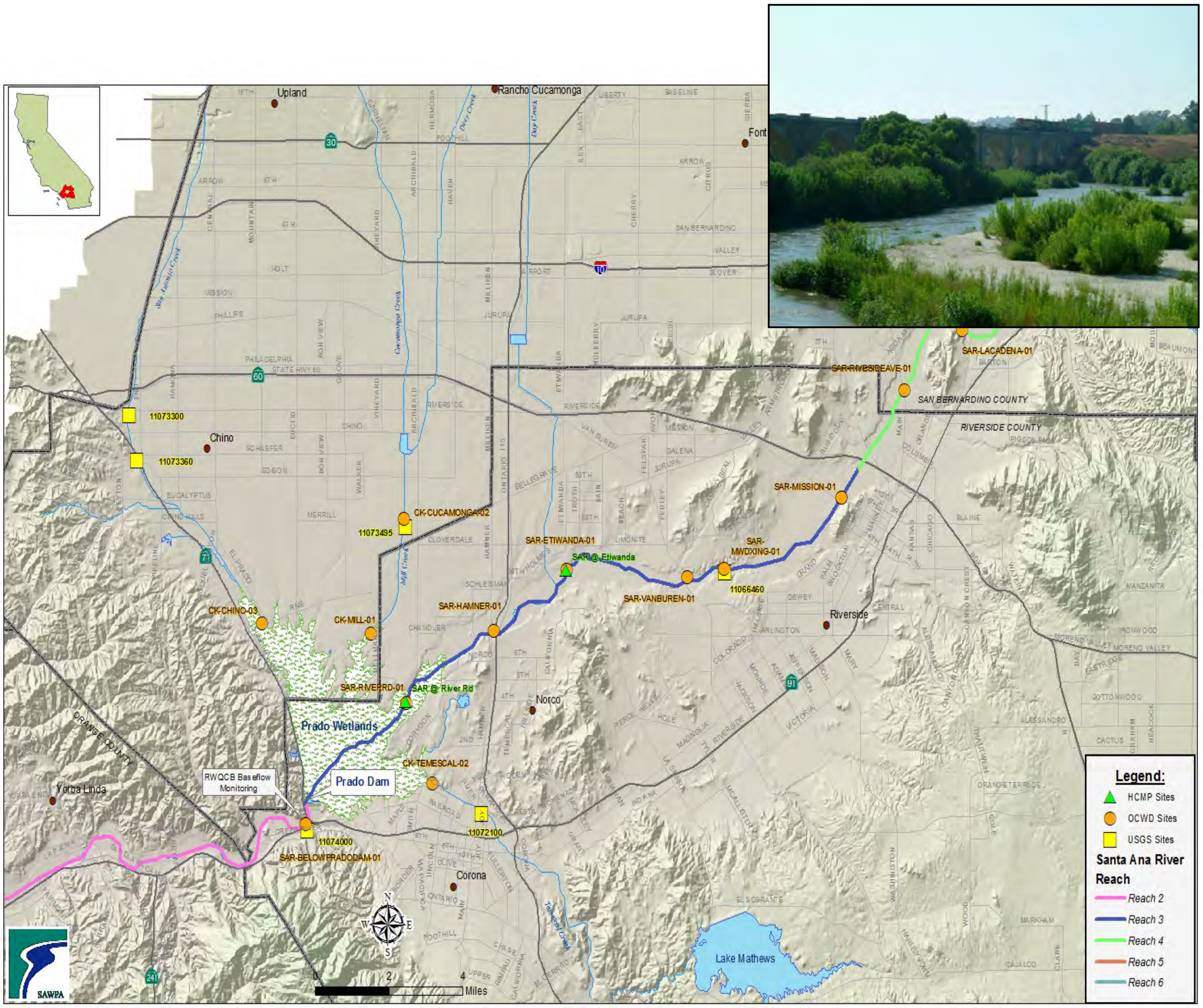
2019 Annual Report

of Santa Ana River Water Quality

Final Report



P:\projects\Rick_Whetsel\SAR\SAR_Surface_Monitoring_2014.mxd

Prepared by:

SANTA ANA WATERSHED PROJECT AUTHORITY

July 2020

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

Acronym and Abbreviations List

AFY	acre-feet per year
COD	chemical oxygen demand
EC	electrical conductivity
HCMP	Hydraulic Control Monitoring Program
mg/L	milligrams per liter
umhos/cm	micromhos per centimeter
MWD	Metropolitan Water District of Southern California
NTU	nephelometric turbidity units
OCWD	Orange County Water District
RIX	Regional Tertiary Treatment Rapid Infiltration and Extraction Facility
RWQCB	Regional Water Quality Control Board, Santa Ana Region
SAR	Santa Ana River
SAWPA	Santa Ana Watershed Project Authority
TDS	total dissolved solids
TIN	total inorganic nitrogen
TN	total nitrogen
USGS	United States Geological Survey

1 Introduction

In 1996, the Nitrogen and Total Dissolved Solids (N/TDS) Task Force was formed to conduct scientific investigations regarding the then existing nitrogen and TDS water quality objectives of the 1995 Water Quality Control Plan for the Santa Ana River (SAR) Basin (Region 8). This Task Force, administered by the Santa Ana Watershed Project Authority (SAWPA) was comprised of 22 water supply and wastewater agencies. The work performed by the Task Force was broken out into several phases. In 2003, the Final Technical Memorandum was completed, which reported the results of this scientific investigation, *The TIN/TDS Study – Phase 2B of the Santa Ana Watershed Wasteload Allocation Investigation*.

As a result of this work, the Regional Water Quality Control Board (Regional Board) staff amended the Santa Ana River Watershed Water Quality Control Plan (Basin Plan). The Basin Plan Amendment (hereafter the 2004 Basin Plan Amendment) was adopted by the Regional Board in January 2004, approved by the State Water Resources Control Board in September 2004, and approved by the Office of Administrative Law in December 2004.

Pursuant to the 2004 Basin Plan Amendment, certain participants in the N/TDS Task Force are required to conduct the following investigations:

- Re-computation of the Triennial Ambient Water Quality over a 20-year period; and
- Preparation of an Annual Report of Santa Ana River Water Quality.

This report fulfills the second requirement listed above – *Preparation of an Annual Report of Santa Ana River Water Quality*[1]. Contained within this report are water quality data required to implement the surface water monitoring program necessary to determine compliance with the nitrogen and TDS objectives of the SAR and, thereby, the effectiveness of the wasteload allocations.

In Chapter 4 of the Basin Plan, the baseflow TDS and total nitrogen objectives for Reach 3 of the River are specified. For Reach 2, a TDS objective based on a five-year, volume-weighted, moving average of the annual TDS concentration is also defined. The use of this moving average allows the effects of wet and dry years to be integrated over the five-year period and reflects the long-term quality of water recharged by Orange County Water District (OCWD) downstream of Prado Dam.

The Basin Plan specifies a monitoring program to determine compliance with the Reach 3 baseflow objectives at Prado Dam (see Chapter 4 of the Basin Plan), whereas baseflow is defined by the Basin Plan as composed of wastewater discharges, rising groundwater, and nonpoint source discharges. Regional Board staff conducts this program on an annual basis. The measurement of baseflow quality, rather than the quality of flows in Reach 2, has long been used to indicate the effects of recharge of SAR flows on Orange County groundwater. The efficacy of this approach was evaluated as part of the 2004 Basin Plan Amendment for the TDS/nitrogen management plan in the Basin Plan. As discussed in the 2004 Basin Plan Amendment, Reach 3 baseflow objectives are considered protective of the Orange County Groundwater Basin and the existing monitoring program designed to measure compliance is sufficient.

In addition to the baseflow sampling program and the surface water monitoring commitments associated with certain agencies' "maximum benefit" programs, the comprehensive monitoring program implemented by the Task Force members must include an evaluation of compliance with the TDS and nitrogen objectives for Reaches 2, 4, and 5 of the SAR. Compliance with the Reach 2 TDS objective can be determined by the

[1] The 2019 Annual Report was prepared in accordance with the Santa Ana River Water Quality Work Plan approved by the Regional Board in Res. No. R8-2005-0063.

evaluation of data collected by OCWD, the United States Geological Survey (USGS), and others. Compliance with Basin Plan objectives for Reach 4 and 5 of the SAR can be determined in the same manner.

A description of the data collected for this report is discussed in Section 2. Section 3 presents the analysis of the monitoring data collected. Results are presented by Reach of the SAR. Section 4 provides Conclusions and Recommendations of the report. Section 5 presents the Response to Comments. The complete set of 2019 surface water quality data is included as Appendix B, available on the SAWPA website.

2 Data Collection

Water quality and discharge data used to prepare the 2019 Annual Report of Santa Ana River Water Quality, were collected from a number of regional efforts to monitor surface water quality along the SAR and its tributaries, including in-stream gauges employed by USGS, shown in Figure 2-1.

A detailed description of each of these monitoring efforts, representing the 2019 calendar year follows:

Regional Board staff typically conducts annual water quality monitoring of baseflow in the SAR exiting Reach 3, below Prado Dam. Monitoring typically extends over a five-week period during the months of August and September and is used to determine compliance with Reach 3 baseflow objectives. In 2019 baseflow monitoring consisted of six sampling events from August 21 through September 26, as shown in Table 3-3. The complete set of 2019 baseflow water quality data collected exiting Reach 3 below Prado Dam by the Regional Board is included in Appendix B, available on the SAWPA website.

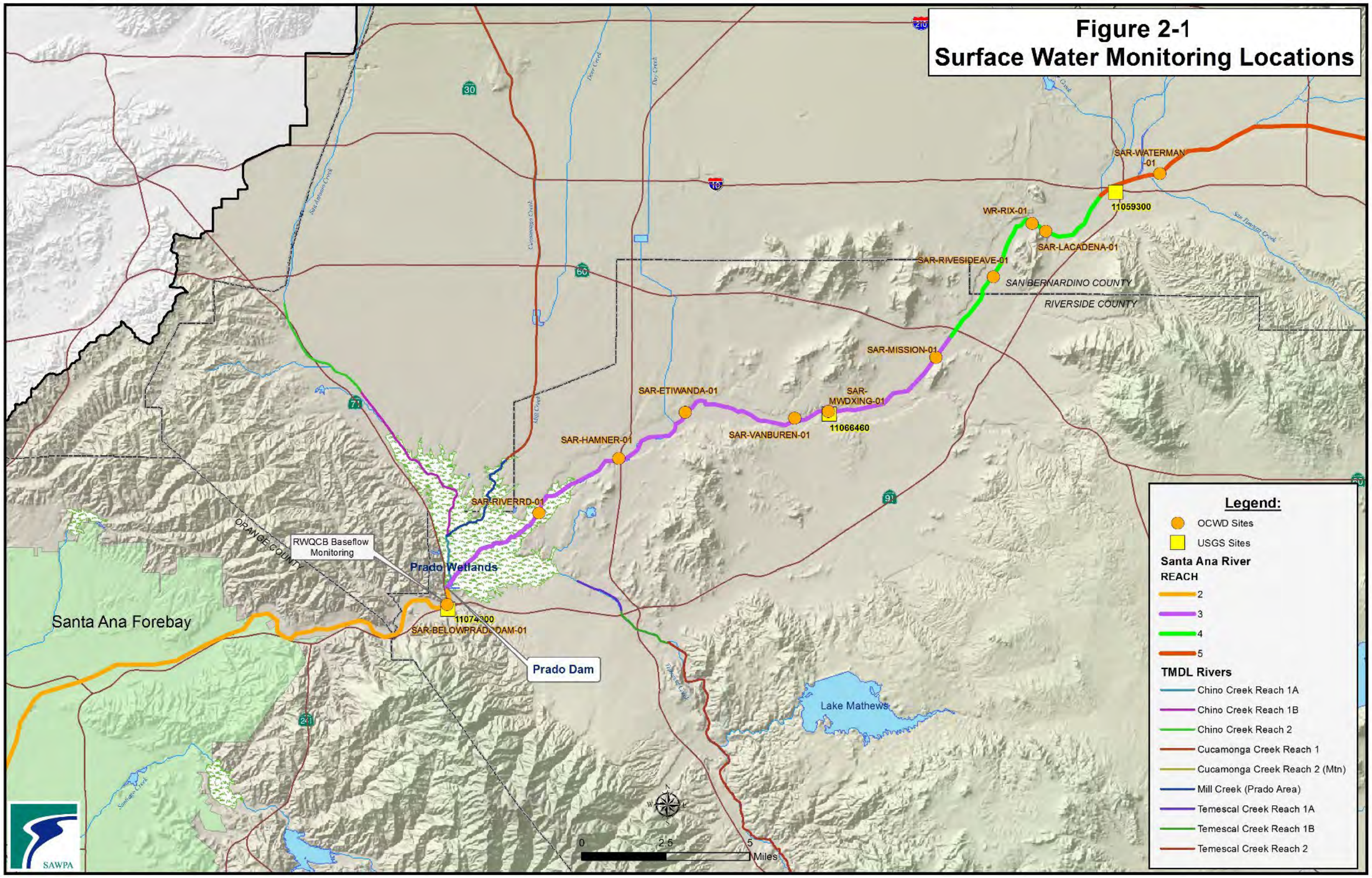
OCWD conducts a monitoring program for the SAR to assess the quality of the SAR water recharged into the Orange County Groundwater Basin. OCWD collects monthly and quarterly samples from the SAR at Imperial Highway in Anaheim and other locations along the SAR below Prado Dam and its tributaries. During the month of August, monitoring is performed with a greater sampling frequency to capture base flow conditions within the Watershed. At sites Above Prado Dam, OCWD collects samples from a single monitoring event in August (event took place on 08/27/2019). These data are used in this report to evaluate water quality for Reaches 2, 3, 4, and 5 of the SAR during low flow conditions. OCWD monitoring locations used in this report are presented in Table 2-1. In later tables and figures, OCWD stations are referred to by their map location. The complete set of 2019 SAR water quality data collected by OCWD and used in this report is included in Appendix B, available on the SAWPA website.

Table 2-1. OCWD's Santa Ana River Water Quality Monitoring Locations

Station ID	Station Name	Tributary	X Coordinate	Y Coordinate
8105	SAR-BELOWDAM-01	Santa Ana River Reach 2	- 117.644996	33.883665
8096	SAR-RIVERRD-01	Santa Ana River Reach 3	- 117.666485	33.948989
8111	SAR-HAMNER-01	Santa Ana River Reach 3	- 117.556597	33.947337
9672	SAR-ETIWANDA-01	Santa Ana River Reach 3	- 117.522230	33.967365
8112	SAR-VANBUREN-01	Santa Ana River Reach 3	- 117.465465	33.965049
8113	SAR-MWDXING-01	Santa Ana River Reach 3	- 117.448032	33.968027
8114	SAR-MISSION-01	Santa Ana River Reach 4	- 117.392523	33.991576
8115	SAR-RIVERSIDEAVE-01	Santa Ana River Reach 4	- 117.362809	34.026480
8116	SAR-LACADENA-01[1]	Santa Ana River Reach 4	- 117.335710	34.046335
8117	SAR-WATERMAN-01[1]	Santa Ana River Reach 5	- 117.276721	34.071365

[1]No flow at these sites in 2019.

Figure 2-1. Surface Water Monitoring Locations



The USGS maintains three active gauging stations to monitor flow and water quality along the SAR. Long-term stream flow and water quality data are available for gauging stations 11074000, *located at Below Prado Dam*, and 11066460, *located at MWD Crossing*. Additionally, stream flow data is available for gauging station 11059300, located at *SAR at E St near San Bernardino*. The list of USGS gauging stations used in this report is presented in Table 2-2. The complete set of 2019 flow and water quality data available from these USGS gauging stations is included in Appendix B, available on the SAWPA website.

Table 2-2. USGS Stream Gauge Stations

USGS ID	Station Name	2019 Flow (AFY)	Tributary	X Coordinate	Y Coordinate
11074000	SAR Below Prado Dam	251,078	SAR Reach 2	- 117.644446	33.881583
11066460	SAR at MWD Crossing	99,139	SAR Reach 3	- 117.447501	33.966858
11059300	SAR at E St near San Bernardino	27,187	SAR Reach 5	- 117.729724	34.016857

3 Analysis of Monitoring Data

3.1 *Santa Ana River Reach 2*

Table 4-1 of the Basin Plan specifies only a TDS objective for Reach 2 of the Santa Ana River. The determination of compliance with the TDS objective for Reach 2 is made by using the mean of the five most recent flow-weighted annual averages as reported by the SAR Watermaster, shown in Table 3-1. In years of normal rainfall, most of the total flow of the river is percolated in the Santa Ana Forebay (see Figure 2-1), and directly affects the quality of the groundwater. For that reason, compliance with the TDS water quality objective for Reach 2 is based on the five-year moving average, which is estimated by computing the arithmetic average of the five most recent annual estimates of flow-weighted TDS for total flow at Below Prado (from Appendix F of the 2018-19 Annual SAR Watermaster Report[2]). Use of this moving average allows the effects of wet and dry years to be smoothed out over the five-year period.

Table 3-1. Yearly Volume-Weighted Moving Average TDS at Below Prado Dam (SAR Watermaster Report)

Water Year Ending[A]	Yearly Flow-weighted TDS (mg/L)
2015	522
2016	560[B]
2017	408
2018	625
2019	401
5 Year Average	503

Note: [A] Santa Ana River Watermaster data reported for FY 2018-19 water year
[B] FY 2015-16 water year data adjusted from 541 mg/L to remove the influence of non-tributary water transfer flow from OC59.

Alternative Method to Determine Compliance with TDS Objective for Reach 2

In addition, to the method prescribed in the Basin Plan, as presented in Table 3-1, the Task Force employs an alternative method to determine compliance with the TDS objective for Reach 2 of the Santa Ana River. This alternative method was first employed in 2005 when the Task Force began preparing the Annual Reports of Santa Ana River Water Quality. This method computes compliance with the TDS objective in Reach 2 as a five-year average based on the 60-month volume-weighted[3] dataset. This alternative method was the sole method to demonstrate compliance through the first four reports (2005 through 2008). While this method was technically correct, the Task Force became concerned that it might

[2] Determination of flow-weighted TDS for total flow at Below Prado for Water Year 2018-19 is based on records from a continuous monitoring device operated by the USGS for EC of the river flow below Prado Dam. This record is supplemented by grab samples for EC collected by the USGS and analyzed for TDS. Using the daily EC data, flow-weighted average daily concentrations for TDS are calculated using the following best fit correlation equation:

TDS = EC x 0.6068 (where the units of TDS and EC are mg/L and umhos/cm, respectively)

[3]

$$5-Year\ Moving\ Average\ TDS\ (mg/L) = \frac{\left(\sum_{n=first\ month\ of\ 1st\ year}^{last\ month\ of\ 5th\ year} Monthly\ Flow\right) x \left(\sum_{n=first\ month\ of\ 1st\ year}^{last\ month\ of\ 5th\ year} Volume\ Weighted\ Monthy\ Average\ TDS\right)}{\left(\sum_{n=first\ month\ of\ 1st\ year}^{last\ month\ of\ 5th\ year} Monthly\ Flow\right)}$$

not be legally correct. Additional review of the Basin Plan text indicated that the volume-weighted five-year average should be computed as the arithmetic mean of the five discrete volume-weighted values for each of the five years (as presented in Table 3-1).

While it is true that the 60-month volume-weighted averaging approach implemented by the Task Force more accurately estimates the true long-term volume weighted average TDS concentration in Reach 2, the approach, as prescribed in the Basin Plan provides a better estimate of the long-term volume-weighted average of TDS concentrations in the river flow that percolates through the streambed into the underlying groundwater basin. In very wet years, the volume-weighted average TDS concentration is much lower, but some of this high-quality water flows out to the Pacific Ocean rather than percolating to groundwater. By assuming the same volume of water percolates every year, the method specified by the Basin Plan tends to slightly overestimate the TDS concentrations entering the OC groundwater basin, whereas the 60-month volume-weighted averaging approach tends to slightly underestimate the TDS concentration.

Beginning with the 2009 Annual Report, the Task Force started applying and reporting both methods and results. The Task Force has continued with this approach because it provides the context for a better understanding of the data. It also helps illustrate how small changes in the assumptions and procedures used to perform the calculations can lead to consequential changes in the subsequent compliance determinations. Regardless of which method is used, the resulting five-year, volume-weighted average has never exceeded the Basin Plan objective of 650 mg/L for the period shown.

Computation of the 60-month Volume-weighted Average TDS Concentration

During the 2019 calendar year, 61 samples were collected for TDS at *Below Prado Dam*. These included grab samples collected by the USGS, OCWD and the Regional Board. From the results of these samples, electrical conductivity (EC) and TDS were graphically plotted. A linear regression of TDS versus EC yielded the following equation:

$$\text{TDS} = (\text{EC} \times 0.6028) + 1.7288$$

The coefficient of determination (R^2) of the linear regression was 0.95, which indicates a strong correlation between TDS and EC; that is, about 95 percent of the variability in TDS is explained by this equation. Using the above equation and daily EC data from a continuous monitoring device operated by USGS, daily TDS values were calculated for 2019 data. Daily stream flow values at *Below Prado Dam* were multiplied by the computed TDS values and summed for each month. This total was divided by the total monthly flow to yield a volume-weighted average for each month. These results are shown in Table 3-2. The 60-month volume-weighted moving average for the period January 2015 through December 2019 was 473 mg/L. This represents a decrease of 42.0 mg/L from last year's 60-month volume-weighted moving average TDS of 515 mg/L.

Figure 3-1 shows the time history for TDS observations for 1999 to the present at *Below Prado Dam* as depicted as the mean TDS concentration of five annual flow-weighted averages, and the flow-weighted, 60-month moving average[4] TDS concentration.

4

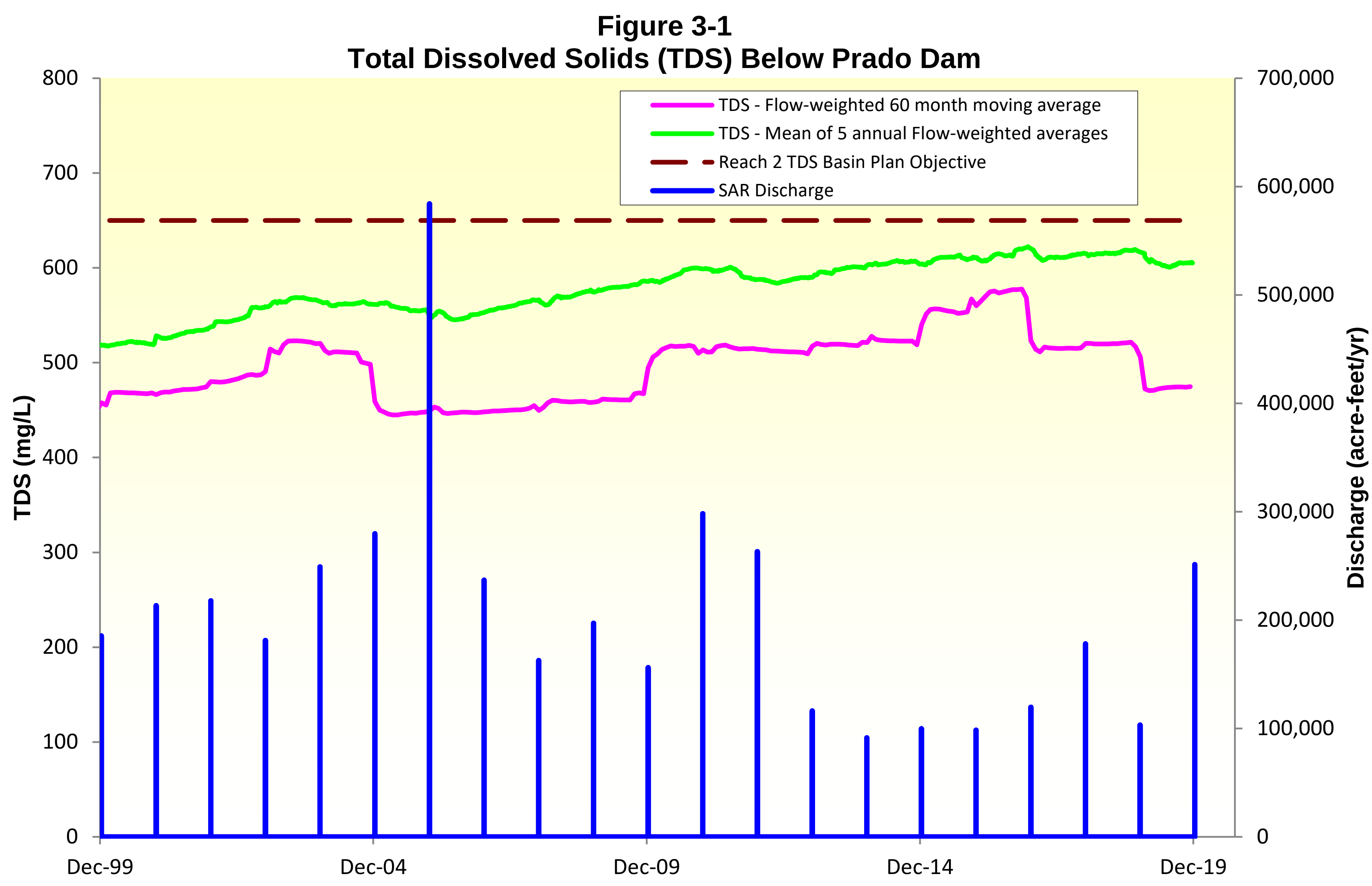
$$Volume\ Weighted\ Monthy\ Average\ TDS\ (mg/L) = \sum_{n=first\ day\ of\ month}^{last\ day\ of\ month} \frac{Daily\ TDS\ Sample\ \left(\frac{mg}{L}\right) x\ Daily\ Flow\ (cfs)}{\sum_{n=first\ day\ of\ month}^{last\ day\ of\ month} Daily\ Flow\ (cfs)}$$

Table 3-2. Monthly Volume-Weighted Moving Average TDS at Below Prado Dam (2019 OCWD, USGS and Regional Board at Below Prado Dam)

Month	Monthly Flow (cfs-days)	Monthly Volume Weighted TDS (mg/L)	Monthly Flow X TDS
Jan-15[1]	8,443	558	4,713,608
Feb-15[1]	4,181	548	2,292,593
Mar-15	5,971	611	3,647,810
Apr-15	3,055	705	2,153,348
May-15	3,917	649	2,540,633
Jun-15[1]	2,031	658	1,335,858
Jul-15[1]	3,114	553	1,722,216
Aug-15[1]	1,975	594	1,173,280
Sep-15[1]	3,766	451	1,699,702
Oct-15	4,935	631	3,115,713
Nov-15	3,795	659	2,502,562
Dec-15	4,420	586	2,590,772
Jan-16	11,015	355	3,913,599
Feb-16	6,529	610	3,979,901
Mar-16[2]	2,454	493	1,209,018
Apr-16	3,753	629	2,362,198
May-16	3,421	614	2,102,066
Jun-16[2]	3,792	570	2,162,097
Jul-16[2]	903	520	469,962
Aug-16	3,830	499	1,910,346
Sep-16	2,064	683	1,408,987
Oct-16[2]	2,907	637	1,851,646
Nov-16	4,082	574	2,344,955
Dec-16	8,304	337	2,795,675
Jan-17	37,876	218	8,255,609
Feb-17	13,557	407	5,515,481
Mar-17	10,781	508	5,473,628
Apr-17[2]	7,278	784	5,706,514
May-17	2,958	642	1,899,575
Jun-17[2]	1,757	871	1,530,123
Jul-17	2,071	694	1,437,099
Aug-17	2,189	697	1,524,789
Sep-17	2,472	708	1,749,396
Oct-17	2,408	714	1,718,722
Nov-17	3,003	703	2,110,679
Dec-17	2,816	705	1,984,819
Jan-18	8,373	516	4,322,665
Feb-18	3,508	661	2,320,359
Mar-18	7,407	558	4,131,392
Apr-18	3,270	688	2,250,705
May-18	2,855	681	1,943,094
Jun-18	2,346	695	1,629,552
Jul-18	1,840	709	1,304,255
Aug-18	1,681	728	1,223,652
Sep-18[2]	1,986	717	1,423,443
Oct-18	3,529	647	2,284,490
Nov-18	3,311	630	2,084,681
Dec-18	11,799	453	5,350,226
Jan-19	14,494	323	4,680,018
Feb-19	44,004	248	10,896,992
Mar-19	15,464	403	6,227,282
Apr 19[2]	11,236	531	5,963,072
May-19	11,137	566	6,298,555
Jun-19[2]	3,572	680	2,428,738
Jul-19	2,927	661	1,934,719
Aug-19	2,484	672	1,668,363
Sep-19	2,601	685	1,780,391
Oct-19	2,517	674	1,696,256
Nov-19[2]	3,468	591	2,049,773
Dec-19	12,047	341	4,111,578
Total	**369,679**		**174,909,232**
60 - Month Volume Weighted Average: 473 mg/L			

Note: [1]*Denotes monthly results with missing EC readings due to instrumentation issues with USGS equipment Monthly Flow weighted results with missing EC used for missing days.*
[2]*Denotes monthly results missing EC readings due to instrumentation issues with USGS equipment only available EC data was used.*

Figure 3-1. Total Dissolved Solids (TDS) Below Prado Dam



Notes:
TDS Weighted = Monthly flow weighted TDS calculated from EC. Data prior to October 2003 from Watermaster; October 2003 to December 2004 from WeInc, 2005 to 2019 from SAWPA.

K:\projects\PA-20 Basin Monitoring Prog\2019 SAR WQ Basin Monitoring

3.2 *Santa Ana River Reach 3*

3.2.1 Below Prado Dam

In order to determine whether water quality and quantity objectives for base flow in Reach 3 are being met, the Regional Board typically collects a series of grab and composite samples at *Below Prado Dam* during August and September when the influence of storm flows and nontributary flows is at a minimum. In 2019, there were no non-tributary flows and at this time of year there is usually no water impounded behind Prado Dam, the volumes of storm flows, rising water, and nonpoint sources discharges tend to be low, and the major component of base flow is municipal wastewater. Water quality objectives specified for Reach 3 of the SAR by the Basin Plan include TDS, hardness, sodium, chloride, Total Nitrogen (TN), sulfate, Chemical Oxygen Demand (COD) and boron. In 2019, baseflow monitoring below Prado Dam consisted of six sampling events conducted during the months of August and September. The data collected through this program are presented in Table 3-3.

Table 3-3. Results for 2019 Annual Baseflow Monitoring Program for the Santa Ana River at Below Prado Dam (Regional Board Data Only)

Parameter	Units	Basin Plan Objectives SAR Reach 3	8/21/2019	8/28/2019	9/4/2019	9/11/2019	9/18/2019	9/26/2019
Ammonia-Nitrogen	mg/L	**X[1]**	X[3]	X[3]	X[3]	X[3]	X[3]	X[3]
Bicarbonate (as CaCO3)	mg/L		na	na	na	na	na	na
Boron	mg/L	**0.75**	0.26	0.28	0.26	0.34	0.33	0.31
Calcium	mg/L		74	41	43	39	37	38
Carbonate (as CaCO3)	mg/L		na	na	na	na	na	na
Chemical Oxygen Demand	mg/L	**30**	29	21	25	20	< 20	18
Chloride	mg/L	**140**	170	182	234	145	168	137
Electrical Conductivity	umhos/cm		1160	1140	1140	1150	1120	1150
Magnesium	mg/L		13	14	14	15	13	14
Nitrate-Nitrogen	mg/L		4.4	4.7	3.8	4.0	3.8	4.0
Nitrite-Nitrogen	mg/L		X[3]	X[3]	X[3]	X[3]	X[3]	X[3]
Organic Nitrogen	mg/L		X[3]	X[3]	X[3]	X[3]	X[3]	X[3]
Potassium	mg/L		13.8	10.6	10.3	10.8	10.2	10.7
Sodium	mg/L	**110**	91	83	77	87	81	83
Sulfate	mg/L	**150**	149	173	186	114	106	120
Total Alkalinity (as CaCO3)	mg/L		208	202	196	202	200	198
Total Dissolved Solids	mg/L	**700**	698	722	704	X[2]	684	708
Total Hardness (as CaCO3)	mg/L	**350**	314	317	304	302	290	307
Total Inorganic Nitrogen	mg/L	**10**	X[3]	X[3]	X[3]	X[3]	X[3]	X[3]
Total Kjeldahl Nitrogen	mg/L		X[3]	X[3]	X[3]	X[3]	X[3]	X[3]
Total Nitrogen	mg/L		2.1	2.2	4.0	1.9	1.7	2.0
Total Organic Carbon (total)	mg/L		4.2	4.9	5.2	4.6	4.9	5.0
Turbidity	NTU		37.4	36.9	39.0	36.4	37.0	37.8

Notes: All nitrogen species filtered
na not available
X[1] *Santa Ana River Basin Plan specifies an un-ionized ammonia objectives for WARM designated surface water bodies including site specific objectives for the Santa Ana River and certain tributaries including the middle Santa Ana River, Chino Creek, Mill Creek (Prado Area), Temescal Creek, and San Timoteo Creek. Site specific objectives must be computed based upon temperature and pH.*
X[2] *9/11/20 Total Dissolved Solids value was deemed to be a laboratory error and disqualified from the dataset.*
X[3] *Regional Board declared results not useable as there were response hits in filter blanks of Dissolved Nitrogen Parameters other than Nitrate-Nitrogen.*

A summary of all baseflow monitoring data collected by the USGS, OCWD and the Regional Board at *Below Prado Dam* during 2019 along with Basin Plan objectives for baseflow conditions for SAR Reach 3 water quality are presented in Table 3-4. This includes six monitoring events conducted by the Regional Board for their annual water quality monitoring of baseflow in the SAR during August and September of 2019. OCWD conducted five baseflow monitoring events at Below Prado Dam in 2019. However, as the nitrogen species data collected by OCWD was not filtered, it was not used to evaluate the water quality objective for TIN. The USGS conducted monthly baseflow sampling events at Below Prado Dam in August and September 2019. Table 3-4 presents the results of this monitoring.

Table 3-4. Summary of Baseflow Water Quality Observations for the Santa Ana River at Below Prado Dam (2019 OCWD, USGS and Regional Board at Below Prado Dam)

Constituent	Units	Basin Plan Objectives SAR Reach 3	Baseflow Average	# of Samples
Ammonia-Nitrogen[3]	mg/L	**X[1]**	0.04	2
Ammonia-Nitrogen (unfiltered)	mg/L		<0.1	5
Bicarbonate (as CaCO3)	mg/L		234	7
Boron	mg/L	**0.75**	0.30	8
Calcium	mg/L		56	8
Carbonate (as CaCO3)	mg/L		1.5	7
Chemical Oxygen Demand (unfiltered)	mg/L	**30**	19	9
Chloride	mg/L	**140**	163	13
Electrical Conductivity	umhos/cm		1131	78
Electrical Conductivity (field)	umhos/cm		1144	5
Fluoride	mg/L		0.40	4
Hydroxide (as CaCO3)	mg/L		<1.0	5
Magnesium	mg/L		15	8
Nitrate-Nitrogen[3]	mg/L		4.2	8
Nitrate-Nitrogen (unfiltered)			4.3	5
Nitrite-Nitrogen[3]	mg/L		0.02	2
Nitrite-Nitrogen (unfiltered)			0.04	5
Organic Nitrogen[3]	mg/L		0.44	2
Organic Nitrogen (unfiltered)			0.88	5
Potassium	mg/L		11.8	8
Sodium	mg/L	**110**	90	8
Sulfate	mg/L	**150**	129	13
Total Alkalinity (as CaCO3)	mg/L		214	15
Total Dissolved Solids	mg/L	**700**	692	16
Total Hardness (as CaCO3)	mg/L	**350**	303	10
Total Inorganic Nitrogen[3]	mg/L	**10[2]**	4.4	2
Total Inorganic Nitrogen (unfiltered)			4.5	5
Total Kjeldahl Nitrogen[3]	mg/L		na	na
Total Kjeldahl Nitrogen (unfiltered)			0.88	5
Total Nitrogen	mg/L		4.9	2
Total Nitrogen (unfiltered)			5.3	5
Total Organic Carbon (total)	mg/L		4.6	11
Turbidity	NTU		32	13

Notes: *Table presents average concentration data*
na *not available*
Table summarizes baseflow monitoring data collected by USGS, OCWD and the Regional Board at Below Prado Dam during 2018
X[1] *Santa Ana River Basin Plan specifies an un-ionized ammonia objectives for WARM designated surface water bodies including site specific objectives for the Santa Ana River and certain tributaries including the middle Santa Ana River, Chino Creek, Mill Creek (Prado Area), Temescal Creek, and San Timoteo Creek. Site specific objectives must be computed based upon temperature and pH.*
[2] *Santa Ana River Basin Plan specifies that Total Nitrogen Samples are to be filtered.*
[3] *Regional Board results not useable as there were response hits in filter blanks of Dissolved Nitrogen Parameters other than Nitrate-Nitrogen.*

The USGS also maintains a gauging station, 11074000, located on the SAR below Prado Dam, shown in Figure 2-1. In 2019, this station recorded flows totaling 251,078 AFY.

A long time-history of water quality data has been collected by USGS along with data collected by OCWD, Regional Board baseflow monitoring program, and by CBWM/IEUA at *Below Prado Dam* and *MWD Crossing*. These data were plotted for each constituent that has a Basin Plan objective for January 1999 through to current and are included in Appendix A, to show the longer-term trends in baseflow data, and non-baseflow water quality samples, as well as non-volume-weighted five-year moving averages.

3.2.2 Santa Ana River Mainstem between Riverside Narrows and Prado Wetlands

Monitoring of Reach 3, above Prado Dam is performed by OCWD for their SAR Water Quality Monitoring Program and the USGS at MWD Crossing. This included monitoring of the following locations: *MWD Crossing, Van Buren Blvd., Etiwanda Avenue, Hamner Road, and River Road*, as shown in Figure 2-1. OCWD conducted a single monitoring event for each of the locations on August 27, 2019. However, as the nitrogen species data collected by OCWD was not filtered it was not used to evaluate the water quality objective for TIN. Additionally, the USGS collects electrical conductivity and TDS at their gauge located *Santa Ana River at MWD Xing*. Table 3-5 presents a summary of the results of these monitoring efforts for base flow conditions.

An assessment of Baseflow conditions, represented by water quality data collected in August and September of 2019, showed no exceedances of water quality objectives specified in the Basin Plan. The USGS maintains a gauging station, 11066460, located along Reach 3 of the SAR at the MWD Crossing, shown in Figure 2-1. In 2019, this station recorded flows totaling 99,139 AFY.

Table 3-5. Summary of Baseflow Water Quality Observations for the Santa Ana River Reach 3 (Between Riverside Narrows and Prado Wetlands)

Constituent	Units	Basin Plan Objectives SAR Reach 3	Baseflow Average	# of Samples
Ammonia-Nitrogen (unfiltered)	mg/L	**X[1]**	<0.1	5
Bicarbonate (as CaCO3)	mg/L		224	5
Carbonate (as CaCO3)	mg/L		2.76	5
Chemical Oxygen Demand (unfiltered)	mg/L	**30**	11.4	5
Chloride	mg/L	**140**	121	5
Electrical Conductivity	umhos/cm		1042	9
Electrical Conductivity (field)	umhos/cm		1047	5
Hydroxide (as CaCO3)	mg/L		< 1.0	5
Nitrate-Nitrogen (unfiltered)	mg/L		6.0	5
Nitrite-Nitrogen (unfiltered)	mg/L		0.016	5
Organic Nitrogen (unfiltered)	mg/L		<0.1	5
Sulfate	mg/L	**150**	107	5
Total Alkalinity (as CaCO3)	mg/L		226	5
Total Dissolved Solids	mg/L	**700**	635	9
Total Inorganic Nitrogen (unfiltered)	mg/L	**10[2]**	6.2	5
Total Kjeldahl Nitrogen (unfiltered)	mg/L		<0.2	5
Total Nitrogen (unfiltered)	mg/L		6.1	5
Total Organic Carbon	mg/L		3.0	5
Turbidity	NTU		2.1	5

Note: Table presents average concentration data

X[1] *Santa Ana River Basin Plan specifies an un-ionized ammonia objectives for WARM designated surface water bodies including site specific objectives for the Santa Ana River and certain tributaries including the middle Santa Ana River, Chino Creek, Mill Creek (Prado Area), Temescal Creek, and San Timoteo Creek. Site specific objectives must be computed based upon temperature and pH.*

[2] *Santa Ana River Basin Plan specifies that Total Nitrogen Samples are to be filtered*

- Site SAR River Road includes data collected by OCWD at "SAR-RIVERRD-01"
- Site SAR Hamner includes only data collected by OCWD at "SAR-HAMNER-01"
- Site SAR Etiwanda includes data collected by OCWD at "SAR-ETIWANDA-01"
- Site SAR Van Buren includes only data collected by OCWD at "SAR-VANBUREN-01"
- Site SAR MWD includes data collected by USGS at "Santa Ana River at MWD Xing" and OCWD at "SAR-MWDXING-01"

3.3 *Santa Ana River Reach 4*

The Basin Plan has specified water quality objectives for SAR Reach 4 for TDS, TIN, and COD. Along SAR Reach 4, OCWD monitors sites, *SAR-MISSION-01*, *SAR-RIVERSIDEAVE-01, and SAR-LACADENA-01*, shown in Figure 2-1.

In 2019, the *SAR-MISSION* and *SAR-RIVERSIDEAVE* sites were monitored once by OCWD in August, but no data was collected at *SAR-LACADENA-01*.

A review of this data showed an insufficient amount of available surface water quality monitoring data to evaluate compliance with the water quality objective specified in the Basin Plan. Table 3-6 presents a summary of the results of this monitoring.

Table 3-6. Summary of Water Quality Observations for Santa Ana River Reach 4

Constituent	Units	Basin Plan Objective SAR Reach 4	SAR Reach 4 Average	# of Samples
Ammonia-Nitrogen (unfiltered)	mg/L	**X[1]**	< 0.1	2
Bicarbonate (as CaCO3)	mg/L		177	2
Carbonate (as CaCO3)	mg/L		< 1	2
Chemical Oxygen Demand (unfiltered)	mg/L	**30**	4.5	2
Chloride	mg/L		89	2
Electrical Conductivity	umhos/cm		838	2
Electrical Conductivity (field)	umhos/cm		780	2
Hydroxide (as CaCO3)	mg/L		< 1	2
Nitrate-Nitrogen (unfiltered)	mg/L		7.1	2
Nitrite-Nitrogen (unfiltered)	mg/L		0.074	2
Organic Nitrogen (unfiltered)	mg/L		< 0.1	2
Sulfate	mg/L		77	2
Total Alkalinity (as CaCO3)	mg/L		177	2
Total Dissolved Solids	mg/L	**550**	518	2
Total Inorganic Nitrogen (unfiltered)	mg/L	**10**	7.2	2
Total Kjeldahl Nitrogen (unfiltered)	mg/L		< 0.2	2
Total Nitrogen (unfiltered)	mg/L		7.3	2
Total Organic Carbon	mg/L		2.5	2
Turbidity	NTU		1.1	2

Note: Table presents average concentration data

X[1] *Santa Ana River Basin Plan specifies un-ionized ammonia objectives for WARM designated surface water bodies including site specific objectives for the Santa Ana River and certain tributaries including the Middle Santa Ana River, Chino Creek, Mill Creek (Prado Area), Temescal Creek, and San Timoteo Creek. Site specific objectives must be computed based upon temperature and pH.*

3.4 *Santa Ana River Reach 5*

The Basin Plan has specified water quality objectives for the SAR Reach 5 for TDS, hardness, sodium, chloride, TIN, sulfate, and COD. Along the SAR Reach 5, OCWD monitors a single site, *SAR-WATERMAN-01*, shown in Figure 2-1. In 2019, no data was collected at *SAR- WATERMAN -01*, as during the time scheduled for sampling there was no stream flow.

The USGS maintains a gauging station, 11059300, located along the SAR at E Street near San Bernardino, shown in Figure 2-1. In 2019, this station recorded flows totaling 27,187 AFY.

4 Conclusions and Recommendations

4.1 Conclusions

The five-year running average TDS concentration, for samples collected immediately below Prado Dam, continues to comply with the water quality objectives established for Reach 2 of the Santa Ana River and the underlying Orange Country Groundwater Management Zone (650 mg/L and 580 mg/, respectively). The average TDS concentration of the 16 samples collected at the same location in August and September of 2019 were in compliance with the water quality objective established for Reach 3 during baseflow conditions (692 mg/L vs. 700 mg/L, respectively).

In 2015, the Basin Monitoring Program Task Force commissioned an investigation to determine the cause for the steady increase in the average TDS concentrations measured during the summer baseflow conditions since about 2005. The study found that average TDS concentrations were increasing because the POTWs, while still meeting their discharge obligations were discharging less treated wastewater to the Santa Ana River system.[5] Additionally, the watershed is in a long term dry period[7], which makes the interpretation of trend data more difficult, as shown in Figure 4-1. During the late summer months of August and September, the combined volume-weighted average TDS concentration for the nine municipal effluents that eventually converge at Prado Dam ranges between 535-570 mg/L.[6] High quality (low TDS) municipal effluent tends to dilute low quality (high TDS) discharges from other sources (e.g. dry weather urban runoff, rising groundwater, etc.) that also contribute flows to Reach 3. In the period from 2005 to 2014, POTWs reduced the total volume of treated wastewater discharged to Reach 3 of the Santa Ana River (and its major tributaries) by 45%; from 145 mgd down to 79 mgd. Additional modeling revealed that, if the total volume of municipal effluent discharge had remained unchanged, average TDS concentrations at Prado Dam would also have remained stable. The reduction in wastewater flows, and the subsequent loss of dilution, also appears to be a correlation to the long-term rising trend in the average concentration of various individual salt ions (i.e. chloride, sodium, and sulfate) during baseflow conditions.

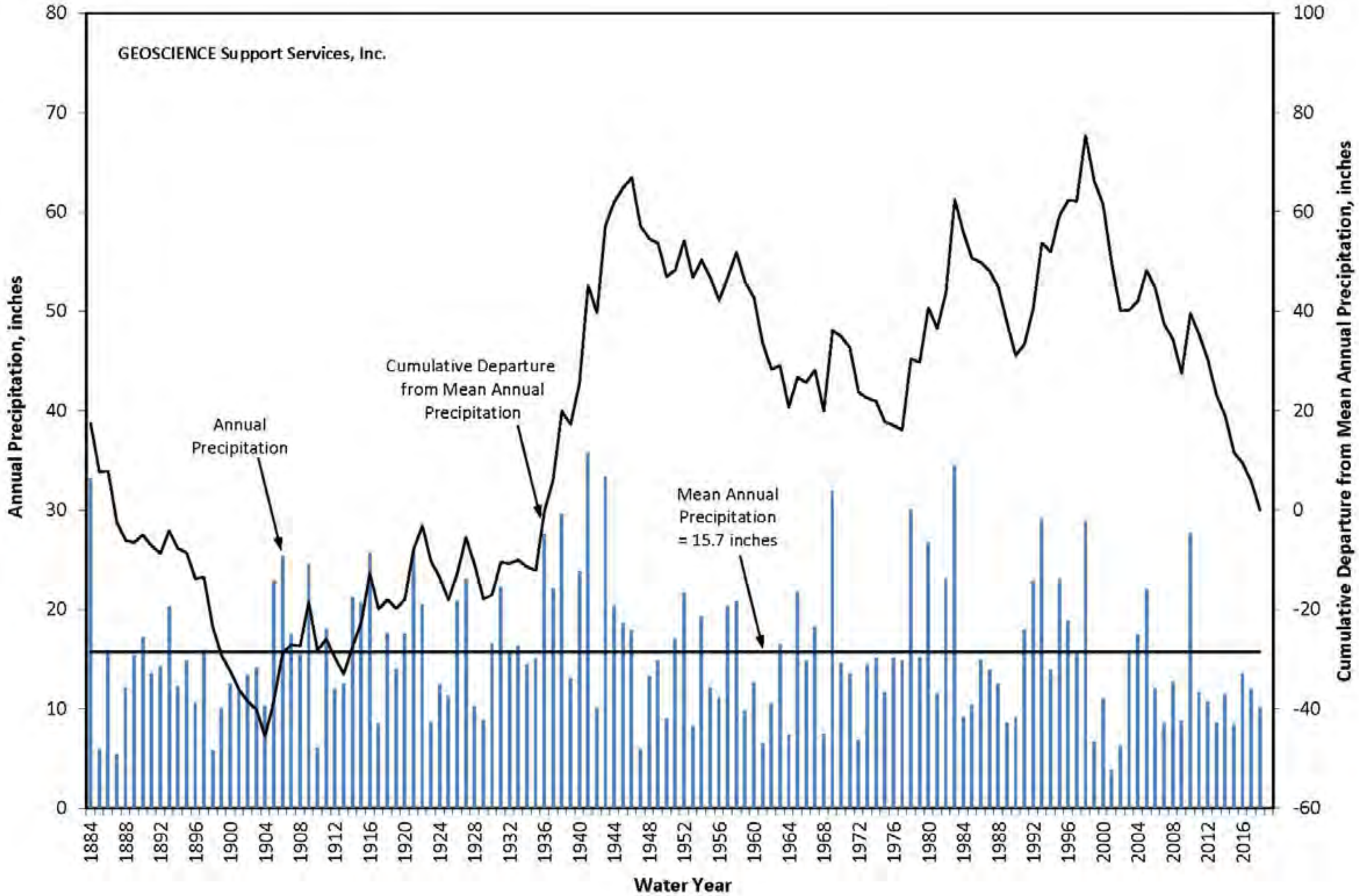
In 2019, the average baseflow concentration of Total Nitrogen at Prado Dam was 4.9 mg/L, well below the water quality objective established for Reach 3. Long-term water quality monitoring data confirms that average nitrogen concentrations are continuing to slowly decline over time (see Figure 3-2). This is also the result of discharging less treated wastewater into the river system because the average nitrogen concentration in municipal effluent ranges from 8-10 mg/L.

[5] Wildermuth Environmental, Inc. Investigation and Characterization of the Cause(s) of Recent Exceedances of the TDS Concentration Objective for Reach 3 of the Santa Ana River. Feb. 11, 2015.

[6] Wildermuth Environmental, Inc. Volume-Weighted TDS Concentration of POTW Discharges above Prado Dam during August-September. June 15, 2015.

[7] Long term Dry Period as shown by the Mean Annual Precipitation as reported by San Bernardino County Flood Control District. http://www.sbcounty.gov/dpw/pwg/Precip_Data/Zone_2_Precip_Stations.htm

Figure 4-1. Cumulative Departure from Mean Annual Precipitation San Bernardino County Hospital Station (1884-2018)



In addition, some of the observed trend toward lower average nitrogen concentrations is likely due to the operation of OCWD's treatment wetlands immediately above Prado Dam.

Baseflow samples are also collected further upstream where the MWD pipeline crosses the Santa Ana River in Riverside. The average TDS concentration of these samples was 635 mg/L and the average TIN concentration was 6.2 mg/L. Both values were in compliance with the water quality objective for Reach 3 of the river.

The average TDS concentration for the two samples collected in Reach 4 of the Santa Ana River was 518 mg/L which complies with the applicable water quality objective of 550 mg/L. The average TIN concentration in these same two samples was 7.2 mg/L which complies with the applicable water quality objective of 10 mg/L.

4.2 Recommendations

The Task Force has now been implementing the approved monitoring plan for more than ten years. Through the implementation of the existing monitoring plan, some issues have been identified regarding the most appropriate way to collect, analyze, interpret, and report the resulting data. To address these issues, the Task Force has identified some recommendations related to Basin Plan Amendments, and for additional discussion.

1) The monitoring plan should be reviewed to ensure that we are collecting all data necessary to assess compliance with relevant water quality objectives and the overall effectiveness of the new wasteload allocation model. We recommend that the Basin Plan be amended to require stakeholders to submit an update to the 2005 monitoring plan to the Regional Water Board within six months of U.S. EPA approval of the Basin Plan Amendments for Regional Board review and approval. In particular, the update to the 2005 monitoring plan should consider if the monitoring program should be expanded to include the major tributaries to the Santa Ana River (e.g. Chino Cr., Mill-Cucamonga Cr., Temescal Cr., Hole Lake Cr., San Timoteo Cr., etc.).

2) As part of the 2005 monitoring plan update discussed in paragraph 1 above, the update should include a list of parameters to be analyzed, sites to be sampled, and the sampling schedule. A Quality Assurance Project Plan (QAPP) should also be prepared to support the monitoring program. It should also be decided if monitoring data collected should be uploaded to CEDEN or other state database.

3) The Basin Plan should be revised to include a clear definition of what constitutes "baseflow" with respect to the water quality objectives for Reach 3 that is consistent with the Annual Report and the updated Wasteload Allocation Model. Should data influenced by summer precipitation in August and September be included? Can we use data from other months to characterize

baseflow conditions provided that no recent precipitation has occurred? Should data influenced by State Water Project transfers be excluded?

4) In order to assure more consistent application of water quality standards, the Basin Plan should be amended to clarify that filtered samples should be used to evaluate all surface water TIN objectives. This approach would be consistent with the approach used for evaluating compliance with TIN objectives in Reach 3.

5) The application of existing WQOs for various salt ions may no longer be necessary. Most were established based on very limited sampling data collected in the early 1980's. All were intended to represent antidegradation targets - not use impairment thresholds. The Nitrogen/TDS Task Force recommends that the Basin Plan be amended to properly clarify application of the existing WQOs for individual salt ions (chloride, sodium, sulfate, etc.) that references and integrates prior Regional Board decisions that pertain to application of the WQOs.

5 Response to Comments

Comments and Responses to 2019 Draft Annual Report of Santa Ana River Water Quality

Comments Received	Agency	Page/Table/Section	Detail	Response to Comments
Jennifer McMullin (6/5/20)	**City of Corona**	Table 3-1	Are all the years listed fiscal year or only some years?	Table 3-1 data represented as Water Years defined by the USGS as October 1st to September 30th
		Page 3-2	Paragraph 3, second to last sentence "The 5-year volume-weighted TDS average for the period January 2015 through December 2019 was 473 mg/L." I think this should read the 60-month volume-weighted moving average.	Text revised from "5-year volume-weighted TDS average" to "60-month volume-weighted moving average"
		Page 4-3	Recommendation 4 – I think the TN should be TIN	Text revised from TN to TIN
		Page 4-4	I recommend to remove recommendation #6	Removed Recommendation 6
		Appendix A	for Figures 3-2 through 3-8, assuming the blue line is flow, since it is not defined in the key. Suggest adding this to the key and note if it represents a specific gauging station.	Figure legends were reformatted to show annual flow at gauging station

		Table 2-1	**WR-RIX-01 data not used in this report at this site was collected directly in the RIX Outfall pool and is not considered representative of the mainstem of the Santa Ana River In regards to this footnote, has this been the case in the past? If so, why include it as a SAR monitoring location in this Table?	All references to the WR-RIX-01 monitoring location have been removed from the report.

Mark Norton (5/20/20)	**SAWPA**	Page 3-1	Paragraph 2, first sentence - An additional sentence would be good here to explain “why” we are showing this alternative method. I would suggest adding some text here somewhat similar to the explanation shown in the 3rd paragraph of the next page. You also should indicate when this alternative compliance metric was started.	The Task Force began preparing the Annual Reports of Santa Ana River Water Quality in 2007. In the first two reports (2007 & 2008) compliance with the TDS objective in Reach 2, which is expressed as a five year average, was computed based on the 60-month volume-weighted dataset. While this is technically correct, we became concerned that it might not be legally correct. Careful review of the Basin Plan text indicated that the volume-weighted five year average should be computed as the arithmetic mean of the five discrete volume-weighted values for each of the five years. The latter approach uses the monthly data to calculate a volume-weighted average for each year, but it then sums those values and divides by 5 to generate the five-year mean. In effect, this causes "wet" years to be weighted the same as "dry" years. While it is true that the first approach more accurately estimates the true long-term volume weighted average TDS concentration in Reach 2, the second approach provides a better estimate of the long-term volume-weighted average of TDS concentrations in the river flow that percolates through the streambed into the underlying groundwater basin. In very wet years, the volume-weighted average TDS concentration is much lower, but some of this high quality water flows out to the Pacific Ocean rather than percolating to groundwater. By assuming the same volume of water percolates every year, the method specified by the Basin Plan tends to slightly overestimate the TDS concentrations entering the OC groundwater basin while the 60-month volume-weighted averaging approach tends to slightly underestimate the TDS concentration. Beginning with the 2009 Annual Report, the Task Force started applying both methods and reporting both results. We have continued to do it this way ever since because we believed it provided the context needed to ensure better understanding of the data. It also helps illustrate how small changes in the assumptions and procedures used to perform the calculations can lead to consequential changes in the subsequent compliance determinations.
		Page 3-2	Paragraph 3, last sentennce - suggest modifying, "Since 2008 there has been an increase in TDS concentrations.", Both tables 3-1 and 3-2 show TDS concentrations decreasing over the past year.	Recommend removing the narrative description from the report. There is little value in trying to describe the trend as a narrative, when the graphic figure and Table provide the complete story of the data.
		Table Footnotes	Why are so many footnotes stars shown here when you don’t show * or **?	Footnotes reformatted
		Page 4-1	Replace the 720 value be replaced with the Aug/Sept baseflow value for TDS shown as 692mg/L in Table 3-4?	Value of 720 replaced with 692
		Page 4-1	Paragraph 2, first sentence - Some dips going back down in recent years based on the recent TDS sampling. Perhaps indicate prior to 2015.	Recommend removing the narrative description from the report. There is little value in trying to describe the trend as a narrative, when the graphic figure and Table provide the complete story of the data.

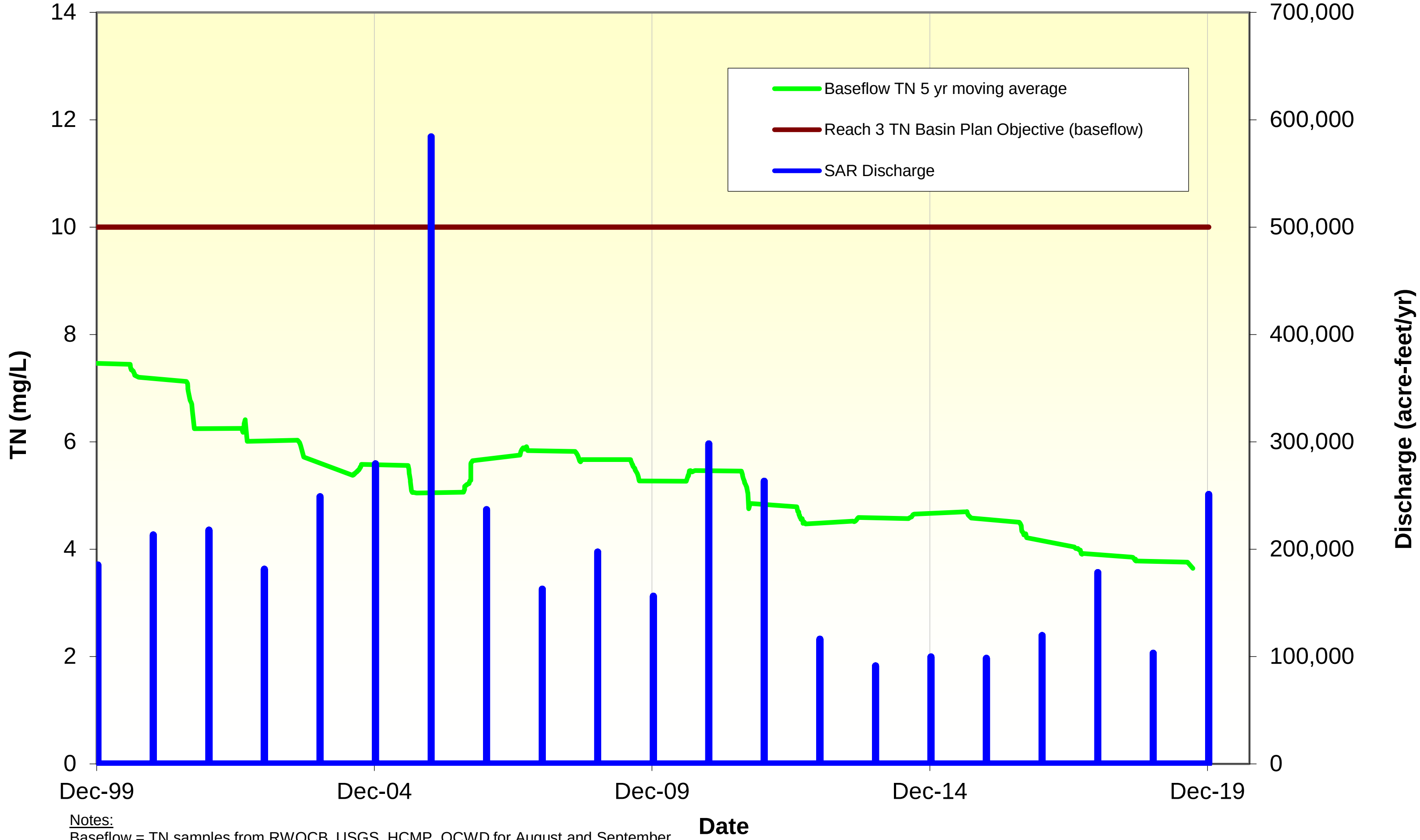
		Page 4-3	It would be good to get feedback from Tim Moore to see if any of these items will be addressed in the next Basin Plan Amendment which I think is the case. If so, we may modify this section indicate that these items have been discussed and will be resolved as part of the BPA. For others, we may indicate that they will need to be addressed in the future.	Will incorporate the following into the Recommendations: 1 & 2) The Basin Plan amendment will include a provision to require stakeholders to update the 2005 monitoring plan and re-submit it for Regional Board review and approval 6 months after the EPA approves the BPA. 3) The BPA will include a formal definition of what constitutes "baseflow" that will be consistent with how we now do the Annual Report and how we instructed Geosciences to implement the WLAM. 4) The BPA will (probably) add a provision clarifying that filtered samples should be used to evaluate all surface water TIN objectives. 5) The BPA will include new language to clarify proper application of the existing WQO for individual salt ions (chloride, sodium, sulfate, etc.) that references and integrates prior Board resolutions on the subject. 6) The Task Force decided not complicate matters by expanding BMPTF requirements to other dischargers (MS4, Ag, CAFO, De Minimus, etc.). You can delete this recommendation.
		Appendix A Figure 3-11	Why is the Baseflow green line ending in Dec. 2013?	Boron data is not currently being collected by the agencies providing baseline data at MWD Crossing. Boron, sodium and total hardness data have not been collected since the HCMP monitoring program monitoring requirements were revised in 2014.

Tim Moore (5/28/20)	**Risk Sciences**	Appendix A	Relable Figures to Reflect Appendix A	Figures will be relabled as A-1 through A-15

Appendix A

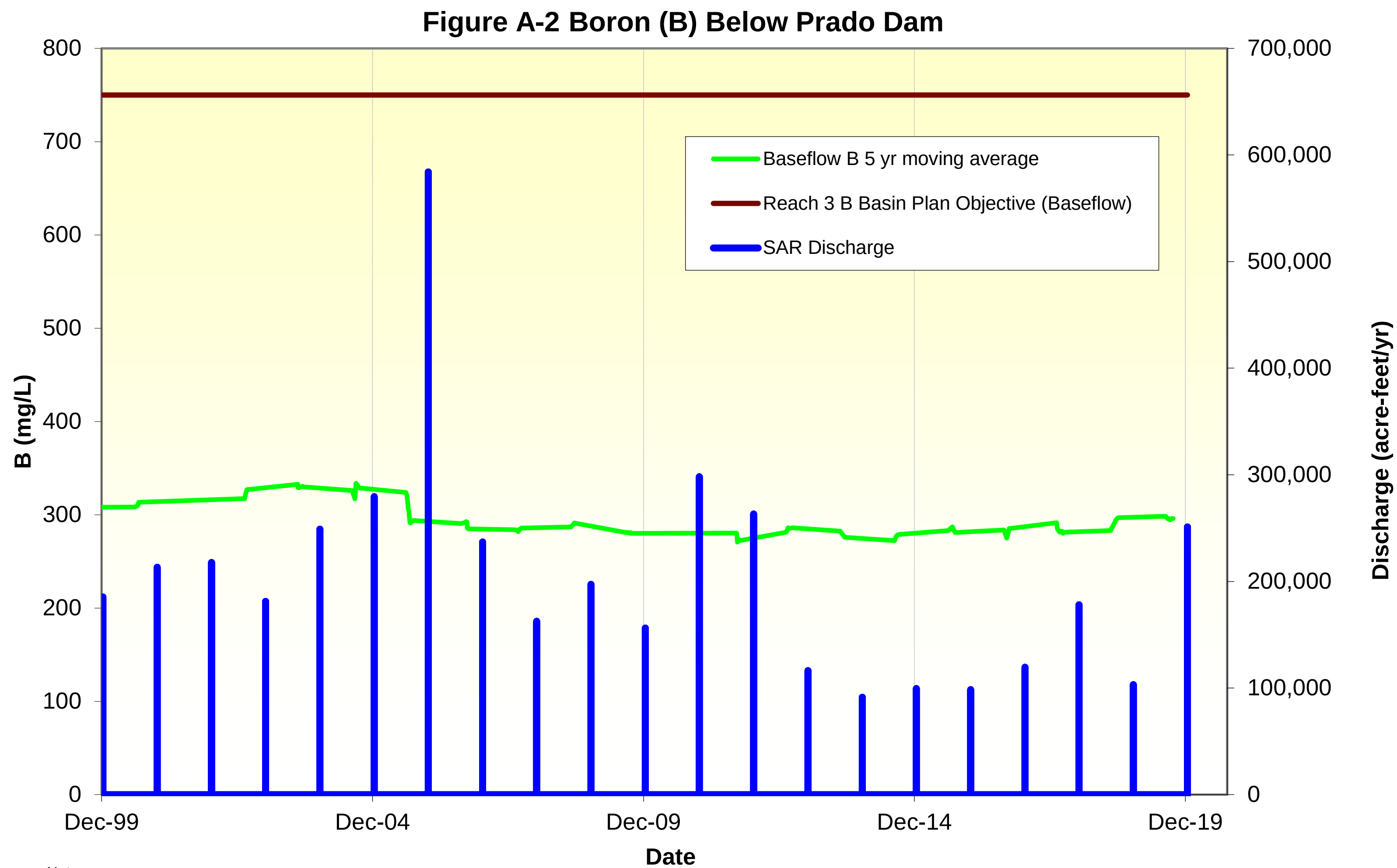
Water Quality Trends
at Below Prado Dam and MWD Crossing
1998 to Current

Figure A-1 Total Nitrogen (TN) Below Prado Dam



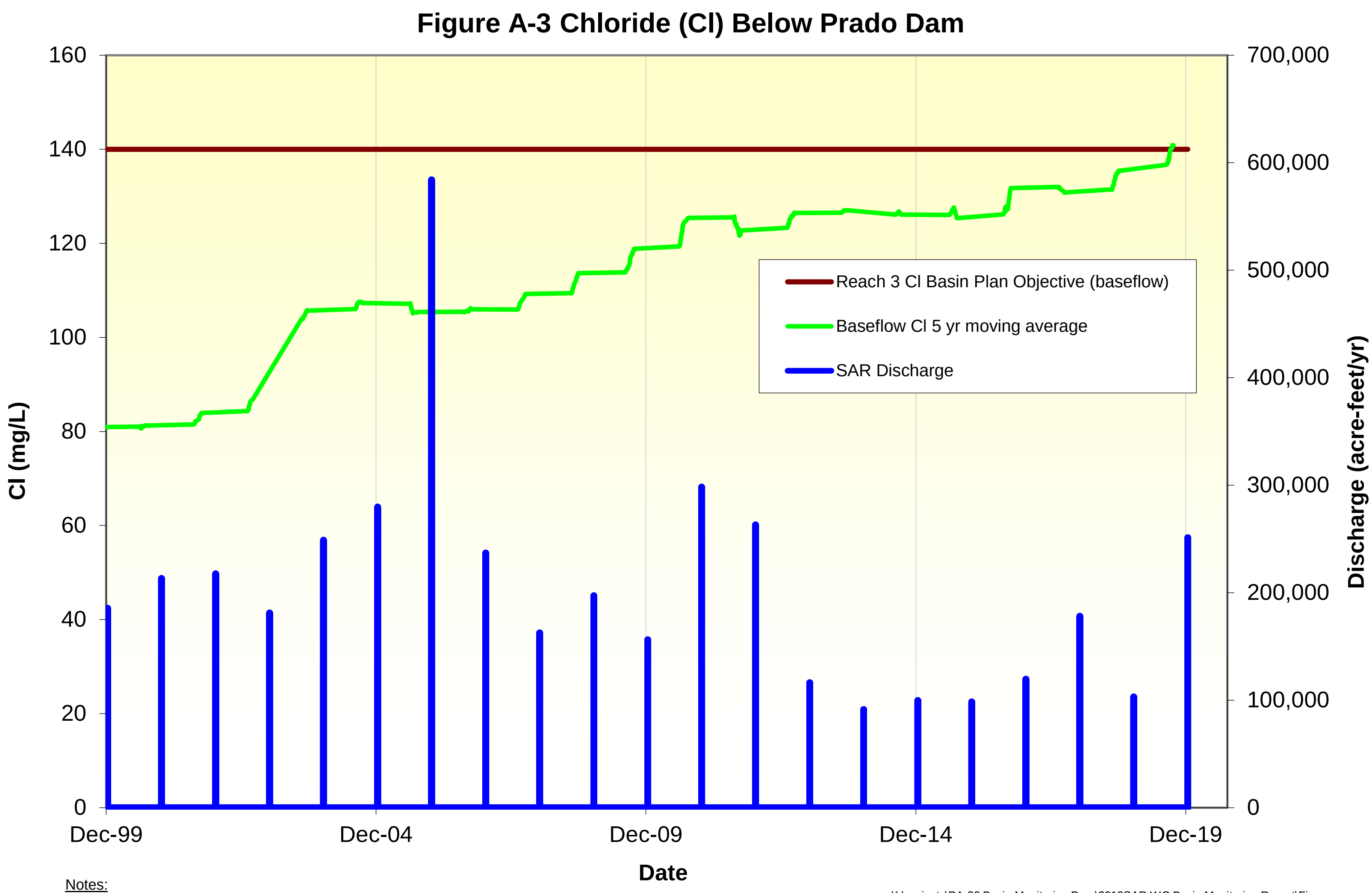
Notes:
Baseflow = TN samples from RWQCB, USGS, HCMP, OCWD for August and September..

K:\projects\PA-20 Basin Monitoring Prog\2019 SAR WQ Basin Monitoring Report\Figures



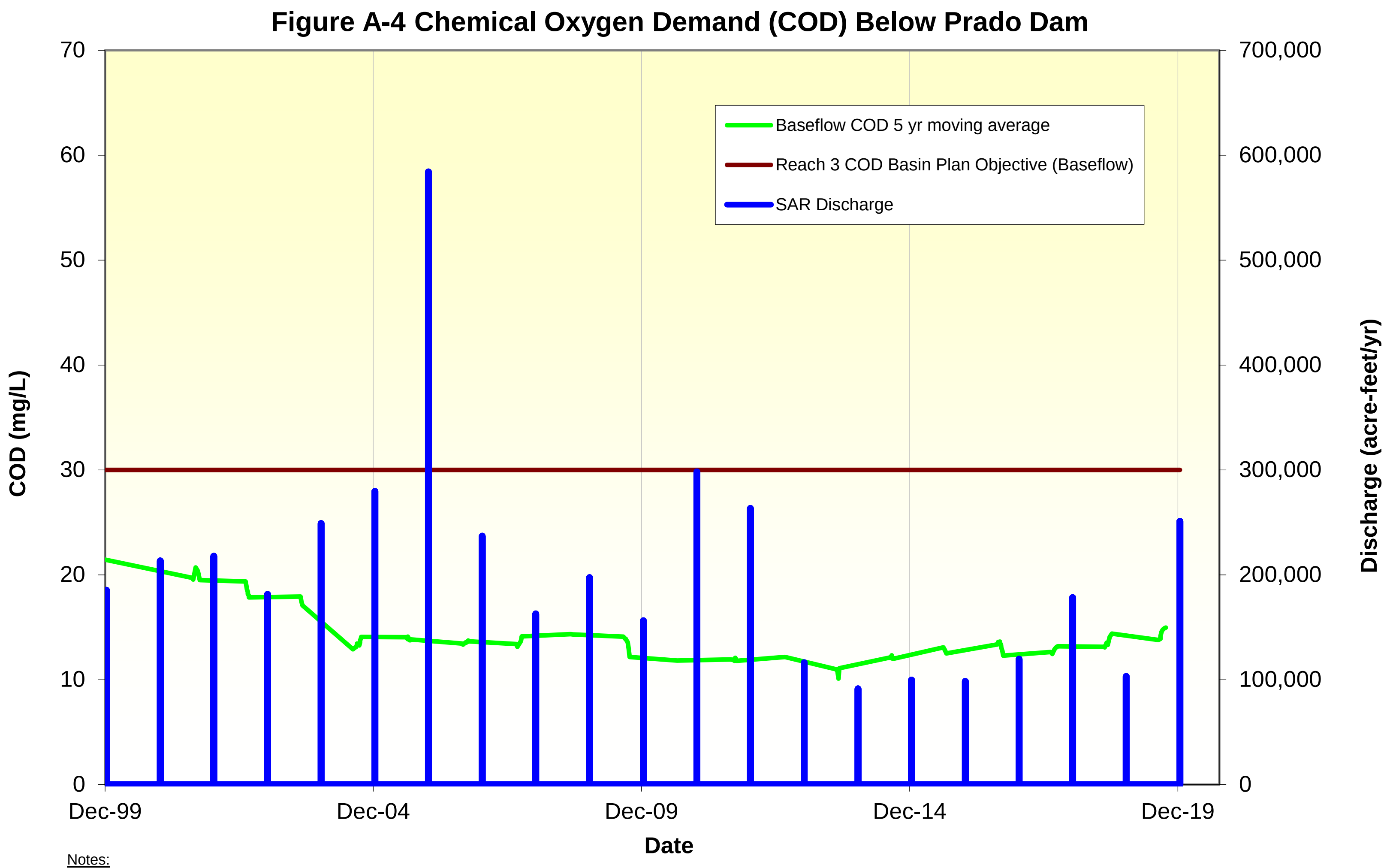
Notes:
Baseflow = B samples from RWQCB, USGS, HCMP, OCWD for August and September.

K:\projects\PA-20 Basin Monitoring Prog\2019 SAR WQ Basin Monitoring Report\Figures



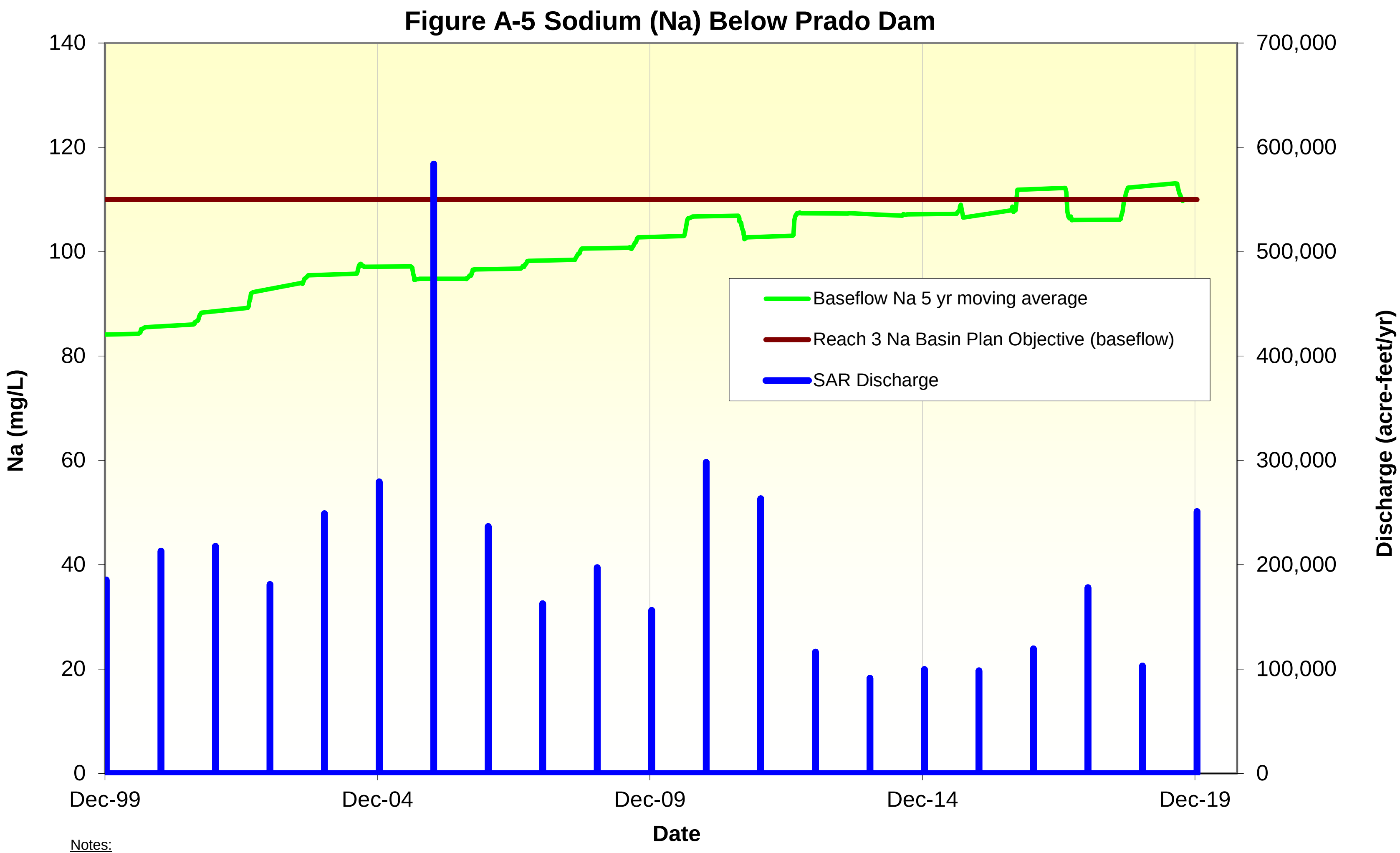
Notes:
Baseflow = Cl samples from RWQCB, USGS, HCMP, OCWD for August and September

K:\projects\PA-20 Basin Monitoring Prog\2019SAR WQ Basin Monitoring Report\Figures



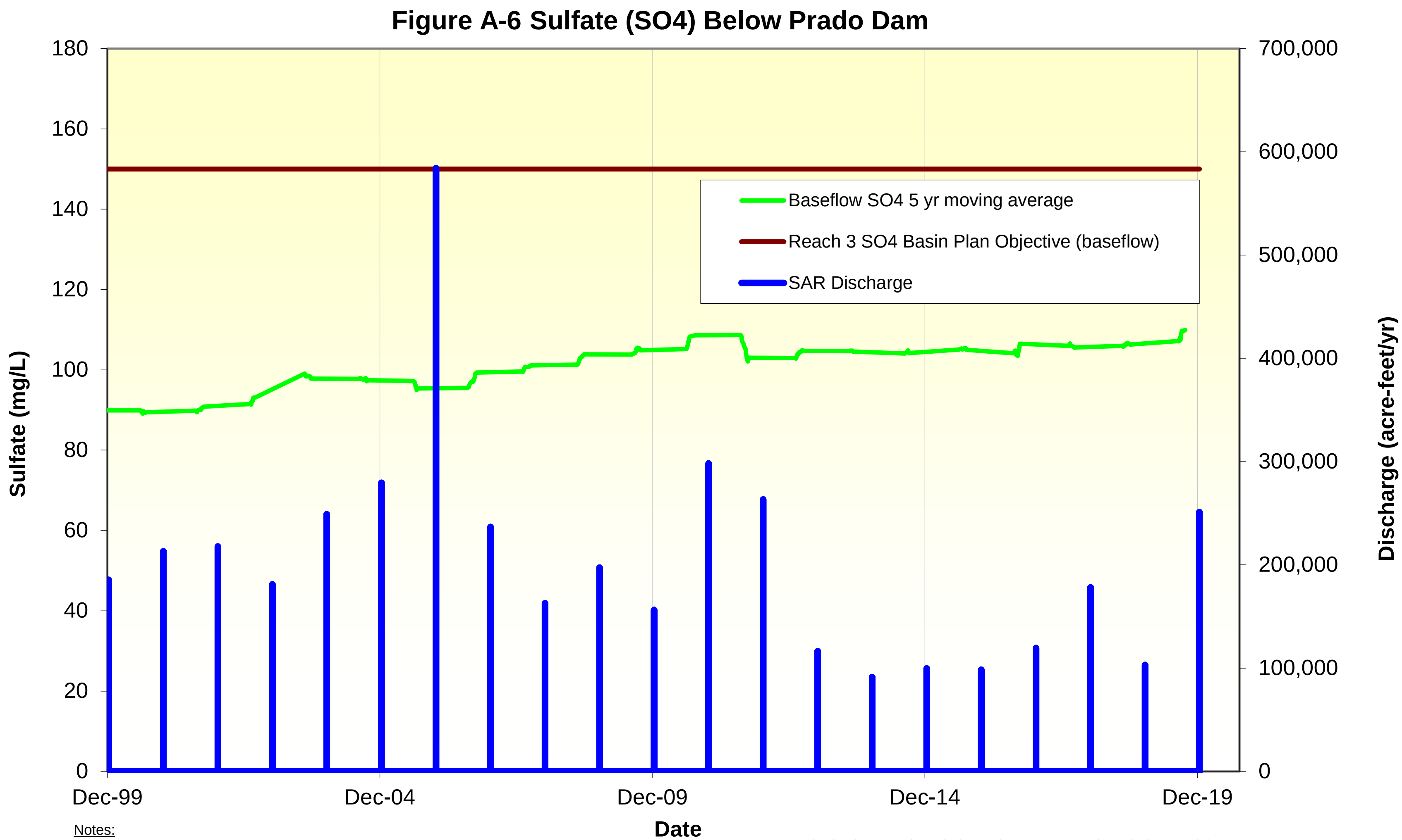
Notes:
Baseflow = COD samples from RWQCB, USGS, HCMP, OCWD for August and September

K:\projects\PA-20 Basin Monitoring Prog\2019 SAR WQ Basin Monitoring Report\Figures



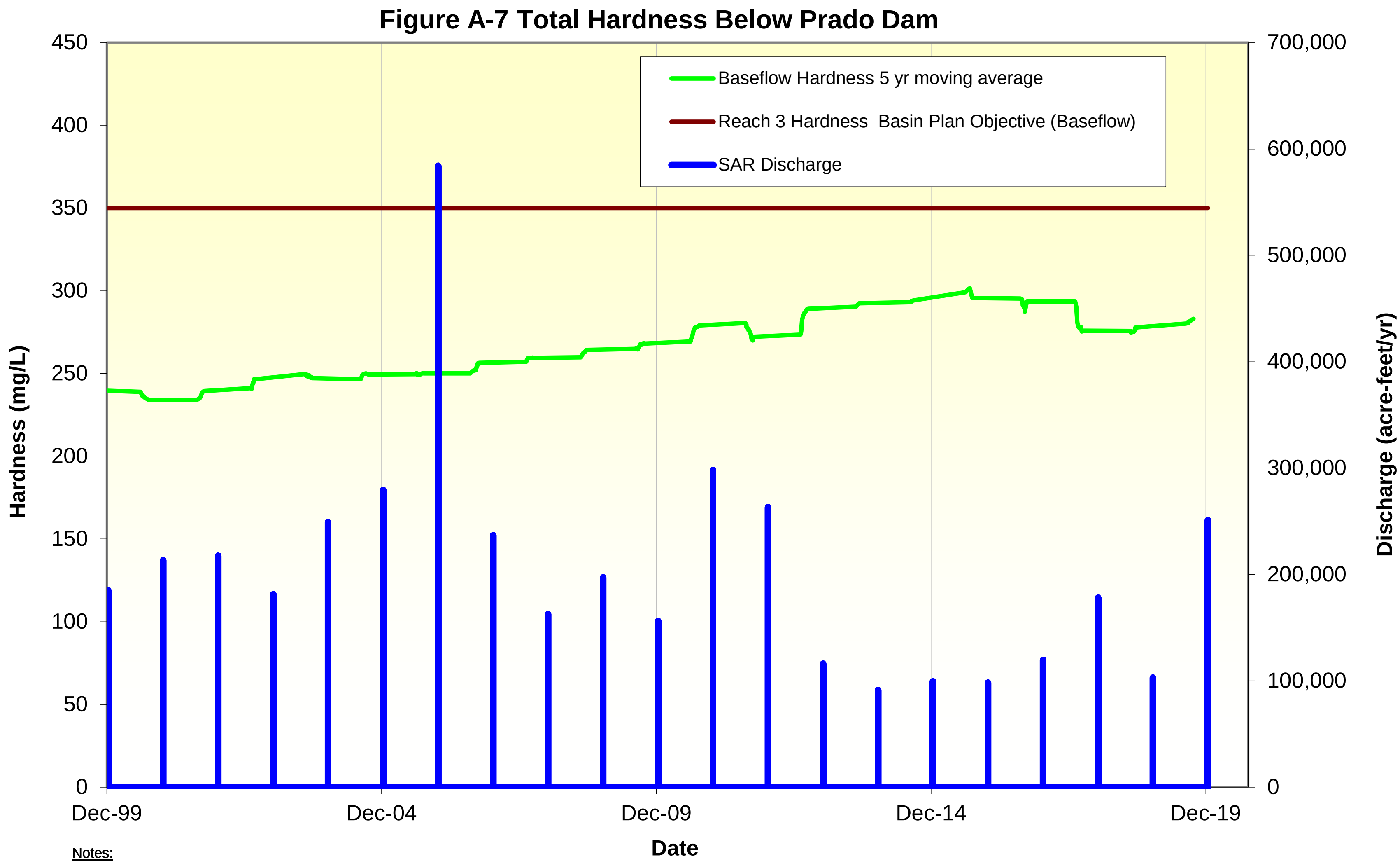
Notes:
Baseflow = Na samples from RWQCB, USGS, HCMP, OCWD for August and September.

K:\projects\PA-20 Basin Monitoring Prog\2018 SAR WQ Basin Monitoring Report\Figures



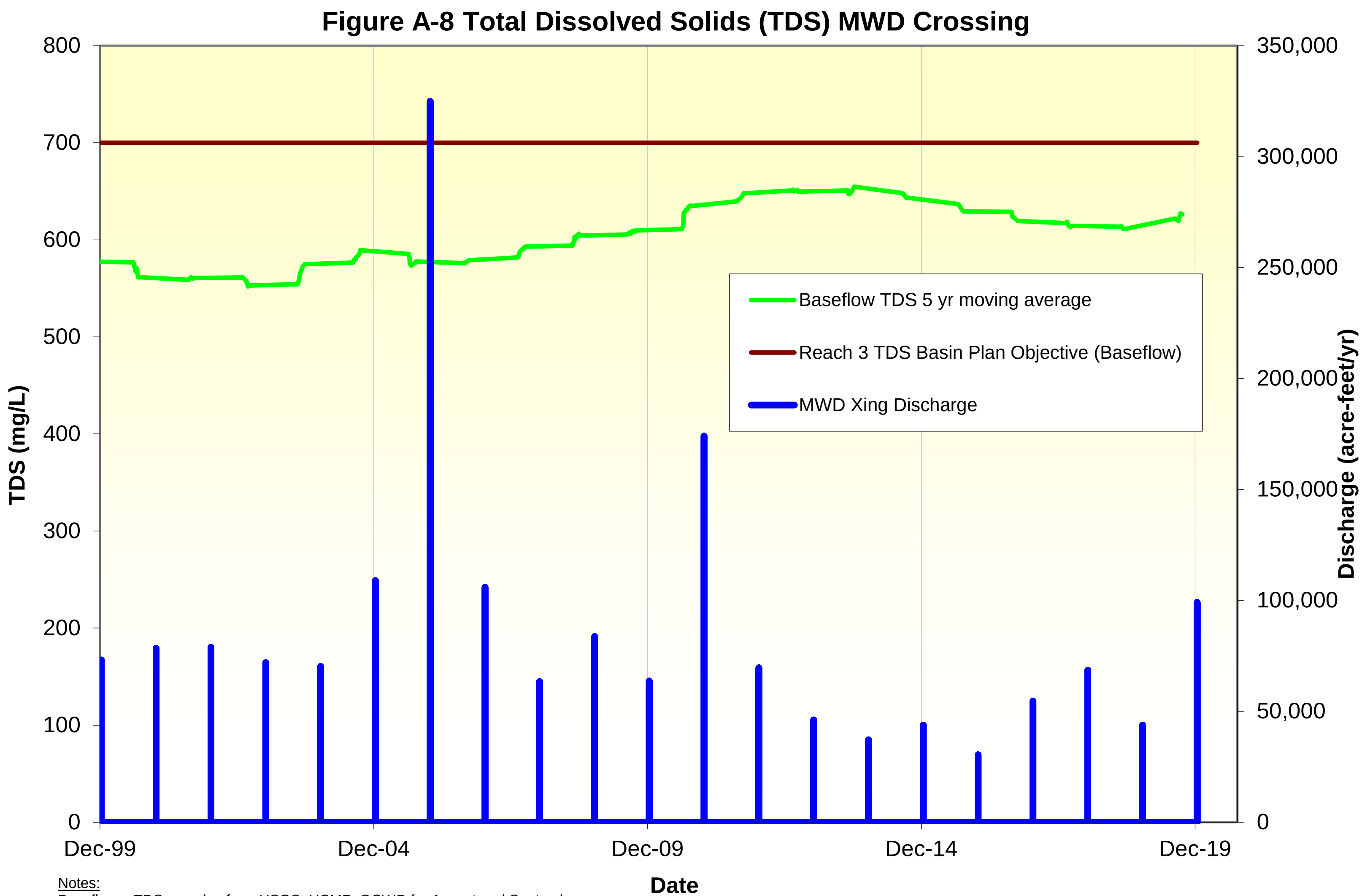
Notes:
Baseflow = SO4 samples from RWQCB, USGS, HCMP, OCWD for August and September.

K:\projects\PA-20 Basin Monitoring Prog\2019 SAR WQ Basin Monitoring Report\Figures



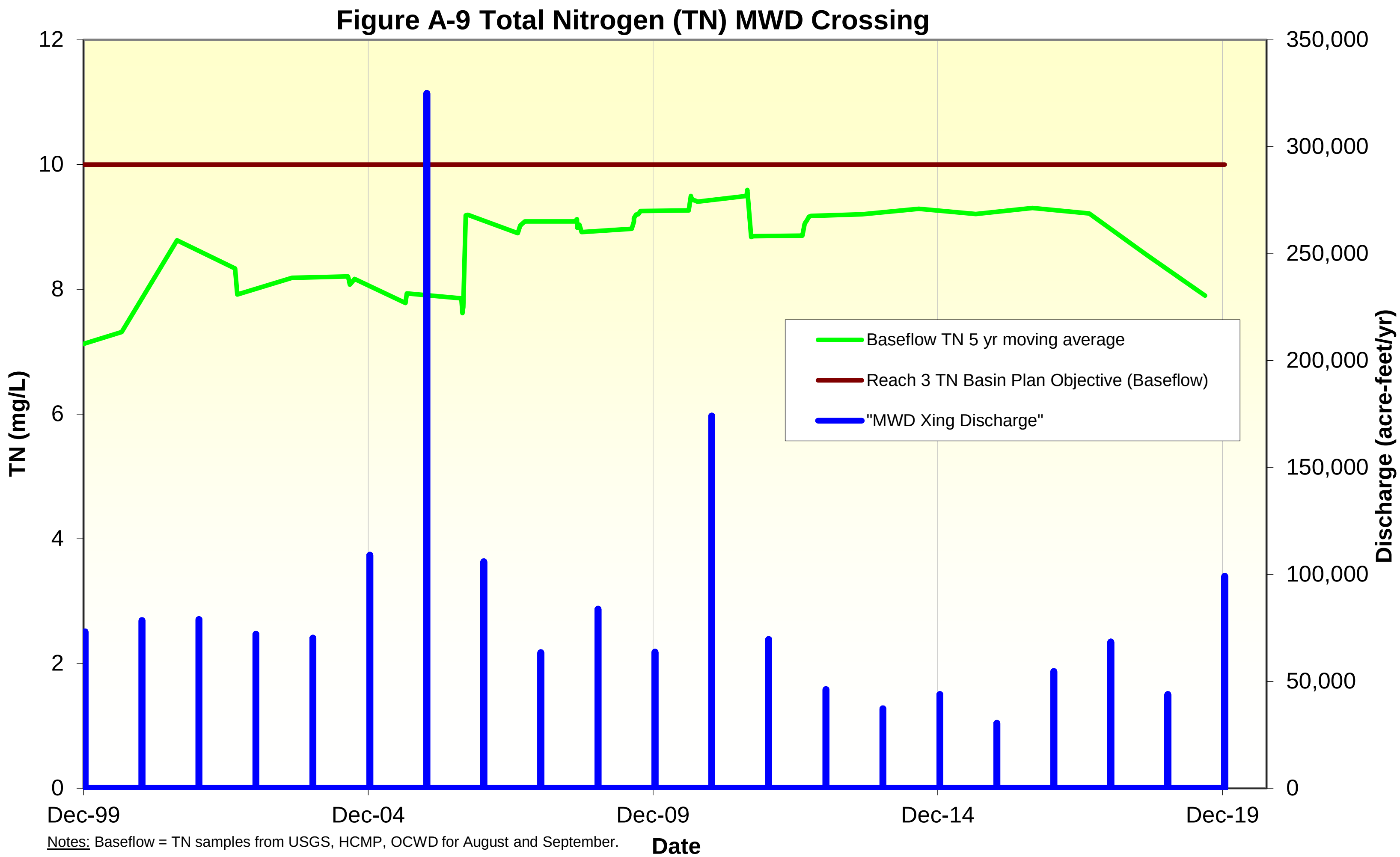
Notes:
Baseflow = Hardness samples from RWQCB, USGS, HCMP, OCWD for August and September.

K:\projects\PA-20 Basin Monitoring Prog\2019 SAR WQ Basin Monitoring Report\Figures



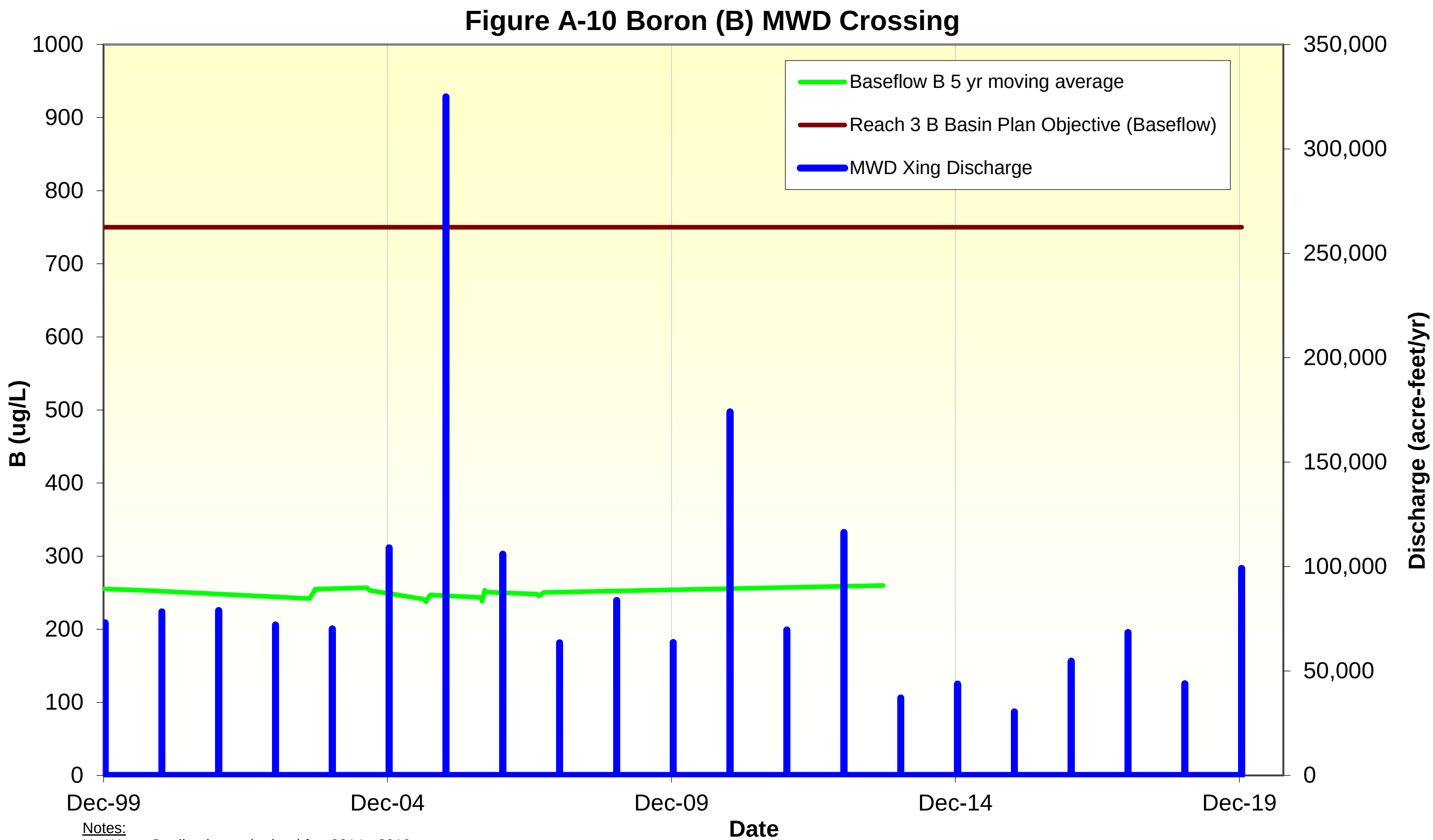
Notes:
Baseflow = TDS samples from USGS, HCMP, OCWD for August and September..

K:\projects\PA-20 Basin Monitoring Prog\2019 SAR WQ Basin Monitoring Report\Figures



Notes: Baseflow = TN samples from USGS, HCMP, OCWD for August and September.

K:\projects\PA-20 Basin Monitoring Prog\2019 SAR WQ Basin Monitoring Report\Figures



Notes:
No Water Quality data submitted for 2014 - 2019.

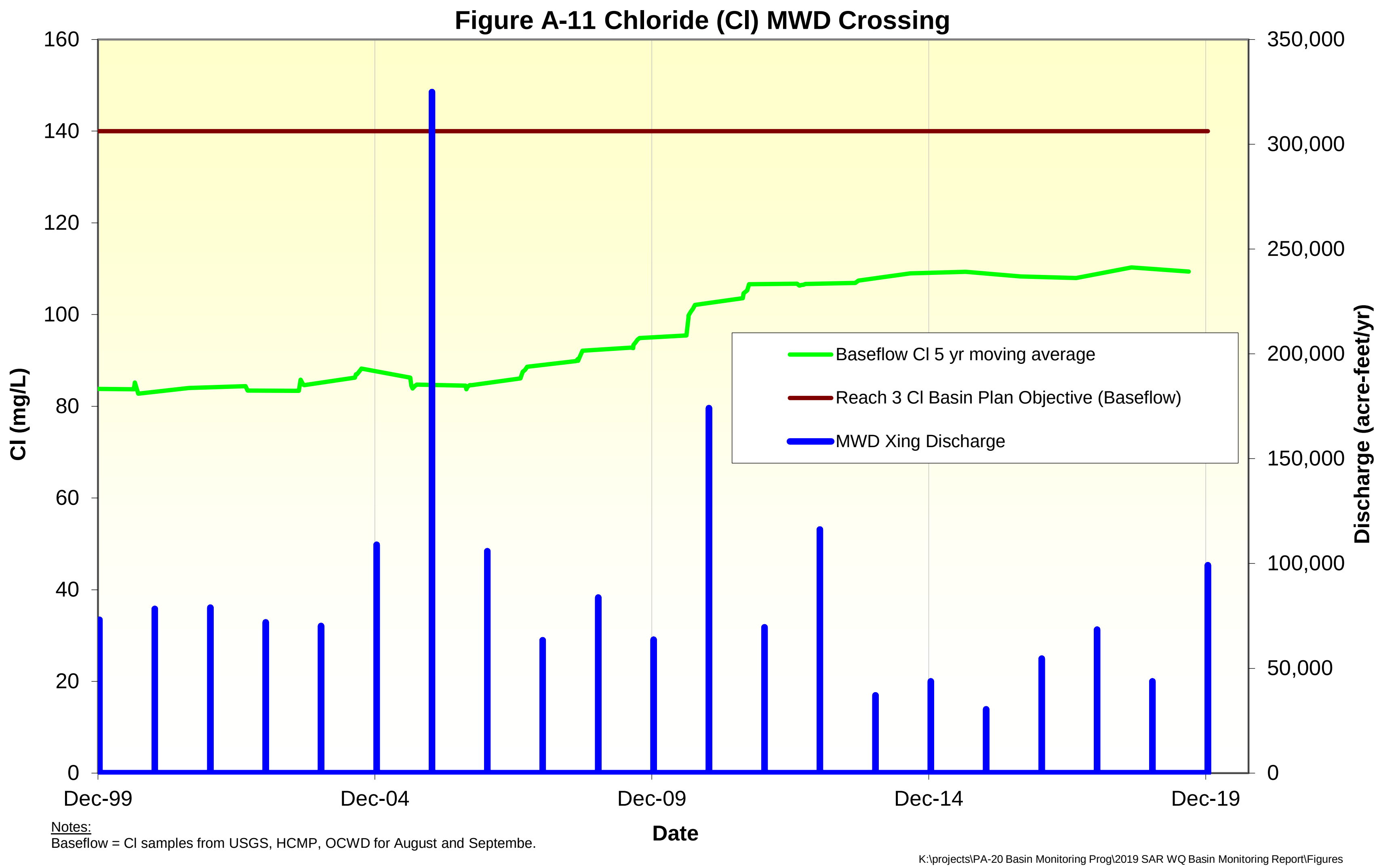
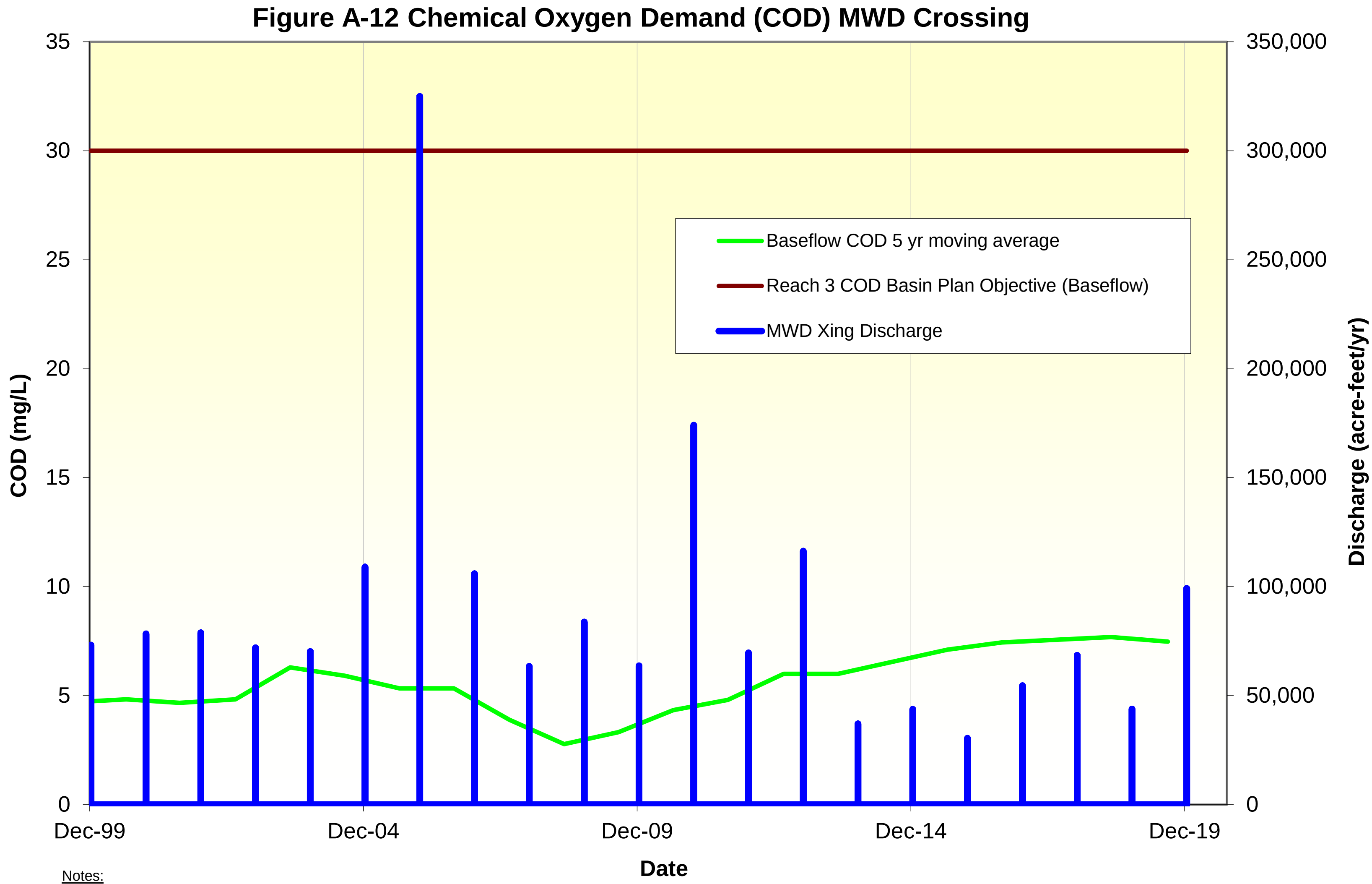
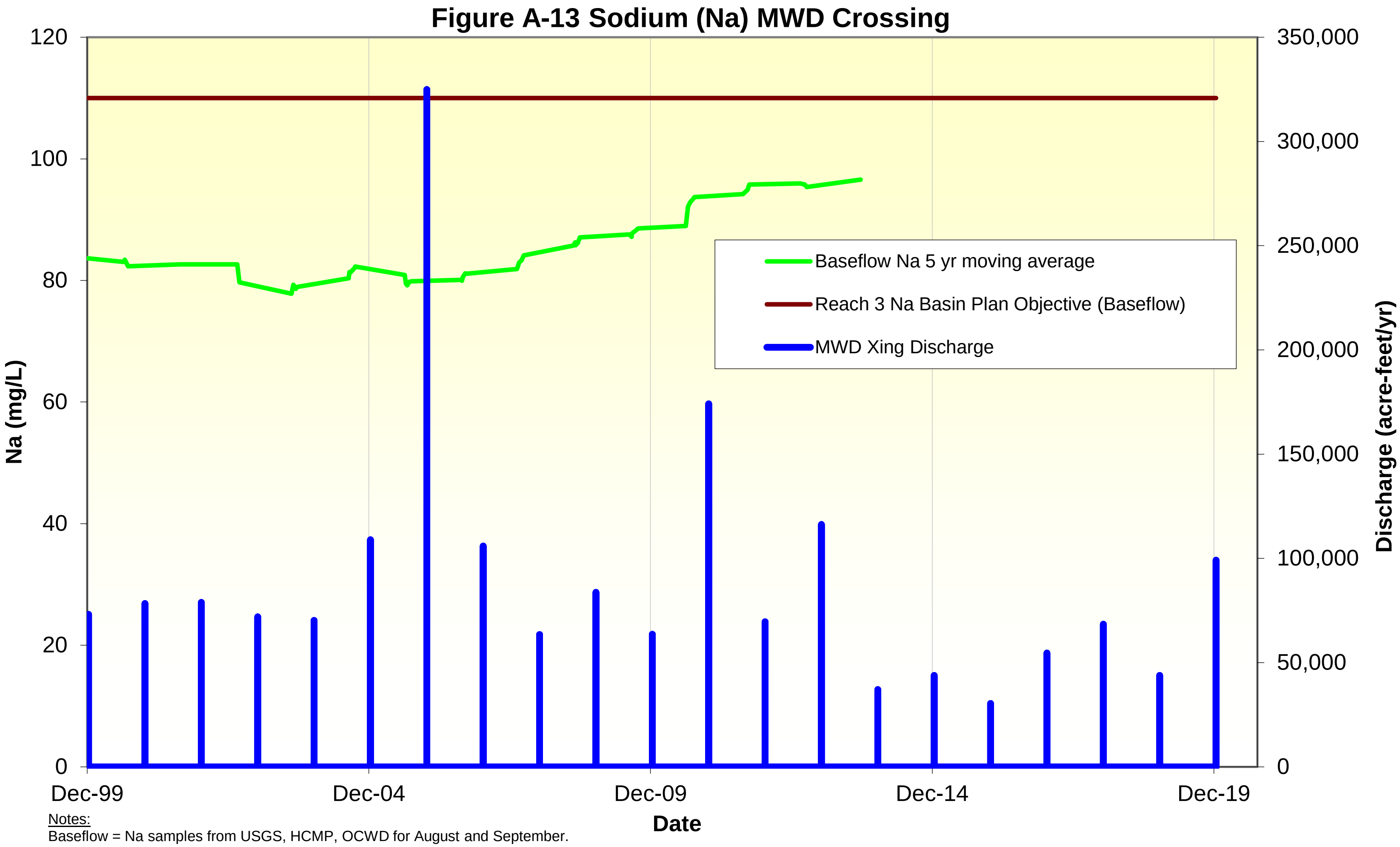


Figure A-11 Chloride (Cl) MWD Crossing
Cl (mg/L)
0
20
40
60
80
100
120
140
160
Discharge (acre-feet/yr)
0
50,000
100,000
150,000
200,000
250,000
300,000
350,000
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19
Date
Baseflow Cl 5 yr moving average
Reach 3 Cl Basin Plan Objective (Baseflow)
MWD Xing Discharge
Notes:
Baseflow = Cl samples from USGS, HCMP, OCWD for August and Septembe.
K:\projects\PA-20 Basin Monitoring Prog\2019 SAR WQ Basin Monitoring Report\Figures



Notes:
Baseflow = COD samples from USGS, HCMP, OCWD for August and September..



Notes:
Baseflow = Na samples from USGS, HCMP, OCWD for August and September.
No Water Quality data submitted for 2014 - 2019.

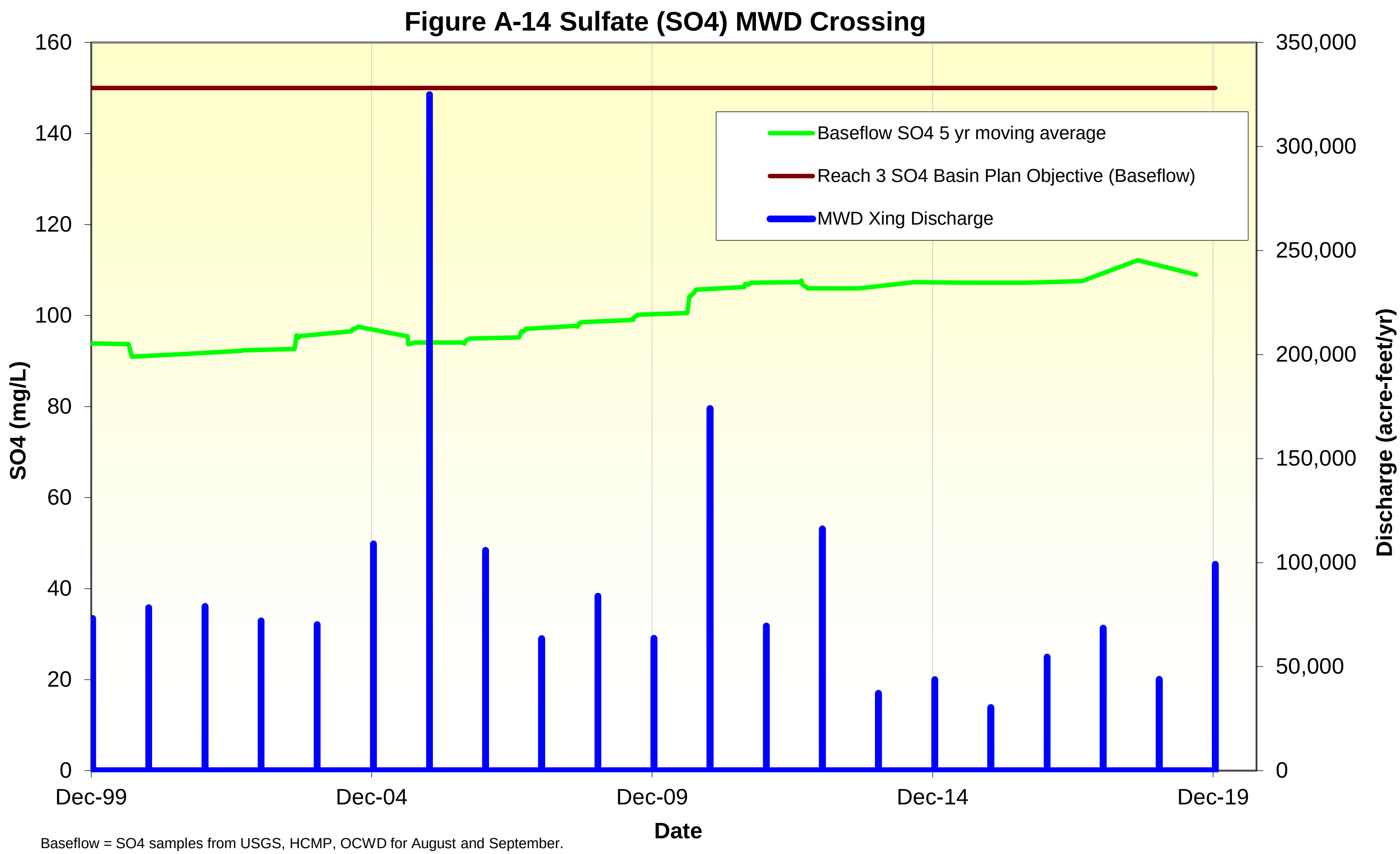
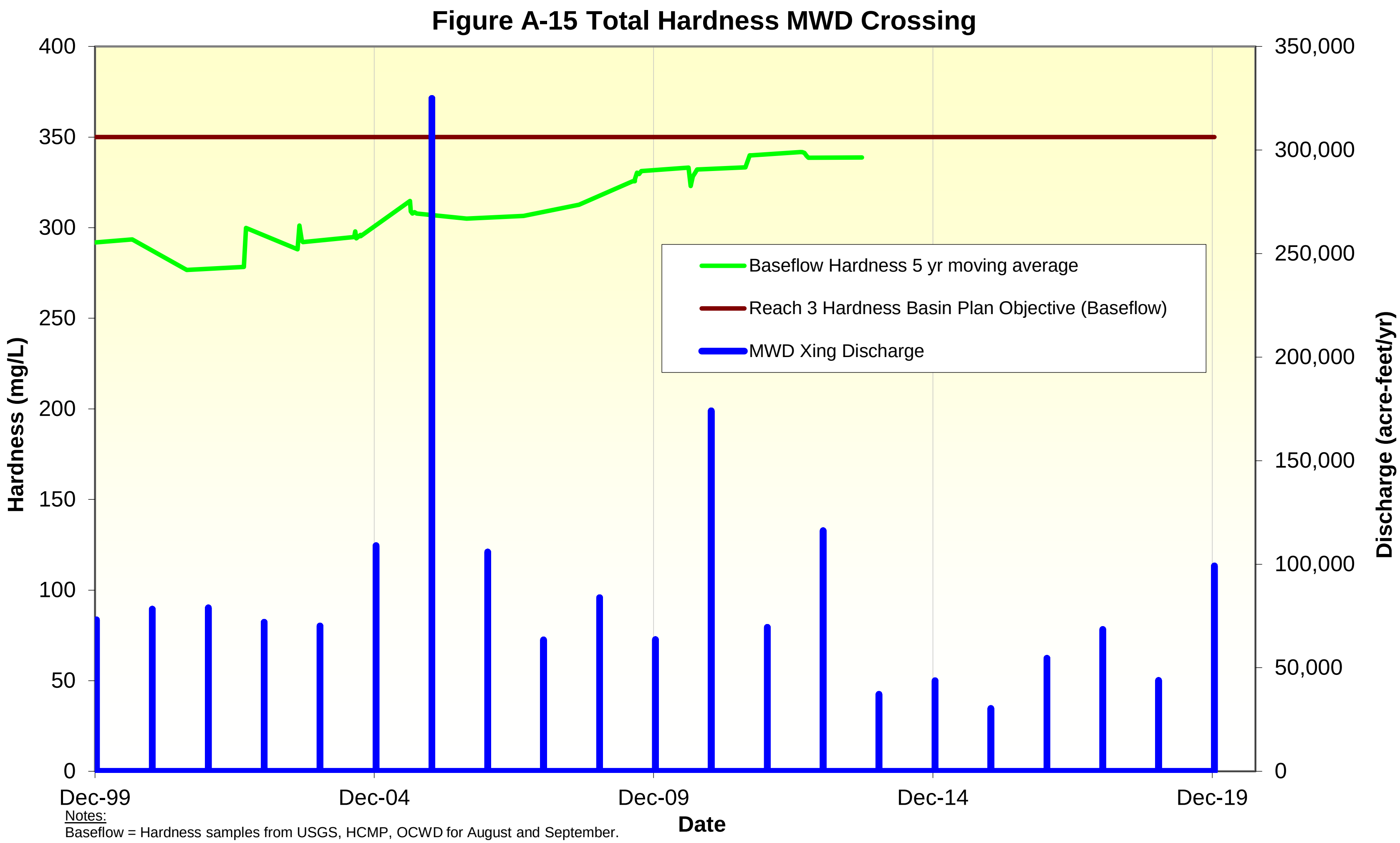


Figure A-14 Sulfate (SO4) MWD Crossing
Baseflow SO4 5 yr moving average
Reach 3 SO4 Basin Plan Objective (Baseflow)
MWD Xing Discharge
SO4 (mg/L)
160
140
120
100
80
60
40
20
0
Discharge (acre-feet/yr)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Dec-99
Dec-04
Dec-09
Dec-14
Dec-19
Date
Baseflow = SO4 samples from USGS, HCMP, OCWD for August and September.



Notes:
Baseflow = Hardness samples from USGS, HCMP, OCWD for August and September.
No Water Quality data submitted for 2014 - 2019.

Appendix B
All 2018 Water Quality and Flow Data
(Available on the SAWPA Website)