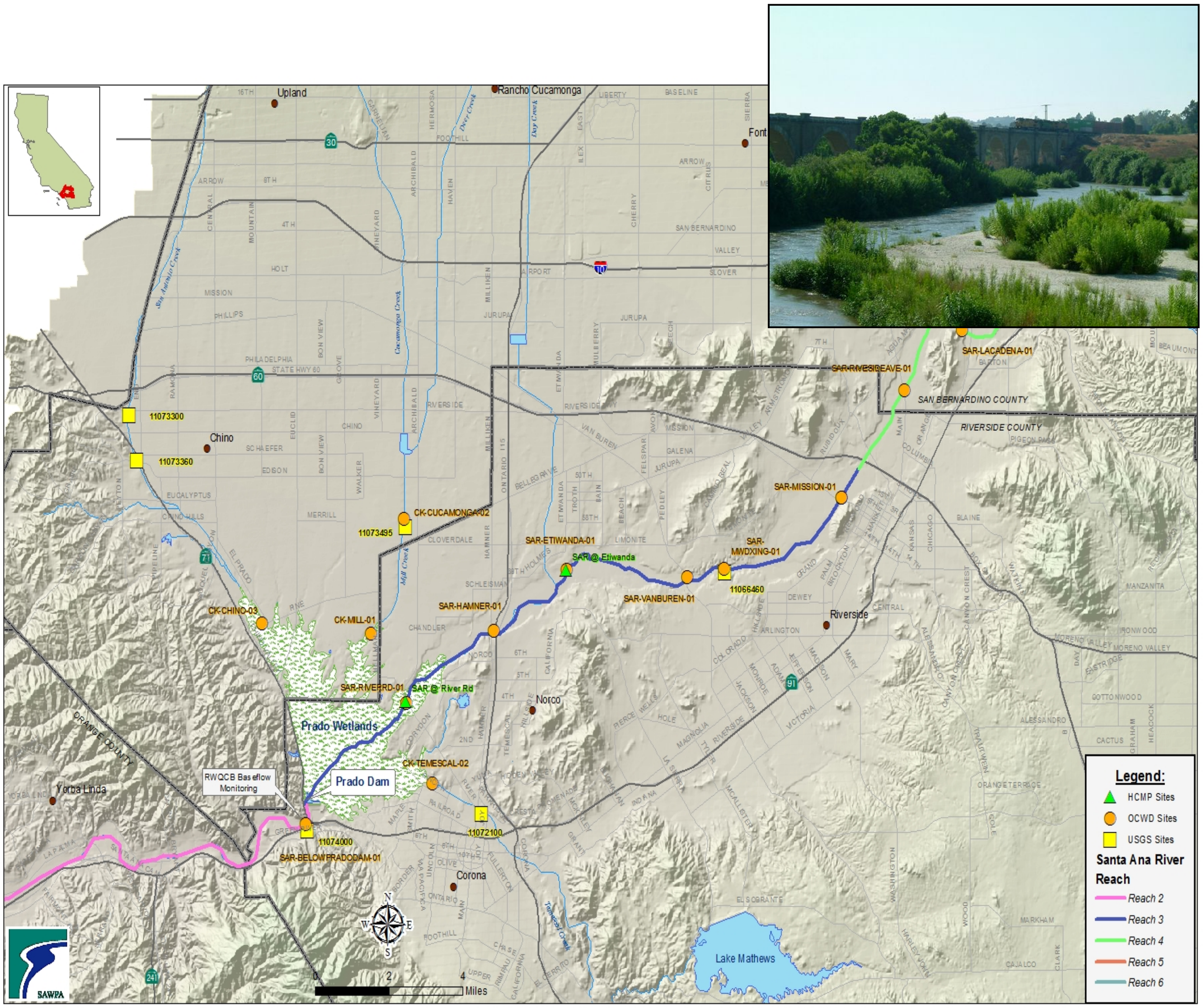
2020 Annual Report

of Santa Ana River Water Quality

Final Report



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Prepared by:

SANTA ANA WATERSHED PROJECT AUTHORITY

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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 base flow 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 base flow objectives at Prado Dam (see Chapter 4 of the Basin Plan), whereas base flow 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 base flow 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 base flow 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 base flow 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 2020 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 2020 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 2020 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 2020 calendar year, follows:

Regional Board staff typically conducts annual water quality monitoring of base flow 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 base flow objectives. In 2020, base flow monitoring consisted of three sampling events from September 1 through September 22, as shown in Table 3-3. The complete set of 2020 base flow water quality data collected exiting Reach 3 below Prado Dam by the Regional Board is included in Appendix B, available on the SAWPA website.

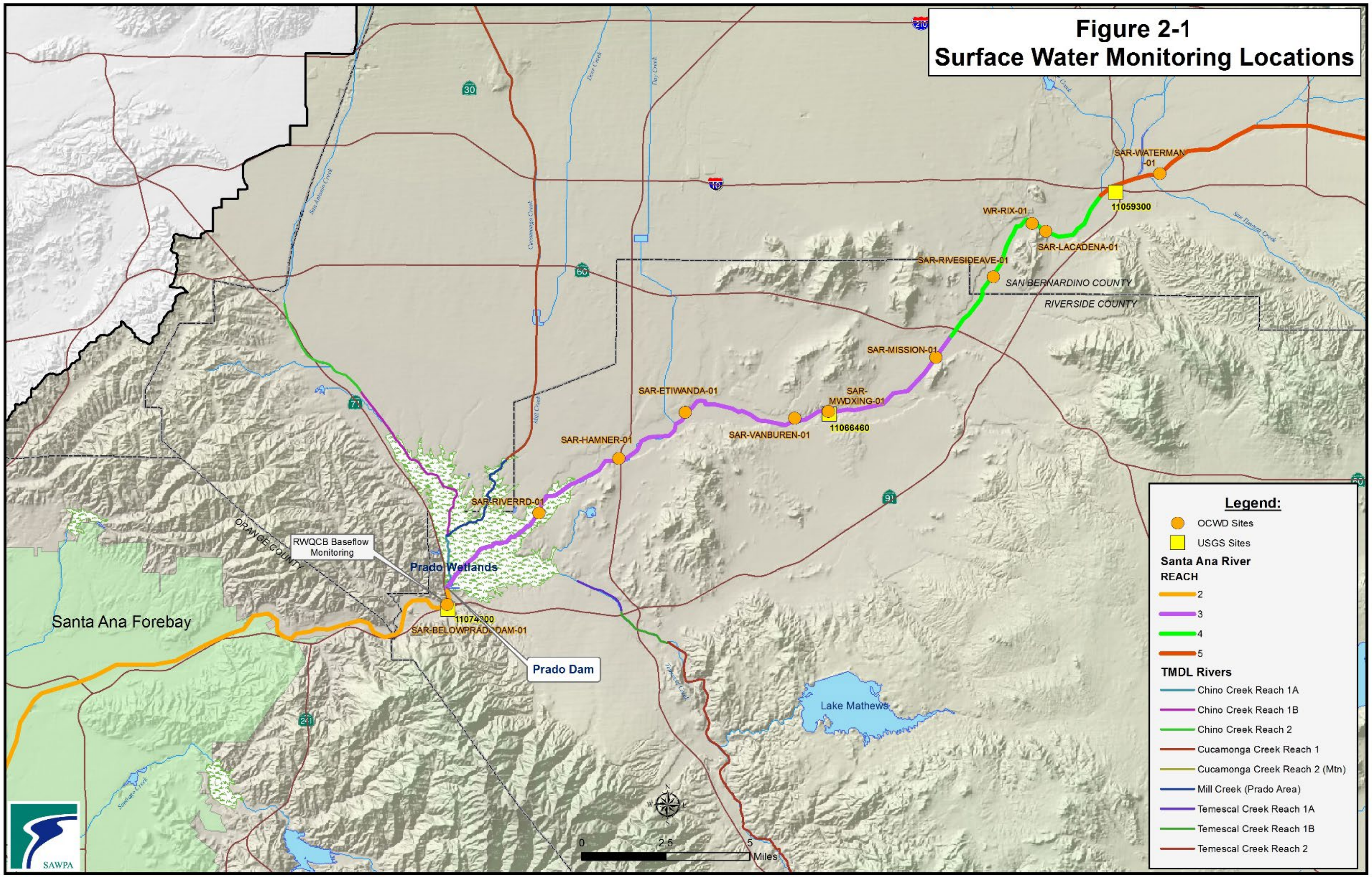
OCWD conducts a monitoring program for the SAR to assess the quality of the SAR water recharged into the Orange County Groundwater Basin. OCWD collects monthly and quarterly samples from the SAR at Imperial Highway in Anaheim and other locations along the SAR below Prado Dam and its tributaries. During 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 08/11/2020). 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 the name of the reach. The complete set of 2020 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 2020.*

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 2020 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	2020 Flow (AFY)	Tributary	X Coordinate	Y Coordinate
11074000	SAR Below Prado Dam	144,590	SAR Reach 2	- 117.644446	33.881583
11066460	SAR at MWD Crossing	49,724	SAR Reach 3	- 117.447501	33.966858
11059300	SAR at E St near San Bernardino	13,564	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 2019-20 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)
2016	560[B]
2017	408
2018	625
2019	401
2020	468
5 Year Average	492

Note: [A] Santa Ana River Watermaster data reported for FY 2019-20 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 2019-20 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 2020 calendar year, 59 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:

$$TDS = (EC \times 0.5746) + 41.725$$

The coefficient of determination (R^2) of the linear regression was 0.92, which indicates a strong correlation between TDS and EC; that is, about 92 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 2020 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 2016 through December 2020 was 466 mg/L. This represents a decrease of 7.0 mg/L from last year's 60-month volume-weighted moving average TDS of 473 mg/L.

Figure 3-1 shows the time history for TDS observations for 2000 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

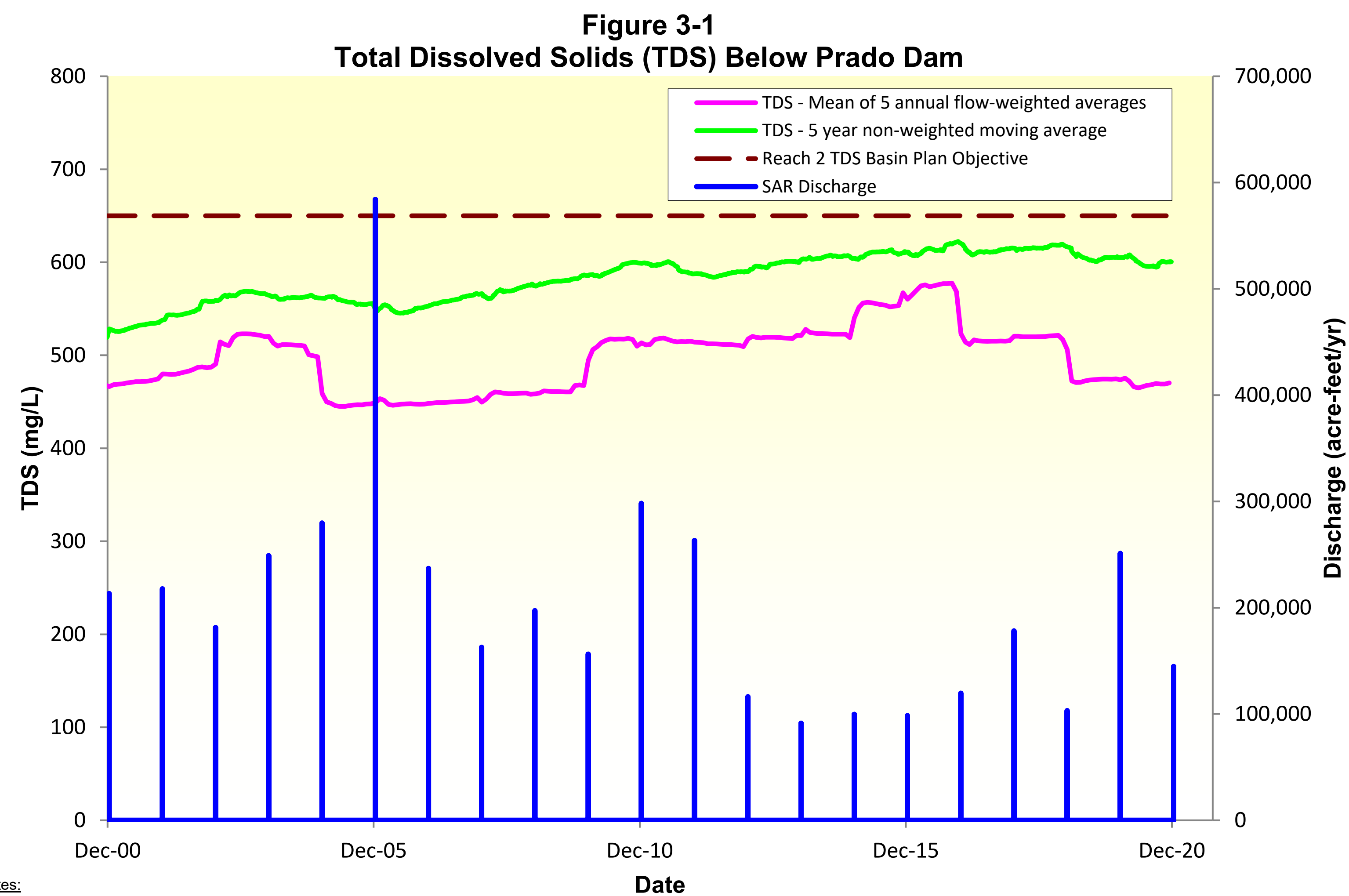
$$Volume\ Weighted\ Monthy\ Average\ TDS\ (mg/L) = \sum_{n=first\ day\ of\ month}^{last\ day\ of\ month} \frac{Daily\ TDS\ Sample\ \left(\frac{mg}{L}\right) x\ Daily\ Flow\ (cfs)}{\sum_{n=first\ day\ of\ month}^{last\ day\ of\ month} Daily\ Flow\ (cfs)}$$

Table 3-2. Monthly Volume-Weighted Moving Average TDS at Below Prado Dam (2020 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-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
Jan-20	11,716	499	5,846,560
Feb-20	4,400	701	3,086,465
Mar-20	7,376	411	3,032,135
Apr-20	15,982	371	5,926,254
May-20	8,432	489	4,120,666
Jun-20	6,364	615	3,911,894
Jul-20[2]	1,408	729	1,026,766
Aug-20	2,142	694	1,487,298
Sep-20	2,282	688	1,570,905
Oct-20	2,400	698	1,673,975
Nov-20	3,723	653	2,429,466
Dec-20[2]	3,138	680	2,133,983
Total	**389,439**		**181,667,504**
60 - Month Volume Weighted Average: 466 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 2020 from SAWPA.

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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 non-tributary flows is at a minimum. In 2020, 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 2020, base flow monitoring below Prado Dam consisted of three sampling events conducted during the month of September. The data collected through this program are presented in Table 3-3.

Table 3-3. Results for 2020 Annual Base Flow Monitoring Program for the Santa Ana River at Below Prado Dam (Regional Board Data Only)

Parameter	Units	Basin Plan Objectives SAR Reach 3	9/1/2020	9/16/2020	9/22/2020
Ammonia-Nitrogen	mg/L	**X[1]**	0.110	0.082	0.080
Bicarbonate (as CaCO3)	mg/L		< 8	196	199
Boron	mg/L	**0.75**	0.30	0.28	0.30
Calcium	mg/L		82	78	86
Carbonate (as CaCO3)	mg/L		X[3]	< 1.7	< 1.7
Chemical Oxygen Demand	mg/L	**30**	< 10	22	< 10
Chloride (dis)	mg/L	**140**	51[4]	161	144
Electrical Conductivity	umhos/cm		1200	1150	1150
Fluoride (dis)	mg/L		0.45	0.47	0.41
Hydroxide	mg/L		< 8	na	na
Iron	mg/L		2.4	< 1.5	2.7
Magnesium	mg/L		21	18	20
Manganese	mg/L		< 0.25	< 0.25	< 0.25
Nitrate-Nitrogen	mg/L		2.2	4.2	4.8
Nitrite-Nitrogen	mg/L		0.039	0.049	0.028
Organic Nitrogen	mg/L		na	na	na
Potassium	mg/L		11.6	10.9	7.4
Sodium	mg/L	**110**	117	110	115
Sulfate (dis)	mg/L	**150**	117	115	108
Total Alkalinity (as CaCO3)	mg/L		210	196	199
Total Dissolved Solids	mg/L	**700**	700	728	680
Total Hardness (as CaCO3)	mg/L	**350**	318	320	312
Total Inorganic Nitrogen (calc)	mg/L	**10[2]**	2.4	4.3	4.9
Total Kjeldahl Nitrogen	mg/L		1.0	1.4	1.3
Total Nitrogen	mg/L		3.2	5.6	6.1
Total Organic Carbon (total)	mg/L		4.2	4.3	4.3
Turbidity	NTU		77	99	78

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] *Santa Ana River Basin Plan specifies that Total Nitrogen Samples are to be filtered.*
X[3] *9/1/20 Carbonate (as CaCO3) value was deemed to be a laboratory error and disqualified from the dataset.*
X[4] *9/1/20 Chloride sample was diluted 100x possibly due to an issue with the sample matrix.*

A summary of all base flow monitoring data collected by the USGS, OCWD and the Regional Board at *Below Prado Dam* during 2020 along with Basin Plan objectives for base flow conditions for SAR Reach 3 water quality are presented in Table 3-4. This includes three monitoring events conducted by the Regional Board for their annual water quality monitoring of base flow in the SAR during September of 2020. OCWD conducted five base flow monitoring events at Below Prado Dam in 2020. 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 base flow sampling events at Below Prado Dam in August and September 2020. Table 3-4 presents the results of this monitoring.

Table 3-4. Summary of Base Flow Water Quality Observations for the Santa Ana River at Below Prado Dam (2020 OCWD, USGS and Regional Board at Below Prado Dam)

Constituent	Units	Basin Plan Objectives SAR Reach 3	Base Flow Average	# of Samples
Ammonia-Nitrogen	mg/L	**X[1]**	0.086	5
Ammonia-Nitrogen (unfiltered)	mg/L		0.14	5
Bicarbonate (as CaCO3)	mg/L		208	10
Boron	mg/L	**0.75**	0.30	7
Calcium	mg/L		81	7
Carbonate (as CaCO3)	mg/L		1.3	9
Chemical Oxygen Demand (unfiltered)	mg/L	**30**	15	6
Chloride	mg/L	**140**	145	10
Electrical Conductivity	umhos/cm		1134	75
Electrical Conductivity (field)	umhos/cm		1161	7
Fluoride	mg/L		0.4	4
Hydroxide (as CaCO3)	mg/L		< 8.0	6
Iron	mg/L		2.2	3
Magnesium	mg/L		21	7
Manganese	mg/L		< 0.25	3
Nitrate-Nitrogen	mg/L		3.6	5
Nitrate-Nitrogen (unfiltered)	mg/L		3.1	5
Nitrite-Nitrogen	mg/L		0.038	5
Nitrite-Nitrogen (unfiltered)	mg/L		0.058	5
Organic Nitrogen	mg/L		0.4	2
Organic Nitrogen (unfiltered)	mg/L		1.0	5
Potassium	mg/L		12.4	7
Sodium	mg/L	**110**	118	7
Sulfate	mg/L	**150**	118	10
Total Alkalinity (as CaCO3)	mg/L		220	12
Total Dissolved Solids	mg/L	**700**	708	14
Total Hardness (as CaCO3)	mg/L	**350**	317	7
Total Inorganic Nitrogen	mg/L	**10[2]**	3.7	5
Total Inorganic Nitrogen (unfiltered)	mg/L		3.2	5
Total Kjeldahl Nitrogen	mg/L		1.2	3
Total Kjeldahl Nitrogen (unfiltered)	mg/L		1.2	5
Total Nitrogen	mg/L		4.6	5
Total Nitrogen (unfiltered)	mg/L		4.3	5
Total Organic Carbon (total)	mg/L		< 5	10
Turbidity	NTU		57	10

Notes: *Table presents average concentration data*
na *not available*
Table summarizes base flow monitoring data collected by USGS, OCWD and the Regional Board at Below Prado Dam during 2020
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] *Santa Ana River Basin Plan specifies that Total Nitrogen Samples are to be filtered.*

The USGS also maintains a gauging station, 11074000, located on the SAR below Prado Dam, shown in Figure 2-1. In 2020, this station recorded flows totaling 144,590 AFY.

A long time-history of water quality data has been collected by USGS along with data collected by OCWD, Regional Board base flow 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 2000 through to current and are included in Appendix A, to show the longer-term trends in base flow data, and non-base flow 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 11, 2020. 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 Base flow conditions, represented by water quality data collected in August and September of 2020, 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 2020, this station recorded flows totaling 49,724 AFY.

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

Constituent	Units	Basin Plan Objectives SAR Reach 3	Base Flow Average	# of Samples
Ammonia-Nitrogen (unfiltered)	mg/L	**X[1]**	< 0.1	5
Bicarbonate (as CaCO3)	mg/L		216	5
Carbonate (as CaCO3)	mg/L		< 1.0	5
Chemical Oxygen Demand (unfiltered)	mg/L	**30**	4.6	5
Chloride	mg/L	**140**	123	5
Electrical Conductivity	umhos/cm		1035	9
Electrical Conductivity (field)	umhos/cm		1058	5
Hydroxide (as CaCO3)	mg/L		< 1.0	5
Nitrate-Nitrogen (unfiltered)	mg/L		5.7	5
Nitrite-Nitrogen (unfiltered)	mg/L		0.013	5
Organic Nitrogen (unfiltered)	mg/L		0.20	5
Sulfate	mg/L	**150**	106	5
Total Alkalinity (as CaCO3)	mg/L		216	5
Total Dissolved Solids	mg/L	**700**	647	9
Total Inorganic Nitrogen (unfiltered)	mg/L	**10[2]**	5.8	5
Total Kjeldahl Nitrogen (unfiltered)	mg/L		0.28	5
Total Nitrogen (unfiltered)	mg/L		5.9	5
Total Organic Carbon	mg/L		< 5	5
Turbidity	NTU		3.3	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 2020, 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		168	2
Carbonate (as CaCO3)	mg/L		< 1	2
Chemical Oxygen Demand (unfiltered)	mg/L	**30**	4	2
Chloride	mg/L		90	2
Electrical Conductivity	umhos/cm		842	2
Electrical Conductivity (field)	umhos/cm		842	2
Hydroxide (as CaCO3)	mg/L		< 1	2
Nitrate-Nitrogen (unfiltered)	mg/L		7.1	2
Nitrite-Nitrogen (unfiltered)	mg/L		0.040	2
Organic Nitrogen (unfiltered)	mg/L		< 0.1	2
Sulfate	mg/L		76	2
Total Alkalinity (as CaCO3)	mg/L		168	2
Total Dissolved Solids	mg/L	**550**	525	2
Total Inorganic Nitrogen (unfiltered)	mg/L	**10**	7.1	2
Total Kjeldahl Nitrogen (unfiltered)	mg/L		< 0.2	2
Total Nitrogen (unfiltered)	mg/L		7.1	2
Total Organic Carbon	mg/L		< 5	2
Turbidity	NTU		2.1	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.*

- Site SAR Mission Avenue includes data collected by OCWD at " SAR-MISSION-01"
- Site SAR Riverside Avenue includes only data collected by OCWD at " SAR-RIVERSIDEAVE-01"
- Site SAR La Cadena Drive includes only data collected by OCWD at " SAR-LACADENA-01"

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 2020, 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 2020, this station recorded flows totaling 13,564 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). However, the average TDS concentration of the 14 samples collected at the same location in August and September of 2020 barely exceeded the water quality objective established for Reach 3 during base flow conditions (708 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 base flow 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 volume of 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 base flow conditions.

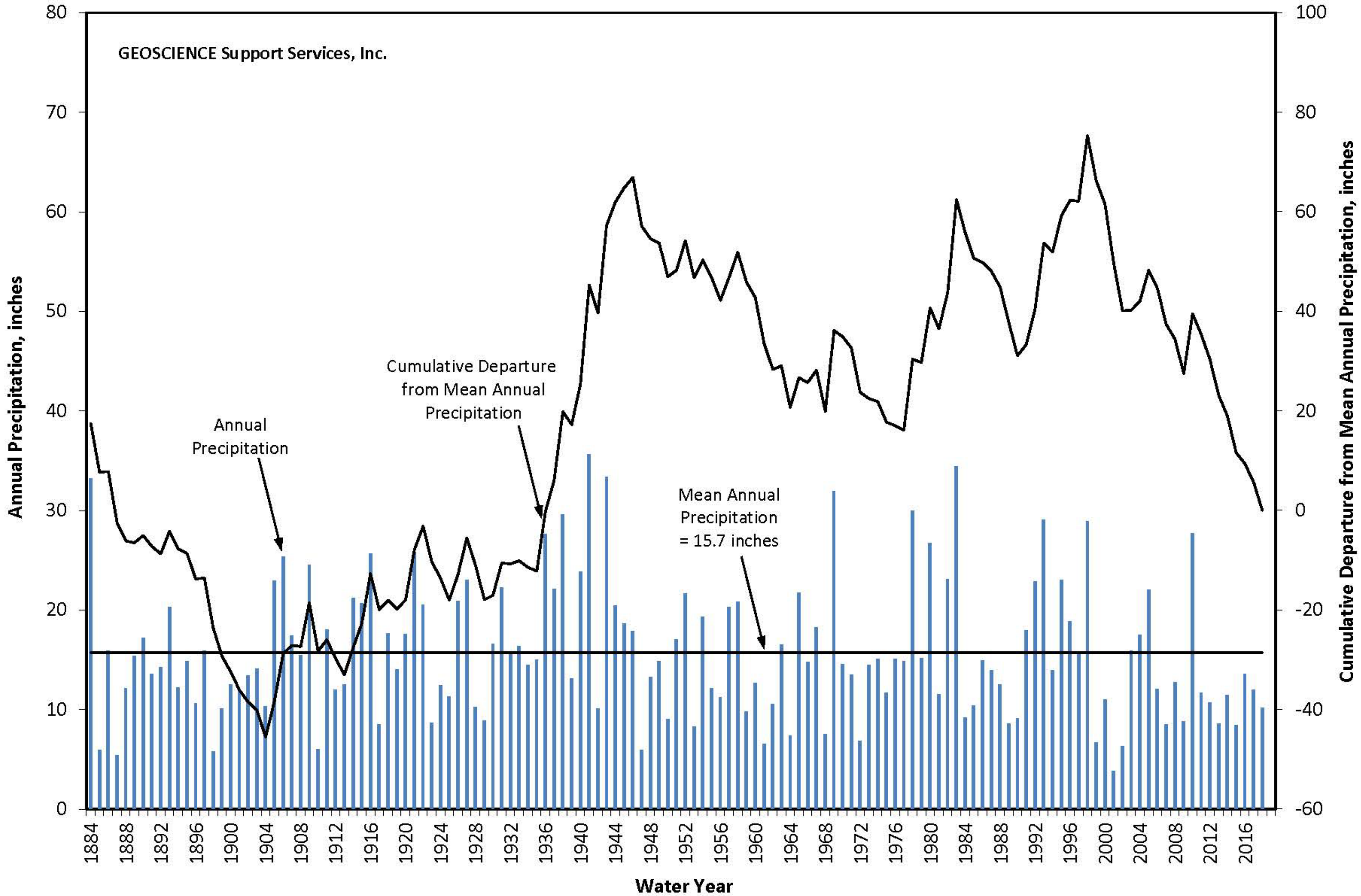
In 2020, the average base flow concentration of Total Nitrogen at Prado Dam was 4.6 mg/L, well below the water quality objective established for Reach 3. Long-term water quality monitoring data confirms that average nitrogen concentrations are continuing to slowly decline over time (see Figure 3-2). This is also the result of discharging less volume of 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.

Base flow 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 647 mg/L and the average TIN concentration was 5.8 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 525 mg/L which complies with the applicable water quality objective of 550 mg/L. The average TIN concentration in these same two samples was 7.1 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 fifteen 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 (WLAM), which was completed in June 2020. 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 by August of 2022 for Regional Board review and approval. Regional Board staff, in conjunction with the Task Force, is in the process of preparing proposed draft Basin Plan Amendments to document the results of the June 2020 WLAM and to require updates to the both the surface and groundwater monitoring approaches. For surface water, 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) Additional future Basin Plan amendments should consider revisions to include a clear definition of what constitutes "base flow" 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 base flow 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 Basin Monitoring Task Force recommends that the Basin Plan be amended in the future 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 2020 Draft Annual Report of Santa Ana River Water Quality

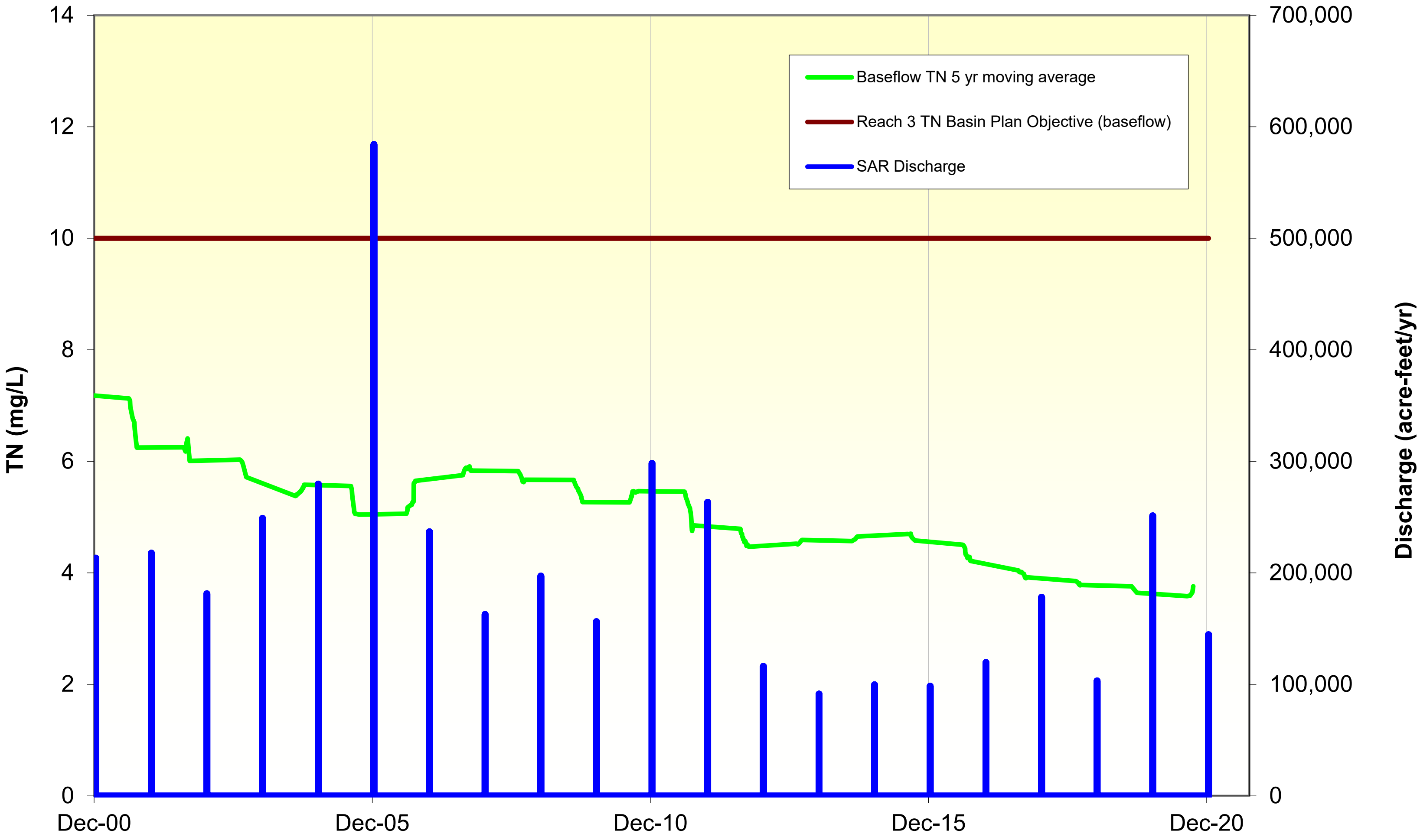
Comments Received	Agency	Page/Table/Section	Detail	Response to Comments
Melissa Estrada-Maravilla (7/14/21)	**City of Corona**	Page 3-1 / Page 3-8	there are two "3-1" pages. Should the second "3-1" page be "3-8"?	Page numbers will be corrected
		Page 2-1	OCWD monitoring locations used in this report are presented in Table 2-1. In later tables and figures, OCWD stations are referred to by their map location. Would it be better to state something like: stations are referred to by their "station name"?	The report tables present the average monitoring results for all monitoring locations within a reach and therefore it may be appropriate to refer to the monitoring locations by reach name.

Comments Received	Agency	Page/Table/Section	Detail	Response to Comments
Eddie Lin (7/19/21)	**IEUA**	Page 4-1	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. "Less treated wastewater" could be misinterpreted as POTWs were discharging lower quality water when the opposite is actually true - POTW effluent has been diluting high TDS discharges to the SAR. Recommend revising the language to say something to the effect of: POTWs were maximizing use of their local supplies and discharging less, resulting in less high quality water for diluting other Santa Ana River system flows.	Text revised to refect "less volume of treated wastewater to the Santa Ana River system"
		Page 4-1	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. Can it also be noted that this is due to a reduction in agricultural activity over time?	This issue has been discussed with the Task Force and has been identified as an item to be addressed in the project planning document.
		4.2 Recommendations	Would suggest bringing up to the Task Force group for discussion to ensure the group is aware and fully understands the recommendations being made, especially as a Basin Plan amendment is underway.	This issue has been discussed with the Task Force and has been identified as an item to be addressed in the project planning document.

Appendix A

Water Quality Trends at Below Prado Dam and MWD Crossing 2000 to Current

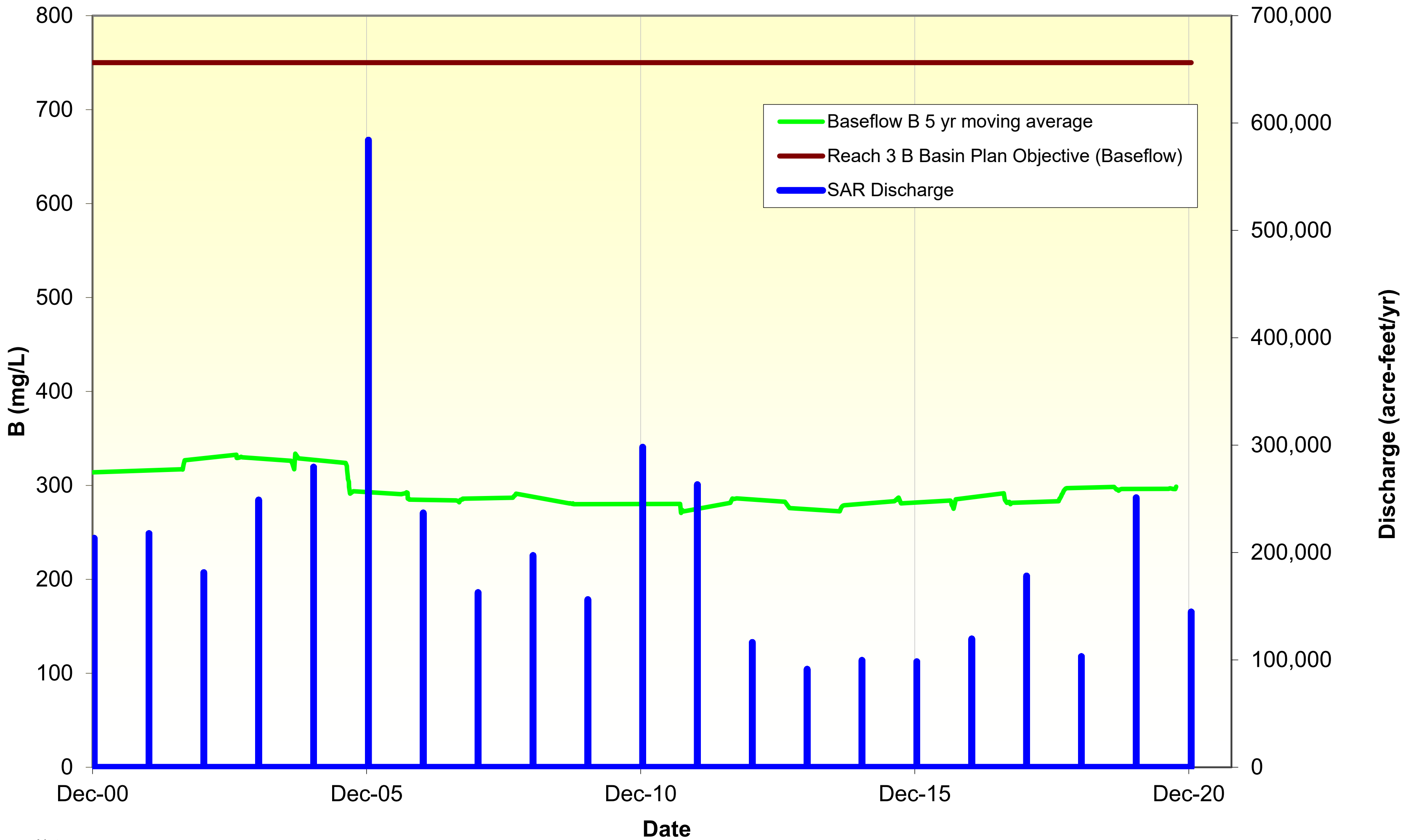
Figure A-1 Total Nitrogen (TN) Below Prado Dam



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

K:\projects\PA-20 Basin Monitoring Prog\2020 SAR WQ Basin Monitoring Report\Figures

Figure A-2 Boron (B) Below Prado Dam



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

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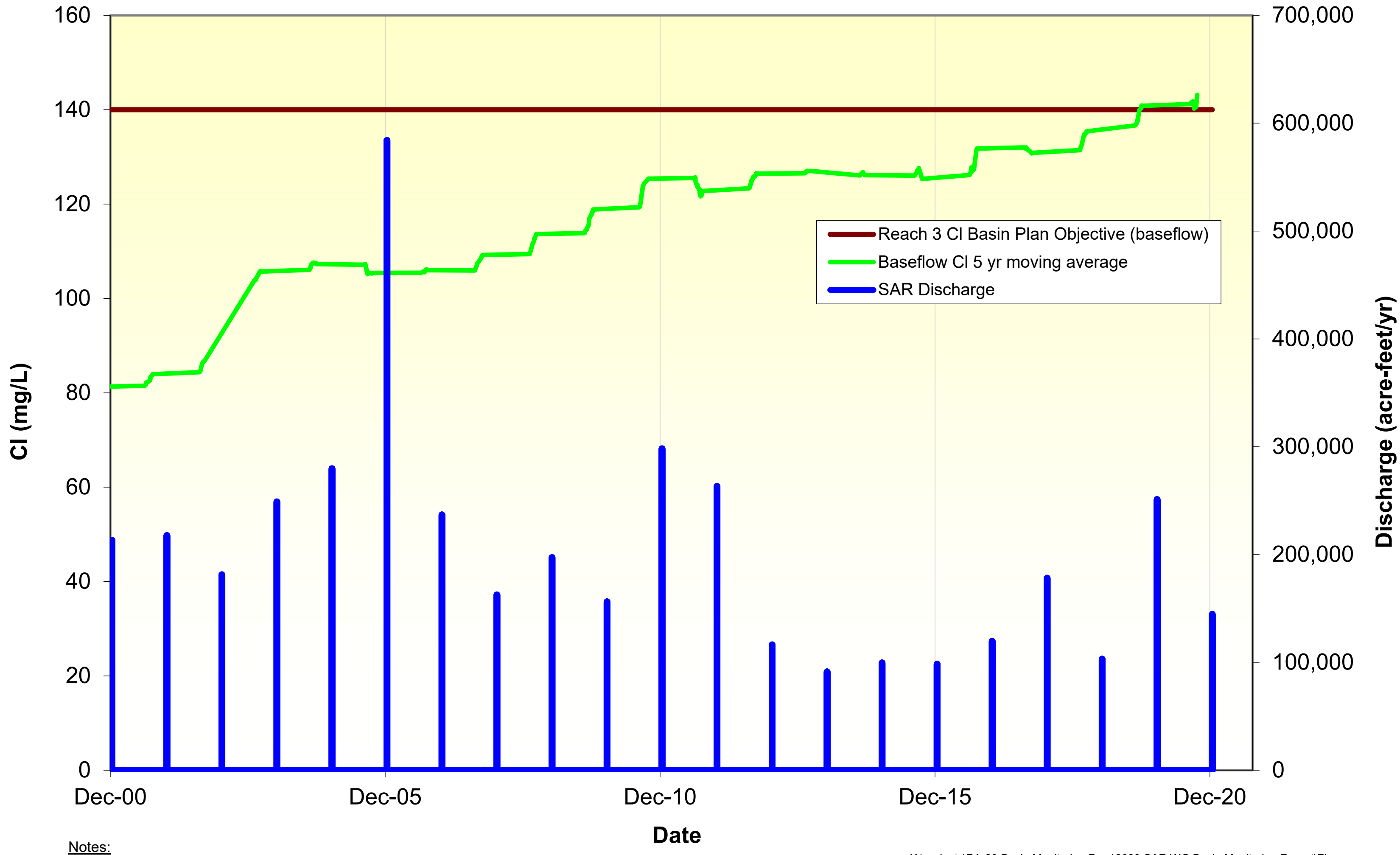
Figure A-3 Chloride (Cl) Below Prado Dam



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

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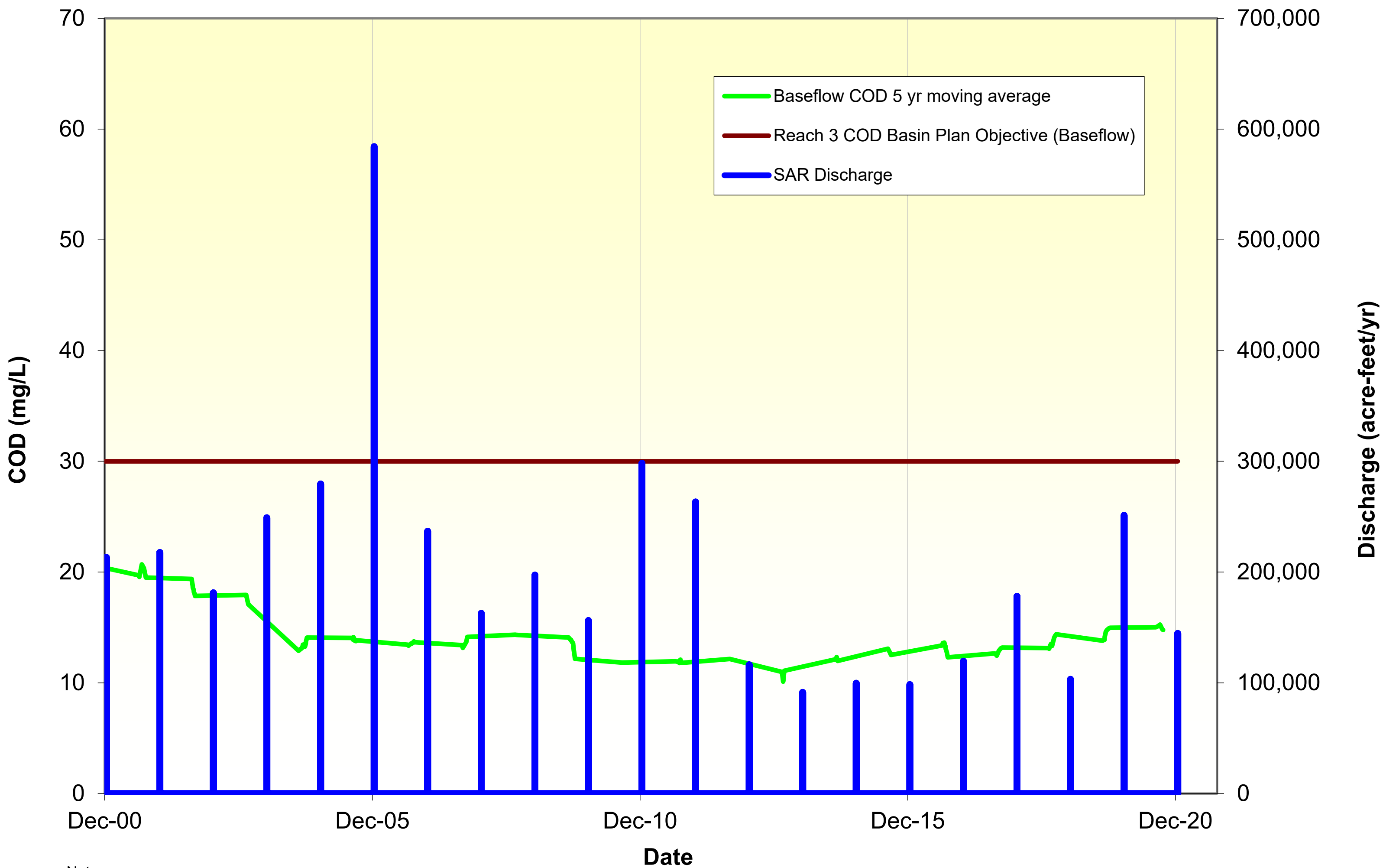
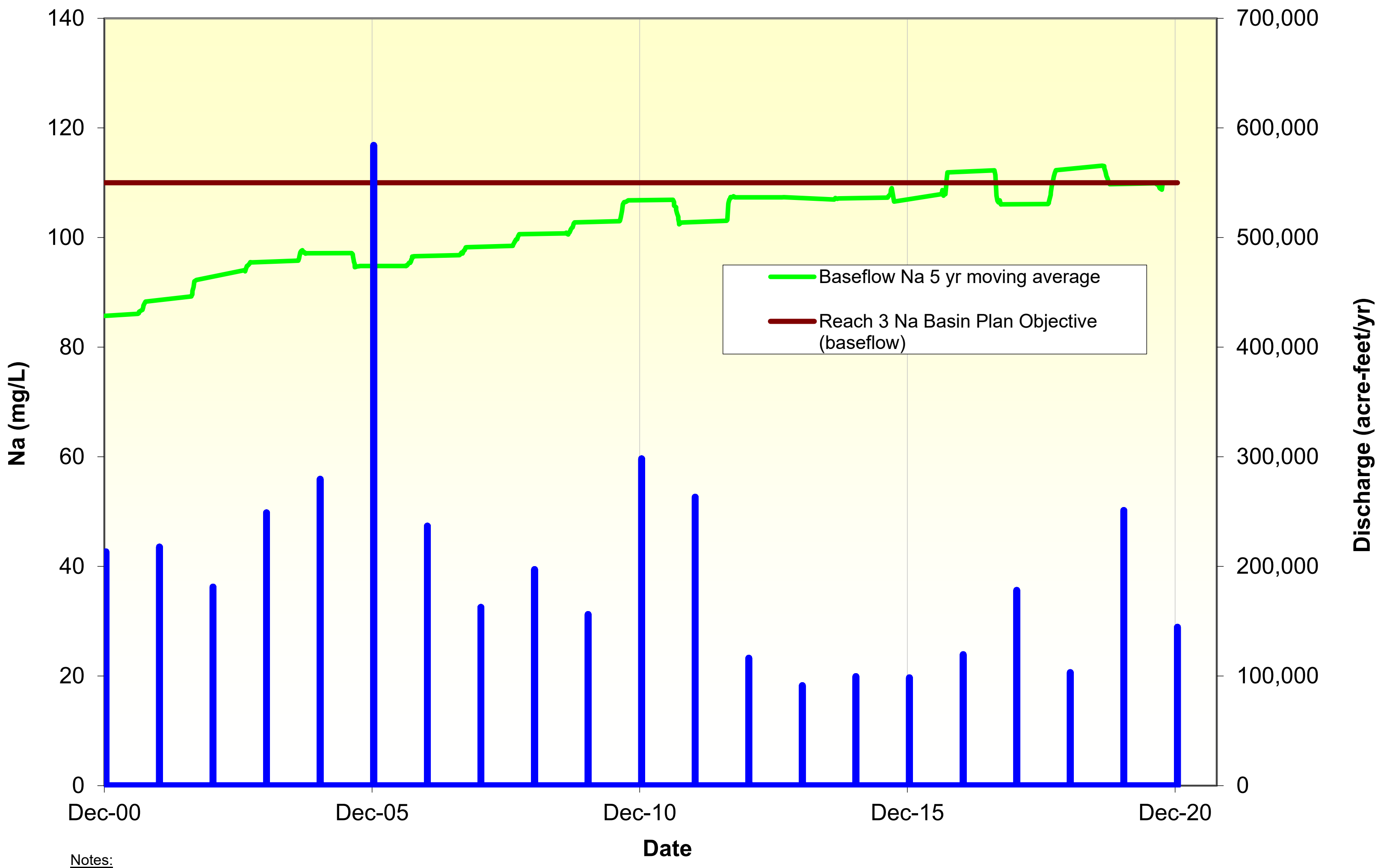
Figure A-4 Chemical Oxygen Demand (COD) Below Prado Dam



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

K:\projects\PA-20 Basin Monitoring Prog\2020 SAR WQ Basin Monitoring Report\Figures

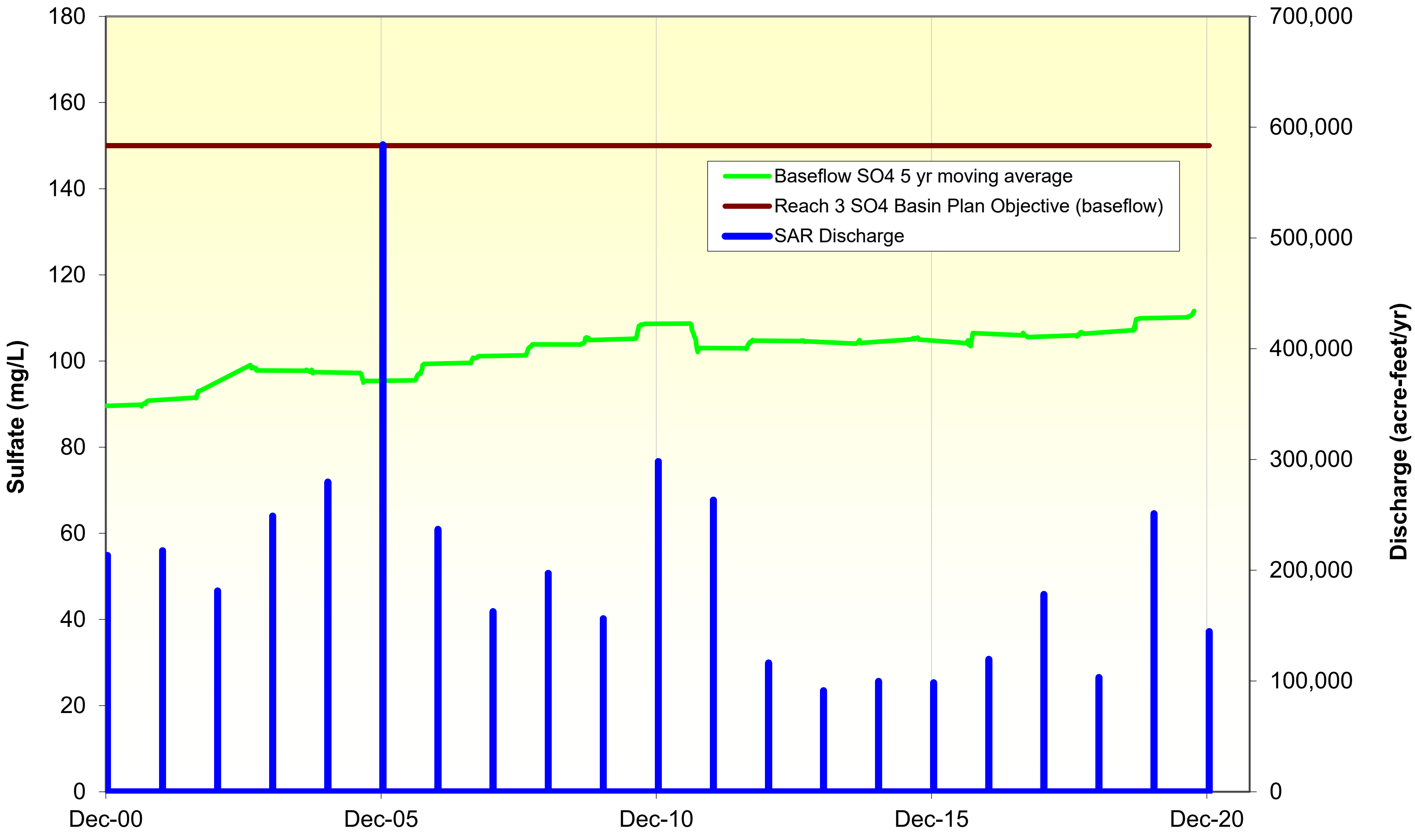
Figure A-5 Sodium (Na) Below Prado Dam



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

K:\projects\PA-20 Basin Monitoring Prog\2020 SAR WQ Basin Monitoring Report\Figures

Figure A-6 Sulfate (SO4) Below Prado Dam



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

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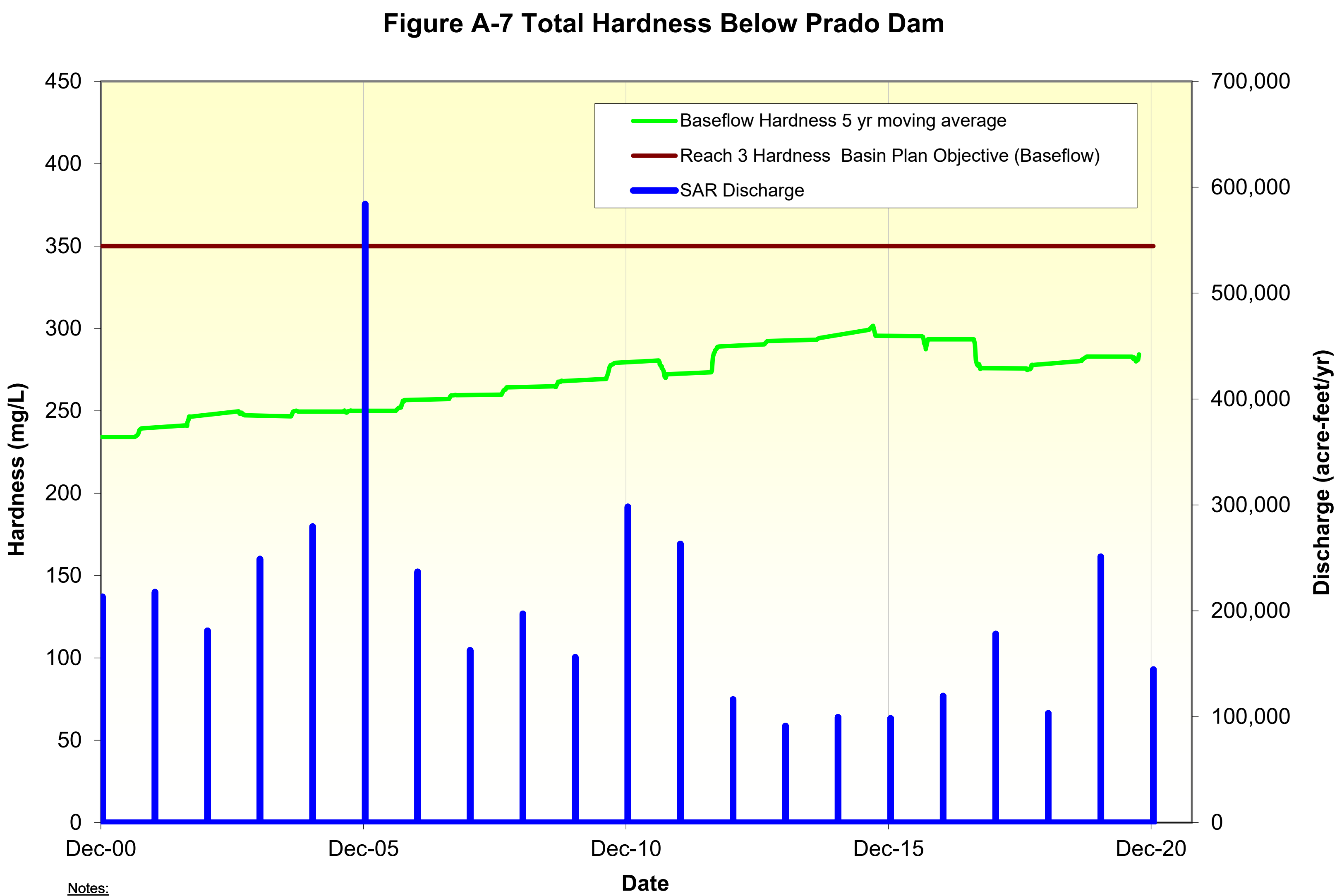
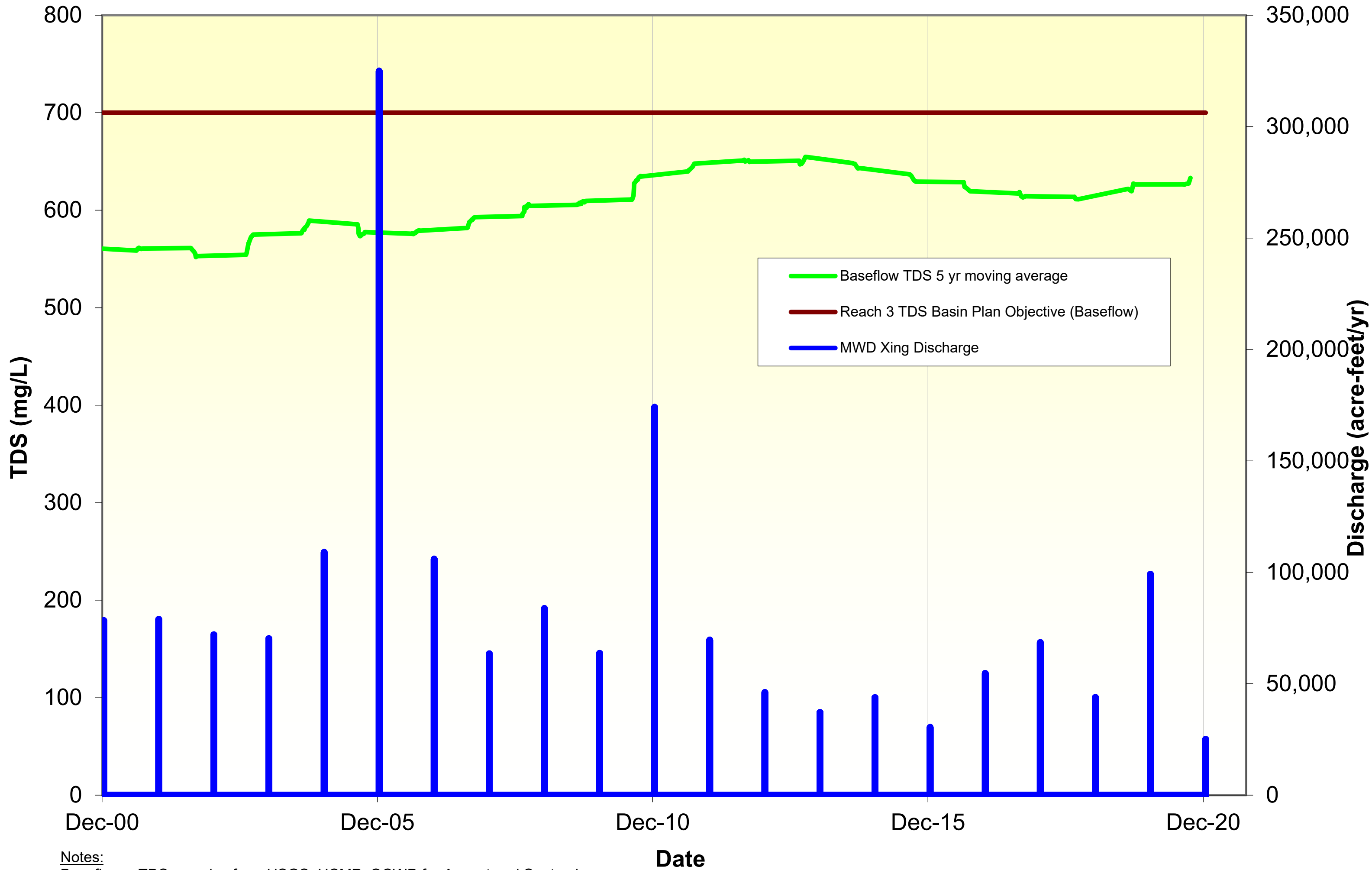


Notes:
Baseflow = Hardness samples from RWQCB, USGS, HCMP, OCWD for August and September.

K:\projects\PA-20 Basin Monitoring Prog\2020 SAR WQ Basin Monitoring Report\Figures

Figure A-8 Total Dissolved Solids (TDS) MWD Crossing



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

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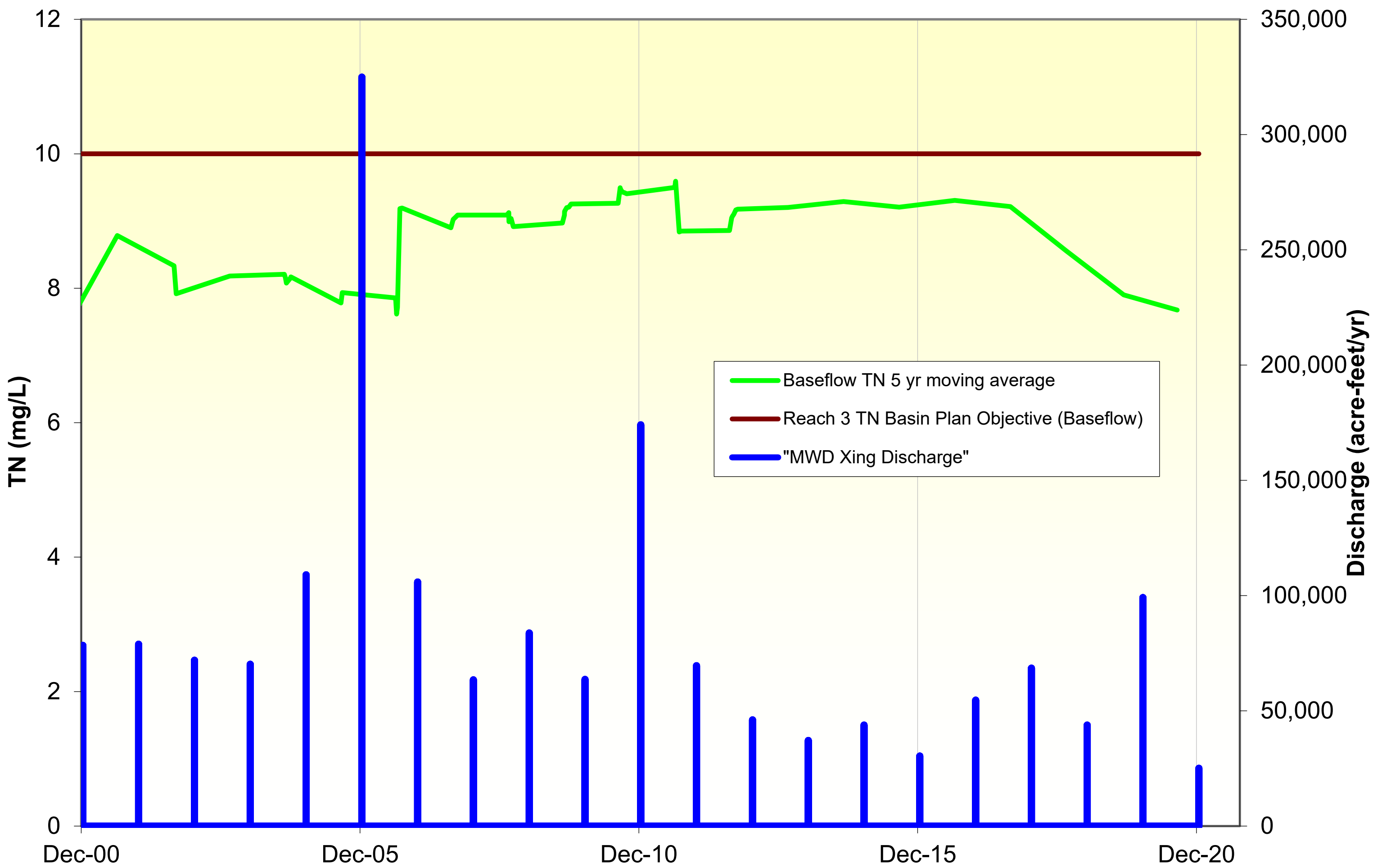
Figure A-9 Total Nitrogen (TN) MWD Crossing



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

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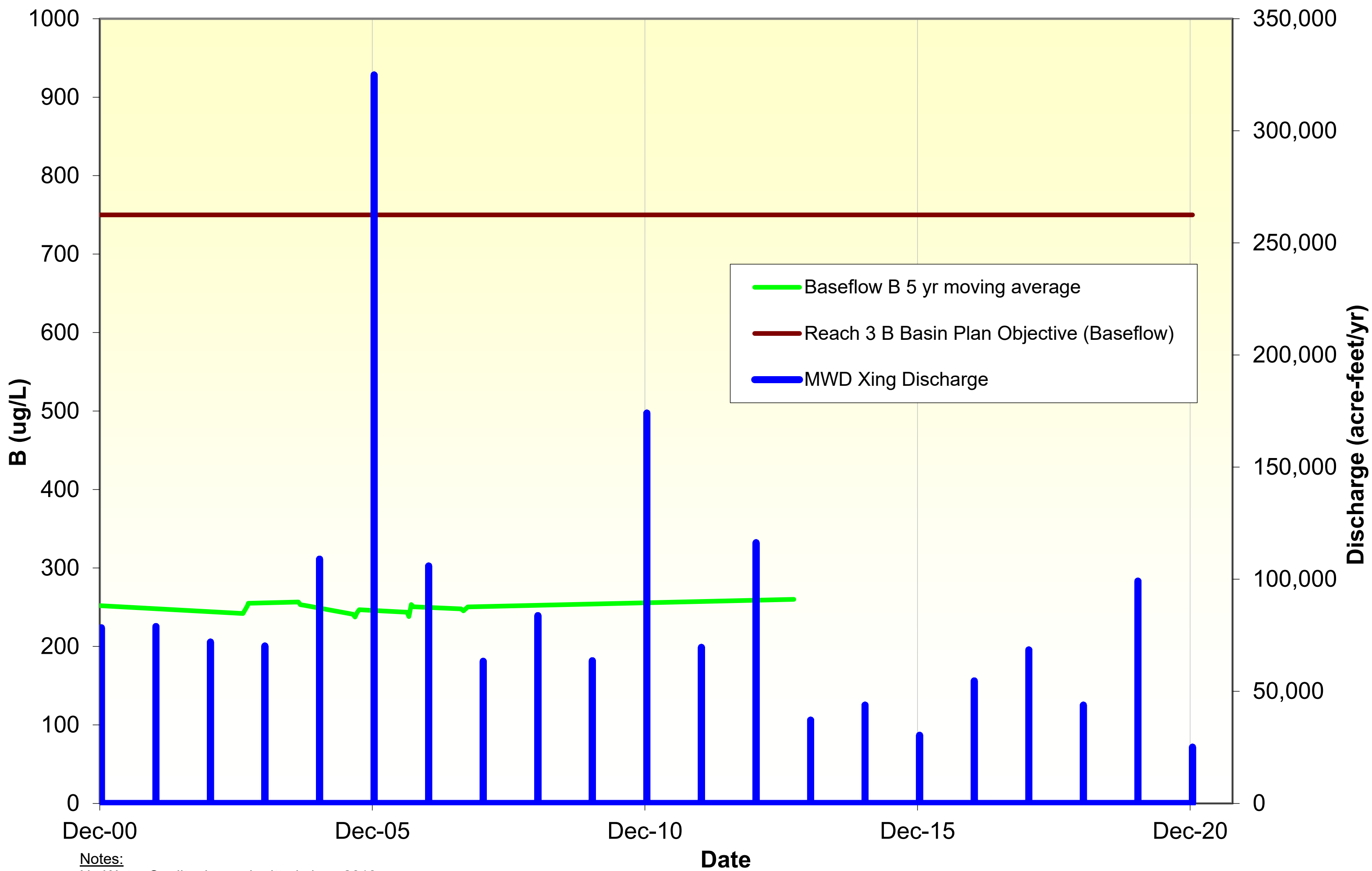
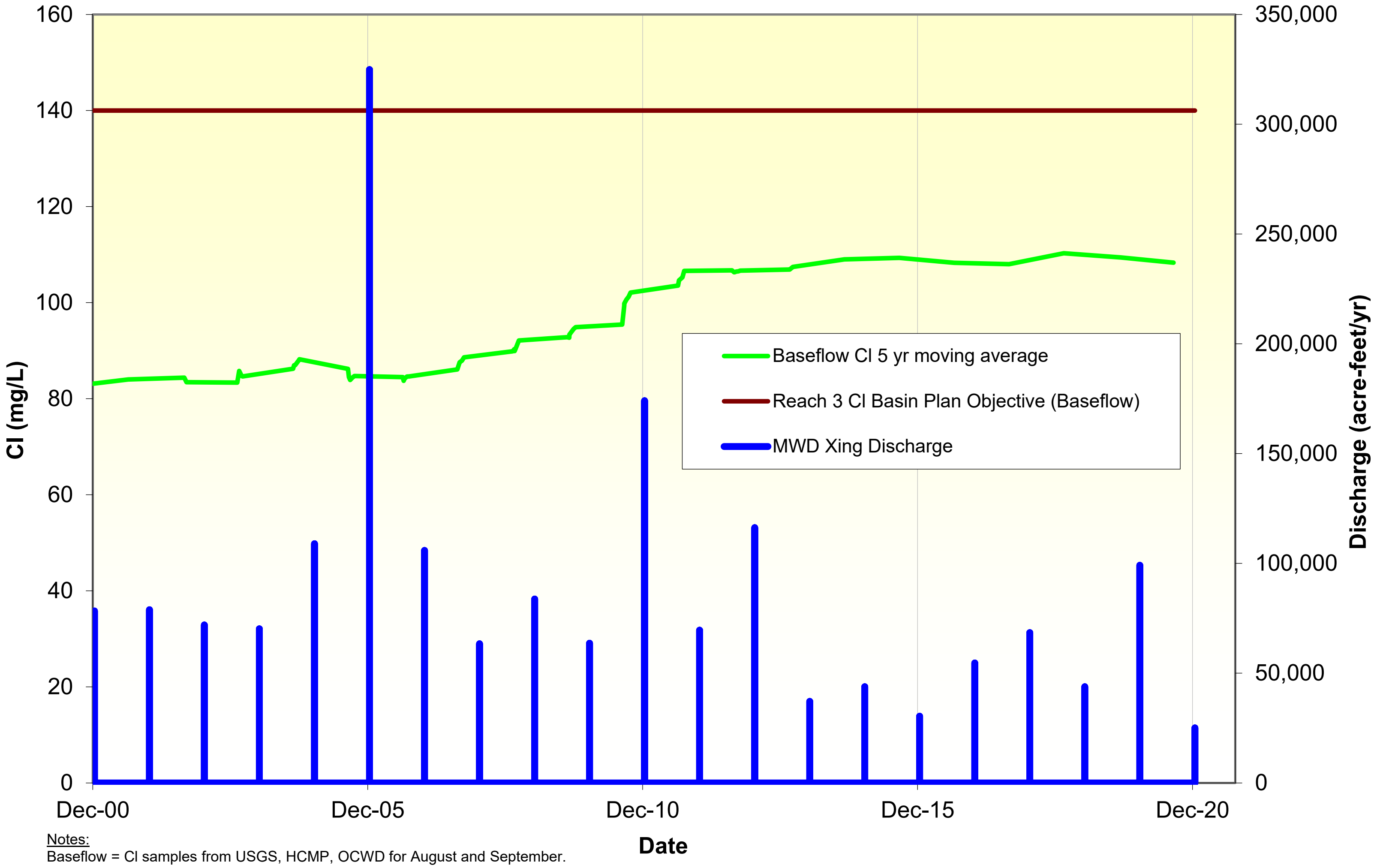
Figure A-10 Boron (B) MWD Crossing



Notes:
No Water Quality data submitted since 2013.

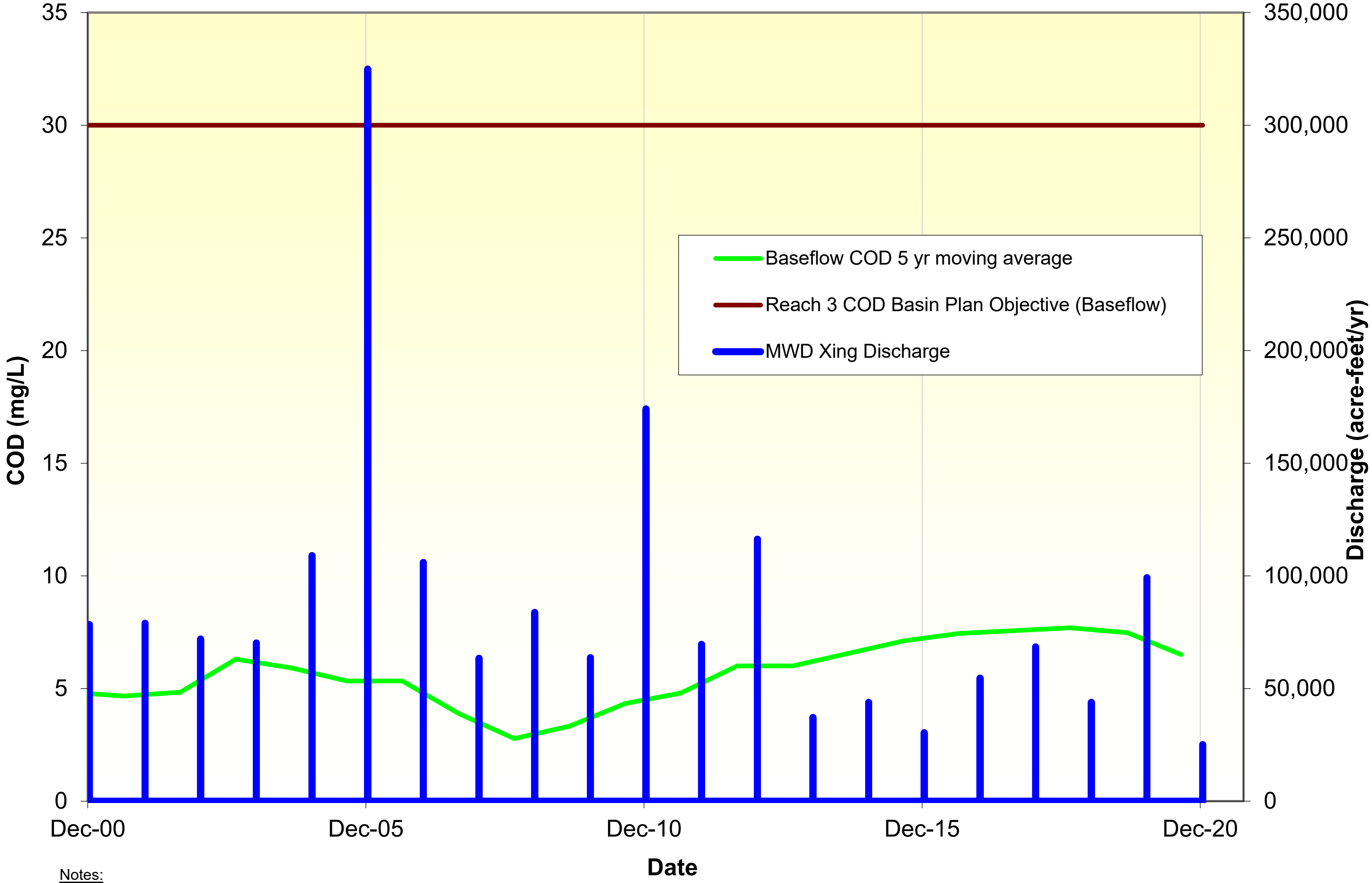
Figure A-11 Chloride (Cl) MWD Crossing



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

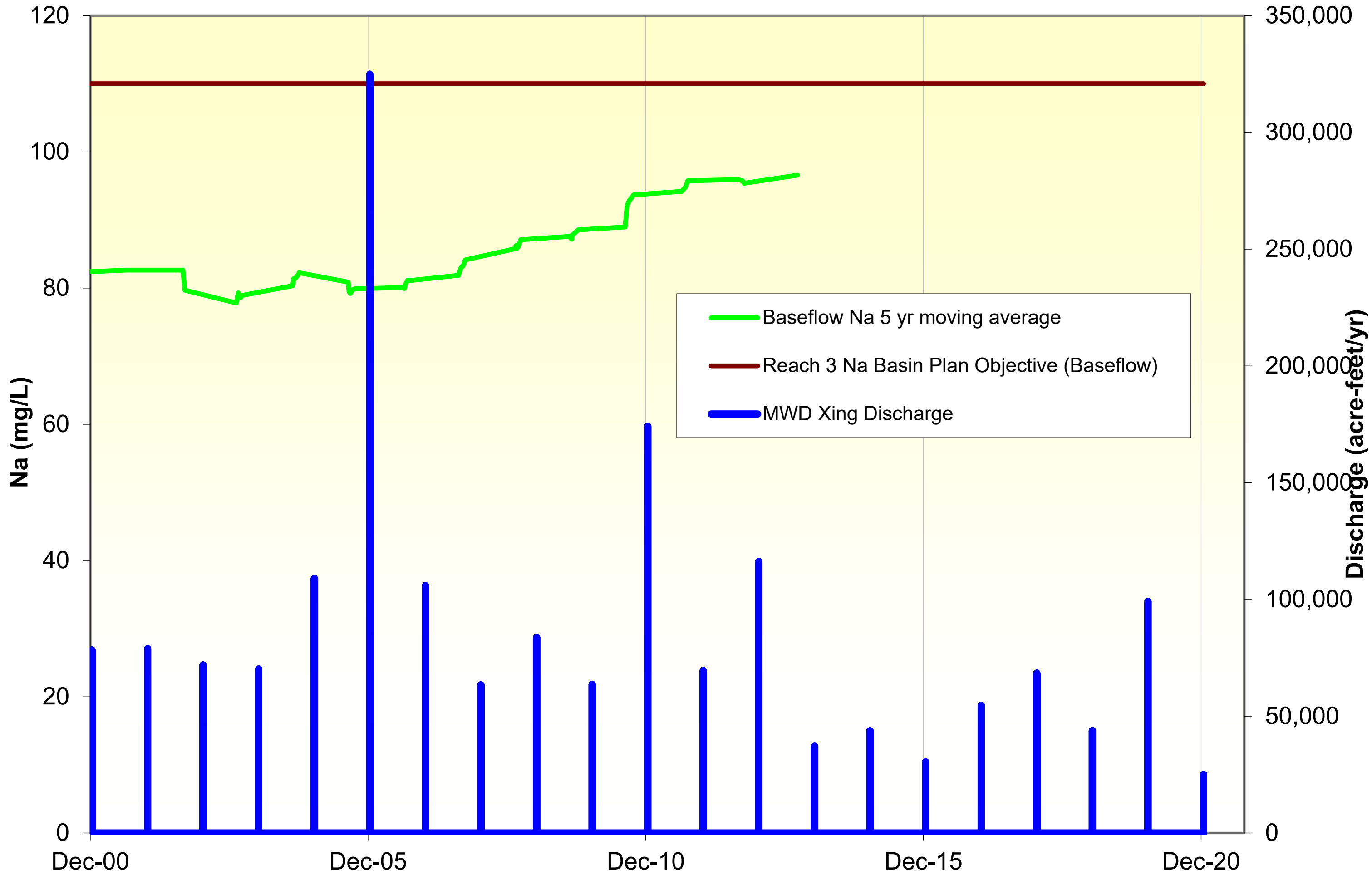
K:\projects\PA-20 Basin Monitoring Prog\2020 SAR WQ Basin Monitoring Report\Figures

Figure A-12 Chemical Oxygen Demand (COD) MWD Crossing



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

Figure A-13 Sodium (Na) MWD Crossing



Notes:
Baseflow = Na samples from USGS, HCMP, OCWD for August and September.
No Water Quality data submitted for 2014 - 2020.

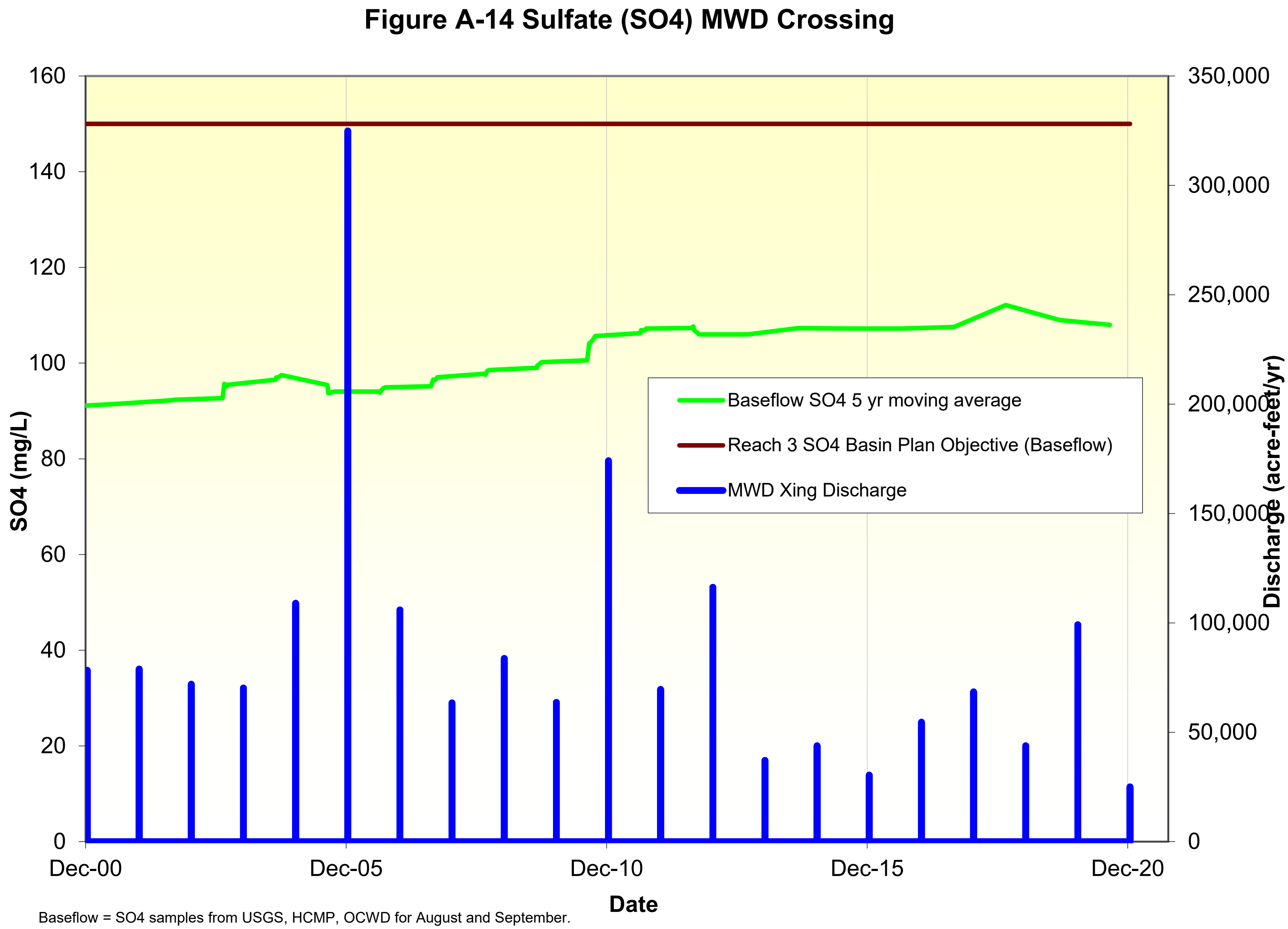
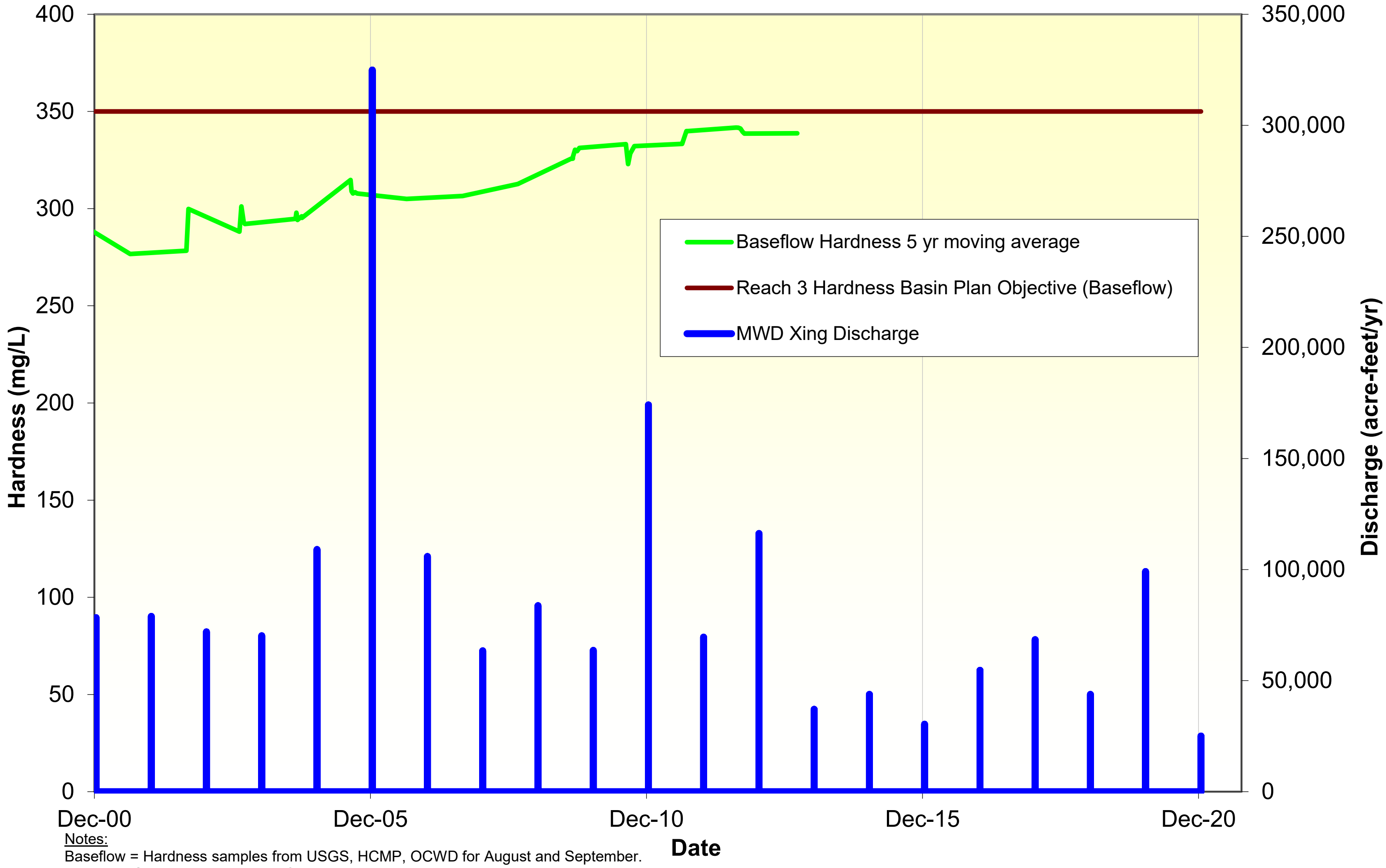


Figure A-14 Sulfate (SO4) MWD Crossing
160
140
120
100
80
60
40
20
0
SO4 (mg/L)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Discharge (acre-feet/yr)
Dec-00
Dec-05
Dec-10
Dec-15
Dec-20
Date
Baseflow SO4 5 yr moving average
Reach 3 SO4 Basin Plan Objective (Baseflow)
MWD Xing Discharge
Baseflow = SO4 samples from USGS, HCMP, OCWD for August and September.

Figure A-15 Total Hardness MWD Crossing



Notes:
Baseflow = Hardness samples from USGS, HCMP, OCWD for August and September.
No Water Quality data submitted for 2014 - 2020.

Appendix B
All 2020 Water Quality and Flow Data
(Available on the SAWPA Website)