--	--	--	--	--	--
6/20/2021	--	--	--	--	--	--
6/27/2021	--	--	--	--	--	--
7/4/2021	--	--	--	--	--	--
7/11/2021	--	--	--	--	--	--
7/18/2021	2169	--	855	--	--	--
7/25/2021	2170	--	847	--	--	--
8/1/2021	2221	--	856	--	--	--
8/8/2021	2200	--	869	--	--	--
8/15/2021	2146	--	840	--	--	--
8/22/2021	--	658	--	508	788	1312
8/29/2021	--	660	--	615	798	809
9/5/2021	--	663	--	573	794	759
9/12/2021	--	644	--	586	808	653
9/19/2021	--	662	--	506	798	604
10/17/2021	--	--	--	--	--	--
10/24/2021	--	--	--	--	--	--
10/31/2021	--	--	--	--	--	--
11/7/2021	--	--	--	--	--	--
11/14/2021	--	--	--	--	--	--

Table A-24. Flow (cfs) Observed at Priority 1 Sites during the 2021 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)
5/9/2021	NA	NA	NA	NA	1	27	24	84
5/16/2021	NA	NA	NA	NA	1	2	22	60
5/23/2021	NA	NA	NA	NA	1	2	52	80
5/30/2021	NA	NA	NA	NA	1	2	56	73
6/6/2021	NA	NA	NA	NA	1	2	55	76
6/13/2021	NA	NA	NA	NA	1	2	41	54
6/20/2021	NA	NA	NA	NA	1	2	35	50
6/27/2021	NA	NA	NA	NA	1	2	36	68
7/4/2021	NA	NA	NA	NA	0.9	0.5	50	93
7/11/2021	NA	NA	NA	NA	0.6	1.0	34	70
7/18/2021	NA	NA	NA	NA	1	0.9	60	97
7/25/2021	NA	NA	NA	NA	1	1.0	28	68
8/1/2021	NA	NA	NA	NA	0.2	1	53	48
8/8/2021	NA	NA	NA	NA	0	1.2	50	151
8/15/2021	NA	NA	NA	NA	2	0	45	68
8/22/2021	NA	NA	NA	NA	1.8	0.6	68	72
8/29/2021	NA	NA	NA	NA	2.3	0.4	48	103
9/5/2021	NA	NA	NA	NA	1.4	4.4	43	72
9/12/2021	NA	NA	NA	NA	1.6	0.8	55	42
9/19/2021	NA	NA	NA	NA	1.2	0.4	40	70
10/17/2021	NA	NA	NA	NA	2.4	0.4	31	93
10/24/2021	NA	NA	NA	NA	5.2	0.7	50	80
10/31/2021	NA	NA	NA	NA	6.0	0.7	63	116
11/7/2021	NA	NA	NA	NA	5.0	0.6	73	113
11/14/2021	NA	NA	NA	NA	2.5	0.8	80	105

Table A-25. Flow (cfs) Observed at Priority 2 Sites during the 2021 Dry Season

Week Beginning Date	Prado Park Lake Outlet	Chino Creek @ Central Avenue	Mill-Cucamonga Creek Below Wetlands	SAR @ MWD Crossing	SAR @ Pedley Avenue	SAR @ Mission Ave
	(WW-C3)	(WW-C7)	(WW-M6)	(WW-S1)	(WW-S4)	(MISSION)
5/9/2021	3.9	9.2	13	24	84	22
5/16/2021	4.4	14.1	14.6	22	60	16
5/23/2021	8.1	11.4	30.6	52	80	18
5/30/2021	7.7	14.4	23.8	56	73	14
6/6/2021	2.2	14.0	9.6	55	76	9
6/13/2021	6.7	8	11.8	41	54	15
6/20/2021	6.6	3.9	14.1	35	50	8
6/27/2021	3.1	5	9.7	36	68	17
7/4/2021	5.9	10.2	12.0	50	93	15
7/11/2021	2.6	6.0	26.0	34	70	14
7/18/2021	2.8	7.3	10	60	97	23
7/25/2021	5.4	8	17.9	28	68	17
8/1/2021	5.7	18.3	7.4	53	48	20
8/8/2021	4.3	6.3	6.3	50	151	13
8/15/2021	5	6.6	5	45	68	19
8/22/2021	2.2	7.3	4	68	72	24
8/29/2021	3	6.4	7	48	103	24
9/5/2021	2.7	7.1	8.8	43	72	17
9/12/2021	4.6	9.2	6.0	55	42	32
9/19/2021	6.0	6.8	4.2	40	70	22
10/17/2021	4.9	5.0	10.3	31	93	26
10/24/2021	5.3	5.9	15	50	80	30
10/31/2021	4.2	14.2	21	63	116	37
11/7/2021	6.5	14.0	NA	73	113	34
11/14/2021	4.4	6.8	19	80	105	33

Table A-26. Flow (cfs) Observed at Priority 3 sites in Orange County during the 2021 Dry Season

Week Beginning Date	Goldenstar Creek	San Timoteo Creek Reach 3	Santa Ana River Reach 3	San Timoteo Creek Reach 1A	San Timoteo Creek Reach 2	Warm Creek
	(P3-RC1)	(P3-RC3)	(P3-SBC1)	(P3-SBC2)	(P3-SBC3)	(P3-SBC4)
5/9/2021	--	--	--	--	--	--
5/16/2021	--	--	--	--	--	--
5/23/2021	--	--	--	--	--	--
5/30/2021	--	--	--	--	--	--
6/6/2021	--	--	--	--	--	--
6/13/2021	--	--	--	--	--	--
6/20/2021	--	--	--	--	--	--
6/27/2021	--	--	--	--	--	--
7/4/2021	--	--	--	--	--	--
7/11/2021	--	--	--	--	--	--
7/18/2021	3.61	--	41.2	--	--	--
7/25/2021	4.44	--	25.3	--	--	--
8/1/2021	3.05	--	49.9	--	--	--
8/8/2021	2.86	--	39.2	--	--	--
8/15/2021	3.45	--	49.5	--	--	--
8/22/2021	--	6.8	--	1.5	1	0.32
8/29/2021	--	20.9	--	1.5	1.1	0.28
9/5/2021	--	19.8	--	2	1.8	0.16
9/12/2021	--	19.9	--	1.3	1.2	0.47
9/19/2021	--	19.4	--	0.8	1.4	0.16
10/17/2021	--	--	--	--	--	--
10/24/2021	--	--	--	--	--	--
10/31/2021	--	--	--	--	--	--
11/7/2021	--	--	--	--	--	--
11/14/2021	--	--	--	--	--	--

Table A-27. Water Quality Data from Priority 2 Sites during the 2021-2022 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)								
3/29/2022	41	22	1290	8.5	3.0	9.2	18.2	8
3/30/2022	41	17	1416	9.2	3.0	9.1	18.2	7
3/31/2022	62	18	1490	8.4	2.0	9.0	18.7	7
4/1/2022	150	14	1702	8.6	3.0	8.8	18.1	7
Chino Creek at Central Avenue (WW-C7)								
3/29/2022	8700	14	457	9.5	NA	8.03	15.1	17.8
3/30/2022	960	ND	995	8.4	NA	7.9	17.4	1
3/31/2022	490	ND	1036	7.8	NA	8.0	19.4	1
4/1/2022	74	2	1033	7.7	NA	8.0	19.4	1
Mill-Cucamonga Creek below Treatment Wetlands (WW-M6)								
3/29/2022	8200	25	428	8.3	NA	7.8	15.6	13
3/30/2022	710	3	642	8.1	NA	7.7	15.9	3
3/31/2022	230	6	788	7.7	23.0	7.8	17.7	2
4/1/2022	200	6	927	7.5	14.0	7.8	17.8	2
SAR at MWD Crossing (WW-S1)								
3/29/2022	16,000	290	441	8.3	NA	7.9	15.5	146
3/30/2022	420	13	991	8.2	88.0	8.1	19.9	4
3/31/2022	280	12	1030	8.2	49.0	8.2	18.8	3
4/1/2022	130	8	1038	8.5	58.0	8.2	18.8	3
SAR at Pedley Avenue (WW-S4)								
3/29/2022	16000	810	404	8.0	NA	7.9	15.6	373
3/30/2022	1000	23	974	8.4	51.0	8.3	19.4	8
3/31/2022	260	17	1033	8.3	110.0	8.3	18.9	6
4/1/2022	140	16	1060	8.4	138.0	8.3	19.2	5

Table A-28. 2021 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	0.48[A]	0.89[A]	0.37[A]	0.31[A]	0.54[A]	0.29[A]	0.20[A]	0.43[A]	0.59[A]	0.41[A]	0.85[A]	0.34[A]
2	0.39[A]	0.67[A]	0.37[A]	0.31[A]	0.50[A]	0.25[A]	0.22[A]	1.02[A]	0.69[A]	0.71[A]	0.61[A]	0.59[P]
3	0.60[A]	0.48[A]	4.63[A]	0.33[A]	0.38[A]	0.23[A]	0.20[A]	1.31[A]	0.52[A]	1.20[A]	0.56[A]	0.50[P]
4	0.44[A]	0.54[A]	0.51[A]	0.31[A]	0.42[A]	0.27[A]	0.21[A]	0.71[A]	0.46[A]	0.44[A]	0.48[A]	0.52[P]
5	0.40[A]	0.46[A]	0.42[A]	0.41[A]	0.29[A]	0.28[A]	0.24[A]	0.79[A]	0.40[A]	0.96[A]	0.78[A]	0.45[P]
6	0.41[A]	0.40[A]	0.57[A]	0.42[A]	0.28[A]	0.25[A]	0.18[A]	0.50[A]	0.53[A]	0.51[A]	0.47[A]	0.35[P]
7	0.43[A]	0.42[A]	0.45[A]	0.45[A]	0.32[A]	0.30[A]	0.24[A]	1.15[A]	0.60[A]	0.43[A]	0.46[A]	0.80[P]
8	0.47[A]	0.70[A]	0.46[A]	0.49[A]	0.34[A]	0.42[A]	0.21[A]	1.73[A]	0.56[A]	2.51[A]	0.51[A]	0.98[P]
9	0.34[A]	0.33[A]	2.43[A]	0.40[A]	0.33[A]	0.35[A]	0.26[A]	0.92[A]	0.49[A]	0.39[A]	0.49[A]	18.7[P]
10	0.34[A]	0.36[A]	132[A]	0.43[A]	0.41[A]	0.36[A]	0.26[A]	0.60[A]	0.74[A]	0.27[A]	0.66[A]	1.17[P]
11	0.35[A]	0.39[A]	27.4[A]	0.38[A]	0.41[A]	0.39[A]	0.28[A]	0.56[A]	0.57[A]	0.32[A]	0.46[A]	0.43[P]
12	0.40[A]	2.08[A]	1.52[A]	0.42[A]	0.32[A]	0.40[A]	0.35[A]	0.48[A]	0.44[A]	0.27[A]	0.61[A]	0.38[P]
13	0.42[A]	0.41[A]	1.06[A]	0.50[A]	0.40[A]	0.46[A]	0.38[A]	0.74[A]	0.49[A]	0.42[A]	0.34[A]	0.36[P]
14	0.43[A]	0.38[A]	1.28[A]	0.42[A]	0.33[A]	0.46[A]	0.31[A]	0.54[A]	0.52[A]	0.33[A]	0.33[A]	535[P]
15	0.48[A]	0.34[A]	9.79[A]	0.31[A]	0.35[A]	0.40[A]	0.36[A]	0.52[A]	0.47[A]	0.34[A]	0.35[A]	2.24[P]
16	0.40[A]	0.63[A]	0.70[A]	0.35[A]	0.34[A]	0.32[A]	0.71[A]	0.57[A]	0.41[A]	0.32[A]	0.45[A]	1.27[P]
17	0.45[A]	0.40[A]	0.46[A]	0.39[A]	0.64[A]	0.55[A]	0.24[A]	0.89[A]	0.49[A]	0.27[A]	0.51[A]	1.01[P]
18	0.40[A]	0.51[A]	0.58[A]	0.38[A]	0.45[A]	1.02[A]	0.76[A]	1.00[A]	0.66[A]	0.78[A]	0.55[A]	3.70[P]
19	0.46[A]	0.36[A]	0.40[A]	0.36[A]	0.33[A]	0.79[A]	0.27[A]	1.03[A]	0.55[A]	0.39[A]	0.34[A]	3.40[P]
20	0.68[A]	0.41[A]	0.47[A]	0.34[A]	0.25[A]	0.43[A]	0.24[A]	0.88[A]	0.66[A]	0.27[A]	0.33[A]	2.57[P]
21	0.41[A]	4.33[A]	0.36[A]	0.37[A]	0.25[A]	0.73[A]	0.35[A]	0.94[A]	0.65[A]	0.56[A]	0.30[A]	1.93[P]
22	0.82[A]	5.16[A]	0.37[A]	0.43[A]	0.32[A]	0.25[A]	0.18[A]	0.78[A]	0.53[A]	0.40[A]	0.32[A]	1.27[P]
23	6.66[A]	0.44[A]	0.38[A]	0.39[A]	0.20[A]	0.23[A]	0.24[A]	0.74[A]	0.49[A]	2.30[A]	0.38[A]	534[P]
24	11.4[A]	0.40[A]	0.39[A]	0.39[A]	0.22[A]	0.23[A]	0.24[A]	0.82[A]	0.62[A]	2.12[A]	0.37[A]	392[P]
25	107[A]	0.39[A]	0.39[A]	0.34[A]	0.28[A]	0.24[A]	0.20[A]	0.81[A]	0.54[A]	35.1[A]	0.66[A]	11.7[P]
26	0.78[A]	0.48[A]	0.37[A]	0.47[A]	0.25[A]	0.24[A]	24.3[A]	0.90[A]	0.73[A]	1.17[A]	0.60[A]	85.1[P]
27	0.51[A]	0.40[A]	0.37[A]	0.49[A]	0.20[A]	0.26[A]	0.66[A]	0.83[A]	0.68[A]	0.51[A]	0.40[A]	272[P]
28	64.5[A]	0.38[A]	0.36[A]	0.47[A]	0.35[A]	0.25[A]	0.61[A]	0.79[A]	0.66[A]	0.43[A]	0.32[A]	12.8[P]
29	207[A]		0.40[A]	0.55[A]	0.27[A]	0.25[A]	0.46[A]	0.57[A]	0.48[A]	0.51[A]	0.30[A]	60.1[P]
30	1.60[A]		0.53[A]	0.48[A]	0.24[A]	0.34[A]	0.63[A]	0.88[A]	0.66[A]	0.50[A]	0.41[A]	340[P]
31	1.25[A]		0.37[A]		0.24[A]		0.58[A]	1.53[A]		0.53[A]		4.78[P]
COUNT	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**
MAX	**207**	**5.16**	**132**	**0.55**	**0.64**	**1.02**	**24.3**	**1.73**	**0.74**	**35.1**	**0.85**	**535**
MIN	**0.34**	**0.33**	**0.36**	**0.31**	**0.2**	**0.23**	**0.18**	**0.43**	**0.4**	**0.27**	**0.3**	**0.34**

[P] Data is considered "Provisional data subject to revision"

Table A-29. 2021 Daily Mean Flow (cfs), Cucamonga Creek near Mira Loma, as Measured by the USGS (Data are provisional)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	108A	92.3A	18.8A	15.9A	5.01A	19.5A	7.11A	59.0A	8.26A	26.3A	34.0A	11.1A
2	102A	71.8A	17.7A	13.0A	3.91A	17.6A	2.78A	37.3A	4.50A	29.2A	36.8A	9.22P
3	108A	60.0A	37.4A	14.6A	10.3A	21.8A	13.0A	8.47A	8.54A	30.4A	33.0A	27.8P
4	107A	47.7A	33.9A	25.2A	7.14A	21.4A	11.9A	5.84A	8.10A	21.0A	42.8A	16.0P
5	109A	31.8A	25.8A	28.6A	14.0A	32.2A	3.39A	11.7A	10.4A	17.6A	46.9A	23.7P
6	102A	40.8A	29.2A	13.1A	15.7A	26.0A	5.47A	7.51A	8.02A	10.9A	65.2A	38.9P
7	99.3A	48.2A	24.5A	20.3A	5.22A	22.2A	1.79A	6.60A	10.7A	22.7A	56.9A	77.5P
8	101A	55.9A	29.1A	20.2A	13.1A	19.4A	4.27A	8.08A	20.4A	40.9A	98.6A	83.4P
9	101A	55.3A	42.7A	25.8A	3.95A	9.64A	3.55A	6.48A	17.3A	25.8A	81.5A	143P
10	95.5A	54.1A	195A	33.2A	3.71A	12.1A	8.93A	5.14A	11.0A	30.4A	101A	90.0P
11	93.3A	42.6A	85.4A	33.5A	9.10A	15.2A	18.6A	6.25A	5.83A	31.3A	45.5A	98.1P
12	90.8A	25.0A	37.5A	26.2A	5.30A	15.2A	6.23A	8.40A	4.68A	34.5A	49.3A	75.5P
13	95.8A	14.0A	34.8A	19.0A	29.8A	14.6A	16.3A	7.90A	6.11A	15.9A	47.5A	91.7P
14	81.1A	15.0A	34.5A	15.9A	40.2A	7.07A	44.0A	10.3A	5.73A	12.8A	26.3A	814P
15	93.6A	20.5A	53.7A	14.2A	46.4A	3.97A	12.1A	9.96A	7.49A	10.2A	12.3A	76.2P
16	72.3A	28.3A	37.0A	23.2A	43.3A	12.5A	11.4A	7.98A	13.9A	9.78A	18.3A	68.3P
17	68.1A	24.8A	34.7A	22.7A	36.0A	15.4A	10.5A	8.05A	19.6A	14.7A	16.7A	68.0P
18	109A	27.6A	44.9A	19.9A	32.8A	2.48A	8.83A	10.7A	15.7A	15.7A	16.5A	68.7P
19	112A	14.7A	34.8A	20.5A	29.9A	14.8A	5.83A	12.3A	9.15A	10.5A	24.9A	66.8P
20	108A	5.53A	32.7A	9.36A	32.5A	16.7A	1.88A	10.8A	6.43A	6.55A	15.8A	63.0P
21	95.6A	7.32A	37.0A	23.9A	31.8A	11.1A	4.14A	13.6A	7.46A	6.67A	14.1A	63.8P
22	116A	23.5A	40.7A	44.6A	48.9A	11.1A	3.90A	12.2A	8.45A	15.2A	9.62A	74.1P
23	157A	28.1A	28.8A	46.2A	55.5A	11.6A	5.08A	8.89A	8.88A	17.0A	8.72A	778P
24	160A	17.6A	28.2A	44.5A	66.4A	20.0A	5.76A	6.01A	6.27A	21.3A	5.39A	738P
25	310A	15.2A	26.7A	46.7A	53.7A	16.9A	12.2A	5.99A	27.2A	63.0A	12.0A	110P
26	114A	13.1A	27.9A	41.8A	37.7A	20.1A	284A	6.08A	17.7A	26.2A	19.3A	201P
27	118A	9.04A	26.3A	14.9A	48.0A	17.1A	27.2A	6.71A	12.9A	19.4A	15.5A	280P
28	200A	17.4A	24.7A	2.23A	20.4A	15.8A	19.1A	10.3A	9.86A	13.7A	25.3A	123P
29	569A		22.0A	5.26A	23.6A	18.2A	7.58A	11.4A	12.4A	12.4A	17.0A	104P
30	139A		15.2A	4.60A	26.5A	18.4A	22.5A	5.95A	22.4A	29.6A	16.8A	349P
31	109A		19.1A		18.3A		48.2A	6.69A		27.6A		84.3P
COUNT	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**
MAX	**569**	**92.3**	**195**	**46.7**	**66.4**	**32.2**	**284**	**59**	**27.2**	**63**	**101**	**814**
MIN	**68.1**	**5.53**	**15.2**	**2.23**	**3.71**	**2.48**	**1.79**	**5.14**	**4.5**	**6.55**	**5.39**	**9.22**

Table A-30. 2021 Daily Mean Flow (cfs), Santa Ana River at MWD Crossing, as Measured by the USGS (Data are provisional)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.01[A]	0.00[A]	0.00[A]	0.02[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]
2	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.01[A]
3	0.00[A]	0.00[A]	24.0[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]
4	0.00[A]	0.00[A]	6.24[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	3.54[A]	0.00[A]	0.00[A]
5	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.01[A]	0.00[A]	0.00[A]	0.01[A]	0.00[A]	0.00[A]
6	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]
7	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]
8	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]
9	0.00[A]	0.00[A e]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]
10	0.00[A]	0.00[A e]	90.1[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]
11	0.00[A]	0.00[A e]	49.3[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]
12	0.00[A]	0.16[A e]	1.49[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]
13	0.00[A]	0.00[A e]	0.05[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]
14	0.00[A]	0.00[A e]	0.01[A]	0.00[A]	0.00[A]	0.01[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	262[A]
15	0.00[A]	0.00[A e]	2.98[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	7.82[A]
16	0.00[A]	0.00[A e]	0.35[A]	0.00[A]	0.21[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]
17	0.00[A]	0.00[A]	0.06[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.03[A]	0.00[A]	0.00[A]	0.00[A]
18	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]
19	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]
20	0.00[A]	0.00[A]	0.02[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]
21	0.01[A]	0.00[A]	0.01[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]
22	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]
23	7.04[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	152[A]
24	4.01[A]	0.00[A]	0.01[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	1,450[A]
25	48.4[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.01[A]	0.00[A]	0.00[A]	1.72[A]	0.00[A]	1,100[A]
26	0.34[A]	0.00[A]	0.02[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	1,010[A]
27	0.00[A]	0.00[A]	0.01[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	224[A]
28	14.5[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	211[A]
29	274[A]		0.01[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	895[A]
30	4.36[A]		0.03[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	0.00[A]	1,670[A]
31	0.00[A]		0.00[A]		0.00[A]		0.00[A]	0.00[A]		0.00[A]		41.6[A]
COUNT	**31**	**28**	**31**	**30**	**31**	**30**	**31**		**30**	**31**		**31**
MAX	**274**	**0.16**	**90.1**	**0.02**	**0.21**	**0.01**	**0.01**		**0.03**	**3.54**		**1,670**
MIN	**0**	**0**	**0**	**0**	**0**	**0**	**0**		**0**	**0**		**0**

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 2021 dry weather monitoring and 2021-2022 storm monitoring. The basis for this evaluation is the approved QAPP.[20]

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 during 2021. Completeness is summarized as follows:

There are fewer planned flow measurements as flow is measured in stream sites only. As four Priority 1 sites are in lakes and two Priority 4 sites are in the tidal zone, there are 260 planned flow measurements (100 less than other field parameters).

Samples were not collected at Bolsa Chica channel (P3-OC1) due to Orange County establishing a source tracking methodology.

Additional samples were collected at Greenville-Banning Channel (P4-OC3) due to an anti-degradation exceedance. Additional samples were collected Cucamonga Creek at Hellman Avenue (P4-SBC1) due to an anti-degradation exceedance.

[20] SAR RBMP QAPP

Table B-1. Dry Weather Field Parameter Completeness Summary

Parameter	Planned[1]	Collected	% Complete
Conductivity	360	361	100.3%
Dissolved Oxygen	360	361	100.3%
Flow[2]	260	261	100.4%
pH	360	361	100.3%
Temperature	360	361	100.3%
Turbidity	360	361	100.3%

[1] Planned represents the number of samples planned based on SAR RBMP 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. All field measurement accuracy expectations met the requirements as listed in the QAPP.

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 2021 dry weather season, 25 weeks of sampling at eight Priority 1 sites and five Priority 2 sites was planned from the week of May 9, 2021, through the week of November 22, 2021. During the same period, 5 weeks of sampling at six Priority 3 sites, and one week of sampling at five Priority 4 sites are also planned. This results in 340 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 360 samples during the entire monitoring period covered in this 2021-2022 Annual Report.

Holding time requirements for TSS (7 days), *E. coli* (6 hours), and *enterococci* (6 hours) were not exceeded for any samples collected during the 2021-2022 sampling year.

Field/Equipment Blanks

The QAPP calls for a field/equipment blank to be collected during each day of sampling. One field/equipment blank sample is also required during each storm event. This results in a frequency of 26 percent, well above the typically required frequency. Per the QAPP, the reporting target limits for TSS and bacterial indicators were 2.0 mg/L and 10 MPN/100 mL, respectively. These method sensitivity guidelines were met. All field/equipment blank results were below detectable counts (< 10 MPN/100 mL) for *E. coli*. For TSS, 6 field blanks were reported at or above the detectable limit. Of those 6, only one was above the reporting limit at 4 mg/L.

Field Duplicates

Field staff collected at least one field duplicate each week of sampling for a total of 38 TSS field duplicates and 38 indicator bacteria field duplicates. As a result, the frequency of field duplicate collection was 10.5 percent, well above the required frequency. Field duplicates will be reduced for the 2022-2023 sampling year to closer match the 5% requirement.

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	Chino Creek at Central Avenue	29	29	0
WW-C3	Prado Park Lake	29	29	0
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
MISSION	Santa Ana River at Mission Avenue	25	25	0
P3-OC1[1]	Bolsa Chica Channel	5	0	5
P3-RC1	Goldenstar Creek	5	5	0
P3-RC3	San Timoteo Creek Reach 3	5	5	0
P3-SBC1	Santa Ana River Reach 4	5	5	0
P3-SBC2	San Timoteo Creek Reach 1A	5	5	0
P3-SBC3	San Timoteo Creek Reach 2	5	5	0
P3-SBC4	Warm Creek	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[2]	Greenville-Banning Channel in Tidal Prism	1	4	0
P4-SBC1[3]	Cucamonga Creek at Hellman Avenue	1	4	0
Total		360	361	5

[1] Bolsa Chica Channel was not sampled in 2021 as Orange County was establishing a source tracking methodology to begin in 2022

[2] Additional samples were collected at Priority 4 site Greenville-Banning Channel in Tidal Prism

[3] Additional samples were collected at the Priority 4 site Cucamonga creek

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. Thirteen duplicate pairs exceeded the QAPP's relative percent difference (RPD) goal of ± 25 percent. One pair of duplicate samples, collected at Warm Creek week of 9/5/2021 have a significant RPD resulting in a large difference in concentration (8 vs 20 mg/L). This is 3 percent of all QA/QC samples and is within a normal frequency. Twelve 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 4 mg/L. Dividing by the low TSS values artificially results in high RPD values.

To determine the precision of the duplicate analysis for each bacterial indicator the following method was used:[21]

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. Two samples exceeded precision criterion.

[21] 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 (%)
5/9/2021	P1-4	Big Bear Lake	10	10	0%
5/16/2021	P1-5	Mill Creek Reach 2	<2	<2	0%
5/23/2021	P1-6	Lytle Creek (Middle Fork)	4	2	67%
5/30/2021	WW-C7	Chino Creek at Central Avenue	6	4	40%
6/6/2021	WW-C3	Prado Park Lake	26	26	0%
6/13/2021	P1-1	Canyon Lake	4	2	67%
6/20/2021	P1-5	Mill Creek Reach 2	8	10	22%
6/27/2021	WW-S4	Santa Ana River Reach 3 at Pedley Avenue	6	7	15%
7/4/2021	P1-1	Canyon Lake	2	3	40%
7/11/2021	P1-2	Lake Elsinore	62	50	21%
7/18/2021	P4-RC2	Temescal Creek at Lincoln Avenue	6	8	29%
7/25/2021	P3-RC1	Goldenstar Creek	3	4	29%
8/1/2021	P3-SBC1	Santa Ana River Reach 4	4	2	67%
8/8/2021	P1-3	Lake Perris	12	8	40%
8/15/2021	P1-4	Big Bear Lake	64	59	8%
8/22/2021	P3-SBC2	San Timoteo Creek Reach 1A	150	180	18%
8/29/2021	P3-SBC3	San Timoteo Creek Reach 2	2	2	0%
9/5/2021	P3-SBC4	Warm Creek	8	20	86%
9/12/2021	P3-RC3	San Timoteo Creek Reach 3	8	4	67%
9/19/2021	P4-SBC1	Cucamonga Creek at Hellman Avenue	17	14	19%
10/17/2021	P1-6	Lytle Creek (Middle Fork)	4	4	0%
10/24/2021	WW-S1	SAR at MWD Crossing	25	19	27%
10/31/2021	WW-S1	SAR at MWD Crossing	8	8	0%
11/7/2021	WW-M6	Mil-Cucamonga Creek below Wetlands	2	3	40%
11/14/2021	WW-C7	Chino Creek at Central Avenue	2	<2	67%

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*

Sample Date	Site ID	Site Location	Duplicate Result (MPN/100 mL)	Sample Result (MPN/100 mL)	Log of Duplicate Result (L_1)	Log of Sample Result (L_2)	Range of Logs (L_1 - L_2) or (R_{log})
5/9/2021	P1-4	Big Bear Lake	46	36	1.6628	1.5563	0.1065
5/16/2021	P1-5	Mill Creek Reach 2	13	15	1.1139	1.1761	0.0621
5/23/2021	P1-6	Lytle Creek (Middle Fork)	32	56	1.5051	1.7482	0.2430
5/30/2021	WW-C3	Prado Park Lake	160	190	2.2041	2.2788	0.0746
6/6/2021	WW-M6	Mil-Cucamonga Creek below Wetlands	120	150	2.0792	2.1761	0.0969
6/13/2021	P1-1	Canyon Lake	<1	2	0.0000	0.3010	0.3010
6/20/2021	P1-5	Mill Creek Reach 2	5.2	6.3	0.7160	0.7993	0.0833
6/27/2021	WW-S4	Santa Ana River Reach 3 at Pedley Avenue	180	300	2.2553	2.4771	0.2218
7/4/2021	P1-1	Canyon Lake	<1	<1	0.0000	0.0000	0.0000
7/11/2021	P1-2	Lake Elsinore	2	17	0.3010	1.2304	0.9294
7/18/2021	P4-RC2	Temescal Creek at Lincoln Avenue	9.8	7.4	0.9912	0.8692	0.1220
7/25/2021	P3-RC1	Goldenstar Creek	340	910	2.5315	2.9590	0.4276
8/1/2021	P3-SBC1	Santa Ana River Reach 4	20	39	1.3010	1.5911	0.2900
8/8/2021	P1-3	Lake Perris	<1	3.1	0.0000	0.4914	0.4914
8/15/2021	P1-4	Big Bear Lake	<1	<1	0.0000	0.0000	0.0000
8/22/2021	P3-SBC2	San Timoteo Creek Reach 1A	370	310	2.5682	2.4914	0.0768
8/29/2021	P3-SBC3	San Timoteo Creek Reach 2	390	290	2.5911	2.4624	0.1287
9/5/2021	P3-SBC4	Warm Creek	1100	440	3.0414	2.6435	0.3979
9/12/2021	P3-RC3	San Timoteo Creek Reach 3	550	770	2.7404	2.8865	0.1461

Sample Date	Site ID	Site Location	Duplicate Result (MPN/100 mL)	Sample Result (MPN/100 mL)	Log of Duplicate Result (L_1)	Log of Sample Result (L_2)	Range of Logs (L_1 - L_2) or (R_{log})
9/19/2021	P4-SBC1	Cucamonga Creek at Hellman Avenue	14000	16000	4.1461	4.2041	0.0580
10/17/2021	P1-6	Lytle Creek (Middle Fork)	71	64	1.8513	1.8062	0.0451
10/24/2021	WW-S1	SAR at MWD Crossing	410	320	2.6128	2.5051	0.1076
10/31/2021	WW-S1	SAR at MWD Crossing	240	190	2.3802	2.2788	0.1015
11/7/2021	WW-M6	Mil-Cucamonga Creek below Wetlands	91	74	1.9590	1.8692	0.0898
11/14/2021	WW-C7	Chino Creek at Central Avenue	52	10	1.7160	1.0000	0.7160
						Sum of R_{log}	5.3173
						Mean R_{log}	0.2127
						Precision Criterion (3.27*Mean R_{log})	0.6955

Appendix C

Laboratory QA/QC Reports

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