# 2022 Santa Ana River Water Quality Work Plan

**PREPARED FOR**

Santa Ana Watershed Project Authority
and the Basin Monitoring Program Task Force


**PREPARED BY**

WEST YOST
Water. Engineered.

# 2022 Santa Ana River Water Quality Work Plan

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## Santa Ana Watershed Project Authority and the Basin Monitoring Program Task Force

**Project No. 986-80-21-01**



10/25/2022

Project Manager: [Name] | Date

10/25/2022

QA/QC Review: [Name] | Date

# Table of Contents

# Table of Contents

## LIST OF TABLES



## LIST OF FIGURES

# Table of Contents

## LIST OF APPENDICES



## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| af | Acre-feet |
| afy | Acre-feet per year |
| CBWM | Chino Basin Watermaster |
| cfs | Cubic feet per second |
| CVM | Chino Valley Model |
| CWA | Clean Water Act |
| EC | Electrical Conductivity |
| EVMWD | Elsinore Valley Municipal Water District |
| Basin Plan | Water Quality Control Plan for the Santa Ana River Basin |
| GSSI | GEOSCIENCE |
| GMZ | Groundwater Management Zone |
| IEUA | Inland Empire Utilities Agency |
| TM | Technical Memorandum |
| TMDLs | Maximum Daily Loads |
| mgl | Milligrams per liter |
| MWDSC | Metropolitan Water District of Southern California |
| NEXRAD | Next Generation Weather Radar |
| Nitrate | Nitrate as Nitrogen |
| OCWD | Orange County Water District |
| PBMZ | Prado Basin Management Zone |
| POTWs | Publicly Owned Treatment Works |
| QAPP | Quality Assurance Project Plan |
| RIX | Rapid Infiltration and Extraction Facility |
| RP-1 | IEUA Regional Water Recycling Plant No. 1 |
| RP-5 | IEUA Regional Water Recycling Plant No. 5 |
| RWQCP | Regional Water Quality Control Plant |
| SNMP | Salt and Nutrient Management Plan |

# Table of Contents

| | |
|---|---|
| Santa Ana Water Board | California Regional Water Quality Control Board, Santa Ana Region |
| SAR Annual Report | Annual Report of Santa Ana River Water Quality |
| State Board | California State Water Resources Control Board |
| SARWM | Santa Ana River Watermaster |
| SAWPA | Santa Ana Watershed Project Authority |
| SW/GW | Surface water/groundwater |
| TBD | To be determined |
| TDS | Total dissolved solids |
| TIN | Total Inorganic Nitrogen |
| USGS | United States Geological Survey |
| WLAM | Wasteload Allocation Model |
| WRCRWA | Western Riverside County Regional Wastewater Authority |
| WRF | Water Reclamation Facility |
| WWTP | Wastewater Treatment Plant |
| WEI | Wildermuth Environmental, Inc. |
| YVWD | Yucaipa Valley Water District |

# Table of Contents

# 2022 Santa Ana River Water Quality Work Plan

This report is the 2022 update to the Santa Ana River Water Quality Work Plan (2022 Work Plan). The 2022 Work Plan was prepared in accordance with requirements in Resolution R8-2021-0025 which amended the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) to revise and update the total dissolved solids (TDS) and nitrogen management program, hereafter referred to as the Basin Plan salt and nutrient management plan (Basin Plan SNMP). This report also describes the updated surface water monitoring program to assess current compliance with the Basin Plan surface water TDS and Total Inorganic Nitrogen (TIN) objectives, and additional recommended monitoring for special studies to support future updates to the modeling tools that are relied on to assess future compliance with surface water objectives and determine the wasteload allocation of recycled water discharges to the Santa Ana River.

This 2022 Work Plan is organized into the following sections:

- **1.0 Background** – This section provides background on the surface water monitoring preformed to date per the Basin Plan SNMP, and the need and methods to update the surface water monitoring program.
- **2.0 Evaluation of the 2004-2020 Surface Water Monitoring Program to Assess Compliance with the Basin Plan TDS and Nitrogen Objectives** – This section describes comprehensive evaluations of the surface water monitoring program to assess current and future compliance with the surface water TDS and TIN objectives of the Santa Ana River, performed through 2020.
- **3.0 2022 Surface Water Monitoring Program to Assess Compliance with the Basin Plan TDS and nitrogen Objectives** – This section describes the updated 2022 surface water monitoring program to assess current compliance with the TDS and TIN objectives for Santa Ana River Reaches 2, 3, 4, and 5.
- **4.0 Recommendation for Special Study** – This section describes the recommended Special Study for the surface water monitoring program of the Santa Ana River to improve the modeling tools ability to predict future compliance with TDS and TIN objectives.
- **5.0 References** – This section lists the references cited in this 2022 Work Plan.

## 1.0 BACKGROUND

This section provides background information on: 1) the 2004 Basin Plan amendment that updated the Basin Plan SNMP for the Santa Ana River Watershed; 2) the surface water monitoring program required to assess compliance with Basin Plan objectives for the Santa Ana River; 3) the development and use of the Wasteload Allocation Model (WLAM); 4) the 2021 Basin Plan Amendment (Resolution R8-2021-0025) and its requirement to update the surface water monitoring program for the Santa Ana River; and 5) the methods used to develop the 2022 Work Plan.

### 1.2 The 2004 Basin Plan SNMP for the Santa Ana River

In January 2004, the Santa Ana Regional Water Quality Control Board (Santa Ana Water Board) amended the Basin Plan to incorporate a revised SNMP for both surface water and groundwater in the Santa Ana River Watershed. A task force of 22 water supply and wastewater agencies, including the Santa Ana Water Board (the Task Force), performed the scientific studies to support the development of the updated Basin Plan SNMP. The Task Force, administered by the Santa Ana Watershed Project Authority (SAWPA), performed the scientific studies in several phases from 1996 to 2003, which are summarized in the *TIN/TDS Phase 2A: Tasks 1 through 5, TIN/TDS Study of the Santa Ana Watershed* (Wildermuth

Environmental [WEI], 2000). The studies culminated in the Santa Ana Water Board's adoption of the Basin Plan amendment in January 2004, which included revised: groundwater subbasin boundaries, termed "groundwater management zones" (GMZs); TDS and nitrogen objectives for the GMZs; TDS and TIN wasteload allocations for Publicly Owned Treatment Works (POTWs) discharges; and TDS and nitrogen objectives and beneficial uses for specific surface waters.

As part of the 2004 Basin Plan SNMP, the Santa Ana Water Board authorized the use of the WLAM to estimate the projected TDS and TIN loading from all major point and nonpoint sources collectively flowing into the Santa Ana River system. The WLAM is a predictive tool that is used to: 1) assess if the TDS and TIN wasteload allocations set for the POTW discharges will comply with surface water TDS and TIN objectives and 2) evaluate whether water percolating from the surface streams to groundwater will comply with the water quality objectives for each affected GMZ. The results of WLAM are used to determine if existing and proposed TDS and TIN discharge limits imposed on the POTWs will comply with the Basin Plan. If the results indicate that the discharge limits will not comply with the Basin Plan objectives, the Santa Ana Water Board is required to update the wasteload allocations to ensure compliance. The 2002 WLAM developed in support of the 2004 Basin Plan SNMP has been updated twice and used to reassess the wasteload allocations for future planning conditions through 2040 (WEI, 2009; GEOSCIENCE [GSSI], 2020a).

The 2004 Basin Plan amendment also required that the Task Force prepare surface water and groundwater quality monitoring programs to support the implementation of the Basin Plan SNMP. In January 2005, the Task Force submitted the *Santa Ana River Water Quality Work Plan* to the Santa Ana Water Board (WEI, 2005 [2005 Work Plan]). The primary objective of the surface water monitoring program documented in the 2005 Work Plan was to collect the data necessary to determine compliance with the Basin Plan TDS and TIN objectives for reaches of the Santa Ana River, and thereby, the effectiveness of the wasteload allocations in the Basin Plan. The surface water monitoring plan was also intended to collect the data required to evaluate the impacts of percolating surface waters on the receiving GMZs. The 2005 Work Plan was approved by the Santa Ana Water Board in Resolution R8-2005-0063 (Santa Ana Water Board, 2005).

Pursuant to the 2005 Work Plan, the Task Force is responsible for collecting the data required to assess the current and future compliance with TDS and nitrogen objectives for Reaches 2, 3, 4, and 5 of the Santa Ana River. Each Year, the Task Force prepare the *Annual Report of Santa Ana River Water Quality* (SAR Annual Report) to document the data and current compliance evaluation. And the Task Force performs the periodic updates to the WLAM to evaluate future compliance with the TDS and TIN surface water objectives based on the wasteload allocations set for the POTW discharges.

## 1.3 2021 Basin Plan Amendment

In December 2021, the Basin Plan was amended by Santa Ana Water Board Resolution R8-2021-0025 (2021 Basin Plan Amendment) to update certain elements of the Basin Plan SNMP documented in *Chapter 5 - Implementation* (Santa Ana Water Board, 2021). Included in the amendment was a discussion of "Future Planning Priorities" to establish requirements for the Task Force's current and future efforts to improve the monitoring and the associated compliance assessments for surface water and groundwater. In this regard, the Basin Plan Amendment addressed:

- Current monitoring and assessment of compliance. On December 11, 2018, the California State Water Resources Control Board (State Board) adopted a revised *Water Quality Control Policy for Recycled Water*, which became effective on April 8, 2019 (State Board, 2019 [2019 Recycled Water

Policy]). The 2019 Recycled Water Policy requires the Regional Water Boards to evaluate SNMPs that were adopted as Basin Plan Amendments prior to April 8, 2019 to determine if they conform with the requirements of the policy. These reviews must be completed by April 8, 2024. The Santa Ana Water Board, in consultation with the Task Force, is evaluating the Basin Plan SNMP to determine if updates or revisions are warranted in order to comply with the 2019 Recycled Water Policy. This review includes evaluating the current surface water, groundwater monitoring, and reporting work plans. The 2021 Basin Plan Amendment requires the Task Force to update the Basin Plan SNMP surface water and groundwater monitoring programs by August 1, 2022[1]. In the case of the surface water monitoring program, it must be reviewed and updated, as appropriate, to ensure that the necessary data is collected to assess (1) compliance with the Basin Plan TDS and TIN objectives for Reaches 2, 3, 4, and 5 and (2) the overall effectiveness of the wasteload allocations.

- Future monitoring and assessment of compliance. The 2021 Basin Plan Amendment requires that the wasteload allocations be evaluated and updated every ten years since the effective date of the last evaluation on December 10, 2021. Dischargers may elect to undertake this task individually or collaboratively through the Task Force. The wasteload allocation analysis must evaluate compliance with the existing water quality objectives for a period of no less than 20 years into the future and take into consideration changes in land use, receiving water quality for both surface and ground waters, changes in volume or quality of discharges from point and nonpoint source, variations in precipitation, new or revised regulatory requirements, and other factors specified by the Santa Ana Water Board. The next wasteload allocation evaluation must be completed by December 10, 2031.

## 1.4 Methods to Update the Surface Water Quality Work Plan

The objective of the surface water quality work plan is to collect monitoring data to assess both current and future compliance with the surface water TDS and TIN objectives. The assessment of current compliance is performed annually and documented in the SAR Annual Report. The assessment of future compliance is done using the WLAM, which predicts if the surface water TDS and TIN objectives will be met based on the wasteload allocations set for the POTW discharges.

The overall approach to develop the updated 2022 Work Plan included performing a comprehensive evaluation of the Basin Plan requirements and current monitoring and reporting programs to (1) understand the questions that need to be answered by the surface water monitoring program to determine compliance, (2) assess the ability of the current monitoring program to answer the questions, (3) identify changes to the monitoring program to improve compliance assessments, and (4) identify any changes that should be made to the Basin Plan to provide for a more clear description of the compliance requirements. The evaluations were presented to and discussed with the Task Force at six Task Force workshops between January and August 2022. The objective of the workshops was to educate the Task Force members on the regulatory requirements and discuss options and recommendations for refinements to the surface water monitoring program. The presentation slides presented at the six Task Force workshops to evaluate and develop an updated surface water monitoring program are included with this 2022 Work Plan as Appendix A. The workshops included:

[1] The Santa Ana Water Board granted an extension to December 1, 2022.

- January 27, 2022: Surface Water Monitoring Requirements and Goals for the Santa Ana River Watershed Part 1
- February 22, 2022: Surface Water Monitoring Requirements and Goals for the Santa Ana River Watershed Part 2 and Analysis of Modeling Tools
- May 24, 2022: Options for Definition of Base flow Conditions in the Santa Ana River for Assessment of Compliance with the Reach 3 Surface Water Objectives
- June 22, 2022: Overview of Recommended Surface Water Monitoring Plan
- July 26, 2022: Recommended Surface Water Monitoring Plan – Reach 3 TDS Compliance Metric and Special Studies for Reach 3 & 4.
- August 30, 2022: Update on Recommended Surface Water Monitoring Plan

Additional meetings were also conducted with Santa Ana Water Board staff to understand their specific priorities to guide the development of a more robust surface water monitoring and compliance assessment program. The main outcome of the meetings with the Santa Ana Water Board was confirmation of the need to amend the Basin Plan to improve descriptions on the specific data and methods to be used in assessing compliance with the surface water quality objectives. These updates to the Basin Plan are necessary to support the Santa Ana Water Board's preparation of the *Integrated Report* in compliance with the Federal Clean Water Act (CWA) Section 303(d). The purpose of the *Integrated Report* is to assess the quality of surface waters compared to the water quality objectives, list impaired water bodies that are out of compliance, and develop Total Maximum Daily Loads (TMDLs) for the impaired water bodies. It is essential that the compliance data and methods are clear in the Basin Plan to guide the analysis for the Integrate Report; absent this clarity, alternative methods are applied by the Santa Ana Water Board that could result in unwarranted 303(d) listings. This 2022 Work Plan documents the recommended changes to the Basin Plan to improve descriptions on the specific data and methods to assess compliance.

# 2.0 EVALUATION OF THE 2004-2020 SURFACE WATER MONITORING PROGRAM TO ASSESS COMPLIANCE WITH THE BASIN PLAN TDS AND NITROGEN OBJECTIVES

This section describes the comprehensive evaluations of the current surface water monitoring program that is relied on to (1) assess current compliance with the surface water TDS and TIN objectives of the Santa Ana River on an annual basis and (2) inform updates of the WLAM to improve predictions of future compliance with the Santa Ana River TDS and TIN objectives and establish wasteload allocations. Section 2.1 describes the comprehensive evaluation of the monitoring program to assess current compliance, the results of which were used as the basis develop the updated surface water quality monitoring program presented in Section 3.0. Section 2.2 summarizes the evaluation of the predictive tools and surface water monitoring program to assess future compliance, the results of which were used as the basis to develop the recommendation for special studies in Section 4.0.

## 2.1 Current Monitoring and Assessment of Compliance

Since 2004, the Task Force has been implementing the surface water monitoring program pursuant to the 2005 Work Plan[2], including compiling the requisite data and assessing compliance with the Basin Plan TDS and TIN surface water objectives for Reaches 2, 3, 4, and 5 of the Santa Ana River. The surface water monitoring is performed by various entities within the watershed and the data are provided to the Task Force. The Task Force uses the data to prepare the SAR Annual Report each year to document the data and current compliance evaluation. As of October 2022, the Task Force has prepared and submitted 18 SAR Annual Reports to the Santa Ana Water Board for the 2004 to 2021 period. The compliance methods and reporting formats used by the Task Force have evolved over time.

The evaluation of the surface water quality monitoring program included a review of the Basin Plan, the SAR Annual Reports from 2004 to 2020, and data available for Reaches 2, 3, 4, and 5. For each reach, the evaluation included:

- Review of the Basin Plan TDS and TIN objectives (Table 4-1 of the Basin Plan) and the beneficial uses the objectives are intended to protect.
- Review of the Basin Plan description (if any) of the criteria and approach for assessing compliance with the objectives (Chapter 4 of the Basin Plan).
- Definition of the questions to be answered by the surface water monitoring program based on the Basin Plan and historical compliance assessments.
- Characterization and review of the surface water flow and quality data collected from 2004 to 2020.
- Assessment and characterization of the metrics applied to determine compliance with the Basin Plan objectives and the specific datasets being used to compute the metrics
- Characterization of the history of compliance with the Basin Plan objectives
- Identification of data or information gaps to answer the monitoring program questions

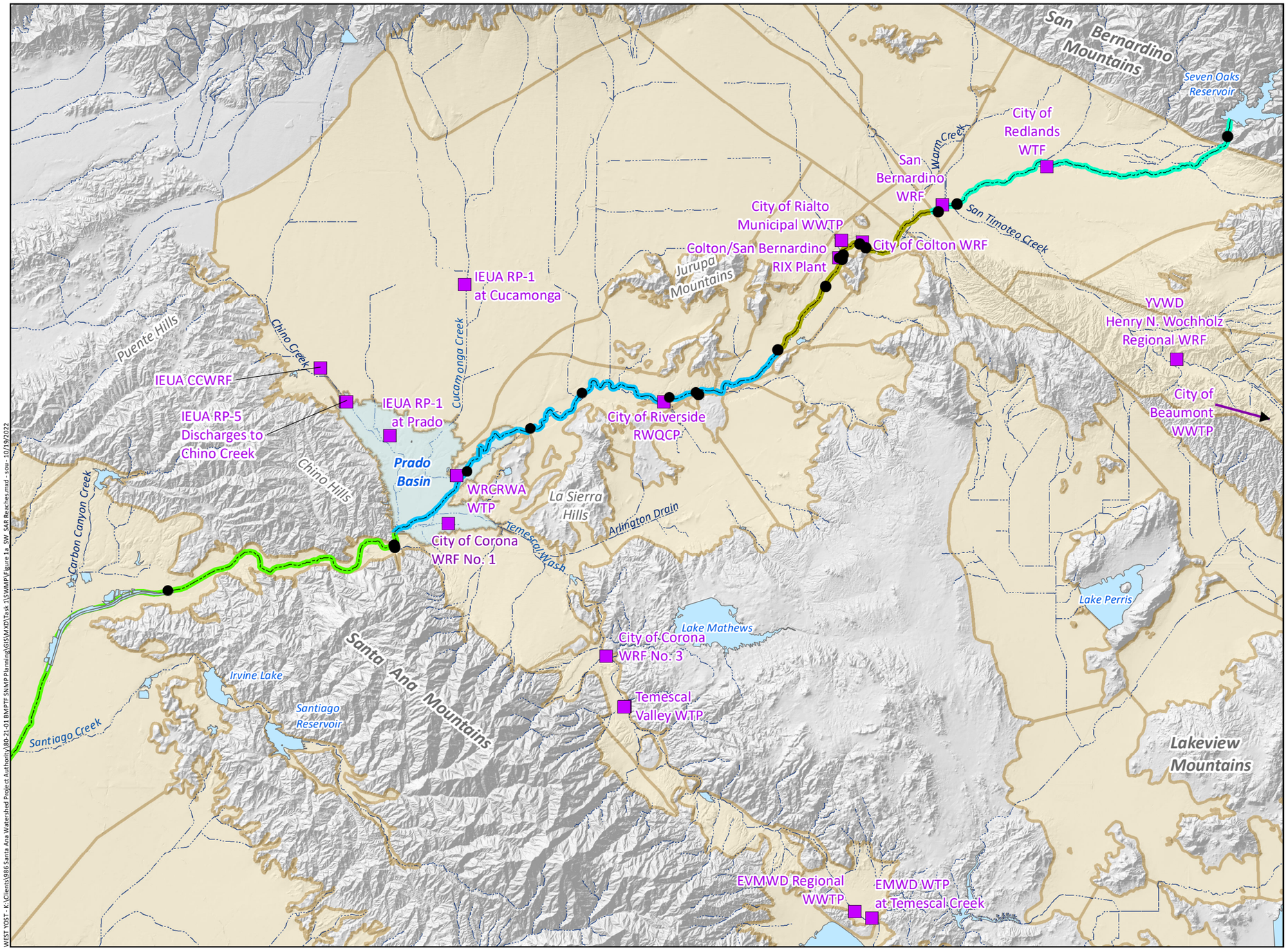
[2] The Task Force begin implementing the surface water monitoring program before the work plan was adopted by the Santa Ana Water Board in 2005.

- Development of recommendations for improved or refined monitoring for the 2022 Work Plan

Figure 1a characterizes the surface water monitoring features in the Santa Ana River Watershed, including the extent of Reaches 2, 3, 4, and 5, the existing surface water discharge and quality monitoring sites, and the POTW discharge locations. Figure 1b provides detail on the relevant monitoring features for Reaches 2, 3, 4, and 5 and identifies whether the data from the monitoring sites are used, or not, in the current approach used to assess Basin Plan compliance. For each reach, Table 1 summarizes:

- The TDS and TIN objectives
- The compliance data and assessment metrics described in the Basin Plan
- The methods used to assess compliance as performed by the Task Force in the SAR Annual Reports.

The information in Table 1 is discussed in detail for each reach in the following subsections.




Surface Water Monitoring Sites along Santa Ana River

Publicly Owned Treatment Works (POTWs) Discharge Locations

* Redlands WTF discharge goes to percolations ponds and is not considered a discharge to the River

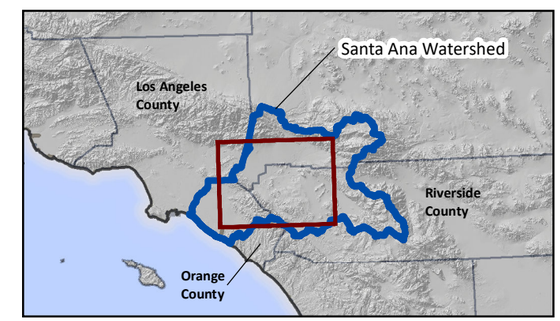
Reaches of Santa Ana River

- Reach 2
- Reach 3
- Reach 4
- Reach 5

Groundwater Management Zone (GMZ)

Streams & Flood Control Channels

Flood Control and Conservation Basins




Prepared by:

WEST YOST

0 5 10 Miles

0 8 16 Km

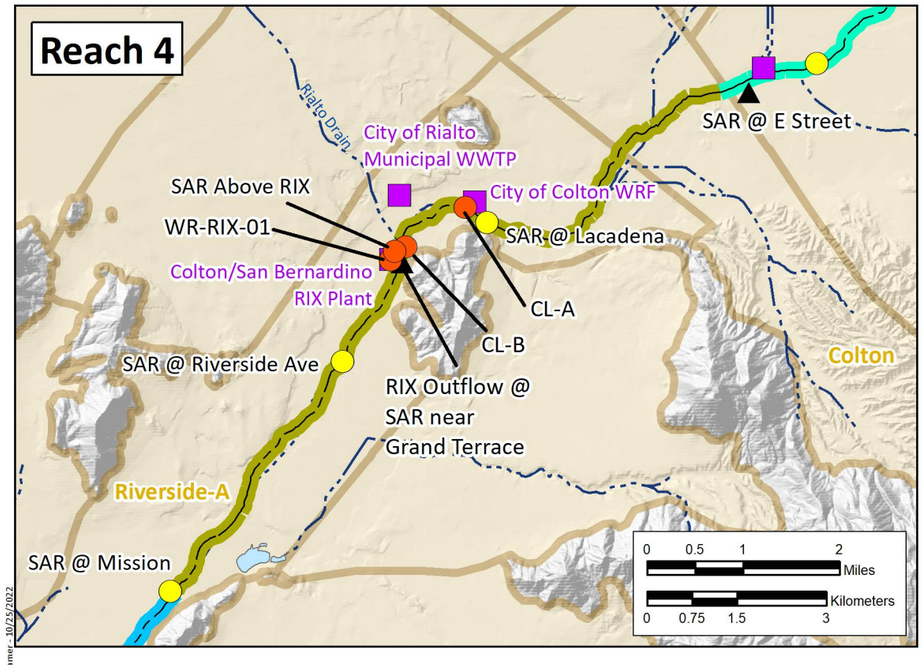
Prepared for:

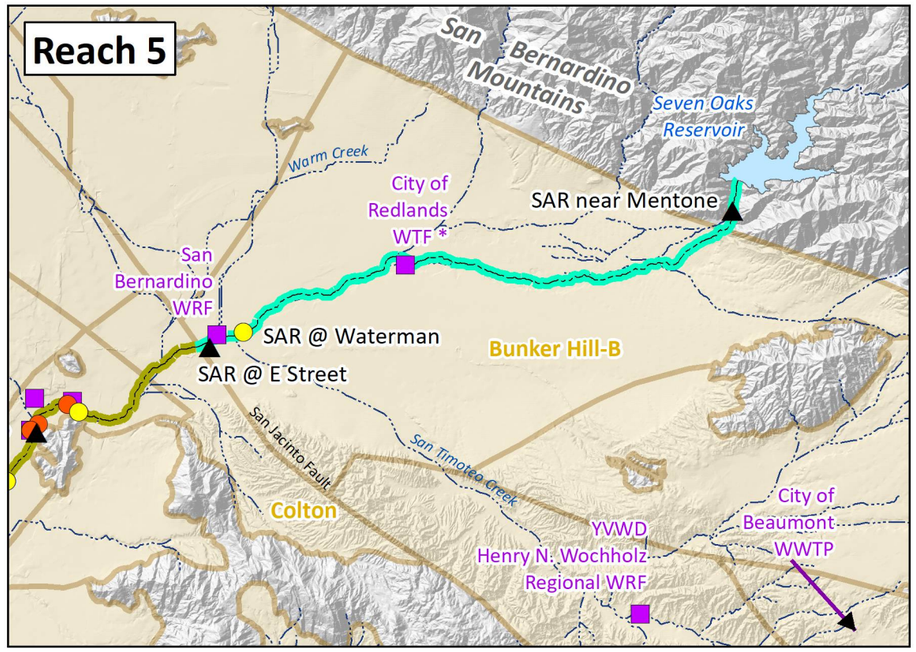
**Santa Ana Watershed Project Authority**
2022 Santa Ana River Water Quality Work Plan

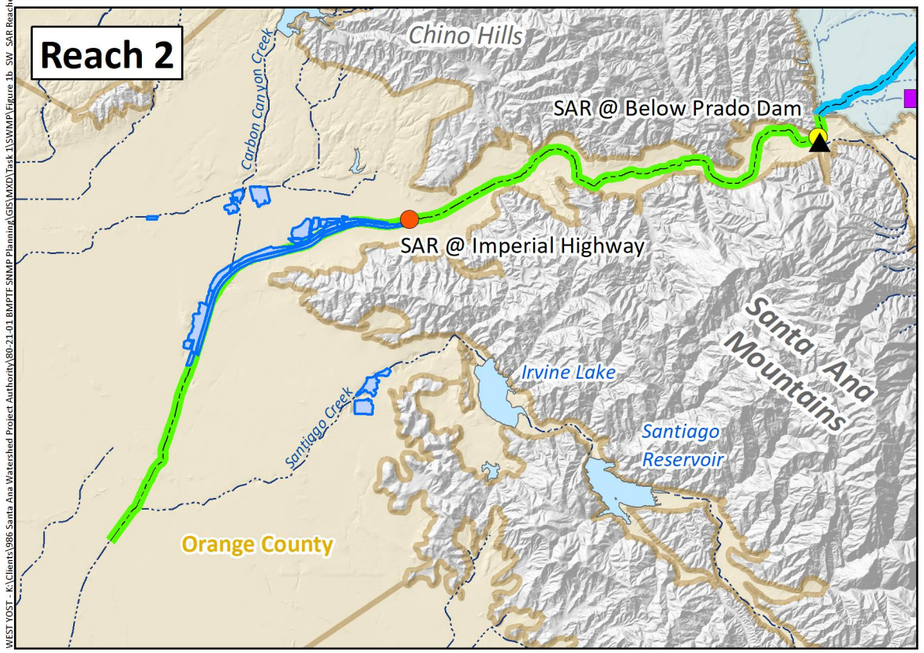
SAWPA

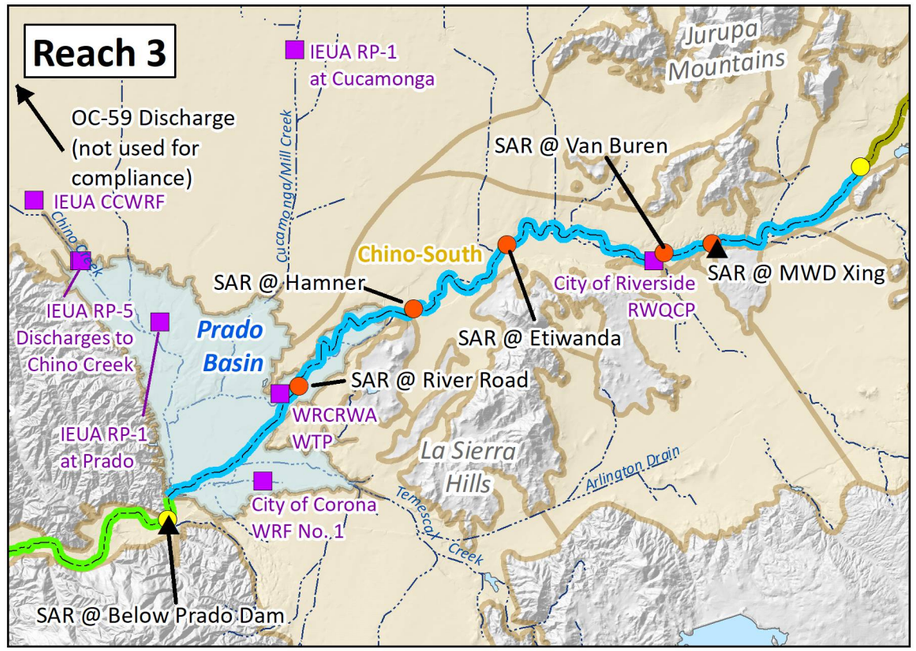
**Surface Water Quality Monitoring Locations along the Santa Ana River**
*2004-2020*

**Figure 1a**



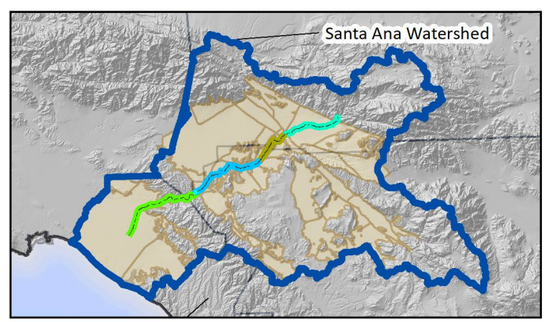

Surface Water Monitoring Sites along Santa Ana River

- Data used for Compliance Metric
- Data not used for Compliance Metric
- USGS Surface Water Gage
- Publicly Owned Treatment Works (POTWs) Discharge Locations

* Redlands WTF discharge goes to percolations ponds and is not considered a discharge to the River

Reaches of Santa Ana River

- Reach 2
- Reach 3
- Reach 4
- Reach 5
- Groundwater Management Zone (GMZ)
- OCWD Recharge Basins in the Forebay
- Streams & Flood Control Channels
- Flood Control and Conservation Basins




Prepared by:

WEST YOST

0 1.25 2.5 5
Miles
0 2 4 8
Kilometers

Prepared for:

**Santa Ana Watershed Project Authority**
2022 Santa Ana River Water Quality Work Plan

SAWPA

**Surface Water Quality Monitoring Locations along the Santa Ana River by Reach**
*2004-2020*

**Figure 1b**

**Table 1 . Basin Plan Surface Water TDS and TIN Objectives for the Santa Ana River Reaches 2, 3, 4, and 5 and Metrics, Data, and Methods Used to Assess Compliance from 2004 to 2020**

| Reach | Objective (mgl) | | Assessment of Compliance as Specified in the Basin Plan | | Assessment of Compliance with Basin Plan Objectives Conducted by the Task Force in the SAWPA Annual Report of Santa Ana River Water Quality | |
|---|---|---|---|---|---|---|
| | TDS | TIN | Monitoring Data | Compliance Metric | | |
| Reach 5 | 300 | 5 | Undefined | Undefined | Grab sample of **base flow** in August at *SAR @ Waterman* | |
| Reach 4 | 550 | 10 | Undefined | Undefined | Average of grab sample of **base flow** in August at *SAR @ Lacadena* , *SAR @ Riverside Ave* , and *SAR @ Mission* | |
| Reach 3 | 700 | 10[(1)] | Regional Board collects grab samples in August and September at Below Prado Dam. "Results can be compared to the continuous monitoring by the USGS and data from other sources" | "… grab and composite samples when the influence of storm flows and nontributary flows is at a minimum. This typically occurs during August and September" - Table 4-1 indicates **base flow** | The annual report utilizes three methods to assess compliance: | |
| | | | | | 1) Based on Basin Plan | 1) Average of the grab samples collected by the Regional Board in August and September at *SAR @ Below Prado Dam* |
| | | | | | 2) Alternatives | 2a) Average of the grab samples collected by the Regional Board and others (OCWD, USGS, CBWM/IEUA) in August and September at *SAR @ Below Prado Dam*<br><br>2b) Average of the grab samples collected by others (OCWD, USGS, CBWM/IEUA) in August and September at locations upstream of Prado Dam between Riverside Narrows and Prado Basin |
| Reach 2 | 650 | -- | The SARWM calculates the volume-weighted TDS of total flow annually for the water year - using continuous monitoring of flow and EC, and grab samples by the USGS at Below Prado Dam. "The SARWM's annual determination of **total flow** quality will be used to determine compliance..." | The "five-year moving average of the annual TDS content of **total flow**" | The annual report utilizes two methods to evaluate compliance: | |
| | | | | | 1) Basin Plan Method | 1) Average of the last five years of SARWM's annual determination of the flow-weighted TDS at Below Prado Dam for total flow |
| | | | | | 2) Alternative Method | 2) 60-month flow-weighted moving average of the TDS concentration of the total flow at Below Prado Dam. This is calculated using daily monitoring of flow and EC by the USGS at the gage at SAR @ Below Prado Dam, and grab samples by the USGS and others (OCWD, Regional Board, CBWM/IEUA) at SAR @ Below Prado Dam |

Note:

(1) Table 4-1 in the Basin Plan indiactes a total nitrogen, filtered sample for Reach 3

### *2.1.1 Santa Ana River Reach 5*

Reach 5 extends from the outlet of the Seven Oaks Dam, located at the foothills of the San Bernardino Mountains, to the San Jacinto Fault at the boundary of the Bunker Hill-B and Colton GMZs. Reach 5 overlies the Bunker Hill-B GMZ. Major tributaries to Reach 5 include San Timoteo Creek and Warm Creek.

The permitted discharges in or tributary to Reach 5 include:

- The City of San Bernardino Municipal Water Department Water Reclamation Facility (WRF). This is the only facility permitted to discharge directly to Reach 5. The discharge occurs infrequently and happens only during storm events when there is enough surface water flow to provide a 20:1 dilution of the discharge. Most of the flows from the City of San Bernardino WRF are sent to the Rapid Infiltration and Extraction Facility (RIX) in the Riverside-A GMZ (see discussion on Reach 4).
- The City of Redlands Wastewater Treatment Facility.[3] The Redlands facility is located along Reach 5 and treated water is discharged to a series of percolation ponds adjacent to the Santa Ana River and does not discharge directly to the river.
- POTW discharges to streams that are tributary to Reach 5, include:
    - The Yucaipa Valley Water District (YVWD) Henry N. Wochholz Regional WRF that discharges to San Timoteo Creek
    - City of Beaumont Wastewater Treatment Plant (WWTP) that discharges to the San Timoteo Creek.

**Basin Plan *TDS and TIN Objectives and Compliance Description*.** The TDS and TIN objectives are 300 milligrams per liter (mgl) and 5 mgl, respectively. The Basin Plan does not provide any description of the monitoring data and metrics that should be used to assess compliance with the Reach 5 TDS or TIN objectives.

***Purpose of Objective and Monitoring.*** The Reach 5 TDS and TIN objectives are intended to protect the quality of stream bed recharge to the underlying Bunker Hill-B GMZ and the downstream Colton GMZ. The Basin Plan TDS and nitrate objectives of the Bunker Hill-B and Colton GMZs are 310 and 410 mgl and 7.3 and 2.7 mgl, respectively. Thus, the question to be answered by the surface water monitoring in Reach 5 is: what is the TDS and TIN concentration of the flow in Reach 5 that can recharge the Bunker Hill-B GMZ and Colton GMZ?

**Existing Surface Water Monitoring**. Surface water quality samples and/or flow measurements are collected along Reach 5 at the following locations:

- *SAR @ Waterman.* The site is monitored by the Orange County Water District (OCWD), which collects water quality grab samples once per year in August.
- United States Geological Survey (USGS) gage *SAR near Mentone.* The USGS maintains a gage that measures and records daily flow.
- USGS Gage *SAR @ E Street near San Bernardino.* The USGS maintains a gage that measures and records daily flow.

[3] The City of Redlands Wastewater Treatment Facility has a permit to discharge to infiltration ponds that are adjacent to Reach 5 and are not considered discharges to the Santa Ana River.

***Data and Metric Used to Assess Compliance with TDS and TIN Objectives.*** Compliance is assessed annually by the Task Force in the SAR Annual Report. The annual TDS and TIN concentrations of the annual sample collected at the *SAR @ Waterman* are used to assess compliance. If the annual TDS and TIN concentrations are less than the objectives, the objectives are met.

***History of Data and Compliance with Objectives.*** Figures 2a and 2b show the time history of the data and metrics used to assess compliance with the Reach 5 TDS and TIN objectives from 2004 to 2020. The figures also show the total annual flow exiting Reach 5 as measured by the *SAR @ E Street near San Bernardino* USGS Gage (expressed in acre-feet [af]), including the portion of the total flow that occurs in August (the month during which the annual sample is collected). In 14 of the 17 years, flow was not present at *SAR @ Waterman* during the August sampling event, and no sample was collected for those years. Based on the available data, there have been no exceedances of the TDS and TIN objectives for Reach 5 since 2004. However, as evident in Figure 2a and 2b, there is little to no flow in Reach 5 in the month of August. When flow was present, the TDS concentration ranged from 132 to 216 mgl, and the TIN concentration ranged from 0.33 to 0.37 mgl.

***Data Gaps and Uncertainties with Monitoring and Compliance.*** Based on the purpose and objectives for monitoring Reach 5 and the data available to assess compliance, the following data gaps and questions were identified for consideration in the design of the 2022 Work Plan:

- Since 2004, sampling has not occurred in Reach 5 at *SAR @ Waterman* in most years because no surface water flow was present when OCWD performed its annual sampling event in August. Data exists in only 3 of the 17 years. The TDS and TIN concentration of the flow during the remainder of the year is unknown.
    - Should the sampling frequency be increased to more than once per year to understand the variability in quality throughout the year?
- Reach 5 is generally a losing reach with surface flows recharging the Bunker Hill-B GMZ. Most of Reach 5 can be dry for most of the year. Review of daily flow data at the USGS gages located at the upstream and downstream ends of Reach 5 (*SAR near Mentone* and *SAR @ E Street),* show that flows are very low at 0 to 10 cubic feet per second (cfs) for most of the year, except during and immediately after storm events when the flow can reach 10,000 cfs. The annual total flow out of Reach 5 measured at *SAR @ E Street* ranged from 2,000 af to 176,000 af and during August ranged from 0 af to 6,000 af.
    - Is it important to characterize the quality of storm-influenced flows along Reach 5 to understand the TDS and TIN concentration of annual recharge to the Bunker Hill-B GMZ and thus determine if the intended beneficial use is protected?
- There are no Reach 5 sampling sites upstream of *SAR @ Waterman* to represent stream bed recharge to the Bunker Hill-B GMZ from the Santa Ana River and the San Timoteo Creek; nor downstream of *SAR @ Waterman* to assess the influence of tributary flows and POTW discharges that flow into Reach 4 and that can recharge the Colton GMZ.
    - Should there be additional monitoring locations upstream and/or downstream of *SAR @ Waterman* to assess the compliance with the Reach 5 TIN/TDS objectives?

*Recommendations for the 2022 Work Plan.* Based on the data gaps and questions identified, the following recommendations should be considered for the 2022 Work Plan:

- Increase the frequency of sampling at locations in Reach 5 to better understand the variability of water quality over high-flow and low-flow conditions that occur throughout the year.
- Add sample locations upstream and downstream of SAR *@ Waterman* to more fully understand the quality of the surface water in Reach 5 that recharges to the Bunker Hill-B GMZ and the flows into Reach 4 overlying the Colton GMZ.
    - Add one location between the USGS gage *SAR near Mentone* and SAR *@ Waterman* to understand the quality of the flow primarily influenced from storm water upstream of all POTW discharges that recharge Bunker Hill-B GMZ.
    - Add one location near or at the USGS gage *SAR @ E Street in San Bernardino* to understand the quality of the flow that enters Reach 4 overlying the Colton GMZ.

**Figure 2a. Time-Series of TDS Concentration and Compliance Metric in Reach 5 of the Santa Ana River - 2004 to 2020**

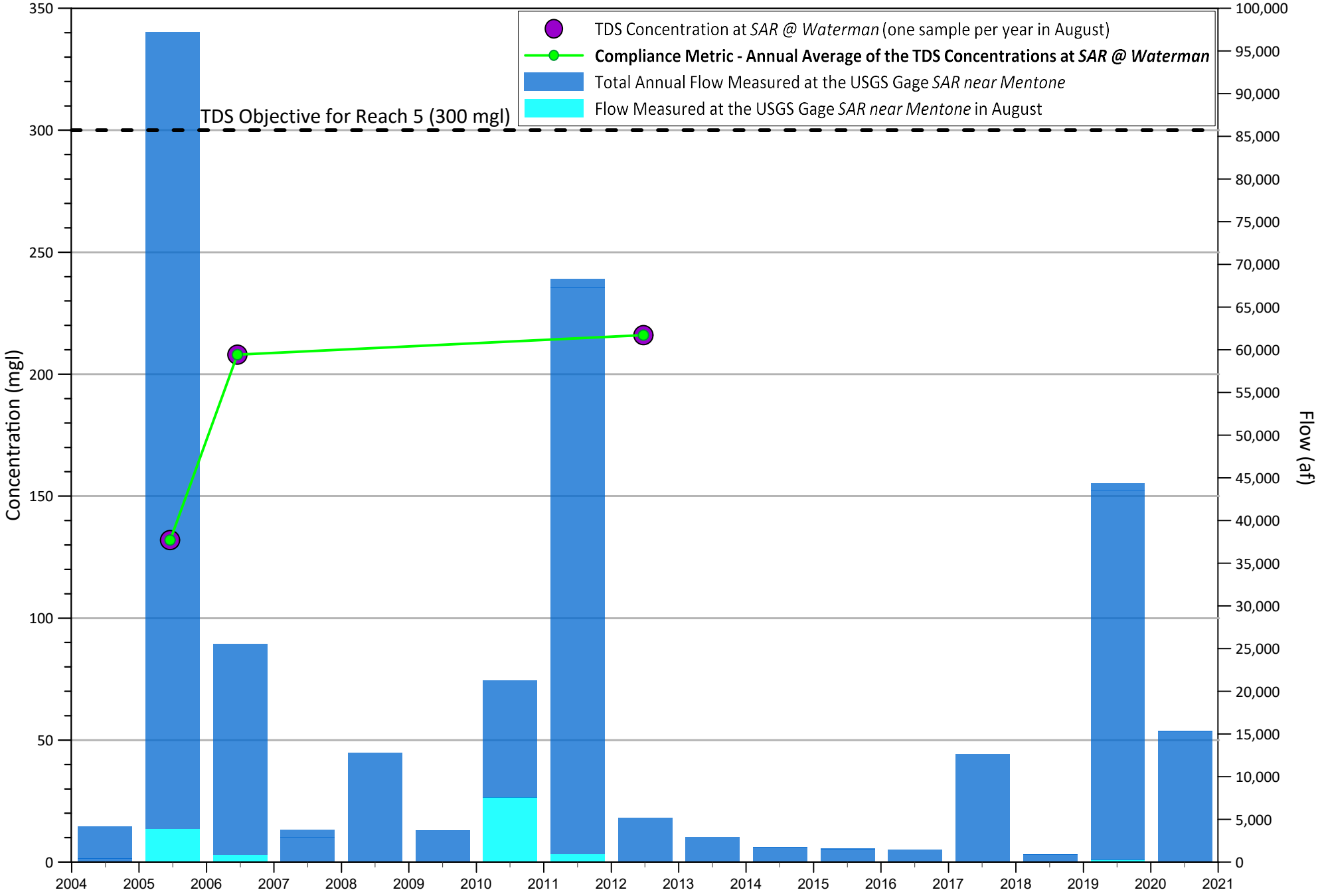
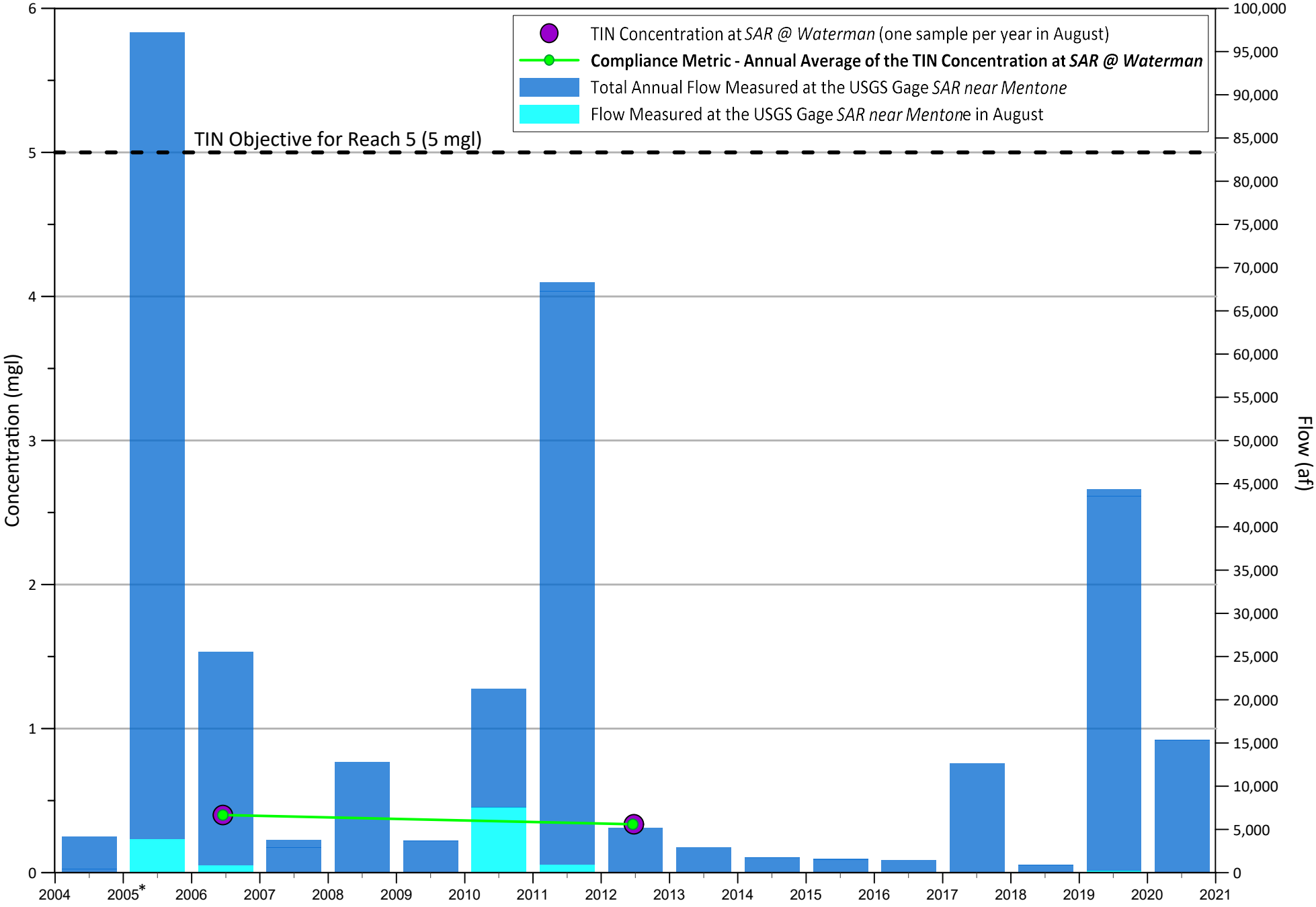


**Figure 2b. Time-Series of TIN Concentration and Compliance Metric in Reach 5 of the Santa Ana River - 2004 to 2020**




*TIN was not sampled in 2005

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Santa Ana Watershed Project Authority
2022 Santa Ana River Water Quality Work Plan
Last Revised: 10/25/2022

### *2.1.2 Santa Ana River Reach 4*

Reach 4 extends from the San Jacinto Fault at the Bunker Hill-B/Colton GMZs boundary to Mission Boulevard in the City of Riverside. Reach 4 overlies the Colton and Riverside-A GMZs. Major tributaries to Reach 4 include the Rialto Drain.

The permitted discharges in or tributary to Reach 4 include:

- The City of Colton WRF. The discharge occurs infrequently and happens only during storm events when there is enough surface water flow to provide a 20:1 dilution of the discharge. Discharges to the river from the City of Colton WRF have not occurred in over 15 years. Most of the flows from the City of Colton WRF are sent to the Colton/San Bernardino RIX Plant, which discharges further downstream in Reach 4.
- The Colton/San Bernardino RIX Plant.
- POTW discharges to streams that are tributary to Reach 4, include:
    - City of Rialto Municipal WWTP, which discharges to the Rialto Drain.

**Basin Plan *TDS and TIN Objectives and Compliance Description*.** The TDS and TIN objectives are 550 mgl and 10 mgl, respectively. The Basin Plan does not provide any description of the monitoring data and metrics that should be used to assess compliance with the Reach 4 TDS or TIN objectives.

***Purpose of Objective and Monitoring*.** The Reach 4 objectives are intended to protect the quality of the stream bed recharge to the underlying Riverside-A GMZ. The Basin Plan TDS and nitrate objectives for the Riverside-A GMZ are 560 and 6.2 mgl. Thus, the question to be answered by the surface water monitoring in Reach 4 is: what is the TDS and TIN concentration of the flow in the river within Reach 4 that can recharge the Riverside-A GMZ?

**Existing Surface Water Monitoring.** Surface water quality samples and/or flow measurements are collected along Reach 4 of the Santa Ana River at the following locations:

- *SAR @ Lacadena.* The site is monitored by the OCWD, which collects water quality grab samples once per year in August.
- *SAR Above RIX*. The site is monitored by the OCWD, which collects water quality grab samples once per year in August. The location of this site is in the Santa Ana River just downstream of the Rialto Drain confluence and before the RIX discharge to the river. Flow at this location during non-storm events is primarily flow the Rialto Drain where the Rialto Municipal WWTP discharges.
- *WR-RIX-01*. The site is monitored by the OCWD, which collects water quality grab samples once per year in August. The location of this site is at the RX outfall to the Santa Ana River and is not considered representative of the mainstream Santa Ana River.
- *SAR @ Riverside Ave.* The site is monitored by the OCWD, which collects water quality grab samples once per year in August.
- *SAR @ Mission*. The site is monitored by the OCWD, which collects water quality grab samples once per year in August.
- *CL-A.* The site is monitored by the County of San Bernardino, which collects water quality grab samples quarterly upstream of the Colton Landfill.

- *CL-B.* The site is monitored by the County of San Bernardino, which collects water quality data quarterly downstream of the Colton Landfill, and just downstream of the point where the Rialto Drain enters the Santa Ana River.
- USGS Gage *RIX Outflow @ SAR near Grand Terrace.* The USGS maintains a gage that measures and records the daily maximum and minimum height (e.g. stage) of the RIX outflow to the river.

**Data and Metric Used to Assess Compliance with TDS and TIN Objectives.** Compliance is assessed annually by the Task Force in the SAR Annual Report. The annual average TDS and TIN concentrations of all samples collected from the *SAR @ Lacadena, SAR @ Riverside Ave, and SAR @ Mission* are used to assess compliance. If the annual average TDS and TIN concentrations are less than the objectives, the Basin Plan Objectives are met.

**History of Data and Compliance with Objective.** Figures 3a and 3b show the time history of the data and the metrics used to assess compliance with the Reach 4 TDS and TIN objectives from 2004 to 2020. The annual TDS metric ranged from 250 to 534 mgl, and the annual TIN metric ranged from 5.8 to 10.9 mgl. The figures also show the total annual flow measured by the USGS gage *SAR @ E Street near San Bernardino* before entering Reach 4, expressed in af, including the portion of the total flow that occurs in August (the month during which the annual sample is collected). During all years except 2012, there was no flow at the *SAR @Lacadena site* and only two of the three sample locations had flow present during the sampling event. Based on the data available and used, there has never been an exceedance of the TDS Basin Plan objective, and one exceedance of the TIN objective in the last 15 years.

Figures 3a and 3b also show the data in Reach 4 not used to assess compliance for comparison to the data used to assess compliance. This includes:

- Monitoring performed by OCWD at the *SAR Above RIX* in the Santa Ana River above the RIX discharge and *WR-RIX-01* at the outfall for RIX discharge before entering the river. As described above, both locations are representative of POTW discharges and not the main channel of the Santa Ana River. However, the annual average of samples at these two could be representative of the Santa Ana River downstream of the RIX outfall, which is what is sampled at the downstream *SAR @ Riverside Ave* location. Since 2004, the TDS concentrations at these two locations ranged between 440 and 542 mgl and were not above the Reach 4 TDS objective, and the TIN concentration ranged between 6.2 and 12 mgl and exceeded the Reach 4 TIN objective four times.
- Monitoring performed by the Colton Landfill at CL-A and CL-B in the Santa Ana River above and below the Colton Landfill. TIN data is not collected at CL-A and CL-B so Figure 3b shows the nitrate as nitrogen (nitrate-N) data which is the main component of TIN. CL-B location is often dry during the quarterly monitoring events and there was enough flow in the river to collect a sample nine times between 2004 and 2020. And since mid-2018, the CL-A and CL-B sites were mostly dry when the County performed monitoring and a sample was not collected. Since 2004, the TDS concentrations at CL-A and CL-B ranged from 180 to 600 mgl; and 10 percent of the time the samples at CL-A were above the Reach 4 TDS objective.

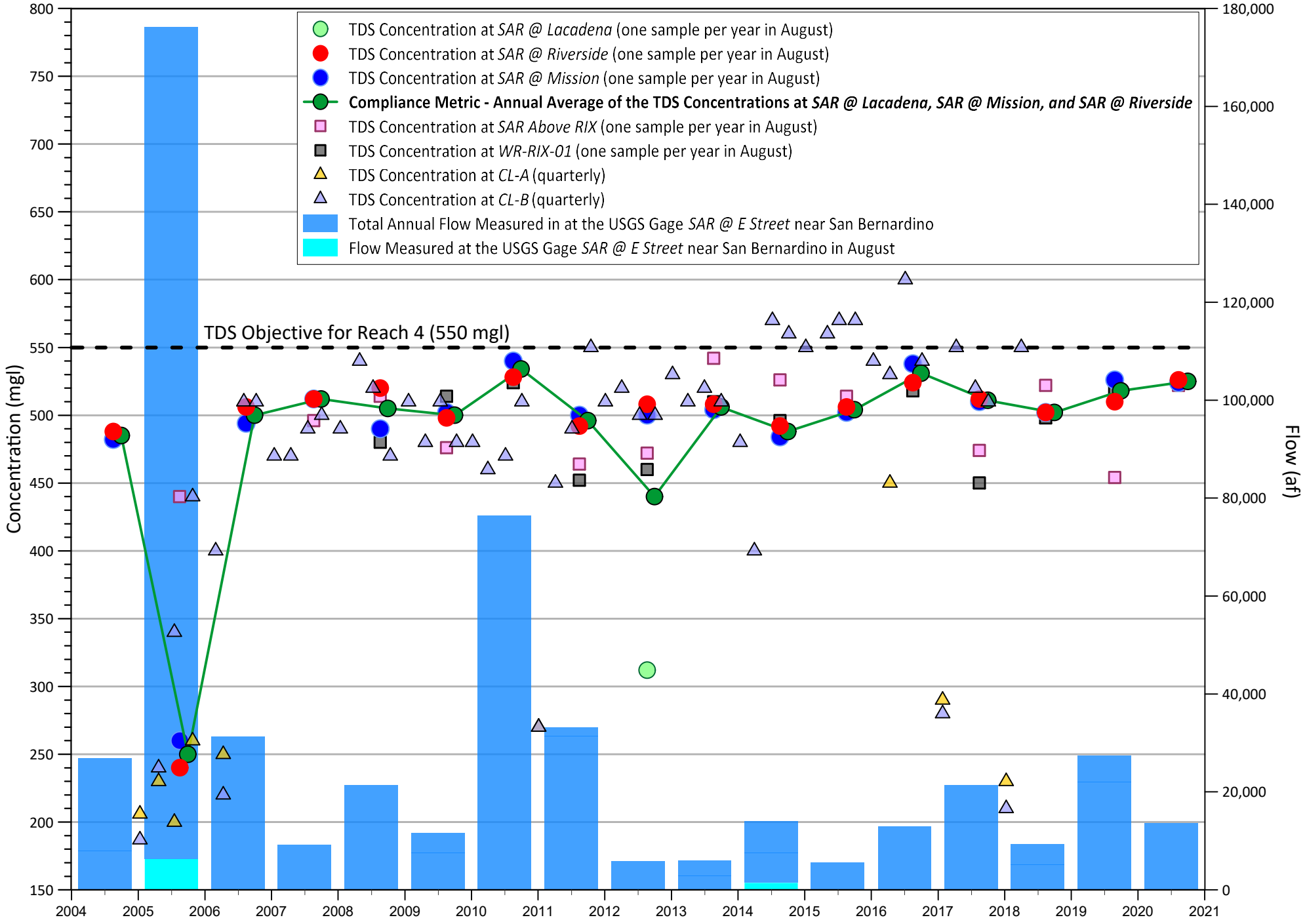
**Data Gaps and Uncertainties with Monitoring and Compliance.** Based on the purpose and objectives for monitoring Reach 4 and the data available to assess compliance, the following data gaps and questions were identified for consideration in the design of the 2022 Work Plan:

- Since 2004, sampling has not occurred at the *SAR @ Lacadena* location in 16 out of the 17 years because no surface water flow was present on the day of the OCWD annual sampling event in August.
- The flow at the upstream end of Reach 4 in August, if any, represents an insignificant portion of the total annual flow. The annual total flow into Reach 4 measured at *SAR @ E Street* ranged from 2,000 af to 176,000 af and during August ranged from 0 af to 6,000 af.
    - Should the sampling frequency be increased to more than once per year to understand the variability in quality throughout the year?

**Recommendations for Improved Monitoring.**

- Increase the frequency of sampling at compliance locations in Reach 4 to better understand the variability of water quality over high-flow and low-flow conditions throughout the year.
- Use the data from the CL-A and CL-B when available for assessment of compliance with the Reach 4 TDS objective.

**Figure 3a. Time-Series of TDS Concentration and Compliance Metric in Reach 4 of the Santa Ana River - 2004 to 2020**

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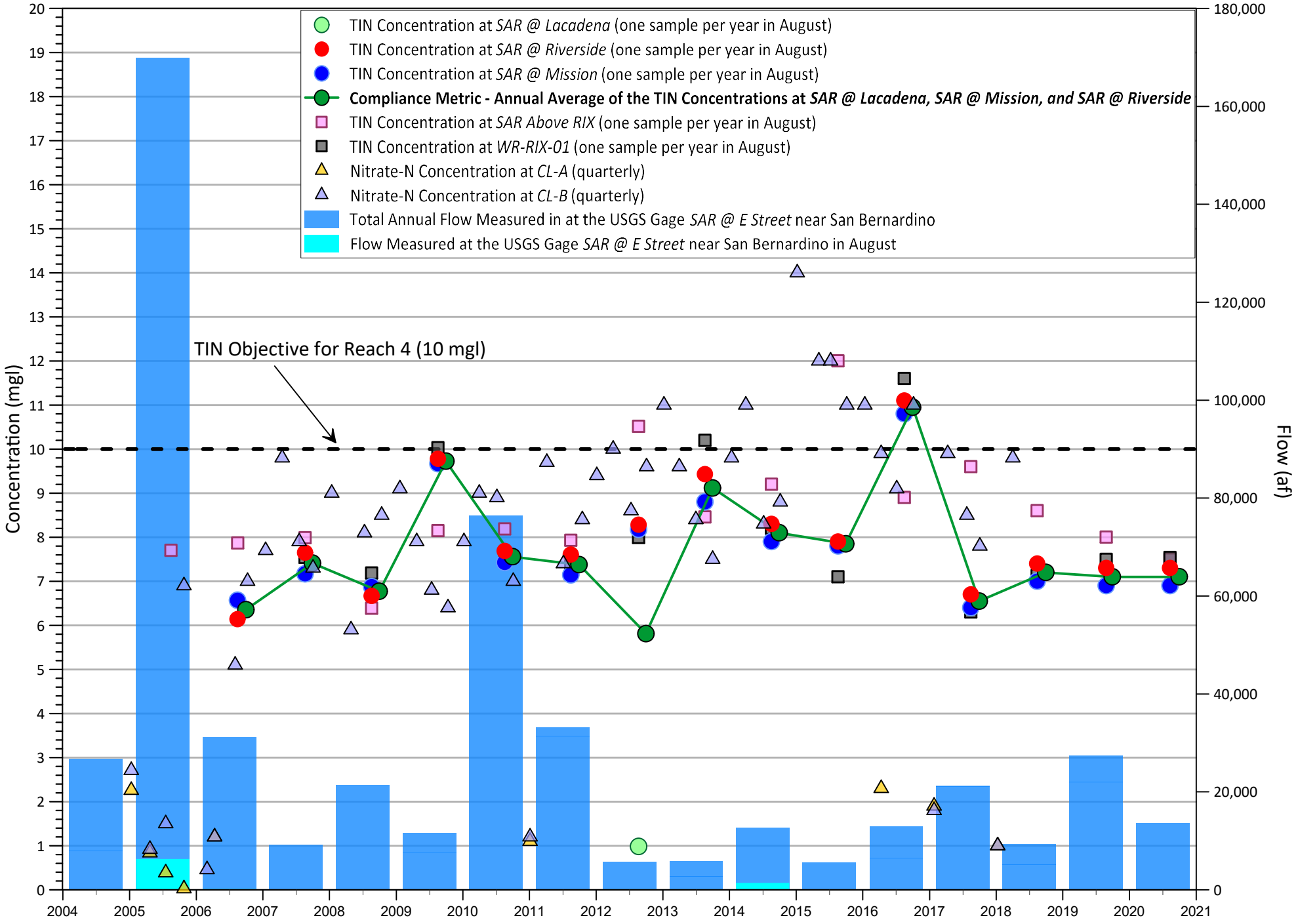
Santa Ana Watershed Project Authority
2022 Santa Ana River Water Quality Work Plan
Last Revised: 10/25/2022

**Figure 3b. Time-Series of TIN Concentration and Compliance Metric in Reach 4 of the Santa Ana River - 2004 to 2020**

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Santa Ana Watershed Project Authority
2022 Santa Ana River Water Quality Work Plan
Last Revised: 10/25/2022

### *2.1.3 Santa Ana River Reach 3*

Reach 3 of the Santa Ana River extends from Mission Boulevard in the City of Riverside to Prado Dam. Reach 3 overlies the Riverside-A and Chino-South GMZs, and Prado Basin Management Zone[4] (PBMZ). Major tributaries to Reach 3 include Temescal Wash, Chino Creek, and Cucamonga/Mill Creek.

The permitted discharges in or tributary to Reach 3 include:

- The City of Riverside Regional Water Quality Control Plant (RWQCP).
- The Western Riverside County Regional Wastewater Authority (WRCRWA) Regional WWTP
- City of Corona WRF No. 1.
- POTW discharges to streams that are tributary to Reach 3, include:
    - The Elsinore Valley Municipal Water District (EVMWD) Regional WRF that discharges to Temescal Creek.
    - Temescal Valley Water District WRF that discharges to Temescal Creek and to a series of percolation ponds adjacent to the Temescal Creek. Since 2013, discharge directly to the creek is rare and occurs primarily at the percolation ponds.
    - City of Corona WRF No. 3 that discharges to Temescal Creek. Since 2013, there has been no discharge to the creek.
    - The Inland Empire Utilities Agencies' (IEUA) Regional Plant No. 1 (RP-1) at Prado, Carbon Canyon WRF, and Regional Water Recycling Plant No. 5 (RP-5) that discharge to Chino Creek.
    - The IEUA RP-1 at Cucamonga that discharges to Cucamonga/Mill Creek.

**Basin Plan TDS and TIN Objectives and *Compliance Description*.** The TDS and TIN objectives are 700 mgl and 10 mgl, respectively. The Basin Plan indicates that the Reach 3 TDS and TIN objectives are for base flow conditions and describes base flow as composed of "wastewater discharges, rising groundwater, and nonpoint source discharges." Chapter 4 of the Basin Plan describes the monitoring data to use to assess compliance with the Reach 3 objectives:

- *"In order to determine whether the water quality and quantity objectives for base flow in Reach 3 are being met, the Regional Board will collect a series of grab and composite samples when the influence of storm flows and non-tributary flows is at a minimum. This typically occurs during August and September. At this time of year, there is usually no water impounded behind Prado Dam. The volumes of storm flows, rising water and nonpoint source discharges tend to be low. The major component of base flow at this time is municipal wastewater. The results of this sampling will be compared with the continuous monitoring data collected by USGS and data from other sources. These data will be used to evaluate the efficacy of the Regional Board's regulatory approach, including the TDS and nitrogen wasteload allocations."*

Table 4-1 of the Basin Plan indicates that Reach 3 TIN objective is based on a filtered total nitrogen sample.

[4] PBMZ is a surface water management zone

**Purpose of Objective and Monitoring.** The Reach 3 objectives are intended to protect the quality of the river for beneficial uses in Orange County GMZ, which is primarily groundwater recharge. Chapter 5 of the Basin Plan states:

- *Base flow generally provides 70% or more of the water recharged in the Orange County Management Zone. In rare wet years, base flow accounts for a smaller, but still significant, percentage (40%) of the recharge on an annual basis. Therefore, to protect Orange County groundwater, it is essential to control the quality of base flow. To do so, base flow TDS and nitrogen objectives are specified in this Plan for Reach 3 of the River. Wasteload allocations have been established and periodically revised to meet those and other Santa Ana River objectives."*

Thus, the question to be answered by the surface water monitoring in Reach 3 is: what is the quality of the base flow in the river within Reach 3 that flows into Reach 2?

**Existing Surface Water Monitoring.** Surface water quality samples and/or flow data are collected along Reach 3 at the following locations:

- *SAR @ MWD Xing.* The site is monitored by the OCWD and USGS for water quality. The OCWD collects water quality grab samples once per year in August, and USGS collects water quality grab samples bi-weekly (every two weeks).
- *SAR @ Van Buren.* The site is monitored by the OCWD, which collects water quality grab samples once per year in August.
- *SAR @ Etiwanda*. The site is monitored by the OCWD and Chino Basin Watermaster (CBWM)/ IEUA. The OCWD collects water quality grab samples once per year in August, and CBWM/IEUA collects water quality grab samples quarterly.
- *SAR @ Hamner.* The site is monitored by the OCWD, which collects water quality grab samples once per year in August.
- *SAR @ River Road.* The site is monitored by the OCWD and CBWM/IEUA for water quality. The OCWD collects water quality grab samples once per year in August, and CBWM/IEUA collect water quality grab samples quarterly.
- *SAR @ Below Prado Dam.* The site is monitored by the USGS, OCWD, and Santa Ana Water Board for water quality. The OCWD collects grab samples monthly, the USGS collects grab samples bi-weekly, and Santa Ana Water Board collects grab samples during August and September. This site is in Reach 2 just downstream of the Reach 2/3 boundary and used to evaluate water quality conditions in both Reaches 2 and 3.
- USGS Gage *SAR @ MWD Xing.* The USGS maintains a gage that measures and records daily flow.
- USGS Gage *SAR @ Below Prado Dam.* The USGS maintains a gage that measures and records daily flow and salinity as electrical conductivity (EC).

**Data and Metrics Used to Assess Compliance with TDS and TIN Objectives.** Compliance is assessed annually by the Task Force in the SAR Annual Report. The annual average TDS and total nitrogen concentrations from all samples collected by the Santa Ana Water Board in August and September at *SAR @ Below Prado Dam are* used to assess compliance. The *SAR @ Below Prado Dam* sample site is the compliance sample location because it is representative of all tributaries and POTW effluent discharges

that flow to end of Reach 3 at Prado Dam, where flows are released to Orange County GMZ in Reach 2 and recharged at basins in the Santa Ana Forebay.

Pursuant to the requirements in the Basin Plan the Santa Ana Water Board collects filtered total nitrogen samples to assess compliance with the Reach 3 TIN objective. If the annual average TDS and filtered total nitrogen concentrations are less than the objectives, the Basin Plan objectives are met.

In the SAR Annual Reports, two additional analyses of the data are reported in addition to the compliance metric: 1) the annual average of TDS and total nitrogen for all samples collected by the Santa Ana Water Board, OCWD, and USGS in August and September at *SAR @ Below Prado Dam*; and 2) annual average of TDS and total nitrogen for all sample locations in Reach 3 upstream of Prado Dam collected by the Santa OCWD and CBWM/IEUA in August and September.

**History of Data and Compliance with Objective.** Figures 4a and 4b show the time history of the data and the metrics used to assess compliance with the Reach 3 TDS and TIN objectives from 2004 to 2020. Since 2004, there have been exceedances of the Reach 3 TDS objective in 5 of the 17 years. These exceedances occurred in 2013, 2017, 2018, 2019, and 2020. The annual TDS metric ranged from 485 to 745 mgl. Since 2004, there has never been an exceedance of the TIN objective for Reach 3 and the annual TIN metric ranged from 2.2 to 6.7 mgl.

Figures 4a and 4b also show the data not used to assess compliance from the monitoring performed by various entities for all sample locations in Reach 3 upstream of Prado Dam collected in August and September (*SAR @ at MWD Xing, SAR @ Hamner, SAR @ Etiwanda, SAR @ River Road)*. Both the sample data and average of all samples for the year collected in August and September for these other locations along Reach 3 are shown in Figures 4a and 4b. Since 2004, the annual average for all TDS samples along Reach 3 upstream of Prado Dam collected in August and September ranged from about 600 to 650 mgl and was typically less than the annual TDS compliance metric for Reach 3. The annual average for all total nitrogen samples along Reach 3 upstream of Prado Dam collected in August and September ranged from about 5.5 to 8.5 mgl and was typically more than the annual TIN compliance metric.

**Data Gaps and Uncertainties with Monitoring and Compliance.** Based on the purpose and objectives for monitoring Reach 3 and the data used to assess compliance, the following data gaps and questions were identified for consideration in the design of the 2022 Work Plan:

- The *SAR @ Below Prado Dam* location is the best suited location to characterize the quality of flow from Reach 3 into Reach 2 that is used for downstream beneficial uses in Orange County GMZ. There are TDS and TIN data collected at *Below Prado Dam* other than that collected by the Santa Ana Water Board that are not used to assess compliance with the Reach 3 objectives.
    - Should the monitoring data collected by other entities besides the Santa Ana Water Board at *Below Prado Dam* be used to assess compliance with the Reach 3 objectives?
    - Should daily TDS concentration data that can be calculated from the daily EC measurements at the USGS gage at SAR @ *Below Prado Dam* be used to evaluate compliance with the Reach 3 TDS objective?
    - Should monitoring data representative of base flow conditions in months other than August and September be used assess compliance with the Reach 3 objectives?

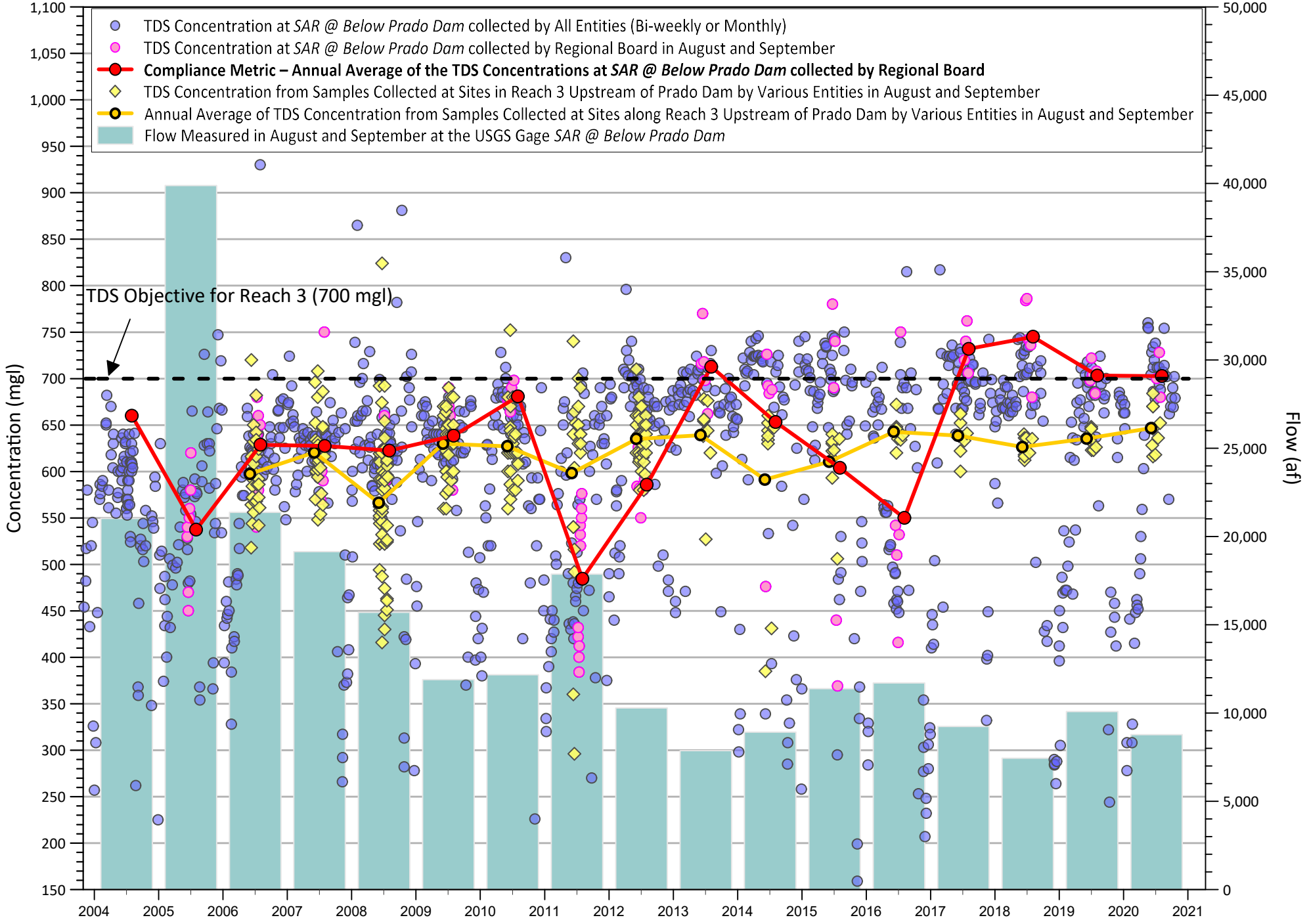
- The Basin Plan does not provide a clear definition of base flow conditions in Reach 3 to collect compliance samples, besides indicating that the Santa Ana Water Board will collect base flow samples in August and September.
- The compliance samples collected by the Santa Ana Water Board in August and September have not always occurred when there were conditions indicative of base flow when storm flows and nontributary flows are at a minimum. An evaluation of daily discharge, precipitation, and conservation pool elevation behind Prado Dam was presented and discussed at the Task Force workshop on May 24th, 2022, that indicated that some of the historical base flow samples collected by the Santa Ana Water Board in August and September used to assess compliance, were sampled during conditions not indicative of base flow. These non-base flow samples occurred when the flow in the river was influenced by stormwater, when water was held behind the dam, and/or when there was non-tributary discharge from OC-59[5].
- Reach 3 is the only reach of the Santa Ana River that requires a filtered total nitrogen sample for compliance with the TIN objective. The Basin Plan does not provide an explanation of intent of the filtered total nitrogen sample requirement for Reach 3 compliance assessment, and the use of a filtered total nitrogen sample is a conservative analysis (filtered total nitrogen is typically higher than TIN). Does there need to be this requirement to use a filtered total nitrogen sample to assess compliance with the Reach 3 TIN objective, or can a TIN sample be used instead? The SAR Annual Reports show that filtered total nitrogen and TIN results from the Santa Ana Water Board samples at *SAR @ Below Prado Dam* track similarly and differ within 0.5-1.5 mgl. And since 2004, the Reach 3 TIN objective has not been exceeded and TIN concentrations show a decreasing trend. Using TIN data for assessment of compliance with the Reach 3 TIN objective would be consistent with the other reaches of the Santa Ana River.
- What are the causes of the exceedances of the Reach 3 TDS objective 2013, 2017, 2018, 2019, and 2020? After the initial exceedance, the Task Force commissioned a study to investigate the causes of the exceedance (WEI, 2015a). The results of the investigation indicated that average TDS concentrations in August and September were increasing because the lower-TDS POTW discharges in the Santa Ana River were decreasing. The investigation also concluded that there are likely other gains and losses of Santa Ana River discharge that occur in Reach 3 and Reach 4 (e.g., rising groundwater, streambed recharge, evapotranspiration, dry-weather runoff, etc.), and that some of these discharges may have TDS concentrations much higher than 700 mgl. To what extent do the gains and losses of the river (e.g., rising groundwater, dry-weather flow) drive changes in the water quality in Reach 3 and contribute to the exceedances in the Reach 3 TDS objective? In 2015 and 2022, follow-up investigations were completed for the Task Force, to characterize the volume-weighted TDS concentration of discharge from POTWs that could potentially reach Prado Dam in August and September (WEI 2015b; 2022). Both of these investigations supported the conclusion of the prior investigation in 2015 that the observed increase in TDS concentration in base flow at Below Prado Dam in August and September since 2004 is correlated with the decrease in POTW discharge of relatively low TDS concentration.

[5] OC-59 is a turnout where imported water from the Metropolitan Water District of Southern California (MWDSC) is delivered to the OCWD and discharged to San Antonio/Chino Creek and is conveyed through the Prado Basin for groundwater recharge in Orange County.

**Recommendations for the 2022 Work Plan.** Based on the data gaps and questions identified, the following recommendations should be considered for the 2022 Work Plan:

- Develop a clear definition of base flow conditions in Reach 3, that can be used to identify all data to use for compliance assessment of the Reach 3 TDS and TIN objectives for base flow. This will allow for better characterization of the quality of base flow in Reach 3 throughout the year, and the use of data already being collected by others, which includes:
    - Monitoring data collected at *SAR @ Below Prado Dam* by entities other than the Santa Ana Water Board (USGS and OCWD).
    - Daily TDS data that can be calculated from the daily EC measurements at the USGS gage using the observed average TDS/EC ratio from samples at SAR @ *Below Prado Dam*.
- If the recommendation in the first bullet above is implemented, the Santa Ana Water Board will not need to perform their monitoring at *SAR @ Below Prado Dam* because there is already enough data collected by others that can be used to assess compliance.
- Amend the Basin Plan to remove the requirement to collect filtered total nitrogen samples for compliance with the Reach 3 TIN objective.
- Develop and perform a Special Study to address data gaps in Santa Ana River Reach 3 to better quantify the magnitude and quality of rising groundwater and streambed recharge and to understand the cause(s) of the recent TDS exceedances. Such an investigation will require monitoring surface water and groundwater. This Special Study is not required to assess current compliance but can help understand these TDS exceedances and used to identify potential strategies for maintaining compliance with the Basin Plan objectives and inform and update the WLAM to assess future compliance.

## Figure 4a. Time-Series of TDS Concentration and Compliance Metric in Reach 3 of the Santa Ana River - 2004 to 2020

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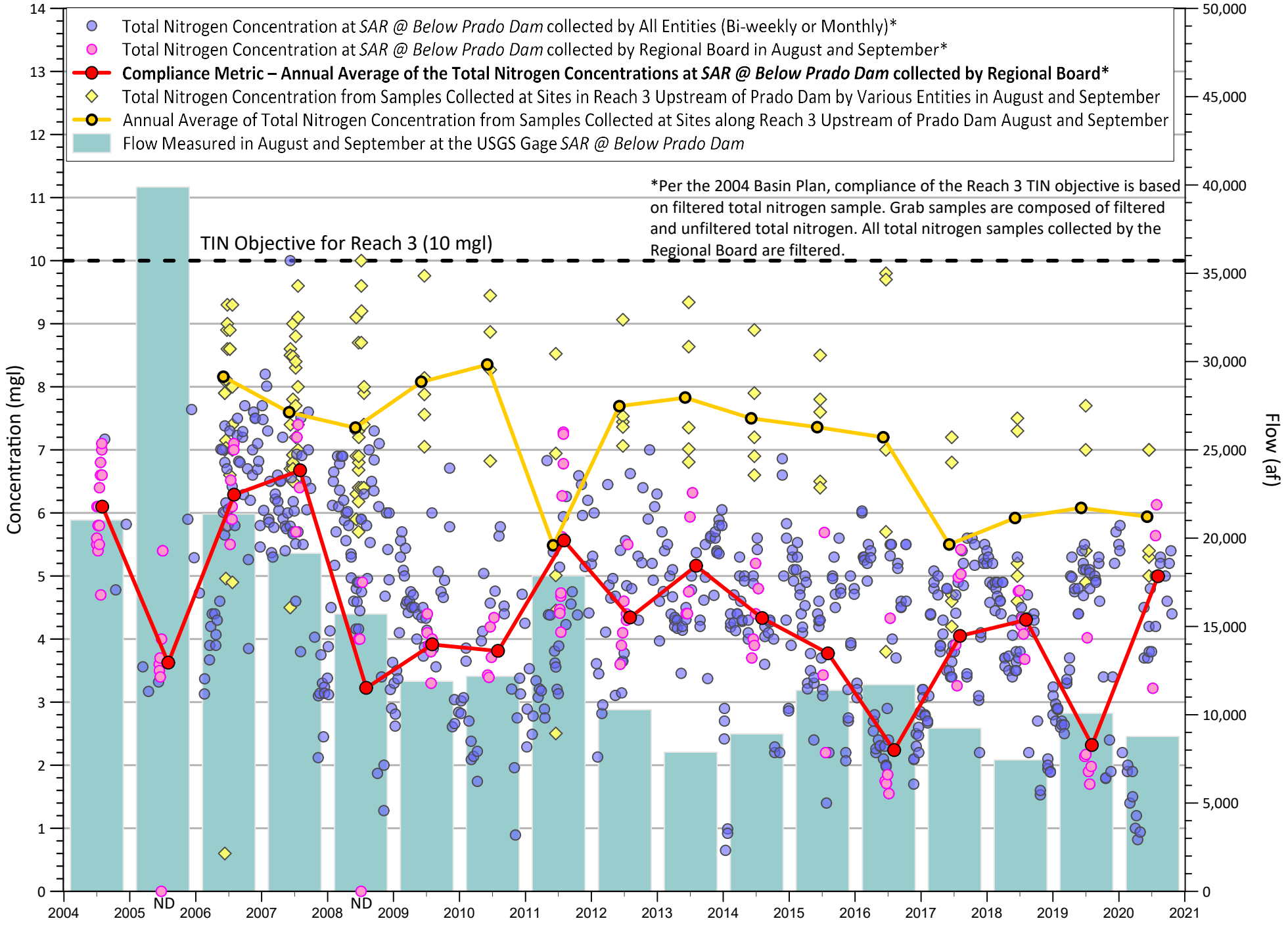
Santa Ana Watershed Project Authority
2022 Santa Ana River Water Quality Work Plan
Last Revised: 10/25/2022

**Figure 4b. Time-Series of TIN Concentration and Compliance Metric in Reach 3 of the Santa Ana River – 2004 to 2020**

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Santa Ana Watershed Project Authority
2022 Santa Ana River Water Quality Work Plan
Last Revised: 10/25/2022

### *2.1.4 Santa Ana River Reach 2*

Reach 2 extends from Prado Dam to the 17th Street in the City of Santa Ana. Reach 2 overlies the Orange County GMZ. Major tributaries to Reach 2 include Carbon Canyon Creek and Santiago Creek. There are no POTW discharges to Reach 2. OCWD recharges flow from the Santa Ana River at a series of recharge basins located along Reach 2 just south of the *SAR @ Imperial Highway* site in the Santa Ana Forebay.

**Basin Plan TDS and TIN Objectives and Compliance Description.** The TDS objective is 650 mgl and there is no TIN objective**.** Chapter 4 of the Basin Plan describes the metric and data to use to assess compliance with the Reach 2 TDS objective:

- "*…compliance with the total TDS water quality objective for Reach 2 will be based on the five-year moving average of the annual TDS content of total flow. Use of this moving average allows the effects of wet and dry years to be smoothed out over the five-year period*."
- "*The [Santa Ana River] Watermaster's annual determination of total flow quality will be used to determine compliance with the total flow objective in this Plan*."

**Purpose of Objective and Monitoring.** The Reach 2 TDS objective is protecting the quality of the river for beneficial uses in Orange County GMZ, which is primarily groundwater recharge. In Chapter 4 of the Basin Plan it states:

- *"In years of normal rainfall, most of the total flow of the river is percolated in the Santa Ana Forebay, and directly affects the quality of the groundwater for that reason compliance with the total TDS water quality objective for Reach 2 will be based on the five-year moving average of the annual TDS content of total flow.*

Thus, the question to be answered by the surface water monitoring in Reach 2 is: what is the flow-weighted quality of the Santa Ana River that flows into Reach 2?

**Existing Surface Water Monitoring.** Surface water quality samples and/or flow data are collected along Reach 2 at the following locations:

- *SAR @ Below Prado Dam.* The site is monitored by the USGS, OCWD, and Santa Ana Water Board for water quality. The OCWD collects grab samples monthly, the USGS collects grab samples bi-weekly, and Santa Ana Water Board collects grab samples during August and September.
- *SAR @ Imperial Highway.* The site is monitored by the OCWD, which collects water quality grab samples monthly.
- USGS Gage *SAR @ Below Prado Dam.* The USGS maintains a gage that measures and records daily flow and salinity as EC.

**Data and Metric Used to Assess Compliance with TDS Objective.** Compliance is assessed annually by the Task Force in the SAR Annual Reports. The five-year average of the annual flow-weighted TDS concentration at Below Prado Dam calculated by the Santa Ana River Watermaster (SARWM)[6] in their annual reports, is used to assess compliance with the Reach 2 TDS objective. The SARWM uses the daily

[6] The SARWM calculates the annual flow-weighted TDS concentration at Prado Dam for the water year for compliance with the stipulated judgement for the Santa Ana River

flow at *SAR @ Below Prado Dam* and daily TDS concentrations calculated from the EC measurements at that gage, to calculate the annual-flow-weighted TDS concentration. The SARWM uses USGS grab sample data to establish a TDS/EC relationship to calculate the daily TDS concentrations from the daily EC measurements. The SARWM prepares annual reports that describe the calculation and result of the annual flow-weighted TDS concentration at Prado Dam.[7] The arithmetic average of the five most recent SARWM-reported annual flow-weighted TDS concentrations at Below Prado Dam is used to assess compliance with the Reach 2 TDS objective. If the five-year average TDS concentration is less than the objective of 650 mgl, the Basin Plan TDS objective is met. This method is in alignment with the Basin Plan description on how to assess compliance with the Reach 2 TDS objective (Basin Plan method), however the Task Force includes an alternative method in the SAR Annual Reports to calculate a five-year flow-weighted metric for Reach 2 (alternative method).

The Reach 2 alternative method includes the calculation of a 60-month volume-weighted TDS concentration at the *SAR @ Below Prado Dam.* The 60-month volume-weighted TDS concentration calculation also utilizes the daily flow at *SAR @ Below Prado Dam* and daily TDS concentrations calculated from the EC measurements at that gage, but uses grab sample data from the USGS, OCWD, and the Santa Ana Water Board to establish a TDS/EC relationship to calculate the daily TDS concentrations from the daily EC measurements. There are other slight differences between these two methods which are summarized Table 2 below:

**Table 2. Difference between the Two Methods to Calculate the Five-year Volume-Weighted TDS Concentration at Below Prado Dam for Compliance with the Reach 2 TDS Objective**

| Method | Year Type | Source of Grab Sample Data Used to Calculate the TDS/EC Relationship Used to Calculate Daily TDS from Daily EC | Type of Calculation used to Determine TDS and EC Relationship, to Calculate Daily TDS from Daily EC | Calculation Type |
|---|---|---|---|---|
| Basin Plan Method | Water Year | USGS | average ratio of TDS/EC | Arithmetic mean of five most recent annual flow-weighted averages by the SARWM |
| Alternative Method | Calendar Year | USGS, OCWD, Santa Ana Water Board | linear regression equation | Five-year (60-month) volume-weighted average |

**History of Data and Compliance with Objective.** Figure 5 shows the time history of the data and the metrics used to assess compliance with the Reach 2 TDS objective from 2004 to 2020. Figure 5 shows the time history for the annual metrics using the Basin Plan method (compliance metric) and alternative method (both annual metric and moving average), which yield similar metrics. Since 2004, there has not

[7] SARWM Annual Reports are available at https://www.wmwd.com/292/Santa-Ana-Watermaster-Reports

been an exceedance of the TDS objective for Reach 2, and the annual metric using the Basin Plan method ranged from 483 to 576 mgl.

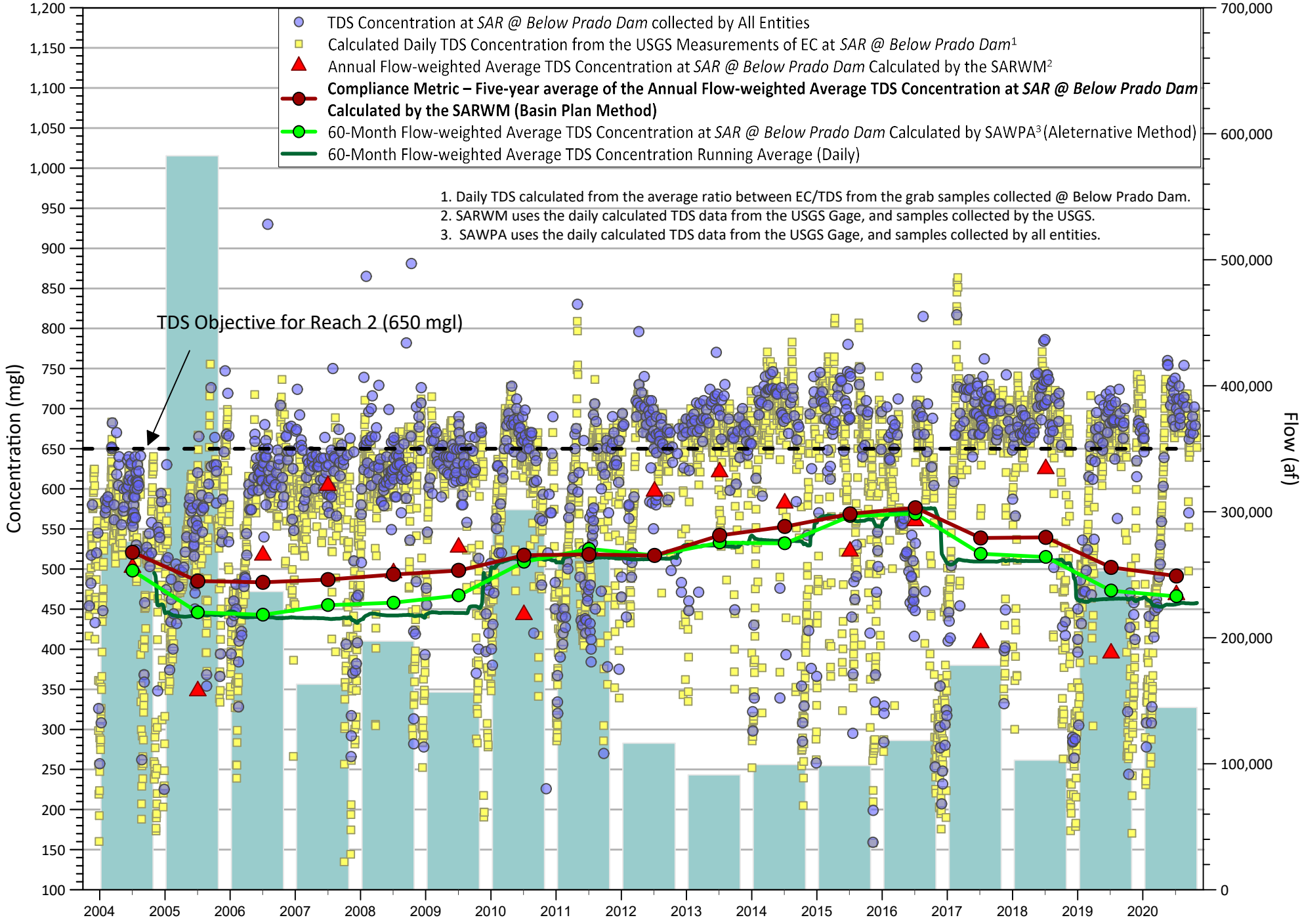
**Data Gaps and Uncertainties with Monitoring and Compliance.** Based on the purpose and objectives for monitoring Reach 2 and the data available to assess compliance, the following data gaps and questions were identified for consideration in the design of the 2022 Work Plan:

- Is it necessary for SAWPA to assess compliance for the Reach 2 TDS objective using the two different methods, the Basin Plan method and the alternative method? Figure 5 shows that the annual metrics for the Basin Plan method and alternative method are very similar and always below the Reach 2 TDS objective.

**Recommendations for the 2022 Work Plan.** Based on the data gaps and questions identified, the following recommendations should be considered for the 2022 Work Plan:

- There are no recommendations for improved monitoring. There is enough reliable and available data collected at *SAR @ Below Prado Dam* to calculate a five-year volume-weighted TDS concentration at Prado Dam.
- Eliminate the use of one of either the Basin Plan method or alternative method to calculate the Reach 2 TDS metric. The use of both metric is not necessary. At the Task Force workshop on August 30, 2022, the consensus was to use the alternative method because it is one continuous averaging period instead of averaging five different annual averages, and because you can analyze the data as a daily or monthly moving average.

**Figure 5. Time-Series of TDS Concentration and Compliance Metric in Reach 2 of the Santa Ana River – 2004 to 2020**

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## 2.2 Future Monitoring and Assessment of Compliance

The Basin Plan requires that the Santa Ana Water Board set TDS and TIN wasteload allocations for POTW discharges to the Santa Ana River and its tributaries and evaluate their efficacy every ten years. The Task Force uses the WLAM as a predictive watershed modeling tool to evaluate TDS and TIN concentrations of the Santa Ana River and assess the ability to comply with Basin Plan objectives in the future based on the current wasteload allocations. The Basin Plan does not provide specific guidance on the requirements of the WLAM, but it describes the purpose of a prior analysis using the WLAM "to estimate discharge, TDS and TIN concentrations in the Santa Ana River and tributaries and in stream bed recharge."

The WLAM is a numerical surface water model used to simulate future conditions in the watershed (i.e., POTW discharges, land use, hydrologic conditions) to estimate the TDS and TIN concentrations of surface water discharge and streambed infiltration. The TDS and TIN concentrations are compared to the surface water and groundwater quality objectives to determine whether changes in wasteload allocations are necessary. The WLAM is built and calibrated based on historical monitoring data (i.e., flow and quality).

The current WLAM is the 2017 WLAM (Geoscience Support Services Inc. [GSSI], 2020a). To determine if the current surface water monitoring in the Watershed is sufficient to update and recalibrate the WLAM for the next wasteload allocation assessment due in 2030, the 2017 WLAM calibration and the data that supported it were reviewed in detail. The approach for analyzing the WLAM and identifying monitoring data gaps involved two steps:

- Evaluating the sensitivity of the WLAM results to changes in the rising groundwater volume and TDS assumptions, which were not well-constrained by available monitoring data. This can identify monitoring data gaps that, if filled, could improve understanding of rising groundwater in the Santa Ana River, and thus, reduce the uncertainty in the model results.
- Comparing the WLAM to other available predictive modeling tools regarding the simulated surface water/groundwater (SW/GW) interactions along the Santa Ana River. By comparing simulated results of the WLAM to modeling tools that explicitly simulate SW/GW interactions, the assumptions and monitoring data used in the WLAM can be evaluated to identify monitoring data gaps that could more accurately represent the magnitude and quality of stream flow and stream bed recharge.

### *2.2.1 2017 WLAM Sensitivity Analysis*

The 2017 WLAM is calibrated, in part, by adjusting model parameters (e.g., watershed characteristics, streambed properties) to match simulated discharge and TDS and TIN concentrations with observed data. Figure 6 shows the locations where discharge and quality data were used to calibrate the 2017 WLAM. The 2017 WLAM achieved a satisfactory calibration based on comparison of model-simulated and measured stream discharge data at nine stream gages and of model-simulated and measured TDS and TIN data at three monitoring locations in the Santa Ana River watershed for the period of Water Year 2007 through 2016.

Several of the assumptions required to build the 2017 WLAM were made due to lack of available data include the volume, quality, and location of rising groundwater and the rate and location of streambed infiltration along the Santa Ana River and its tributaries. The assumptions used in the 2017 WLAM are generally based on field measurements and other modeling studies. The assumptions are necessary because of the limitations of representing a complex physical system in a model. For example, rising groundwater occurs along segments of the Santa Ana River based on complex interactions between the

groundwater table and the streambed, and the location and magnitude of rising groundwater fluctuates over time. The 2017 WLAM simplifies this process, representing rising groundwater as a point inflow at a location where it is assumed that the rising groundwater consistently occurs at a rate informed by other model results or field measurements. This is a common simplifying assumption used in surface water models that do not directly simulate the interaction with groundwater.

One way to understand the relative importance of the uncertainty of a model assumption is through a sensitivity analysis, which quantifies the effect of a model assumption on the model-calculated outputs. During the development of the 2017 WLAM, a sensitivity analysis was performed to "determine the effect of changes in rising [ground]water on model-calculated streambed recharge." Stated simply, the Task Force sought to better understand if the rising groundwater assumptions used in the WLAM impact the assessment of compliance with the Basin Plan objectives.

GSSI performed and documented a sensitivity analysis in their 2017 WLAM report (GSSI, 2020a), which involved developing a "sensitivity run" to compare to the calibrated WLAM over the calibration period (Water Year 2007 through 2016). The sensitivity run assumed a 50 percent reduction in the volume of rising groundwater upstream of Riverside Narrows (near the *SAR @ MWD Xing* gage) compared to the original calibration run (calibration run) for the 2017 WLAM. The sensitivity run did not include any changes to the assumed concentration of the rising groundwater of between 770 and 870 mgl. The sensitivity run was calibrated to the discharge and TDS and TIN at the *SAR @ MWD Xing* gage and the resulting water budget was compared to the calibration run. The calibration statistics of the sensitivity run for discharge, and TDS and TIN at the *SAR @ MWD Xing* gage are similar between the calibration run and the sensitivity run.[8] In other words, the model was able to be satisfactorily calibrated (e.g., produce similar model-estimated TDS concentrations at *SAR @ MWD Xing)* in both the calibration and sensitivity runs. However, the sensitivity run caused changes to other WLAM model outputs as a result of changing the volume of the rising groundwater.

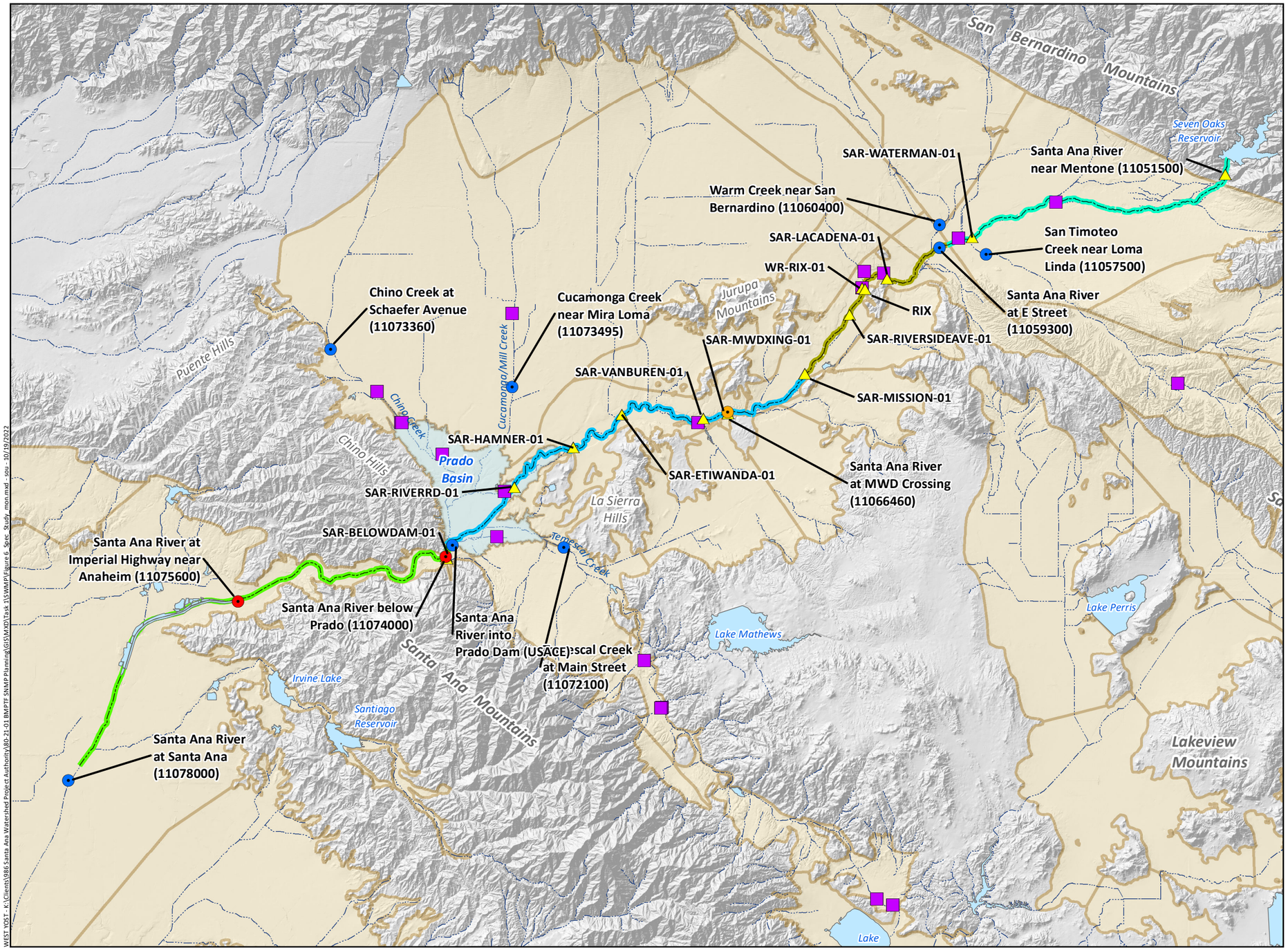
West Yost expanded upon the water budget components documented in the 2017 WLAM Report to assess the effect of the reduced rising groundwater on the TDS of the components of the water budget not specified in the sensitivity analysis. Reducing the amount of rising groundwater had the effect of altering the flow and TDS components of the water budget between the *SAR @ MWD Xing* gage and the *SAR @ E Street* gage (the next upstream gage to which the 2017 WLAM was calibrated). Some notable differences in the water budgets between the sensitivity run and the calibration run include:

- The average surface water discharge at the boundary of Reach 4 and flowing into Reach 3 increased by 34 percent in the sensitivity run compared to the calibration run.
- The average volume of streambed infiltration into the Riverside-A GMZ decreased by about 24 percent in the sensitivity run compared to the calibration run.
- The average TDS concentration of the streambed infiltration into Riverside-A GMZ decreased by about 30 percent. The TDS concentration decreased from 413 mgl in the calibration run to 290 mgl in the sensitivity run, a decrease of about 123 mgl.

A detailed summary of the sensitivity analysis in the 2017 WLAM and our exploration of its implications was presented at the February 22, 2022 Task Force workshop.

[8] See the calibration statistics in Tables 4-19 through 4-22 of the 2017 WLAM Report.

Based on this more-detailed review of the sensitivity and calibration run results, the sensitivity analysis demonstrates that uncertainty exists in the results of the 2017 WLAM due to the lack of monitoring data available to confirm which assumptions for rising groundwater are most appropriate. The current surface water and groundwater data relied on for Reaches 3, 4, and 5 of the Santa Ana River are not sufficient to constrain this uncertainty to provide a more reliable estimate of the water budget components and their associated TDS and TIN concentrations, which are used to make compliance demonstrations. A targeted monitoring program could be implemented to improve the data available and constrain this uncertainty. The enhanced monitoring will improve the utility of future WLAM updates for understanding and setting wasteload allocations.

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Surface Water Monitoring Locations Along and/or Tributary to Santa Ana River

Gage used for Calibration of 2017 WLAM

- TDS/TIN Only
- Discharge Only
- TDS/TIN and Discharge

- Monitoring Location not Used for Calibration of 2017 WLAM
- Publicly Owned Treatment Works (POTWs) Discharge Location

Reaches of Santa Ana River

- Reach 2
- Reach 3
- Reach 4
- Reach 5

- Groundwater Management Zone (GMZ)
- Streams & Flood Control Channels
- Flood Control and Conservation Basins


Prepared by:

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0 8 16 Km

Prepared for:

**Santa Ana Watershed Project Authority**
2022 Santa Ana River Water Quality Work Plan

SAWPA

**Surface Water Monitoring Locations used for the Calibration of the 2017 Wasteload Allocation Model (WLAM)**

**Figure 6**

### 2.2.2 2017 WLAM Comparison to Other Regional Models

In addition to reviewing the sensitivity of the assumptions of the WLAM, comparing simulated results of the WLAM to modeling tools that explicitly simulate SW/GW interactions can also reveal monitoring data gaps. Identifying and addressing these monitoring data gaps and incorporating the data into a future WLAM update would improve the WLAM to represent the magnitude and quality of stream flow and stream bed recharge more accurately.

The evaluation of predictive tools included a review and comparison of the WLAM to two other regional models that directly simulate the SW/GW interaction. The two regional models evaluated were the 2020 Chino Valley Model (CVM) (WEI, 2020) and the Upper Santa Ana River Integrated Model (Integrated Model) (GSSI, 2020b). The objective of the analysis was to understand the differences in the WLAM's characterization of the interactions between the Santa Ana River and the groundwater systems to identify potential data gaps that could be addressed through improved monitoring.

Each of the three models is based on unique assumptions and model construction, but all three are calibrated to field-observed data, where it was available. The comparison between the three models was not meant to determine whether one is more accurate than another, but to illustrate the differences in modeled surface and groundwater interactions when there is limited data available for calibration.

The assumptions and model outputs of all three models were compared over concurrent historical time periods (Water Year 2007 through 2016). For the 2020 CVM and the Integrated Model, the net exchange of water between the surface water and groundwater was calculated over the concurrent historical time period for segments of the Santa Ana River and its tributaries. The results of this analysis were presented at the Task Force workshop on February 22, 2022. The following are conclusions from the comparison of the average net exchange of water in Reaches 3 and 4 between the three models:

- In the Reaches upstream of Riverside Narrows[9] (Reaches 3 and 4):
    - The Integrated Model and the WLAM both indicate streambed infiltration occurs in Reach 4 upstream of Market Street and overlying the Riverside-A GMZ.
    - The Integrated Model indicated rising water occurs across a small segment at the downstream end of Reach 4 near Market Street overlying the Riverside-A GMZ. The WLAM assumes that streambed infiltration occurs along all of Reach 4.
    - The Integrated Model indicated streambed infiltration in the segment of Reach 3 extending from *SAR @ Mission* to about 1.5 miles downstream. The WLAM does not assume any streambed infiltration between *SAR @ Mission* and *SAR @ MWD Xing.*
    - The Integrated Model and the WLAM both indicate that rising groundwater occurs immediately above Riverside Narrows.
- In Reach 3 downstream of Riverside Narrows:
    - All three models indicate streambed infiltration occurs in Reach 3 between Riverside Narrows and *SAR @ River Road*. The CVM indicates some rising groundwater also occurs immediately downstream of Riverside Narrows, whereas the Integrated Model and WLAM do not.

[9] The upstream boundary of the CVM is Riverside Narrows; therefore, the WLAM was only compared to the Integrated Model upstream of Riverside Narrows.

- The Integrated Model generally indicated a larger volume of streambed infiltration to the Chino South GMZ as compared to the CVM estimate.
- The WLAM and the CVM indicate rising groundwater occurs between *SAR @ River Road* and *SAR @ Below Prado Dam*. In contrast, the Integrated Model indicates that streambed infiltration is occurring over this section.

The differences between the three models suggest that the field data to understand and characterize SW/GW interactions are lacking and result in non-unique model outputs. Absent an improved understanding of these interactions, it is difficult to identify the mechanisms of non-compliance with the Basin Plan objectives (if any) and thus the potential strategies that may be needed to maintain compliance in the future. As such, an investigation of SW/GW interactions in Reaches 3 and 4 is needed, which will require monitoring flow and quality of surface water and groundwater.

# 3.0 2022 SURFACE WATER MONITORING PROGRAM TO ANNUALLY ASSESS COMPLIANCE WITH THE BASIN PLAN TDS AND TIN OBJECTIVES

This section describes the updated 2022 surface water monitoring program to be implemented by the Task Force to collect data and annually assess compliance with the Basin Plan TDS and TIN objectives for Reaches 2, 3, 4, and 5 of the Santa Ana River. Table 3 presents the 2022 surface water monitoring program to annually assess compliance, and for each Reach describes:

- The specific questions that the monitoring data needs to answer to address the purpose of the Basin Plan objectives (as described in Section 2)
- The monitoring location(s) (site names) to collect water quality grab samples
- The frequency of sample collection
- The monitoring entity responsible for ensuring the samples are collected, or already monitoring or collecting data.
- The compliance metric that will be used to annually assess the state of compliance

Sections 3.1 through 3.5. summarize the monitoring data and compliance assessment for each reach, how the monitoring and compliance assessment in the 2022 Work Plan differs from the 2005 Work Plan and identifies if the Basin Plan requires an amendment to implement the compliance assessment.

Figure 7 shows the locations of the surface water monitoring sites described in Table 3 to annually assess compliance. At a minimum, samples for water quality will be analyzed for the analytes listed in Table 4, which include TDS, TIN, and general mineral and physical parameters that can be used to characterize source water and/or have surface water objectives in the Basin Plan for the Santa Ana River.

**Table 3. 2022 Surface Water Monitoring Program to Annually Assess Compliance with the Basin Plan TDS and TIN Objectives in Santa Ana River Reaches 2, 3, 4, and 5**

| Reach | TDS/TIN Objectives | Question Answered by the Monitoring Data | Monitoring Site | Data Collected | Frequency | Monitoring Entity | Compliance Metric |
|---|---|---|---|---|---|---|---|
| 5 | TDS = 300 mgl<br>TIN = 5 mgl | What is the TDS and TIN concentration of the flow in Reach 5 that can recharge the Bunker Hill-B GMZ and Colton GMZ? | SAR @ Waterman | Quality [1] | Quarterly | Task Force [2] | Annual average TDS and TIN of all samples |
| | | | SAR @ E Street | Quality [1] | Quarterly | Task Force [2] | |
| | | | New location along the Santa Ana River to be determined by the Task Force between SAR @ Mentone and SAR @ Waterman | Quality [1] | Quarterly | Task Force [2] | |
| 4 | TDS = 550 mgl<br>TIN = 10 mgl | What is the TDS and TIN concentration of the flow in the river within Reach 4 that can recharge the Riverside-A GMZ? | SAR @ Lacadena | Quality [1] | Quarterly | Task Force [2] | Annual average TDS and TIN of all samples |
| | | | SAR @ Riverside Ave | Quality [1] | Quarterly | Task Force [2] | |
| | | | SAR @ Mission | Quality [1] | Quarterly | Task Force [2] | |
| | | | CL-A | TDS, Nitrate-Nitrogen | Quarterly | San Bernardino County [3] | |
| | | | CL-B | TDS, Nitrate-Nitrogen | Quarterly | San Bernardino County [3] | |
| 3 | TDS = 700 mgl<br>TIN = 10 mgl<br><br>- Base Flow Objectives | What is the quality of the base flow in the river within Reach 3 that flows into Reach 2? | SAR @ Below Prado Dam | Quality [4] | Monthly/Bi-weekly | USGS [5]/others [6] | Annual average of all samples collected during base flow conditions.[7] The data used to calculate TDS should include the daily TDS concentrations calculated from the daily EC measurements from the USGS gage at Below Prado Dam, and grab samples collected at SAR @ Below Prado Dam. |
| | | | USGS Gage SAR @ Below Prado Dam | EC [8] | Daily | USGS [5] | |
| | | | Prado Dam Reservoir | Surface Water Elevation [9] | Daily | ACOE or OCWD [10] | |
| | | | OC-59 Turnout | Flow [9] | Daily | MWDSC or OCWD [11] | |
| | | | Precipitation Tributary to Reach 3 | Precipitation [9] | Daily | Various [12] | |
| 2 | TDS = 650 mgl<br>TIN = None | What is the flow-weighted quality of the Santa Ana River that flows into Reach 2? | SAR @ Below Prado Dam | Quality [1] | Monthly/Bi-weekly | USGS/others [4] | 60-month volume-weighted average TDS concentration at Prado Dam |
| | | | USGS Gage SAR @ Below Prado Dam | Flow, EC [8] | Daily | USGS [5] | |

(1) - Sampled for the parameters in Table 4 of the 2022 Work Plan

(2) - Monitoring will be conducted by one or more Task Force members, consultants to the Task Force, or SAWPA on behalf of the Task Force.

(3) - The County of San Bernadino collects semi-annual water quality samples for general minerals and various contaminants at CL-A and CL-B for monitoring for the Colton Landfill. The County samples include TDS but not TIN (only nitrate), so the data from CL-A and CL-B can only be used to assess compliance with the TDS objective for Reach 4. The data is available on GeoTracker at: https://geotracker.waterboards.ca.gov/profile_report?global_id=L10003692464&mytab=esidata#esidata

(4) - The USGS collects bi-weekly grab samples of water quality that includes TDS and TIN (calculated) and other general minerals.

(5) - USGS data for SAR @ Below Prado Dam station can be found on the USGS NWIS web Interface here: https://nwis.waterdata.usgs.gov/nwis/inventory/?&agency_cd=USGS&site_no=11074000

(6) - The USGS collects bi-weekly grab sample data inclusive of TDS and TIN which is sufficient for the surface water monitoring needed to evaluate compliance. In addition, the OCWD collects monthly samples of TDS/TIN (calculated). The USGS data will be used along with all other available data collected by others at the Below Prado Dam to assess compliance with the Reach 3 TDS and TIN objectives.

(7) - Base flow conditions meet the following criteria: i) between March and November; ii) no precipitation events or OC-59 discharge within four days, and iii) the water level elevation of the conservation pool behind Prado Dam is at or below the level that the ACOE considers empty (in 2022 this is 472 ft-above mean sea level).

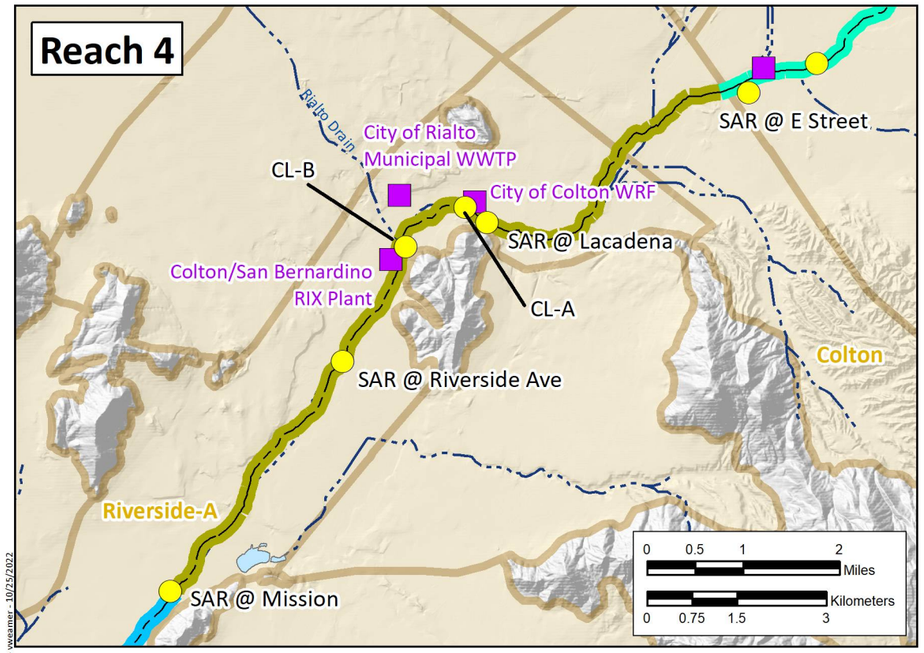
(8) - The daily EC measurements will be used to calculate daily TDS concentrations

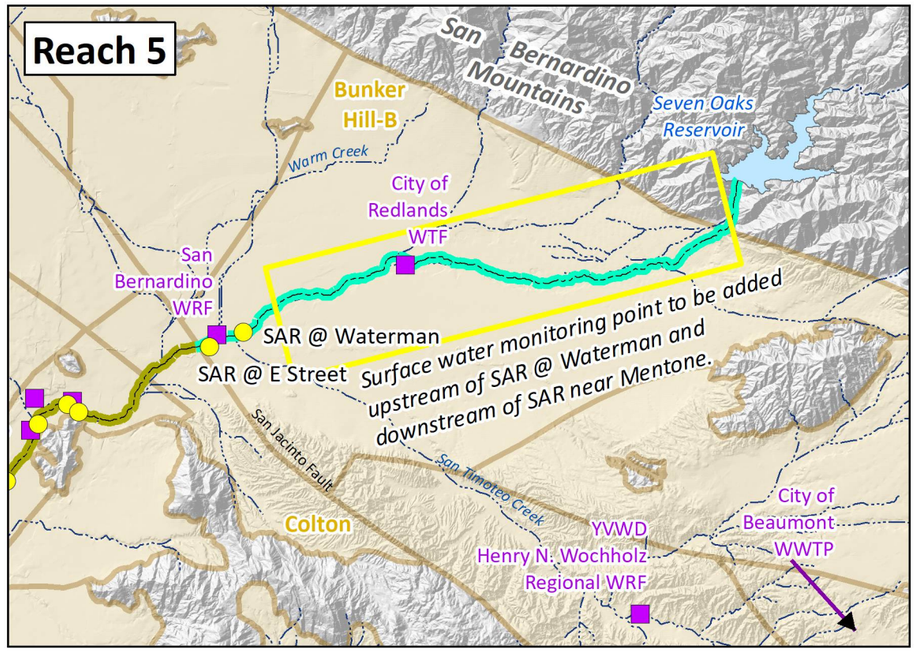
(9) - This monitoring component is required to determine when there are base flow conditions in Reach 3 that TDS and TIN data can be used to compute the compliance metric

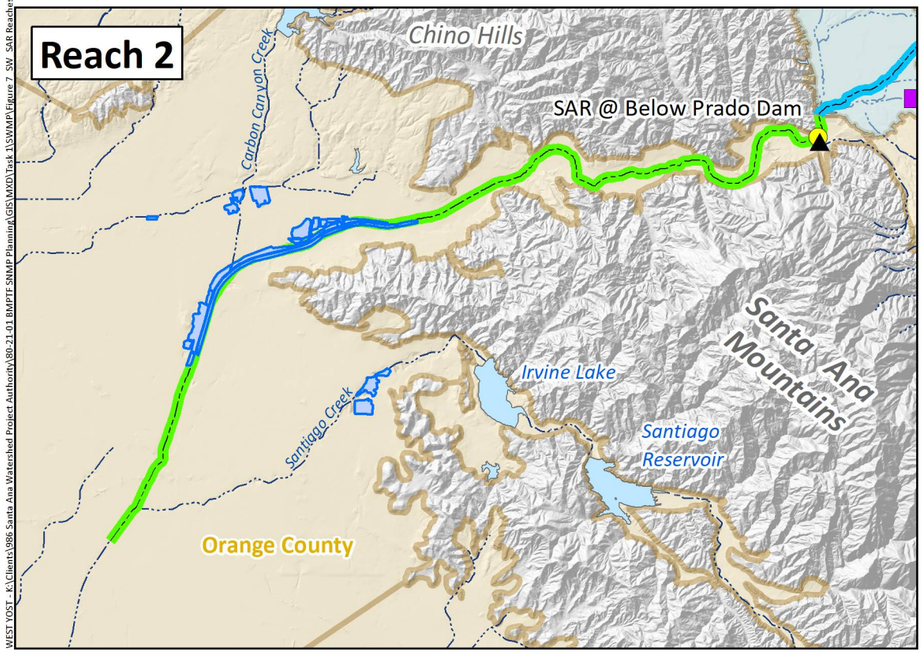
(10) - The ACOE measures and maintains daily data of the surface water elevation of the conservation pool behind Prado Dam https://www.spl.usace.army.mil/Missions/Asset-Management/Prado-Dam/. The OCWD collects this data from ACOE. This data can be collected from the ACOE or OCWD.

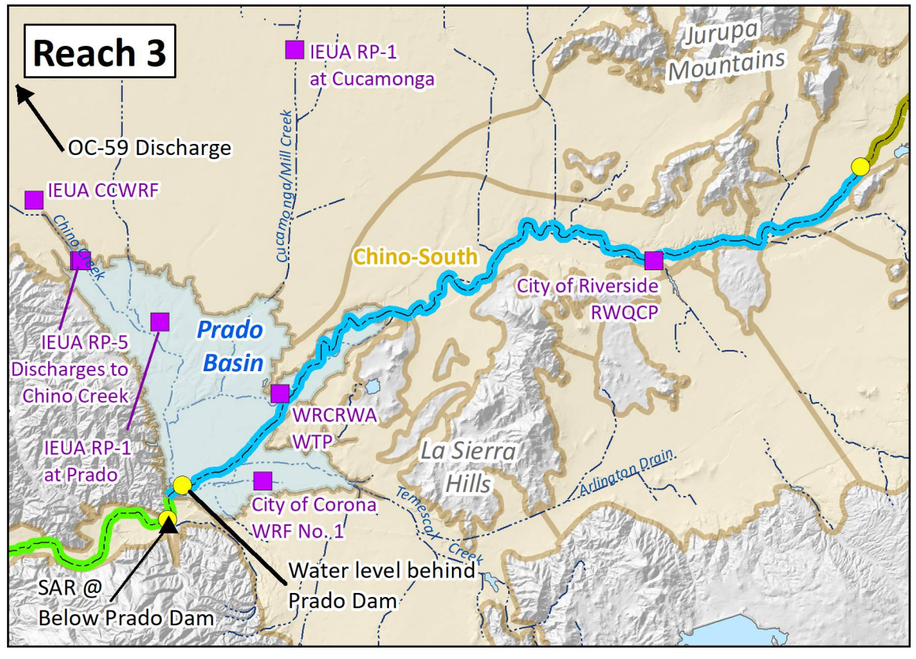
(11) - The MWDSC meters and maintains daily discharge data for the OC-59 turnout of imported water deliveries to the Orange County GMZ. The OCWD collects this data from MWDSC.

(12) - Options for daily precipitation data that could be used to represent the area tributary to Prado Dam in Reach 3. These include: gages operated by the Counties of Riverside (http://content.rcflood.org/RainfallMap/) and San Bernardino( https://dpw.sbcounty.gov/flood-control/); meteorological stations operated by the CIMIS (https://cimis.water.ca.gov/Default.aspx); and NEXRAD spatial datasets managed by the National Weather Service (https://www.ncdc.noaa.gov/cdo-web/datatools/selectlocation). The sources and availability of data will vary over time, so the data used may need to change periodically.




Surface Water Monitoring Sites along the Santa Ana River for Annual Assessment of Compliance with the TDS and TIN Objectives for Reach 2, 3, 4, and 5

USGS Surface Water Gage with Data Used for Annual Assessment of Compliance with the TDS and TIN Objectives for Reach 2, 3, 4, and 5

Publicly Owned Treatment Works (POTWs) Discharge Locations

Reaches of Santa Ana River

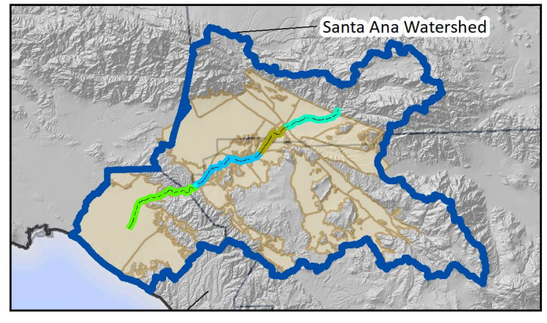
- Reach 2
- Reach 3
- Reach 4
- Reach 5

Groundwater Management Zone (GMZ)

OCWD Recharge Basins in the Forebay

Streams & Flood Control Channels

Flood Control and Conservation Basins




Prepared by:

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Miles
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Prepared for:

**Santa Ana Watershed Project Authority**
2022 Santa Ana River Water Quality Work Plan

SAWPA

**Surface Water Monitoring Program to Annually Assess Compliance with Basin Plan TDS and TIN Objectives in the Santa Ana River Reaches 2, 3, 4, and 5**

**Figure 7**

| Table 4. Parameter List for the Santa Ana River Surface Water Monitoring Program | |
|---|---|
| Parameter | |
| Alkalinity | Nitrite-nitrogen |
| Ammonia-Nitrogen | Nitrite-nitrogen |
| Bicarbonate | Total Inorganic Nitrogen, Calculated |
| Calcium | pH |
| Carbonate | Potassium |
| Chloride | Sodium |
| Chemical Oxygen Demand | Sulfate |
| Electrical Conductivity (Specific Conductance) | Total Hardness |
| Hydroxide | Total Dissolved Solids |
| Magnesium | |

## 3.1 Santa Ana River Reach 5

### Monitoring

The surface water monitoring program in Reach 5 to assess current compliance with Basin Plan TDS and TIN objectives consists of the collecting water quality samples at three sites along the Santa Ana River. The monitoring sites and data for Reach 5 are summarized below:

**Table 5a. Surface Water Monitoring in Reach 5 for Compliance Assessment with the TDS and TIN Objectives.**

| Site | Monitoring Performed | Monitoring Entity | Monitoring Frequency |
|---|---|---|---|
| New Site TBD [(1)] – between *SAR near Mentone* and *SAR @ Waterman* | Grab Samples of Water Quality for Parameters in Table 4 | Task Force [(2)] | Quarterly |
| *SAR @ Waterman* | Grab Samples of Water Quality for Parameters in Table 4 | Task Force [(3)] | Quarterly |
| *SAR @ E Street* | Grab Samples of Water Quality for Parameters in Table 4 | Task Force [(2)] | Quarterly |

1- Location to be determined by the Task Force and included as part of the ongoing monitoring program. Requires field recon of sites for accessibility and ability to sample.

2- Monitoring will be conducted by one or more Task Force members, consultants to the Task Force, or SAWPA on behalf of the Task Force.

3- Monitoring will be conducted by one or more Task Force members, consultants to the Task Force, or SAWPA on behalf of the Task Force. The OCWD is currently collecting an annual sample at *SAR @ Waterman* during August.

### Compliance Assessment

The compliance metric is the annual average TDS and TIN concentrations from all samples collected at the three water quality monitoring sites during the calendar year.

### Updates to the Monitoring and Compliance Assessment

Changes from the 2005 Work Plan include:

- Increase in the frequency of the sampling from once per year to quarterly to understand the variability in quality between low-flow and high-flow conditions throughout the year.
- Addition of two new monitoring sites (one to be determined [TBD] between *SAR near Mentone* and *SAR @ Waterman*, and one at *SAR @ E Street*) to understand the quality of the river throughout Reach 5 that recharges to the Bunker Hill-B GMZ and the flows into Reach 4 overlying the Colton GMZ.

### Basin Plan Amendment

An amendment to Basin Plan is required to:

- Improve description on the specific data and methods to be used in assessing compliance with the Reach 5 TDS and TIN objectives.

## 3.2 Santa Ana River Reach 4

### Monitoring

The surface water monitoring program in Reach 4 to assess current compliance with Basin Plan TDS and TIN objectives consists of the collecting water quality samples at five sites along the Santa Ana River. The monitoring sites and data for Reach 4 are summarized below:

**Table 6b. Surface Water Monitoring in Reach 4 for Compliance Assessment with the TDS and TIN Objectives.**

| Site | Monitoring Performed | Monitoring Entity | Monitoring Frequency |
|---|---|---|---|
| *SAR @ Lacadena* | Grab Samples of Water Quality for Parameters in Table 4 | Task Force (1) | Quarterly |
| *SAR @ Riverside Ave* | Grab Samples of Water Quality for Parameters in Table 4 | Task Force (1) | Quarterly |
| *SAR @ Mission* | Grab Samples of Water Quality for Parameters in Table 4 | Task Force (1) | Quarterly |
| *CL-A* | Quality (2) | County of San Bernadino (2) | Semi-annual |
| *CL-B* | Quality (2) | County of San Bernadino (2) | Semi-annual |

1- Monitoring will be conducted by one or more Task Force members, consultants to the Task Force, or SAWPA on behalf of the Task Force. The OCWD is currently collecting annual samples during August at *SAR @ Lacadena, SAR @ Riverside Ave, and SAR @ Mission*.

2- The County of San Bernadino collects semi-annual water quality samples for general minerals and various contaminants at CL-A and CL-B for monitoring for the Colton Landfill. The County samples include TDS but not TIN (only nitrate), so the data from CL-A and CL-B can only be used to assess compliance with the TDS objective for Reach 4. The data is available on GeoTracker at: https://geotracker.waterboards.ca.gov/profile_report?global_id=L10003692464&mytab=esidata#esidata

### Compliance Assessment

The compliance metric is the annual average TDS and TIN concentration from all samples collected at the five monitoring sites during the calendar year.

### Changes from the 2005 Work Plan include:

- Increase in the frequency of the sampling from once per year to quarterly to understand the variability in quality between low-flow and high-flow conditions throughout the year.
- Inclusion of the monitoring data collected by the County of San Bernardino at sites *CL-A* and *CL-B* to achieve a better representation of the TDS concentration of flow throughout the year.

### Basin Plan Amendment

An amendment to Basin Plan is required to:

- Improve description on the specific data and methods to be used in assessing compliance with the Reach 4 TDS and TIN objectives.

## 3.3 Santa Ana River Reach 3

**Monitoring**

The surface water monitoring program in Reach 3 to assess current compliance with Basin Plan TDS and TIN objectives consists of the collecting water quality samples below Prado Dam and daily EC measurements from the USGS gage *SAR @ Below Prado Dam;* and collecting and using the following data to assess if there are base flow conditions in Reach 3: measurements of daily surface water elevation of the conservation pool behind Prado Dam; daily discharge measurements at the OC-59 turnout of imported water deliveries to the Orange County GMZ; and daily precipitation data representative of the area tributary to Reach 3. The monitoring sites and data for Reach 3 are summarized below:

**Table 7c. Surface Water Monitoring in Reach 3 for Compliance Assessment with the TDS and TIN Objectives.**

| Site | Monitoring Performed | Monitoring Entity | Monitoring Frequency |
|---|---|---|---|
| *SAR @ Below Prado Dam* | Grab Samples of Water Quality (1) | USGS[1] and others (2) | Bi-weekly or monthly |
| USGS Gage *SAR @ Below Prado Dam* | EC Measurements (3) | USGS (1) | Daily |
| Prado Dam Reservoir (4) | Surface Water Elevation (4) | United State Army Corps of Engineers (ACOE) or OCWD (5) | Daily |
| OC-59 Imported Water Turnout (4) | Discharge (4) | MWDSC or OCWD (6) | Daily |
| Precipitation Data Tributary to Reach 3 (4) | Precipitation (4) | Various (7) | Daily |

1- The USGS collects bi-weekly grab samples of water quality that includes TDS and TIN (calculated), and other general minerals. USGS data for *SAR @ Below Prado Dam* station can be found on the USGS National Water Information System web Interface here: https://nwis.waterdata.usgs.gov/nwis/inventory/?&agency_cd=USGS&site_no=11074000

2- The USGS collects bi-weekly grab sample data inclusive of TDS and TIN (calculated) which is sufficient for the surface water monitoring needed to evaluate compliance. In addition, the OCWD collects monthly samples of TDS and TIN (calculated). The USGS data will be used along with all other available data collected by others at the Below Prado Dam to assess compliance with the Reach 3 TDS and TIN objectives.

3- The daily EC measurements will be used to calculate daily TDS concentrations using the method described herein in this section.

4- This monitoring component is required to determine when there are base flow conditions in Reach 3 that TDS and TIN data can be used to compute the compliance metric

5- The ACOE measures and maintains daily data of the surface water elevation of the conservation pool behind Prado Dam. The OCWD collects this data from ACOE. This data can be collected from the ACOE or OCWD.

6- The MWDSC meters and maintains daily discharge data for the OC-59 turnout of imported water deliveries to the Orange County GMZ. The OCWD collects this data from MWDSC. This data can be collected from the MWDSC or OCWD.

7- There are multiple sources of daily precipitation data that could be used to represent the area tributary to Prado Dam in Reach 3. These include: gages operated by the Counties of Riverside http://content.rcflood.org/RainfallMap/ and San Bernardino https://dpw.sbcounty.gov/flood-control/; meteorological stations operated by the California Irrigation Management Information System (CIMIS) https://cimis.water.ca.gov/Default.aspx; and Next Generation Weather Radar (NEXRAD) spatial

| Table 7c. Surface Water Monitoring in Reach 3 for Compliance Assessment with the TDS and TIN Objectives. | | | |
|---|---|---|---|
| Site | Monitoring Performed | Monitoring Entity | Monitoring Frequency |
| datasets managed by the National Weather Service https://www.ncdc.noaa.gov/cdo-web/datatools/selectlocation. The sources and availability of data will vary over time, so the data used may need to change periodically. | | | |

The daily EC measurements are converted to daily TDS concentrations using a multiplier (*f*) to convert between EC and TDS using the following equation:

*Daily TDS = Daily EC measurement x f*

*EC measurement = the average daily EC measurement from the USGS gage SAR @ Below Prado Dam*

*f = the average TDS/EC ratio from all the grab samples that include analysis of EC and TDS that are collected at Below Prado Dam during the year*[10]

**Compliance Assessment**

The compliance metric is the annual average of all TDS and TIN data collected at *SAR @ Below Prado Dam* during base flow conditions.

***Base flow conditions in Reach 3 are defined as occurring between March and November, when there have been no precipitation events and no OC-59 discharge within the last four days, and the surface water elevation of the conservation pool behind Prado Dam is at or below the level that the ACOE considers empty***.[11]

Each year, the Task Force will evaluate all daily precipitation, elevation of the conservation pool behind Prado Dam, and OC-59 discharge to determine which days between March and November represent base flow conditions. All sources of precipitation data should be collected, and the method used to analyze the precipitation each year described. Flexibility in the approach to using precipitation is necessary as the sources and availability of precipitation data may change over time.

All TDS and TIN data from the days that are determined to represent base flow conditions will be used to compute the compliance metric. For TDS this includes both the daily TDS calculated from daily EC measurements at the USGS gage at *SAR @ Below Prado Dam* and TDS from all grab sample data collected at *SAR @ Below Prado Dam* by the USGS and others. For TIN this includes just the TIN (calculated)[12] from all grab sample data collected at *SAR @ Below Prado Dam* by the USGS and others.

[10] The relationship between EC and TDS in freshwater (e.g., the SAR) can be approximated as linear, where TDS (mgl) is approximated as EC (micro-siemens per centimeter [µmhos/cm]) multiplied by a factor that usually ranges from 0.55 to 0.75 based on the observed TDS/EC ratio from samples (Rusydi, A. (2017). *Correlation between conductivity and total dissolved solid in various type of water: A review. Global Colloquium on GeoSciences and Engineering 2017. IOP Conf Series: Earth and Environmental Science 188, 2018)*.

[11] In 2022, the water level elevation of the conservation pool behind Prado Dam that is considered empty is 472 ft-above mean sea level. This condition could change in the future.

[12] TIN will need to be calculated from ammonia as nitrogen + nitrate as nitrogen + nitrite as nitrogen

***Changes from the 2005 Work Plan include:***

- A new, more specific definition of base flow conditions in Reach 3 that can be directly used to calculate which days are considered to represent base flow conditions and thus define which TDS and TIN data will be used to calculate the compliance metric.
- The collection and use of available daily data of precipitation, water-level elevation of the conservation pool behind Prado Dam, and OC-59 discharge, to determine when there are base flow conditions.
- The use of all data collected during base flow conditions at *SAR @ Below Prado Dam* to evaluate compliance with the Reach 3 objectives versus just the samples collected by the Santa Ana Water Board in August and September. This data could include:
    - Daily EC measurements at the USGS gage used to calculate a daily TDS.
    - Grab sample data collected by the USGS bi-weekly and others at various frequencies (OCWD monthly)
- The removal of the Santa Ana Water Board sampling at *SAR @ Below Prado Dam* because it is not needed to evaluate compliance with the Reach 3 objectives because there is enough data from the USGS gage daily EC measurements and grab samples collected by the USGS and others (OCWD).
- The removal of the requirement in the Basin Plan to sample for and use a filtered total nitrogen sample for compliance assessment with the Reach 3 TIN objective.

**Basin Plan Amendment**

An amendment to Basin Plan is required to:

- Define base flow conditions
- Remove reference to the Regional Board sampling for compliance.
- Remove the requirement for a filtered total nitrogen sample for compliance assessment with the Reach 3 TIN objective.
- Improve description on the specific data and methods to be used in assessing compliance with the Reach 3 TDS and TIN objectives.

## 3.4 Santa Ana River Reach 2

**Monitoring**

The surface water monitoring program in Reach 2 to assess current compliance with Basin Plan TDS and TIN objectives consists of the collecting water quality samples below Prado Dam and daily flow and EC measurements from the USGS gage *SAR @ Below Prado Dam.* The monitoring sites and data for Reach 2 are summarized below:

**Table 8d. Surface Water Monitoring in Reach 2 for Compliance Assessment with the TDS and TIN Objectives.**

| Site | Monitoring Performed | Monitoring Entity | Monitoring Frequency |
|---|---|---|---|
| *SAR @ Below Prado Dam* | Grab Samples of Water Quality for Parameters in Table 4 | USGS (1) and others (2) | Bi-weekly |
| USGS Gage *SAR @ Below Prado Dam* | EC and Flow Measurements (3) | USGS (1) | Daily |

1- The USGS data at SAR @ *Below Prado Dam* can be found on the USGS National Water Information System web Interface here: https://nwis.waterdata.usgs.gov/nwis/inventory/?&agency_cd=USGS&site_no=11074000

2- The USGS collects bi-weekly grab sample data inclusive of TDS which is sufficient for the surface water monitoring needed to evaluate compliance. In addition, the OCWD collects monthly samples of TDS. The USGS data will be used along with all other available data collected by others at the Below Prado Dam to assess compliance with the Reach 3 TDS and TIN objectives.

3- The daily EC measurements will be used to calculate daily TDS concentrations using the method described herein in this section.

The daily EC measurements are calculated to daily TDS concentrations using a factor to convert between EC and TDS using the following equation:

*Daily TDS = Daily EC measurement x factor*

*EC measurement = the average daily EC measurement from the USGS gage SAR @ Below Prado Dam*

*factor = the average TDS/EC ratio from all the grab samples that include analysis of EC and TDS that are collected at Below Prado Dam during the year*[13]

**Compliance Assessment**

The compliance metric is the 60-month volume-weighted average TDS concentration at *SAR @ Below Prado Dam*.

The daily TDS concentration calculated from the EC measurements and the daily flow measured at the USGS Gage *SAR @ Below Prado Dam* are used to calculate the 60-month volume-weighted average as a daily running average through the end of the calendar year.

**Updates to the Monitoring and Compliance Assessment**

Changes from the 2005 Work Plan include:

- The Task Force will no longer assess compliance for the Reach 2 TDS objective using two different methods (the current Basin Plan method and the alternative method described in Section 2.1.4).

[13] The relationship between EC and TDS in freshwater (e.g., the SAR) can be approximated as linear, where TDS (mgl) is approximated as EC (micro-siemens per centimeter [µmhos/cm]) multiplied by a factor that usually ranges from 0.55 to 0.75 based on the observed TDS/EC ratio from samples (Rusydi, A. (2017). *Correlation between conductivity and total dissolved solid in various type of water: A review. Global Colloquium on GeoSciences and Engineering 2017. IOP Conf Series: Earth and Environmental Science 188, 2018)*.

- The 60-month volume-weighted concentration metric (alternative method) will be used to assess compliance with the Basin Plan objectives. Feedback from the Task Force during the development of the 2022 Work Plan indicated that this method is a more accurate representation of the continuous volume-weighted concentration
- The method to calculate the relationship between EC and TDS that is used to calculate TDS from daily EC, changed from a linear regression equation to the use of a factor based on the average TDS/EC ratio.

**Basin Plan Amendment**

An amendment to Basin Plan is required to:

- Remove the language on the use of the SARWM data for compliance with the Reach 2 Basin Plan objective
- Describe the 60-month volume-weighted metric as the compliance metric for Reach 2
- Improve description on the specific data and methods to be used in assessing compliance with the Reach 2 TDS and TIN objectives.

## 3.5 Annual Monitoring, Data Collection, and Reporting

The Task Force will be responsible to perform field monitoring, collect and manage the data, and prepare the SAR Annual Reports. The following subsections describe the necessary details and costs to implement each of these steps for the annual compliance efforts.

### *3.5.1 Field Monitoring Program*

The Task Force will conduct the field monitoring to collect quarterly water quality grab samples at six surface water sites listed in Table 3 along Santa Ana River Reaches 5 and 4 (where the Task Force is the listed monitoring entity). These locations include:

- Site TBD between *SAR near Mentone* and *SAR @ Waterman*
- *SAR @ Waterman*
- *SAR @ E Street*
- *SAR @ Lacadena*
- *SAR @ Riverside Ave*
- *SAR @ Mission*

The grab samples will be sent to an accredited laboratory for analysis of the parameters listed in Table 3.

Note that some of the sites that would be monitored by the Task Force are sampled annually by the OCWD This plan is not intended to create redundant monitoring and the efforts to collect samples quarterly can be collaborative with the OCWD and others to ensure redundancies don't exist.

The field monitoring program will be implemented in three steps as follows:

1. Sampling Setup. This step would involve coordinating with collaborators to ensure all monitoring efforts are covered, a field reconnaissance to establish and access all monitoring locations and

identifying the TBD location between *SAR near Mentone* and *SAR @ Waterman,* and set up of the monitoring program.

2. Protocols. Prepare a quality assurance project plan (QAPP) to define QA/QC criteria and protocols.[14] The QAPP should contain the following:
    a. Objectives of the study, project, or monitoring program
    b. Descriptions of monitoring locations
    c. Monitoring schedule and frequency
    d. Methods used for sample collection and handling
    e. Field and laboratory measurement and analysis
    f. Data management, review and validation, and recordkeeping
    g. Quality assurance and quality control requirements
    h. A statement certifying the adequacy of the QAPP plus name of person certifying the document
    i. Dates for which the QAPP is applicable
3. Monitoring. Initiate quarterly monitoring program pursuant to the setup and protocols defined in steps 1 and 2.

### *3.5.2 Data Collection and Management*

Compilation of the remaining surface water monitoring data defined in Table 3 required to assess compliance will be done annually, prior to the preparation of the SAR Annual Report. This task includes compiling the following data monitored/collected by other entities:

- Water quality data from CL-A and CL-B from the County of San Bernadino monitoring
- Grab water quality samples collected at *SAR @ Below Prado* Dam by USGS and OCWD
- Daily EC and flow measurements from the gage at *SAR @ Below Prado Dam*
- Daily precipitation data from various sources
- Daily surface water elevation behind Prado Dam, measured by the ACOE
- Daily discharge at OC-59 recorded by the MWDSC or OCWD

Data collected in the Santa Ana River that is not being used for compliance assessment should be collected annually at the same time as the compliance data listed above and used to compare to the compliance data. This includes:

- TDS and TIN data for the SAR Above RIX and WR-RIX-001 collected by OCWD in August (to compare to *SAR @ Riverside Avenue* in Reach 4)
- TDS and TIN data for the *SAR @ at MWD Xing, SAR @ Hamner, SAR @ Etiwanda, SAR @ River Road* collected by OCWD in August and/or CBWM/IEUA quarterly (to compare to *SAR @ Below Prado Dam* data in Reach 3)

[14] A QAPP is required for any data that is uploaded to California Environmental Data Exchange Network (CEDEN) that is used by the Santa Ana Water Board to prepare the Integrated Report (pursuant to CWA 303[d]) to assess the quality of surface waters compared to the water quality objectives, list impaired water bodies that are out of compliance, and develop Total Maximum Daily Loads (TMDLs) for the impaired water bodies.

All data will be processed into standard formats, and check for QA/QC by comparing the annual results to historical values.

### *3.5.3 Annual Analysis and Reporting*

Each year, all the data defined in Table 3 will be used to perform the evaluation of compliance with the Basin Plan objectives utilizing the metrics that are also defined in Table 3. The SAR Annual Reports will include, at a minimum:

- Summary of the data collected for the year pursuant to the 2022 Work Plan.
- Description of the Basin Plan objectives and compliance metrics.
- Text and tables describing the determination of compliance metrics for the current year
- Figure/s that show the Santa Ana River Reaches 2, 3, 4, and 5 and the data collected pursuant to the 2022 Work Plan.
- Time series charts of the data, metrics, and objectives for TDS and TIN for each reach from 2004 through the current year.
- An electronic appendix of the data collected for the year pursuant to the 2022 Work Plan.

### *3.5.4 Budget Level Cost Estimates to Perform Monitoring, Data Management, and Reporting*

The estimated annual cost[15] to perform the monitoring, data collection and preparation of the Annual Report to assess compliance with the TDS and TIN objectives is:

- $5,000 to perform field reconnaissance and define the monitoring program logistics (first year only)
- $25,000 to prepare the QAPP (first year only)
- $24,000 to conduct field surface water quality monitoring and data processing/management
- $4,000 to compile other surface water monitoring data collected by others
- $50,000 for preparation of the SAR Annual Report

[15] Cost based on 2023 rates for a local consultant and are subject to inflation/rate increases in subsequent years.

# 4.0 RECOMMENDATION FOR SURFACE WATER SPECIAL STUDY

The analysis described in Section 2.2 concluded that additional information is needed to reduce uncertainty in future predictions of the TDS and TIN concentrations of the Santa Ana River using the WLAM. This section describes the objectives, considerations, and design of a recommended special study to improve the predictive capabilities of the WLAM, primarily through development and execution of a limited-term monitoring program (Special Study).

## 4.1 Objective of the Special Study

The objectives of the Special Study are to enhance the data available to characterize TDS and TIN concentrations in the Santa Ana River and improve the ability of the WLAM to predict future TDS and TIN concentrations in the Santa Ana River. More specifically, the Special Study aims to better understand and quantify (i) the cause(s) of increasing TDS concentrations and recent TDS objective exceedances in Reach 3 and (ii) the SW/GW interactions along Reaches 3 and 4. Some of the questions that the Special Study would attempt to answer include:

- What is the quality of the streambed infiltration along Reach 5?
- Where does rising groundwater occur along Reaches 3 and 4?
- Where is surface water infiltrating to groundwater along Reaches 3 and 4?
- What proportions of different types of water (e.g., POTW discharge, rising groundwater) exist at the various compliance points along Reaches 3 and 4?
- What are the TDS and TIN concentrations of rising groundwater where it occurs?
- What are the TDS and TIN concentrations of streambed infiltration where it occurs?

## 4.2 Considerations for Developing a Special Study Monitoring Program

The following are considerations in the development of a cost-effective monitoring program to support the Special Study objectives:

1. What types of data should be collected, such as discharge, TDS and TIN concentrations, water temperature, groundwater levels, etc.?
2. Where should data be collected?
3. How often should each data type be collected?
4. What existing monitoring program(s) could be leveraged to provide data for the Special Study?
5. What is an appropriate duration for the monitoring program?
6. What is the process to define the monitoring and data collection program?
7. How much will the Special Study cost?

## 4.3 Recommended Monitoring Program to Support the Special Study

The following subsections answer the questions specified in Section 4.2 and define the scope of the Special Study to meet the objectives defined in Section 4.1.

### 4.3.2 What types of data should be collected?

Surface water and groundwater monitoring points should be sampled for the following water quality parameters:

- TDS
- TIN
- Temperature
- Major cations (calcium, magnesium, sodium, potassium)
- Major anions (carbonate, bicarbonate, chloride, and sulfate)
- pH

The water quality results will be used in three ways:

- TDS and TIN concentrations will be used to develop the water budget and mass balance between each set of monitoring points. These water budgets will help estimate proportions of different types of water (e.g., POTW discharge, rising groundwater) that exist at various points along Reaches 3 and 4, including points used for measuring compliance with groundwater and surface water quality objectives.
- Temperature data of the surface and groundwater will be compared with the temperature of the POTW effluent to help determine the influence of rising groundwater in the Santa Ana River and its tributaries.
- The major cations and anions will be used to prepare piper diagrams or other similar figures. Piper diagrams are used to characterize water sources in space and time and have been used in prior studies of SW/GW interaction in the SAR (WEI, 2010; WEI, 2019; West Yost, 2022).

In addition to groundwater quality, groundwater levels should be collected and compared to the thalweg elevation of the river to quantify the hydraulic gradient between the groundwater monitoring points and the Santa Ana River.

At this time, it is not recommended to measure stream discharge at the monitoring points beyond the available USGS gage data. Prior surface water monitoring programs in the Santa Ana River that measured stream flow indicated high uncertainty in the stream flow measurements due to the geometry of the Santa Ana River (i.e., shallow depth, braided channels, shifting sediment).

### 4.3.3 Where should data be collected?

Surface water and groundwater monitoring locations should be identified based on (i) perceived data gaps, (ii) existing monitoring networks, and (iii) accessibility. At a minimum, surface water sampling locations should include:

- One monitoring point on Reach 5.
- Three monitoring points in the Santa Ana River overlying Riverside-A GMZ (Reach 3 and 4).
- Four monitoring points in the Santa Ana River overlying Chino South GMZ (Reach 3).
- One monitoring point in each major tributary to the Prado Basin, including Chino Creek, Cucamonga/Mill Creek, and Temescal Creek; and the Arlington Drain.

Groundwater monitoring locations should be identified in areas near the Santa Ana River between *SAR @ Riverside Ave* and *SAR @ Below Prado Dam* (the "targeted area") to better understand the SW/GW interaction. Monitoring locations should be chosen where groundwater interaction with the SAR is probable.

### *4.3.4 How often should data be collected?*

Water quality sampling should be conducted quarterly. Prior and current monitoring programs in the Santa Ana River (e.g., the Maximum Benefit SNMP monitoring program) do not indicate sufficient intra-annual variability in water quality to justify more frequent sampling. All of the surface water monitoring sites should be sampled on the same day to reduce the variability and uncertainty in the resulting water budgets and mass balances. Samples at the groundwater monitoring locations should also be collected on the same day or soon after.

At the groundwater monitoring locations along the targeted area, some groundwater monitoring locations should be monitored in situ utilizing transducers that collect high-frequency (e.g. 15-minute) groundwater level data. High-frequency groundwater level data is valuable to use when combined with the water quality data to estimate changes in the hydraulic gradient between the Santa Ana River and the groundwater system over time.

### *4.3.5 What existing monitoring program(s) could be leveraged to provide data for the Special Study?*

Several existing monitoring programs along the Santa Ana River and its tributaries could be used to provide data to fulfill the objectives of the Special Study, including but not limited to:

- Surface water:
    - The monitoring recommended in Section 3.0 to annually assess compliance with Basin Plan TDS and TIN objectives
    - OCWD annual sampling at *SAR @ MWD Xing, SAR @ Van Buren, SAR @ Etiwanda, SAR @ Hamner,* and *SAR @ River Road* (see Figure 1b)
    - CBWM/IEUA quarterly sampling of Santa Ana River tributaries overlying the Chino Basin
    - Eastern Municipal Water District and Elsinore Valley Municipal Water District's monitoring in the Temescal Creek watershed upstream of the All-American Aggregate Pit
- Groundwater:
    - Sampling of wells near Reach 4 in the Riverside-A GMZ (various entities)
    - CBWM/IEUA quarterly sampling of wells near Reach 3 for the Prado Basin Habitat Sustainability Plan and the Maximum Benefit SNMP
    - OCWD sampling of wells near Reach 3 and in Prado Basin

Prior to finalizing and implementing a monitoring program, the monitoring entities should be consulted to determine the on-going sampling plans, and the existing monitoring data from these sites should be collected, reviewed, and evaluated for suitability to include in the Special Study.

### 4.3.6 What is an appropriate duration for the monitoring program?

The monitoring program should be conducted for two consecutive years. After such time, the data should be analyzed to determine if the data are sufficient to meet the Special Study objectives or what additional data would be needed to fill any ongoing or new data gaps in the understanding of the SW/GW interactions. If it is determined that the data are sufficient to completely satisfy the Special Study objectives, the monitoring program should only continue in future years if conditions in the Watershed change significantly (e.g., if there are significant changes in wastewater discharge, long-term drought conditions, or anything else that would change the dynamics of the Santa Ana River).

### 4.3.7 What is the process to define the monitoring and data collection program?

Prior to implementing a monitoring program, a monitoring and data collection plan will need to be developed to coordinate the monitoring to leverage existing data and efficiently address the data gaps to meet the Special Study objectives. The development of the monitoring and data collection program will include:

1. Collection of existing data and evaluation of current monitoring for suitability for the Special Study
2. Coordination with the relevant monitoring entities to determine viability of leveraging current monitoring identified in Step 1
3. Selection of suitable monitoring locations to address existing data gaps
4. Field reconnaissance to confirm ability to perform monitoring
5. Documentation of monitoring and data collection program

### 4.3.8 How much will the Special Study cost?

The cost of the recommended monitoring program will depend on the extent of the coordination with and availability of data from POTWs and regional agencies, the accessibility of the sampling locations, and staff costs.

A planning-level cost estimate for the Special Study was developed based on the following assumptions:

- The Special Study is recommended to take place over four years:
    - Year 1: Development of a monitoring and data collection plan
    - Years 2 and 3: Monitoring and data collection
    - Year 4: Data analysis and recommendations
- A technical memorandum (TM) documenting the proposed monitoring and data collection plan will be developed in Year 1.
- Monitoring will take place quarterly, including quarterly downloads of the 15-minute transducer data.
- Surface water quality sampling will be performed at 11 monitoring locations.
- Groundwater sampling will leverage existing monitoring locations. The cost associated with the groundwater sampling includes:
    - Coordinating with the monitoring entities to compile data that are already being collected (e.g., from the Chino Basin Maximum Benefit monitoring program)

    - Quarterly sampling at up to four Riverside-A GMZ wells and up to four wells in Prado Basin
    - Installing and calibrating groundwater level transducers and conducting quarterly transducer data downloads at up to five wells
- A quality assurance project plan (QAPP) will not be required for the monitoring program.
- In Year 4, the data collected during the monitoring program in Years 2 and 3 will be analyzed and documented in a technical memorandum (TM). The TM will also include recommendations for future monitoring or modeling (e.g., updates to the WLAM)
- Staff rates for Year 1 are consistent with 2023 rates for a local consultant.

Based on these assumptions, the cost estimate of the four-year Special Study totals $362,000, spread out over four years:

- Year 1 (development of monitoring and data collection program): $70,000
- Year 2 (initial year of monitoring and data collection): $126,000
- Year 3 (second year of monitoring and data collection): $101,000
- Year 4 (data analysis and documentation): $65,000

## 5.0 REFERENCES

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