Water Quality Assessment of Non-Project Turn-ins to the California Aqueduct, 2018

Technical Memorandum Report



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DEPARTMENT OF WATER RESOURCES

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Cover photos

Clockwise from top left: Kern Water Bank well located alongside Highway 43; Cantua Creek Flume floodwater inflows to the San Luis Canal (photo taken in 2017); view westward from Check 29 on the California Aqueduct.

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Acronyms and Abbreviations

µg/L	micrograms per liter
µS/cm	microsiemens per centimeter
AEWSD	Arvin-Edison Water Storage District
af	acre-feet
Aqueduct	Edmund G. Brown California Aqueduct
BVPP	Buena Vista Pumping Plant
COC	constituent-of-concern
CVC	Cross Valley Canal
Delta	Sacramento-San Joaquin Delta
DOC	dissolved organic carbon
DWR	California Department of Water Resources
EPP	Edmonston Pumping Plant
FKC	Friant-Kern Canal
IRWD	Irvine Ranch Water District
KCWA	Kern County Water Agency
KWBA	Kern Water Bank Authority
KWBC	Kern Water Bank Canal
MCL	maximum contaminant levels
mg/L	milligrams per liter

MP	milepost
MRL	minimum reporting limit
non-Project	non-State Water Project
NTU	nephelometric turbidity units
pCi/L	Picocuries per liter
PP	Pumping Plant
POA	Percentage-of-Aqueduct
Rosedale	Rosedale Rio-Bravo Water Storage District
SJFD	San Joaquin Field Division
SLFD	San Luis Field Division
SRIBP	Strand Ranch Integrated Banking Project
SWP	State Water Project
TCP	1,2,3-trichloropropane
TDS	total dissolved solids
TOC	Total organic carbon
us/ds	upstream/downstream
WKWD	West Kern Water District
WRMWSD	Wheeler Ridge-Maricopa Water Storage District

I. Executive Summary

A total of 115,595 acre-feet (af) of non-State Water Project (non-Project) turn-in water was admitted to the Edmund G. Brown California Aqueduct (Aqueduct) during 2018. Non-Project water originates from sources other than the Sacramento-San Joaquin Delta and typically aids in supplying water to areas experiencing shortages, such as during periods of drought or years with below-normal snowpack runoff. In the past, the majority of non-Project water has originated as groundwater pumping. Occasionally during wet years, excess surface water caused by heavier precipitation results in non-Project water being admitted to the Aqueduct from surface water sources. In 2018, non-Project water originated from both source types. Monitoring showed water quality in the Aqueduct was affected, both positively and negatively, but the effects were sometimes inconsistent and depended on a variety of factors, such as water quality parameters, turn-in source, and relative flows. But the overall range of concentration changes observed downstream of a given inflow for nearly all constituents was small relative to the variation observed in the Aqueduct upstream of that turn-in.

In the San Luis Field Division (SLFD), storms in March resulted in runoff from the Coastal Range and adjacent farmland entering the Aqueduct at creek and drain inlets. This water totaled 453 af over two days. Typically, creek inflows are much higher in turbidity and solids concentrations than the Aqueduct and are moderately high for most metal and mineral concentrations. Yet the total impact on downstream water quality is usually limited by the very low flows from these sources when compared with the Aqueduct flow. High-frequency data for conductivity measured upstream and downstream of these surface water inflows showed no impacts from these brief inflows, while data for turbidity showed a short but clear increase.

In the San Joaquin Field Division (SJFD), groundwater turn-ins totaled 115,142 af. Kern Water Bank Canal (KWBC) and Wheeler Ridge-Maricopa Water Storage District (WRMWSD) both conveyed groundwater from March to September (48.4 percent and 11.2 percent of the total groundwater turn-ins, respectively). The Cross Valley Canal (CVC) conveyed groundwater from February to June (27.7 percent of the total). Arvin-Edison Water Storage District (AEWSD) conveyed groundwater in March and Friant-Kern Canal (FKC) water in April and May (combined for 12.1 percent of the total). West

Kern Water District (WKWD) conveyed groundwater only in March (0.6 percent of the total). All combined, SJFD turn-ins comprised 7.8 percent of water in the Aqueduct in SJFD during the eight months of turn-ins and 5.5 percent for the whole year. This is more than the surface water inflow reported in 2017 (1.9 percent of the annual flow) but less than the groundwater turn-ins reported in 2016 (8.3 percent).

Overall, the majority of constituents analyzed in upstream and downstream samples showed minor changes downstream, often coinciding with or confirming expected results based on turn-in grab sample results. But, the correlations between observed and expected results diminished when turn-in volumes were low. Minor decreases in the Aqueduct did occur for bromide, organic carbon, and salinity parameters. Reductions of the first two are beneficial to State Water Project contractors because their presence can increase both the cost of producing drinking water and the potential for creating carcinogenic trihalomethanes, which are regulated by the State Water Resources Control Board's Division of Drinking Water. Reducing the latter is beneficial because of the potential for these parameters to cause consumer-acceptance issues in drinking water. Other benefits of lower concentrations of salt and salt-related parameters include reducing constraints on agricultural and groundwater bank use of this water. Conversely, slight increases were observed for arsenic, chromium, and sulfate. These compounds are undesirable because they pose a potential threat to human health, impact water treatment plant regulatory goals, and can potentially produce unpleasant tastes and odors in finished drinking water.

II. Introduction

Surface water and groundwater admitted to the State Water Project (SWP) as non-State Water Project (or non-Project) waters can alter the chemical composition of water used for drinking or agricultural applications. Any inputs to the SWP that are not diverted directly from the Sacramento-San Joaquin Delta (Delta) are referred to as *non-Project waters*. These waters have, in the past, replaced a portion of Delta-surface supplies that have been depleted during periods of drought or reduced allocation. In wet years, non-Project waters are typically sourced from surface water runoff or excess supplies. Non-Project waters from aquifers or surface-water sources can contain water quality parameters that are either desirable or undesirable to various water users. This report documents water quality changes in the Edmund G. Brown California Aqueduct (Aqueduct) resulting from non-Project inputs in 2018.

During periods of increased precipitation, excess surface water may be actively or passively allowed into the Aqueduct to relieve the strain of local flooding or for transfer to areas where water is in shorter supply. During periods of decreased precipitation or lower water supplies, water from groundwater storage may be pumped and admitted to the Aqueduct for transfer to areas in shorter supply. According to California Water Code Section 1810, no agency may deny a transferor of water the use of a water conveyance, which has unused capacity, if fair compensation is paid. Participants approved by the California Department of Water Resources (DWR) can use available Aqueduct capacity to move candidate waters from a point of surplus or storage to a point of need.

Non-Project waters may be conveyed into the Aqueduct at bidirectional inflow/outflow structures. These structures serve as turn-ins when water is admitted to the Aqueduct and serve as turn-outs when water is diverted out of the Aqueduct for delivery to contractual recipients. Non-Project water can also flow passively into the Aqueduct through drainage weirs or it can be pumped directly into the Aqueduct (pump-ins) from pipelines or through portable pumps, as is the case with some ponded floodwater adjacent to the Aqueduct. The term “turn-ins” has been incorporated to encompass water either pumped directly into the Aqueduct or water passively conveyed into the Aqueduct via bidirectional turn-in/turn-out structures or drainage weirs.

Certain conditions must be met before non-Project water can be admitted to the Aqueduct. In accordance with the California Water Code Section 1810, water may be conveyed or transferred via any unused capacity of the Aqueduct if the comingled water does not result in a diminution of water quality. The transfer must also be made without unreasonably affecting fish, wildlife, or other instream beneficial uses. DWR established an interim procedure, the "Water Quality Policy and Implementation Process for Acceptance of Non-Project Water into the State Water Project" (California Department of Water Resources 2012), to guide the review and approval of turn-in proposals and acceptance of this water into the Aqueduct. This policy is provided in Appendix A.

According to the policy, the proponent of any turn-in proposal shall demonstrate that the water is of consistent, predictable, and acceptable quality. Prospective turn-in entities are required to submit proposals describing their turn-ins, and these proposals should include detailed water quality monitoring and analyses, source water description, and a monitoring plan. Proposals that include water generally lower in quality than historical Aqueduct conditions, and therefore have the potential to cause adverse impacts, are referred to the SWP Contractor Facilitation Group for review and recommendations. The group consists of DWR staff and representatives from each SWP contractor that chooses to participate. While this policy was originally focused on the introduction of groundwater turn-ins and their potentially large impact to Aqueduct water quality, it has also been applied to surface water introductions done by local agencies. Since most surface water sources contain water of equal or better water quality than the Aqueduct, few ever trigger the necessity for SWP Contractor Facilitation Group review.

Typically, participants in the turn-in program have included both SWP and non-SWP contractors that bank groundwater and routinely convey it into the Aqueduct at various locations. Most non-Project turn-ins have originated as groundwater from Kern and Kings counties, along with groundwater from individual wells in Fresno County and surrounding counties. A smaller percentage of turn-ins come from surface flows from southern Sierra Nevada watersheds and floodwaters from ephemeral streams draining watersheds in the Diablo Range west of the Aqueduct.

Turn-ins can have measurable effects on Aqueduct water quality, depending on factors such as inflow volumes, Aqueduct flows, background concentrations, and groundwater well geochemistry or watershed geomorphology. The Aqueduct serves as a source of drinking water for millions of Californians, so understanding the significance of any input on Aqueduct water quality is of foremost importance. Groundwater and surface water turn-ins can exhibit different impacts to Aqueduct water quality. Groundwater has historically exhibited elevated concentrations for certain constituents, such as arsenic, nitrate, and sulfate; variable concentrations for salinity and chromium, depending on source water; and relatively low concentrations for bromide, organic carbon, and solids. Conversely, surface waters have typically exhibited elevated concentrations for organic carbon, solids, and turbidity; variable concentrations for most metals and minerals, depending on source water; and low concentrations for bromide and salinity.

This report uses available data to assess changes in Aqueduct water quality that may be attributed to surface water inflows and groundwater turn-ins during 2018. The evaluation of these changes includes flows, turn-in water characteristics, and upstream/downstream (us/ds) analysis of water quality in the Aqueduct. Nevertheless, factors partially or fully unrelated to turn-ins can magnify or diminish water quality changes between us/ds stations. Comparisons of Aqueduct concentrations can be susceptible to misinterpretation from factors including Aqueduct operations, such as off-peak pumping and check gate closures, or sampling limitations, such as the distance between us/ds water quality sampling stations and downstream migrating parcels of differing water quality. Nonetheless, these factors are often difficult to identify and quantify with periodic sampling. As such, water quality changes, or lack thereof, in the Aqueduct us/ds of a turn-in may be erroneously ascribed to that input. There were several instances in this report in which this was possible, and these instances are acknowledged.

III. San Luis Field Division

In 2018, a small amount of water from rainfall runoff entered the Aqueduct in the San Luis Field Division. This occurrence was similar to inflows that happened in 2017, when creek inflows totaled 2,686 acre-feet (af) over the course of two months (California Department of Water Resources 2018). Daily inflows in 2017 were typically less than 150 af per day with only one day exceeding 300 af. In 2018, creek inflows totaled 453 af over two days, but the first day of inflows recorded 364 af alone (Table 3-1).

Table 3-1 Creek Inflow Volumes and Percentage-of-Aqueduct Values, 2018

Date	Cantua Creek Inflow (af)	Drain Inlet – 166 Inflow (af)	Total Creek Inflow (af)	Dos Amigos Pumping (af)	POA
3/22/2018	354	10	364	2,118	14.7
3/23/2018	89	0	89	3,707	2.3

Notes:
af = acre-feet, POA = percentage-of-Aqueduct.

In addition to the total volume of creek inflows, the percentage of total flow in the Aqueduct contributed by the inflows is also calculated. This value is referred to as the *percentage-of-Aqueduct* (POA) and is useful in assessing impacts from all sources of inflows. In 2017, daily POAs for creek inflows were typically lower than 2 percent, reaching a high of 5.5 percent (California Department of Water Resources 2018). The daily POAs for 2018, though, were 2.3 percent and 14.7 percent (Table 3-1). The cause of the higher POAs seen in 2018 are a result of the lower pumping at Dos Amigos Pumping Plant, located upstream of the creek inflows. In 2017, daily pumping during the inflow period ranged from 3,440 to 15,506 af compared with 2,118 to 3,707 af in 2018 (Table 3-1).

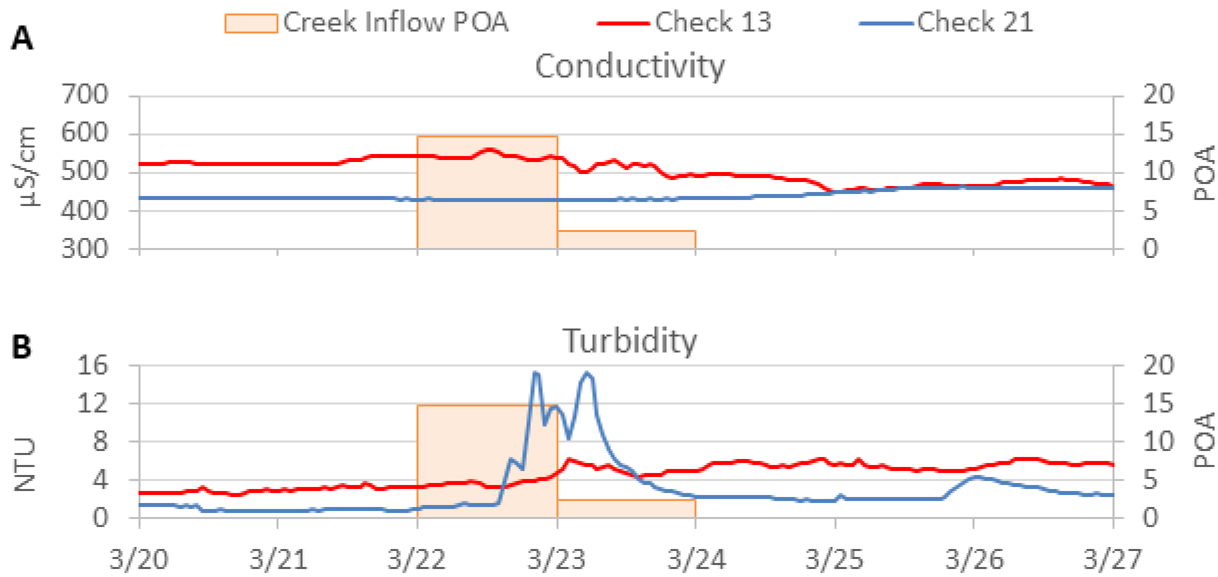
The 2018 inflows originated from two creeks, Cantua Creek at milepost (MP) 133.67 and a drain inlet at MP 166.04 fed by Arroyo Torcido. Inflows in 2017 also originated from Cantua Creek as well as several other creeks (California Department of Water Resources 2018). In all cases, water entrained in these creeks and their ponding areas adjacent to the Aqueduct may come from either rainfall runoff from the east side of the Diablo Range or runoff from local agricultural fields. Both sources may contribute water quality constituents that pose a concern to overall Aqueduct water quality.

In 2017, samples were collected for a large suite of constituents from creek inflows and from within the Aqueduct upstream and downstream of the inflows (California Department of Water Resources 2018). Results from these samples showed high concentrations of sediment-related constituents compared to the Aqueduct. For Cantua Creek specifically, total suspended solids were 450 milligrams per liter (mg/L) compared to 4 mg/L upstream in the Aqueduct, and turbidity was 94 nephelometric turbidity units (NTU) in the creek compared to 13 NTU in the Aqueduct. Higher-than-Aqueduct concentrations were also observed for salinity-related constituents, some metals, and some minerals. Because of the short duration of the 2018 inflows, no samples could be collected.

The assessment of water quality changes upstream/downstream of the 2017 creek inflows showed increases for constituents found to be higher in the creek inflows than in the Aqueduct (California Department of Water Resources 2018). But, despite the much higher concentrations in the creeks, the downstream increases were small. Total suspended solids increased from 4 mg/L to 8 mg/L and turbidity increased from 13 NTU to 15 NTU — all values within the range of natural variation within the Aqueduct. Comparisons of real-time water quality data from stations upstream (Check 13) and downstream (Check 21) of the inflows showed similar results with slight increases in conductivity and turbidity.

In the absence of samples from 2018, creek inflows were assumed to follow similar trends and concentrations as they did in 2017. The potential to impact Aqueduct water quality would likewise be similar. And, while the potential impact in 2018 could be higher in the short-term because of the higher POAs, the long-term effects would be low because of the very short duration of inflow. This effect is seen in the real-time turbidity data for 2018 (Figure 3-1), where a short but sharp increase was observed downstream of the inflows. Yet, no increase was observed for conductivity.

Figure 3-1 Real-Time Measurements for Conductivity and Turbidity with Creek Inflow Percentage-of-Aqueduct Values, 2018



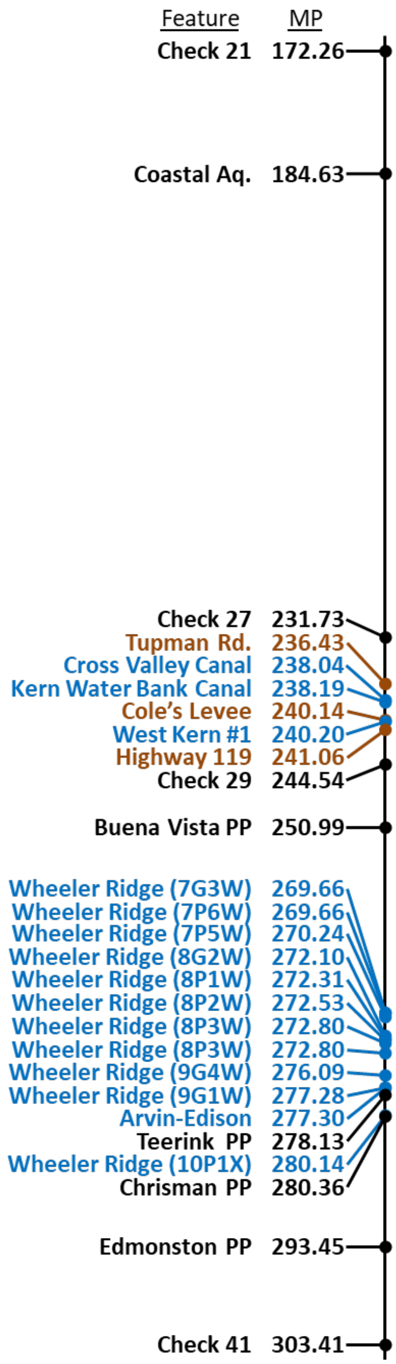
Notes:
POA = percentage-of-Aqueduct, NTU = nephelometric turbidity units, µS/cm = microsiemens per centimeter.
Raw data is posted on the California Data Exchange Center for Check 13 (Station ID: C13) and Check 21 (Station ID: C21).

IV. San Joaquin Field Division

Turn-ins to the Aqueduct during 2018 only occurred in the San Joaquin Field Division (SJFD), which extends from Check 21 to just past Edmonston Pumping Plant (EPP). Turn-in structures are located along the Aqueduct from MPs 207.00 to 280.14. In 2018, five agencies operated a total of 15 turn-in structures (Figure 4-1).

- Kern County Water Agency (KCWA) operated the Cross Valley Canal (CVC) at MP 238.04.
- Kern Water Bank Authority (KWBA) operated the Kern Water Bank Canal (KWBC) at MP 238.19.
- West Kern Water District (WKWD) operated one Aqueduct turn-in structure (West Kern #1) at MP 240.2. WKWD also pumped groundwater into CVC from a separate bank of wells.
- Wheeler Ridge-Maricopa Water Storage District (WRMWSD) operated 11 turn-in structures from MPs 269.66–280.14.
- Arvin-Edison Water Storage District (AEWSD) operated one turn-in structure at MP 277.30.

Figure 4-1 Schematic of Aqueduct Features in the San Joaquin Field Division Including Turn-in Entity Sample Sites and Turn-in Structure Locations



Notes:
MP = milepost, PP = pumping plant.

CVC conveys groundwater and surface water to the Aqueduct from a number of entities and sources. The entities include KCWA-member units and nonmembers that operate groundwater recharge basins around the Kern Fan area. Participants include the Irvine Ranch Water District's (IRWD's) Strand Ranch Integrated Banking Project (SRIBP) and the Rosedale-Rio Bravo Water Storage District (Rosedale). Rosedale, a KCWA-member unit, operates 10 wells and IRWD operates seven wells. WKWD, also a KCWA-member unit, can deliver groundwater from at least five wells directly to CVC. Note that WKWD can also bypass the CVC and pump from these five wells directly into the Aqueduct using the turn-in structure identified as West Kern #1. Cawelo Water District delivers groundwater and surface water from Friant-Kern Canal to CVC via Cawelo's conveyance channels. CVC also accepts groundwater from KWBA, Pioneer Property, City of Bakersfield's 2800 Acres Recharge Facility, and the Berrenda Mesa Project. Additionally, CVC does not always convey all of its capacity to the Aqueduct. When demands within KCWA's service area requires deliveries, either all or a portion of the water in CVC is moved eastward toward the demand and away from the Aqueduct (positive mode). KWBC conveys groundwater to the Aqueduct from up to 96 recovery wells located around the Kern Fan. Along with KWBA wells, several other entities participated in pumping groundwater to KWBC. These included the Pioneer Property, the Berrenda Mesa Project, the City of Bakersfield's 2800 Acres Recharge Facility, and various private lands surrounding these projects. As stated previously, CVC has the ability to convey KWBA water to the Aqueduct. When this occurs, such water is counted in the CVC total turn-in volume and analyzed along with other water conveyed through CVC.

The West Kern Banking Project can operate as many as 13 wells that discharge directly to the Aqueduct at their West Kern #1 turn-in structure. Five WKWD wells can pump groundwater directly into the CVC or through West Kern #1 and an additional eight wells pump through West Kern #1 exclusively. The portion of WKWD groundwater conveyed through the CVC is incorporated with that turn-in's data. All discussion of WKWD groundwater in this report refers only to water introduced through the West Kern #1 turn-in.

WRMWSD operates 11 turn-in structures. Each of these structures conveys groundwater from individual wells or from several wells that were manifolded into a single pipeline.

AEWSD operates a single turn-in structure, the AEWSD Canal, with numerous wells in AEWSD's service area available for participation. Other potential sources of water to the AEWSD Canal throughout the year include water from the CVC, Kern River, Friant-Kern Canal, and AEWSD farm wells. Similar to CVC, turn-ins from AEWSD increased or decreased, depending on internal demand within their respective service areas. Internal demand was usually largest Monday–Friday and smallest on the weekends, resulting in changes to Aqueduct inflows corresponding with those periods.

Turn-in Volumes

Turn-in volumes for all SJFD participants totaled 115,142 af in 2018 (Table 4-1). KWBC contributed the largest volume, which was 55,692 af for the year. This volume was 48.4 percent of the total volume from all SJFD turn-ins combined. The second largest source was CVC with 31,899 af (27.7 percent). AEWSD contributed 13,893 af (12.1 percent). WRMWSD contributed 12,910 af (11.2 percent) from all 11 turn-in structures combined. WKWD contributed the smallest volume of water to the Aqueduct of any agency, with 748 af (0.6 percent). The water WKWD pumped directly into CVC is not included in this total; it is included in the total volume for CVC.

Inflows to the SJFD from the Aqueduct upstream of Check 21 totaled 1,356,560 af for the period of turn-ins (Table 4-1) and 1,964,274 af for the full year. Turn-ins comprised 7.8 percent of the water entering the SJFD during the turn-in period, which includes the water entering the SJFD at Check 21 and the previously discussed SJFD turn-in volume. For the entire year, turn-ins comprised 5.5 percent of Aqueduct water in SJFD. This value is higher than the same statistic for 2017, which was 4.2 percent (California Department of Water Resources 2018).

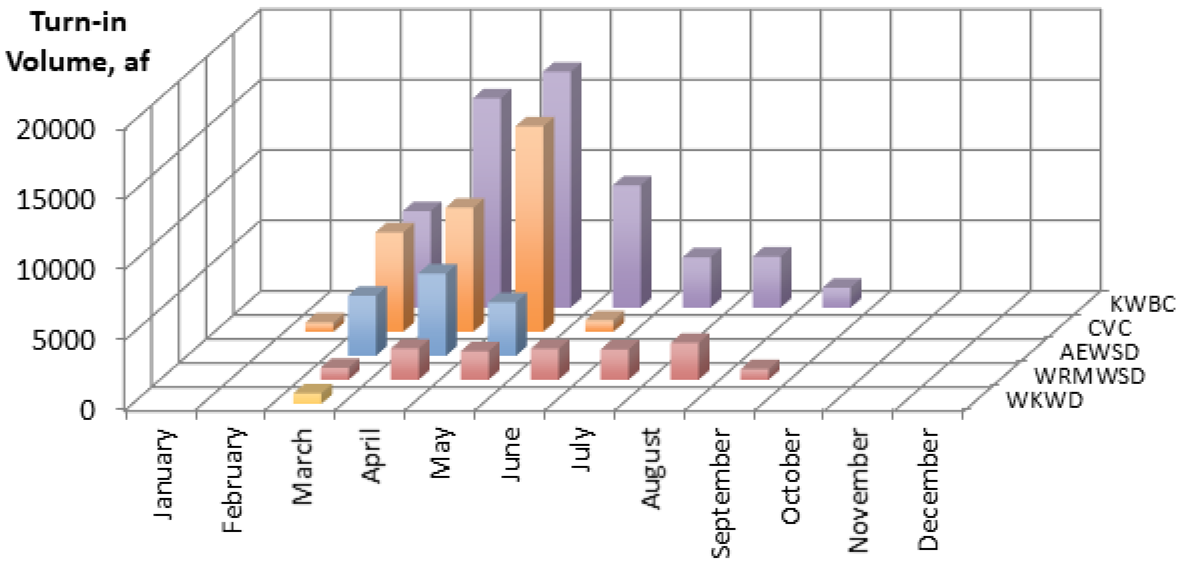
Table 4-1 Annual and Monthly Turn-in Volumes, San Joaquin Field Division, 2018

Month	Inflow Check 21	CVC	KWBC	WKWD	WRMWSD	AEWSD	Monthly Total
February	184,615	668	0	0	0	0	668
March	83,247	7,037	6,835	748	858	4,277	19,755
April	91,716	8,793	14,858	0	2,228	5,813	31,692
May	111,876	14,574	16,743	0	2,037	3,803	37,157
June	183,257	827	8,667	0	2,214	0	11,708
July	247,557	0	3,556	0	2,170	0	5,726
August	239,756	0	3,606	0	2,637	0	6,243
September	214,536	0	1,427	0	766	0	2,193
Period Total	1,356,560	31,899	55,692	748	12,910	13,893	115,142
% of Total Turn-in	—	27.7%	48.4%	0.6%	11.2%	12.1%	—

Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
All units in acre-feet.

The total monthly volume for all turn-ins combined varied from 668 af in February to 37,157 af in May (Table 4-1 and Figure 4-2). No turn-ins were active in January or from October through December. KWBC and WRMWSD were the only turn-ins to operate in the second half of the year. Monthly turn-in volumes were usually highest at KWBC, with volumes ranging from 1,427 af in September to 16,743 af in May. The exception to this was February and March, during which CVC contributed the largest volumes for the month. The total range of monthly volumes at CVC ranged from 668 af in February to 14,574 af in May. AEWSD had the third-highest volumes in the three months it was active, ranging from 3,803 af in May to 5,813 af in April. The AEWSD inflows in March were sourced from groundwater wells, while the April and May inflows were sourced from the Friant-Kern Canal. WRMWSD had relatively consistent volumes while active, ranging from 766 af in September (the last month of pumping) to 2,637 af in August. WKWD was only active in one month, contributing 748 af in March.

Figure 4-2 Monthly Turn-in Volumes in the San Joaquin Field Division, 2018



Notes:

AEWSD = Arvin-Edison Water Storage District, af = acre-feet, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.

Inflow variations from most sources reflect internal demands within the service areas of each turn-in entity. Internal demands typically increase during the summer months, when a greater proportion of the pumped groundwater is used within each individual service area for agricultural irrigation and possibly for drinking water. When these internal demands decrease from fall through spring, groundwater contributions to the Aqueduct typically increase.

Table 4-2 Monthly Percentages-of-Aqueduct Flow Composed of Turn-in Water, 2018

Month	CVC	KWBC	WKWD	WRMWSD	AEWSD
January	0	0	0	0	0
February	0.58	0	0	0	0
March	9.2	8.2	0.89	0.99	4.8
April	12	17	0	2.6	6.7
May	18	17	0	2.5	4.6
June	0.81	7.8	0	2.6	0
July	0	2.4	0	1.7	0
August	0	2.4	0	2.1	0
September	0	1.1	0	0.66	0
Average Monthly POA[a]	8.1	8.0	0.89	1.9	5.4

Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal,
POA = percentage-of-Aqueduct, KWBC = Kern Water Bank Canal, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
[a] Average monthly POA only includes months with turn-in volumes.

Percentage-of-Aqueduct

The percent of Aqueduct water originating from SJFD groundwater, referred to as percentage-of-Aqueduct (POA), provides a useful measure of potential influence from turn-in operations. The POA values for each participant or facility in the SJFD were calculated and are presented in Table 4-2 and Figure 4-3. POA values incorporate the total monthly turn-in volume for a specific turn-in combined with the total monthly Aqueduct volume passing that turn-in structure. The total monthly Aqueduct volume passing each turn-in structure was determined by using the following formula:

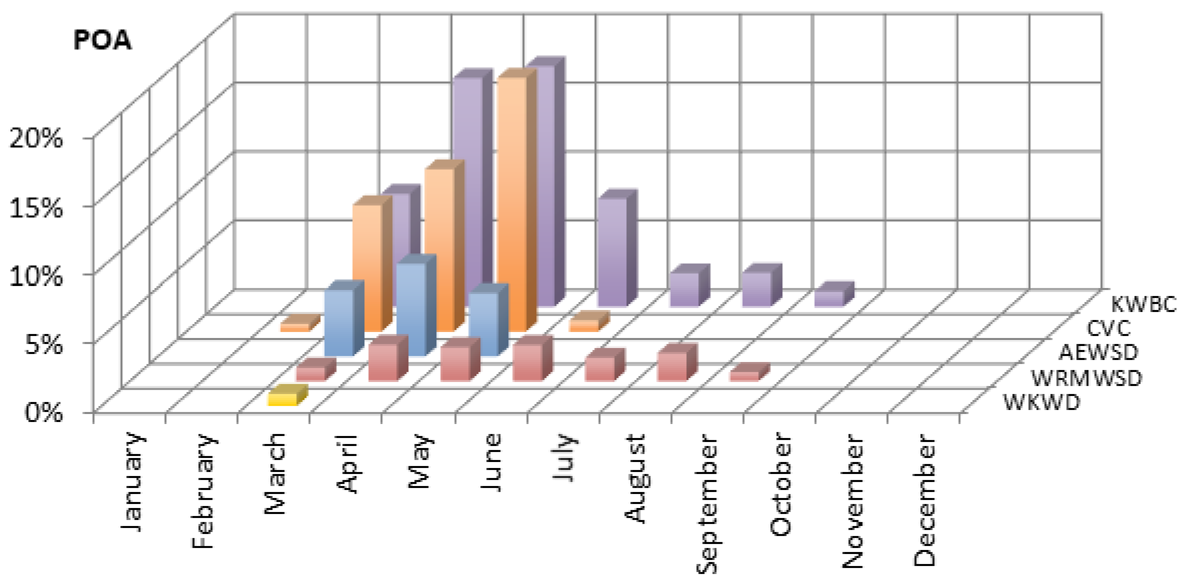
Monthly volume at the nearest gauge − intervening deliveries + intervening turn-ins

This formula provides the most accurate volume for use in the POA calculations for each turn-in structure. Note that these calculations are monthly totals and, as such, POAs would vary on any given day with specific turn-in and Aqueduct flow conditions. The average POA for each turn-in on Table 4-2 only includes months when a turn-in was operational. Since POAs reflect the percentage of all water flowing past a particular turn-in, all of the

POAs (except CVC) include upstream flows composed of both Aqueduct and SJFD turn-in waters.

POA values exhibited large variations between participants and fluctuated throughout the year for each turn-in. CVC had the highest average POA value for the year at 8.1 percent, with the largest values occurring in April and May (Table 4-2 and Figure 4-3). KWBC also produced high POA values in these months (17 percent each month); however, lower POAs later in the year, ranging from 1.1 to 2.4 percent, brought the annual average down to 8.0 percent. Lower annual averages were reported for AEWSD and WRMWSD (5.4 and 1.9 percent, respectively). AEWSD ranged from 4.6 percent to 6.7 percent while WRMWSD ranged from 0.66 percent to 2.6 percent. The only turn-in with lower POAs was WKWD, which had a monthly/annual POA of 0.89 percent for its single month of operation in March.

Figure 4-3 Monthly Percentages-of-Aqueduct Flow Composed of Turn-ins, 2018



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal,
POA = percentage-of-Aqueduct, KWBC = Kern Water Bank Canal, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.

Project Operations

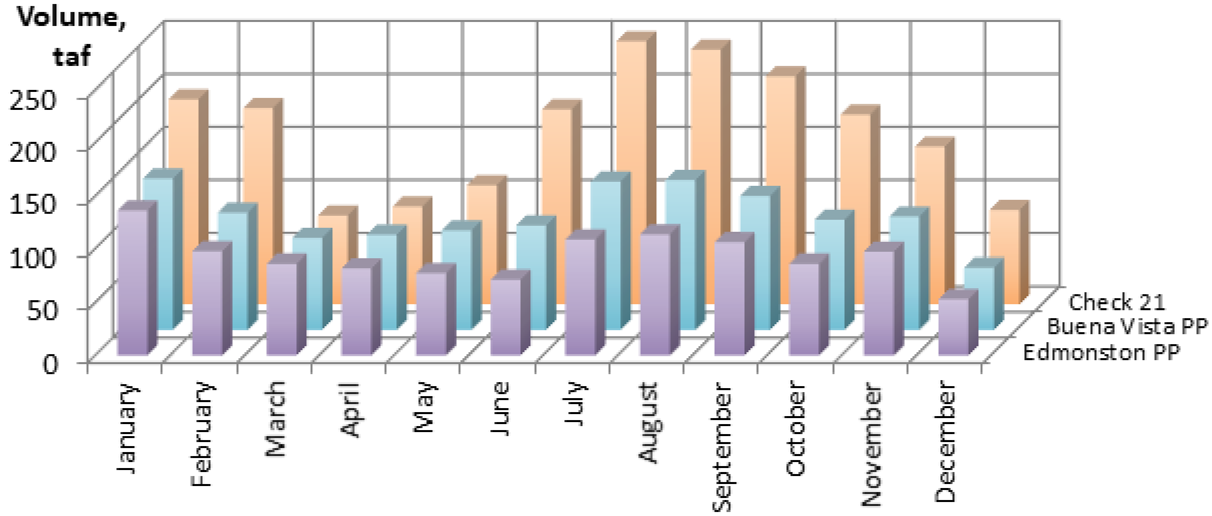
SWP operations in the SJFD varied throughout the year, based on water availability and demand. Water entering SJFD at Check 21 originated as exports from the south Sacramento-San Joaquin Delta and releases from San Luis Reservoir. Monthly flow volumes at Check 21 ranged from 83,247 af in March to 247,557 af in July (Table 4-3 and Figure 4-4), with a total annual volume of 1,964,274 af. Further downstream at Buena Vista Pumping Plant (BVPP), monthly pumping volumes ranged from 58,635 to 142,281 af with a smaller total volume of 1,293,245 af. The volume of water pumped at EPP represented the total amount of water exiting the downstream end of the SJFD. In 2018, this volume ranged from 52,988 to 136,193 af per month, with a total volume of 1,116,573 af. During periods when monthly volumes upstream were less than downstream volumes, which occurred in March, turn-ins provided the additional volume. Through coordinated schedules of pumping, turn-in deliveries, and check-structure operations, DWR was consistently able to deliver available water in the SJFD and further south throughout 2018.

Table 4-3 Monthly Pumping and Aqueduct Flow throughout the San Joaquin Field Division, 2018

Month	Check 21	Buena Vista Pumping Plant	Edmonston Pumping Plant
January	192,699	142,281	136,193
February	184,615	109,905	97,807
March	83,247	86,199	86,227
April	91,716	89,287	82,007
May	111,876	93,299	77,658
June	183,257	97,999	71,350
July	247,557	139,386	108,842
August	239,756	140,778	113,712
September	214,536	125,680	106,245
October	178,429	103,472	86,306
November	148,159	106,324	97,238
December	88,427	58,635	52,988
Annual Total	1,964,274	1,293,245	1,116,573

Note:
All measurements are in acre-feet.

Figure 4-4 **Monthly Pumping and Aqueduct Flow throughout the San Joaquin Field Division, 2018**



Notes:
PP = pumping plant, taf = thousand acre-feet.

Turn-in Water Quality Assessment

Throughout their operations, turn-in entities collected water quality samples from their input structures on the Aqueduct. The parameters sampled in SJFD included arsenic, bromide, chloride, total chromium, hexavalent chromium, conductivity, nitrate, organic carbon, sulfate, TDS, 1,2,3-trichloropropane, and two radiological parameters — gross alpha or uranium. Appendix B lists all sample results by location and origin of data.

Some parameters, such as arsenic, chromium, and organic carbon, can be collected as total (unfiltered) and/or dissolved (filtered) samples. The sample type used in this report was typically the larger dataset for each constituent. But when there is no consistency between all turn-ins, total and dissolved fractions appear together, as occurred for arsenic and organic carbon at WRMWSD. Because data originated from several laboratories, some of the constituents-of-concern (COC) have more than one method reporting limit (MRL). Given these disparities, some data were analyzed below the MRL of other data. For the purpose of consistency, data reported as < MRL were incorporated in the calculations and graphs as a value at the MRL. Because of the quarterly sampling schedule and low turn-in volumes for each individual WRMWSD turn-in structure, all WRMWSD data were combined to form a single dataset. Data from each of these turn-ins are shown separately in Appendix B.

Water quality data are presented in two different graphical formats and a statistics table. As previously stated, data below the MRL are graphed at the value of that MRL. A time-series plot provides an assessment of water quality trends for each COC at each turn-in throughout the year. In these plots, a bold border around a point identifies it as a sample less than the MRL. Additionally, the average concentration of all samples for a turn-in are shown as dashed lines in the background of the figure. While they span the width of the figure, they only represent data from the period of operation for each turn-in. Box-and-whisker plots present the median value bracketed by the first and third quartiles, shown as boxes. Whiskers on each box represent the highest and lowest non-outlying values, which are defined as points within 1.5x of the first and third quartile range. Any outlying values appear as individual points above or below the whiskers. Below the plots, a table provides common statistical information for each turn-in, including the number of samples less than the MRL and the number of samples greater than the maximum contaminant level (MCL).

These box-and-whisker plots also display the annual average Aqueduct concentration from the nearest sampling sites upstream of each turn-in, identified in Table 4-4. The average at each turn-in only includes data from months that the turn-in was active. Statistical information for these upstream samples is provided in a separate table. Several variables are inherent in the calculation of upstream averages, and accordingly, they do not necessarily represent specific or exact changes in concentration downstream of each turn-in. Only general comparisons can be made because multiple sites with variable sampling dates are combined in the calculation of each unique average. A more accurate analysis of concentration changes in the Aqueduct downstream of turn-ins is presented in the next section, titled "California Aqueduct Water Quality."

Table 4-4 Nearest Upstream Sampling Sites and Associated Turn-in Entities

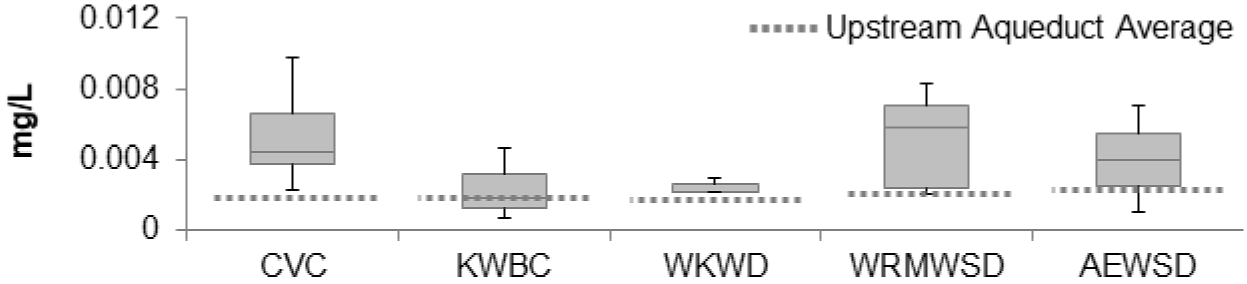
Turn-in Entity	Upstream Sampling Sites	Averaging Period
CVC	Check 27 and Tupman Rd.	February–June
KWBC	Check 27 and Tupman Rd.	March–September
WKWD	Cole's Levee	March
WRMWSD	Hwy 119 Cole's Levee and Check 29	March April–September
AEWSD	Hwy 119 Cole's Levee and Check 29	March April–May

Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.

Arsenic

CVC had the highest turn-in average, 0.0052 mg/L, with a range of 0.0023 to 0.0098 mg/L — the highest concentration of all turn-in samples (Figure 4-5 and Table 4-5). KWBC samples reported a range of < 0.0007 to 0.0047 mg/L and the lowest turn-in average of 0.0023 mg/L. WKWD also reported a low average of 0.0025 mg/L. WRMWSD, in contrast, reported an average of 0.005 mg/L over a wide range, including one sample less than its MRL. The two samples collected at AEWSD were reported at 0.001 mg/L and 0.007 mg/L. The former was collected in April when AEWSD water was sourced from Friant-Kern Canal while the latter was collected in March when AEWSD water was sourced from groundwater. Average arsenic concentrations for all turn-ins were higher than their upstream Aqueduct averages, which ranged from 0.0017 to 0.0023 mg/L. None of the turn-in samples exceeded the MCL of 0.01 mg/L for arsenic in drinking water.

Figure 4-5 **Arsenic Turn-in Box-and-Whisker Plot**



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
Values < MRL are graphed and calculated at the MRL. The MRL was either 0.0007 or 0.002 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
MCL for arsenic is 0.01 mg/L.
Arsenic for WRMWSD is dissolved/filtered. All others are unfiltered.

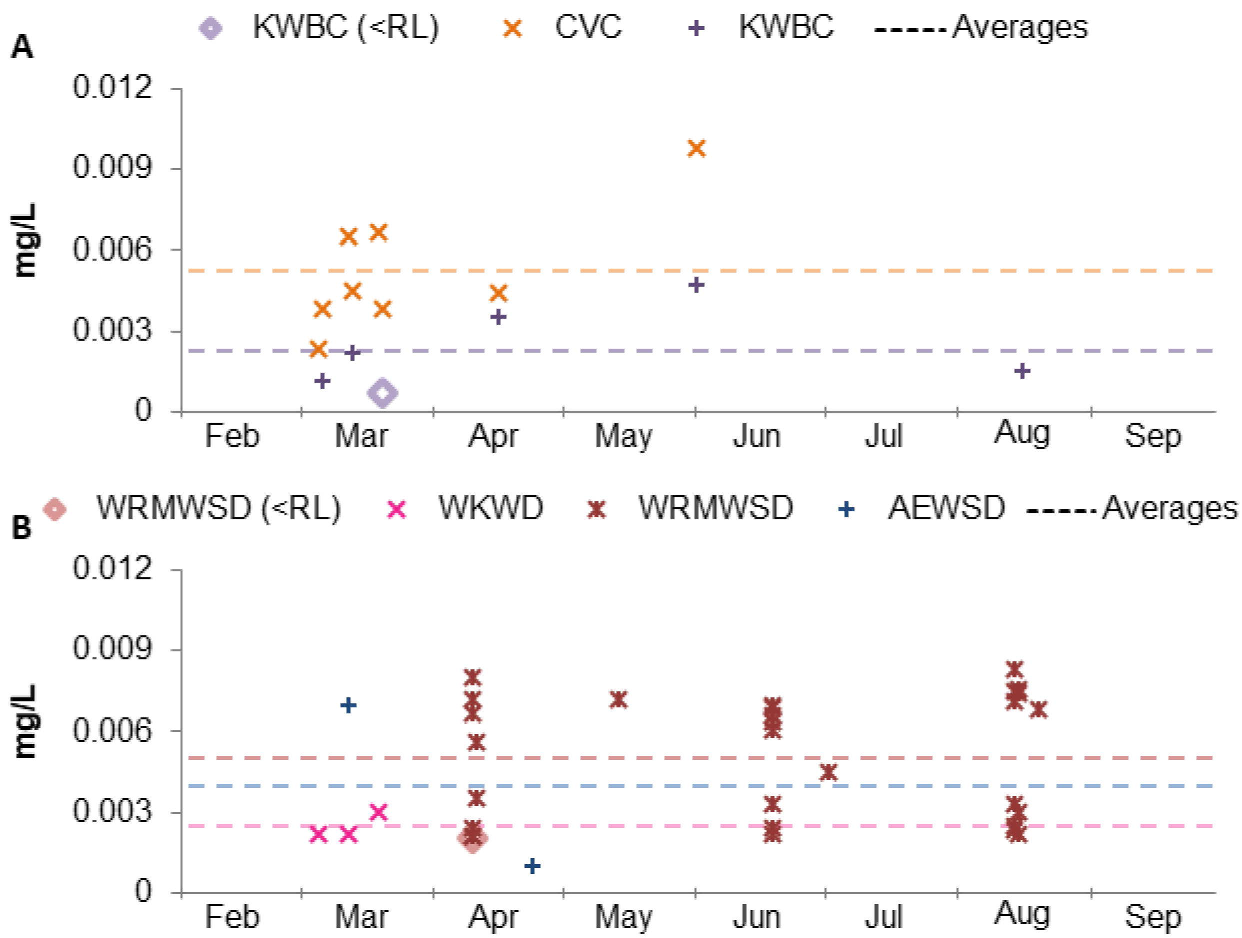
Deviations in arsenic concentrations around the mean were apparent for most turn-ins (Figure 4-6). Arsenic concentrations for CVC showed a wide range around the mean in March and April followed by an increase to its annual high in June. Samples reported from KWBC increased in arsenic concentration between March and June before decreasing in August. Both CVC and KWBC reported their maximum arsenic concentrations from samples taken on June 1. WKWD samples each reported within 0.0005 mg/L of its average. The results for WRMWSD fluctuated widely around the average, depending on turn-in structure, with no clear temporal trends. AEWSD samples dropped from 0.007 mg/L in March to 0.001 mg/L in April, caused by the aforementioned switch in water source.

Table 4-5 Arsenic Turn-in and Upstream Aqueduct Concentration Statistics

Statistic	CVC	KWBC	WKWD	WRMWSD [c]	AEWSD
Count (#)	8	6	3	30	2
< MRL[a] (#)	0	1	0	1	0
> MCL[b] (#)	0	0	0	0	0
> MCL[b] (%)	0	0	0	0	0
Average (mg/L)	0.0052	0.0023	0.0025	0.005	0.004
RSD (%)	45	67	19	46	106
Minimum (mg/L)	0.0023	< 0.0007	0.0022	< 0.002	0.001
Median (mg/L)	0.0045	0.0019	0.0022	0.0059	0.004
Maximum (mg/L)	0.0098	0.0047	0.003	0.0083	0.007
US Count (#)	7	8	6	2	12
US Average (mg/L)	0.0018	0.0018	0.0017	0.002	0.0023
US < MRL[a] (#)	2	2	3	0	4

Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, MCL = maximum contaminate level, mg/L = milligrams per liter, MRL = method reporting limit, RSD = relative standard deviation, US = Aqueduct upstream of each turn-in, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
[a] Values < MRL are graphed and calculated at the MRL. The MRL was either 0.0007 or 0.002 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
[b] MCL for arsenic is 0.01 mg/L.
[c] Arsenic for WRMWSD is dissolved/filtered. All others are unfiltered.

Figure 4-6 Time-Series Plot for Arsenic in Turn-ins

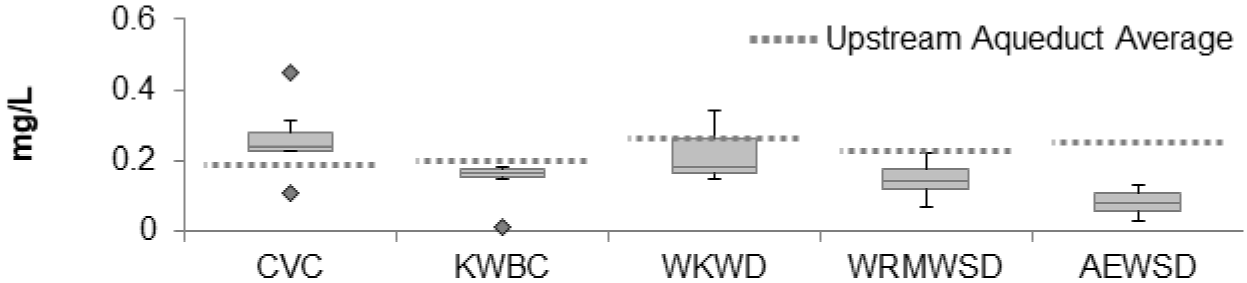


Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
Values < MRL (method reporting limit) are graphed at the MRL and displayed with a thicker light-colored border. The MRL was either 0.0007 or 0.002 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B). Arsenic for WRMWSD is dissolved/filtered. All others are unfiltered.

Bromide

CVC had the highest average bromide concentration, 0.26 mg/L, as well as the highest maximum bromide concentration, 0.45 mg/L (Figure 4-7 and Table 4-6). KWBC and WRMWSD each had similar average bromide sample concentrations at 0.14 and 0.15 mg/L, respectively. The lowest bromide concentration reported was from KWBC at 0.012 mg/L in June. WKWD had the second-highest average bromide concentration at 0.22 mg/L, with a range of 0.15–0.34 mg/L. AEWSD reported the lowest average bromide concentration, 0.08 mg/L, from two samples, one of which was below the MRL. Except for CVC, all average turn-in concentrations were below upstream Aqueduct averages, which ranged from 0.19–0.26 mg/L. There is no MCL for bromide in drinking water.

Figure 4-7 Bromide Turn-in Statistics and Box-and-Whisker Plot



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
Values < MRL are graphed and calculated at the MRL. The MRL equaled 0.03 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
There is no MCL for bromide.

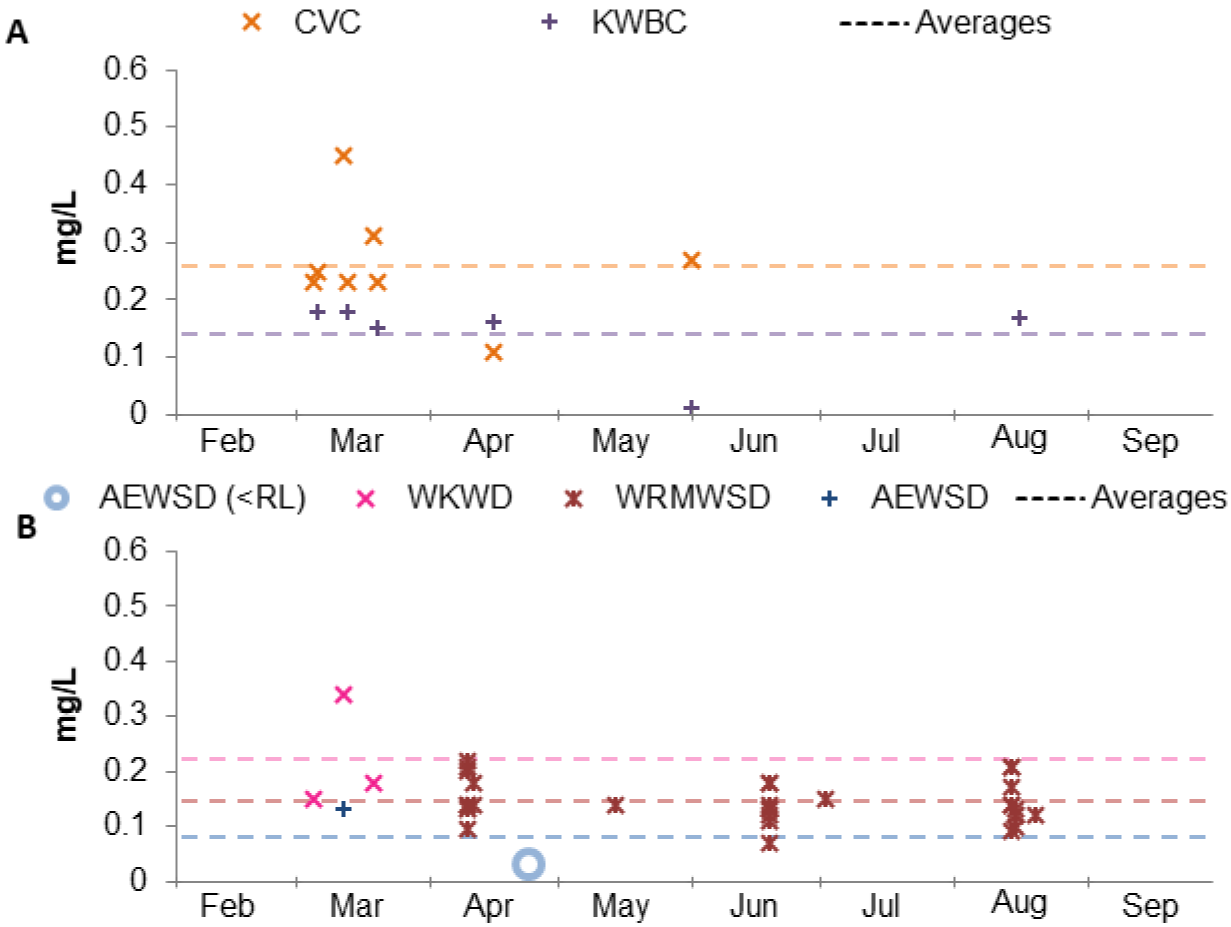
Deviations in bromide concentrations around the mean were apparent for most turn-ins (Figure 4-8). CVC bromide concentrations varied without a clear trend during the sampling period, with its lowest sample occurring in April. KWBC sample concentration mostly stayed near the average of 0.14 mg/L in March and April before a notable drop in June's sample concentration. The three samples at WKWD showed a large peak in concentrations in the second sample. Samples from WRMWSD fluctuated widely around the average, depending on turn-in structure, with no clear temporal trends. AEWSD samples dropped from 0.13 mg/L in March to < 0.03 mg/L in April, caused by the aforementioned switch in water source.

Table 4-6 Bromide Turn-in and Upstream Aqueduct Concentration Statistics

Statistic	CVC	KWBC	WKWD	WRMWSD	AEWSD
Count (#)	8	6	3	30	2
< MRL[a] (#)	0	0	0	0	1
> MCL[b] (#)	NA	NA	NA	NA	NA
> MCL[b] (%)	NA	NA	NA	NA	NA
Average (mg/L)	0.26	0.14	0.22	0.15	0.08
RSD (%)	37	46	46	27	88
Minimum (mg/L)	0.11	0.012	0.15	0.07	< 0.03
Median (mg/L)	0.24	0.17	0.18	0.14	0.08
Maximum (mg/L)	0.45	0.18	0.34	0.22	0.13
US Count (#)	7	8	6	14	12
US Average (mg/L)	0.19	0.20	0.26	0.23	0.25
US < MRL[a] (#)	0	0	0	0	0

Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, MCL = maximum contaminate level, mg/L = milligrams per liter, MRL = method reporting limit, NA = not applicable, RSD = relative standard deviation, US = Aqueduct upstream of each turn-in, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
[a] Values < MRL are graphed and calculated at the MRL. The MRL equaled 0.03 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
[b] There is no MCL for bromide.

Figure 4-8 **Time-Series Plot for Bromide in Turn-ins**

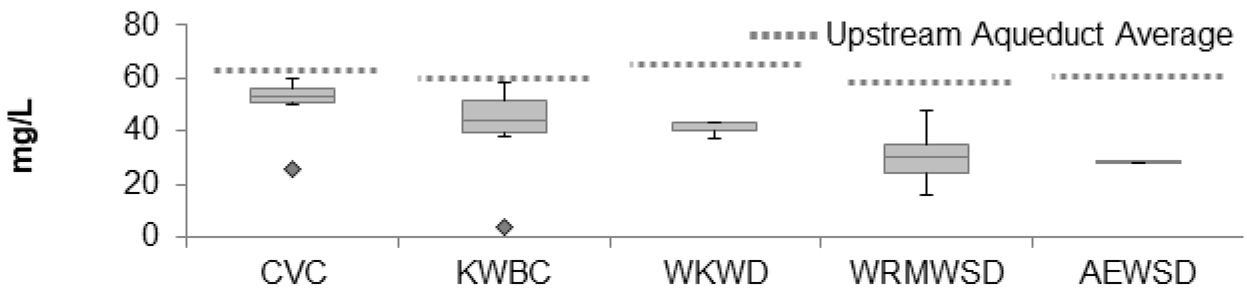


Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
Values < MRL (method reporting limit) are graphed at the MRL and displayed with a thicker light-colored border. The MRL was 0.03 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).

Chloride

CVC had the highest average chloride concentration, 51 mg/L, as well as the highest individual result and largest range, which was 26–60 mg/L (Figure 4-9 and Table 4-7). KWBC and WKWD both reported moderate average concentrations, compared with other turn-ins, for their samples at 40 and 41 mg/L, respectively. Additionally, KWBC reported the lowest individual result, 3.4 mg/L. WRMWSD reported the lowest average of 30 mg/L, while AEWSD reported a slightly lower single sample of 28 mg/L. All turn-ins averaged less than their upstream Aqueduct average, which ranged from 58–65 mg/L. No samples exceeded the recommended secondary MCL of 250 mg/L for chloride in drinking water.

Figure 4-9 Chloride Turn-in Statistics and Box-and-Whisker Plot



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
The recommended secondary MCL for chloride is 250 mg/L.

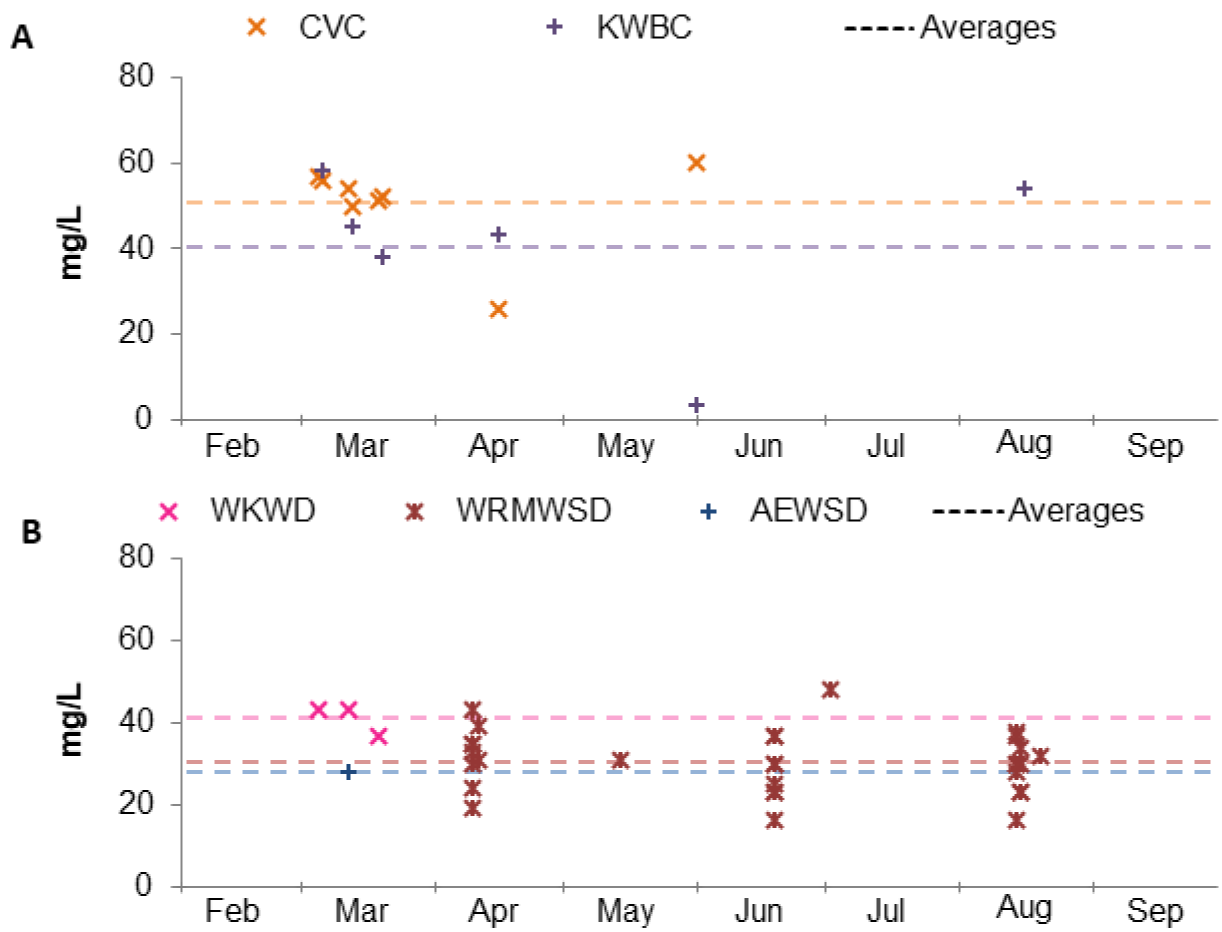
Table 4-7 Chloride Turn-in and Upstream Aqueduct Concentration Statistics

Statistic	CVC	KWBC	WKWD	WRMWSD	AEWSD
Count (#)	8	6	3	30	1
< MRL (#)	0	0	0	0	0
> MCL[a] (#)	0	0	0	0	0
> MCL[a] (%)	0	0	0	0	0
Average (mg/L)	51	40	41	30	28
RSD (%)	21	48	8	25	0
Minimum (mg/L)	26	3.4	37	16	28
Median (mg/L)	53	44	43	30	28
Maximum (mg/L)	60	58	43	48	28
US Count (#)	7	8	6	14	12
US Average (mg/L)	63	60	65	58	61
US < MRL[a] (#)	0	0	0	0	0

Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, MCL = maximum contaminate level, mg/L = milligrams per liter, MRL = method reporting limit, RSD = relative standard deviation, US = Aqueduct upstream of each turn-in, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
[a] The recommended secondary MCL for chloride is 250 mg/L.

Deviations in chloride concentrations around the mean were apparent for most turn-ins (Figure 4-10). CVC chloride concentrations were close to its average in March before decreasing to its minimum in April, followed by its maximum in June. KWBC samples decreased during March before a notable drop in June and an increase in August. The first two WKWD samples were 43 mg/L before decreasing to 37 mg/L. Samples from WRMWSD fluctuated widely around the average, depending on turn-in structure, with no clear temporal trends. AEWSD's single sample, 28 mg/L, occurred in March.

Figure 4-10 **Time-Series Plot for Chloride in Turn-ins**



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.

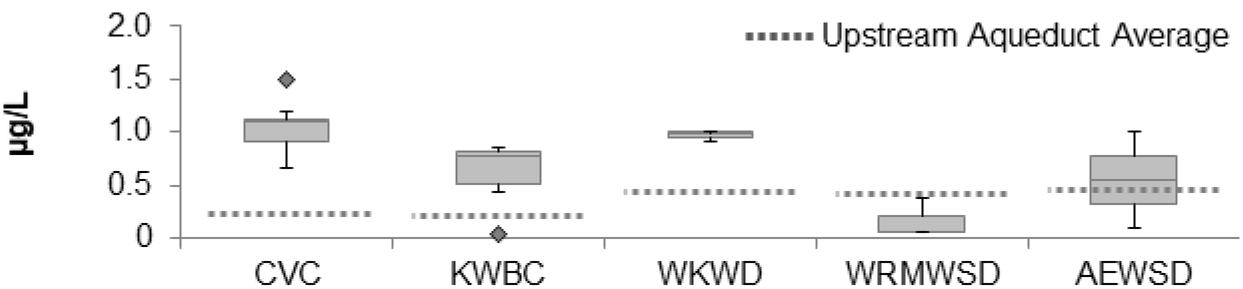
Total Chromium

Total chromium (trivalent plus hexavalent chromium, unfiltered) concentrations were not graphed, because of the paucity of data at some turn-ins, the prevalence of non-detectable results, and inconsistent MRLs between laboratories. WRMWSD reported all of its samples as less than the MRL of 0.01 mg/L (Appendix B). AEWSD reported a concentration of 0.002 mg/L in March (sourced from groundwater) and a concentration of < 0.001 mg/L in April (sourced from Friant-Kern Canal). No turn-in samples exceeded the MCL of 0.05 mg/L for total chromium in drinking water.

Hexavalent Chromium

Hexavalent chromium (filtered) was highest at CVC, with an average of 1.05 micrograms per liter (µg/L) and a range of 0.66–1.5 µg/L (Figure 4-11 and Table 4-8). The second highest average was 0.96 µg/L at WKWD, with a range of 0.9 to 1.0 µg/L. KWBC and AEWSD both reported moderate concentrations for their sample averages compared with other turn-ins — 0.62 and 0.55 µg/L, respectively. WRMWSD reported the lowest average of 0.12 µg/L, with 26 of 30 samples reported less than their MRLs of either 0.05 µg/L or 0.2 µg/L. WRMWSD was the only turn-in to report an average less than its upstream Aqueduct average, which ranged from 0.2 µg/L to 0.45 µg/L. There is no currently active MCL for hexavalent chromium.

Figure 4-11 Hexavalent Chromium Turn-in Statistics and Box-and-Whisker Plot



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District, µg/L = micrograms per liter.
The upstream sample sites used for each turn-in are shown in Table 4-6.
Values < MRL are graphed and calculated at the MRL. The MRL was either 0.031, 0.05, 0.1, or 0.2 µg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
There is no active MCL for hexavalent chromium.

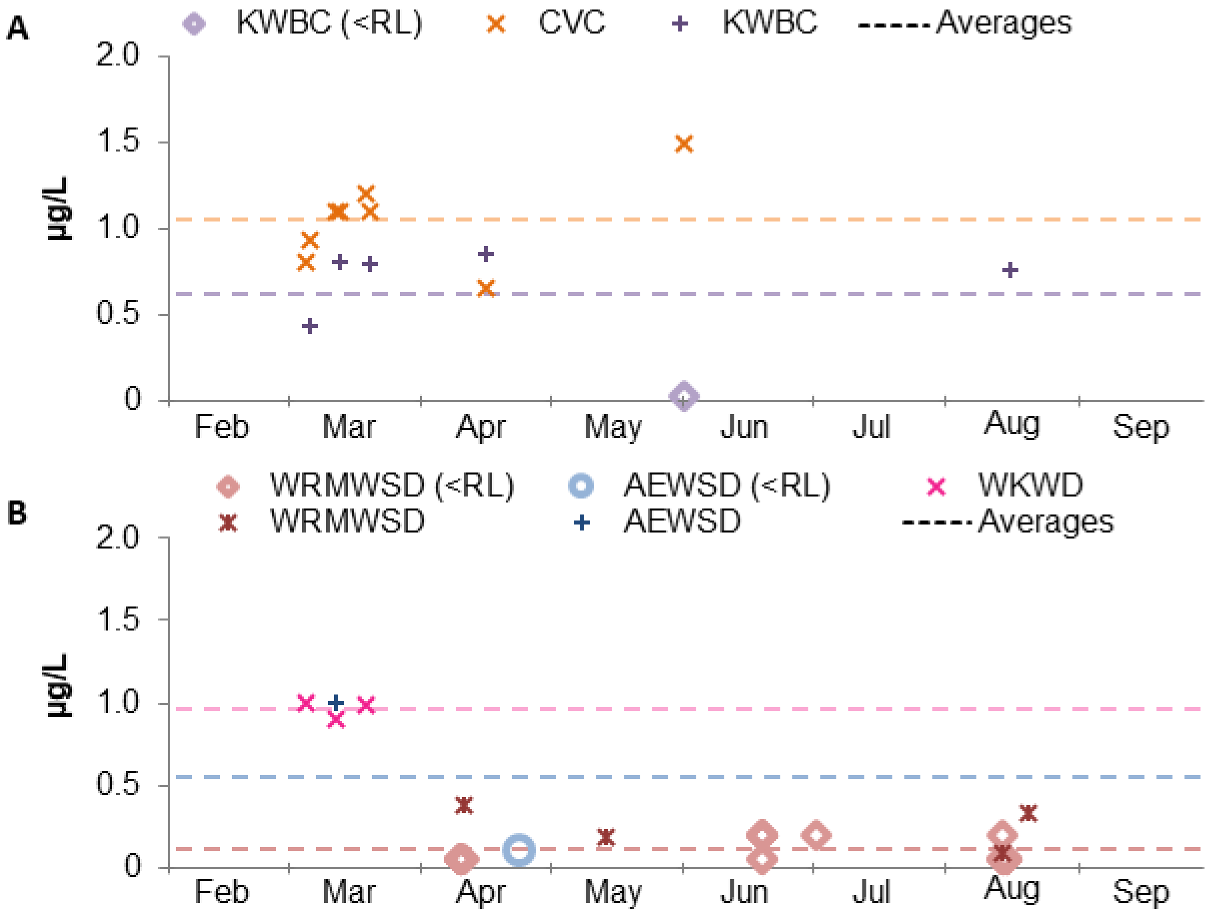
Table 4-8 Hexavalent Chromium Turn-in and Upstream Aqueduct Concentration Statistics

Statistic	CVC	KWBC	WKWD	WRMWSD	AEWSD
Count (#)	8	6	3	30	2
< MRL[a] (#)	0	1	0	26	1
> MCL[b] (#)	NA	NA	NA	NA	NA
> MCL[b] (%)	NA	NA	NA	NA	NA
Average (µg/L)	1.05	0.62	0.96	0.12	0.55
RSD (%)	24	52	6	81	116
Minimum (µg/L)	0.66	< 0.031	0.9	< 0.05	< 0.1
Median (µg/L)	1.10	0.78	0.99	< 0.05	0.55
Maximum (µg/L)	1.5	0.85	1	0.38	1
US Count (#)	8	9	6	15	13
US Average (mg/L)	0.22	0.20	0.43	0.41	0.45
US < MRL[a] (#)	0	0	1	2	2

Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, MCL = maximum contaminate level, MRL = method reporting limit, NA = not applicable, RSD = relative standard deviation, US = Aqueduct upstream of each turn-in, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District, µg/L = micrograms per liter.
The upstream sample sites used for each turn-in are shown in Table 4-6.
[a] Values < MRL are graphed and calculated at the MRL. The MRL was either 0.031, 0.05, 0.1, or 0.2 µg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
[b] There is no active MCL for hexavalent chromium.

CVC samples slightly increased through March before dropping in April and increasing again in June (Figure 4-12). KWBC also increased through March and into April before dropping in June and increasing again in August. WKWD samples fluctuated close to their mean, while WRMWSD sample fluctuated more widely around their mean (dependent on the specific turn-in structure). The only WRMWSD turn-in structures that reported samples greater than the MRL were 8P4W (in one of three samples) and 10P1X (in three of four samples). AEWSD samples dropped from 1 µg/L in March to < 0.1 µg/L in April, caused by the aforementioned switch in water source.

Figure 4-12 Time-Series Plot for Hexavalent Chromium in Turn-ins

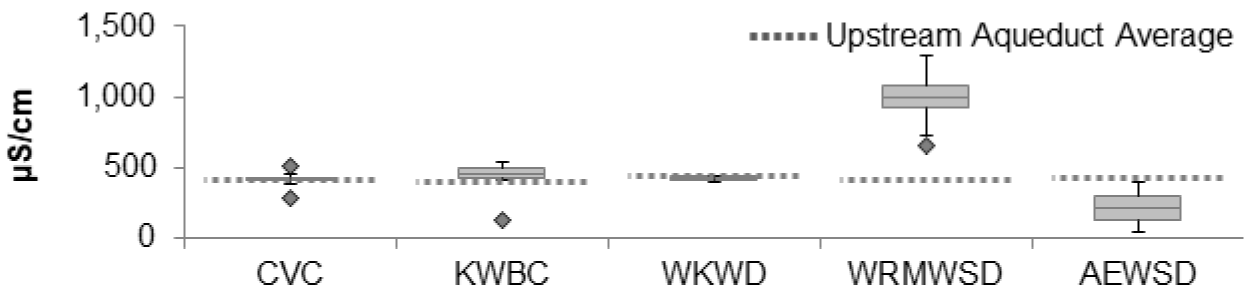


Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District, µg/L = micrograms per liter.
Values < MRL (method reporting limit) are graphed at the MRL and displayed with a thicker light-colored border. The MRL was either 0.031, 0.05, 0.1, or 0.2 µg/L and some results reported concentration less than the MRL of other samples (see Appendix B).

Conductivity

Conductivity was highest for WRMWSD, which averaged 969 microsiemens per centimeter (µS/cm) and had a range of 650 µS/cm to 1,300 µS/cm (Figure 4-13 and Table 4-9). CVC, KWBC, and WKWD each had close averages of 411 µS/cm, 414 µS/cm, and 419 µS/cm, respectively. The lowest average came from AEWSD at 218 µS/cm, which also had the lowest sample result of 43 µS/cm. KWBC and WRMWSD both reported annual averages higher than their upstream Aqueduct average, which ranged from 398 µS/cm to 440 µS/cm for all turn-ins. WRMWSD was the only turn-in to report samples greater than the secondary recommended MCL, 900 µS/cm, for conductivity in drinking water. In all, 23 of 30 samples for WRMWSD (77 percent) were greater than this MCL.

Figure 4-13 Conductivity Turn-in Statistics and Box-and-Whisker Plot



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal,
KWBC = Kern Water Bank Canal, WKWD = West Kern Water District,
WRMWSD = Wheeler Ridge-Maricopa Water Storage District, µS/cm = microSiemens per centimeter.
The upstream sample sites used for each turn-in are shown in Table 4-6.
The recommended secondary MCL for conductivity is 900 µS/cm.

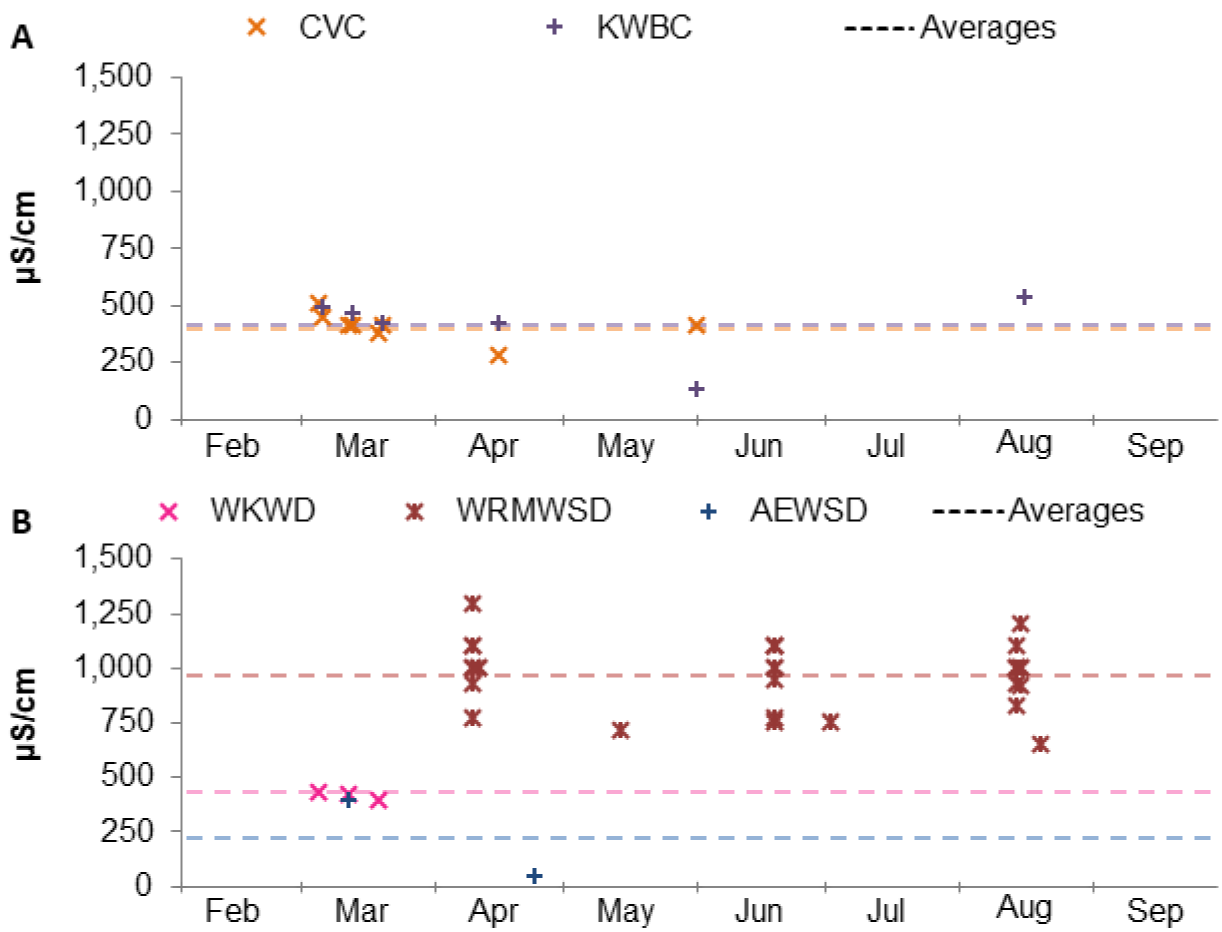
Table 4-9 Conductivity Turn-in and Upstream Aqueduct Concentration Statistics

Statistic	CVC	KWBC	WKWD	WRMWSD	AEWSD
Count (#)	8	6	3	30	2
< MRL (#)	0	0	0	0	0
> MCL[a] (#)	0	0	0	23	0
> MCL[a] (%)	0	0	0	77	0
Average (µS/cm)	411	414	419	969	218
RSD (%)	16	35	4	15	113
Minimum (µS/cm)	282	132	399	650	43
Median (µS/cm)	416	449	421	1,000	218
Maximum (µS/cm)	514	537	436	1,300	392
US Count (#)	7	8	6	14	12
US Average (mg/L)	414	398	440	405	423
US < MRL[a] (#)	0	0	0	0	0

Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, MCL = maximum contaminate level, MRL = method reporting limit, RSD = relative standard deviation, US = Aqueduct upstream of each turn-in, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District, µS/cm = microSiemens per centimeter.
The upstream sample sites used for each turn-in are shown in Table 4-6.
[a] The recommended secondary MCL for conductivity is 900 µS/cm.

Conductivity concentrations for CVC, KWBC, and WKWD slightly decreased through March; CVC dropped in April and KWBC dropped in June before each returned to samples close to the annual average (Figure 4-14). WRMWSD sample fluctuated widely around the annual average dependent on the turn-in structure. AEWSD samples dropped from 392 µS/cm in March to < 43 µS/cm in April, caused by the aforementioned switch in water source.

Figure 4-14 Time-Series Plot for Conductivity in Turn-ins

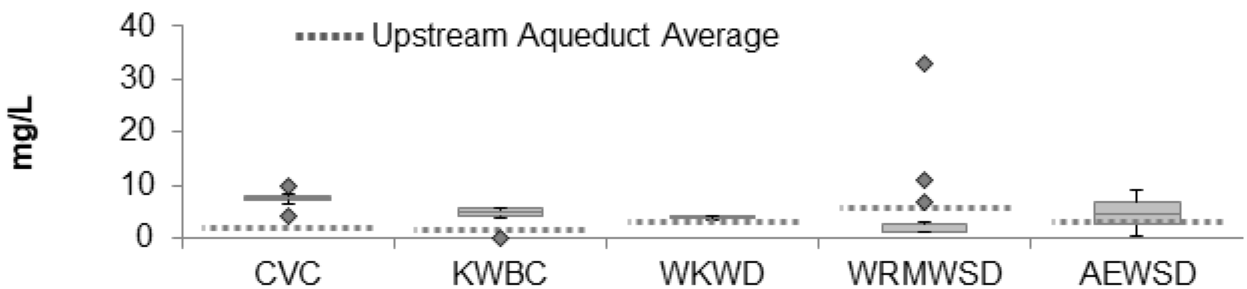


Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal,
KWBC = Kern Water Bank Canal, WKWD = West Kern Water District,
WRMWSD = Wheeler Ridge-Maricopa Water Storage District, µS/cm = microSiemens per centimeter.

Nitrate

The highest average nitrate concentration was 7.38 mg/L at CVC, with a range of 4.1 to 9.7 mg/L (Figure 4-15 and Table 4-10). The six samples collected for KWBC reported a moderate range, compared with other turn-ins, of 0.12 to 5.7 mg/L and an average of 4.24 mg/L. WKWD reported a moderate average at 3.78 mg/L with a very small range of 3.54 to 3.98 mg/L. The lowest average was reported at WRMWSD (3.10 mg/L), with fifteen of the thirty samples reporting below the MRL. Nevertheless, WRMWSD also had the largest range of sample results dependent on the turn-in structure (< 1 to 33 mg/L). Of the two samples taken at AEWSD, one was below the MRL (< 0.4 mg/L), and the average concentration was 4.7 mg/L. WRMWSD was the only turn-in to report an average less than its upstream Aqueduct average, which ranged from 1.62 mg/L to 5.83 mg/L for all turn-ins. No samples exceeded the MCL of 45 mg/L for nitrate in drinking water.

Figure 4-15 Nitrate Turn-in Statistics and Box-and-Whisker Plot



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
Values < MRL are graphed and calculated at the MRL. The MRL was either 0.096, 0.4, or 1 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
The MCL for nitrate is 45 mg/L.

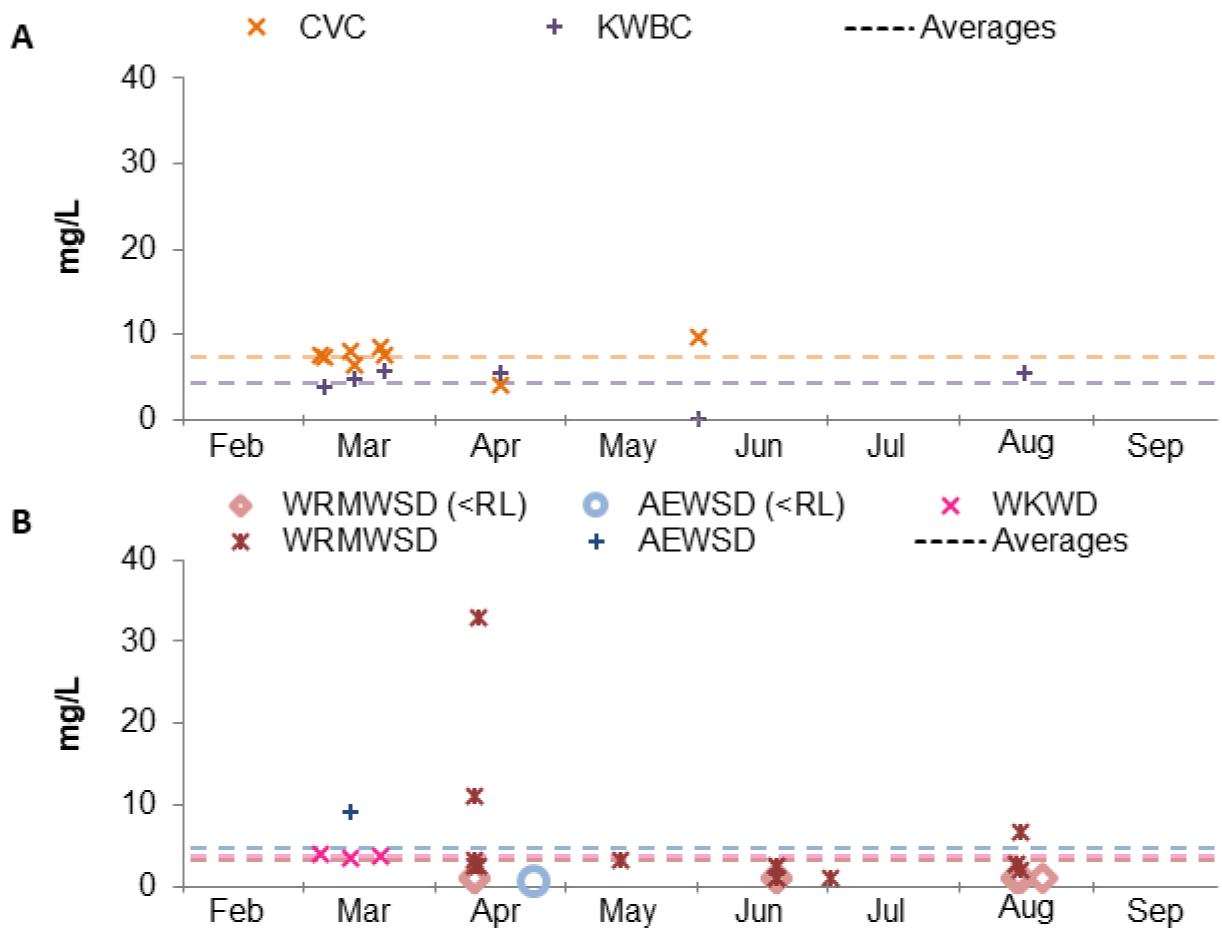
Table 4-10 Nitrate Turn-in and Upstream Aqueduct Concentration Statistics

Statistic	CVC	KWBC	WKWD	WRMWSD	AEWSD
Count (#)	8	6	3	30	2
< MRL[a] (#)	0	0	0	15	1
> MCL[b] (#)	0	0	0	0	0
> MCL[b] (%)	0	0	0	0	0
Average (mg/L)	7.38	4.24	3.78	3.10	4.70
RSD (%)	22	50	6	194	129
Minimum (mg/L)	4.1	0.12	3.54	< 1	< 0.4
Median (mg/L)	7.51	5.10	3.81	1.05	4.70
Maximum (mg/L)	9.7	5.7	3.98	33	9
US Count (#)	7	8	6	14	12
US Average (mg/L)	1.84	1.62	3.02	5.83	2.96
US < MRL[a] (#)	1	2	0	1	0

Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, MCL = maximum contaminate level, mg/L = milligrams per liter, MRL = method reporting limit, RSD = relative standard deviation, US = Aqueduct upstream of each turn-in, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
[a] Values < MRL are graphed and calculated at the MRL. The MRL was either 0.096, 0.4, or 1 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
[b] The MCL for nitrate is 45 mg/L.

Most samples from WRMWSD reported below the annual average because of much higher sample concentrations of 11.1 and 33 mg/L from April shifting the annual average higher (Figure 4-16). Concentrations from KWBC increased throughout March before declining in April and then declining further to an annual low of 0.12 mg/L in June. Results from CVC and WKWD fluctuated close to their annual averages. AEWSD samples dropped from 9 mg/L in March to < 0.4 mg/L in April, caused by the aforementioned switch in water source.

Figure 4-16 Time-Series Plot for Nitrate in Turn-ins

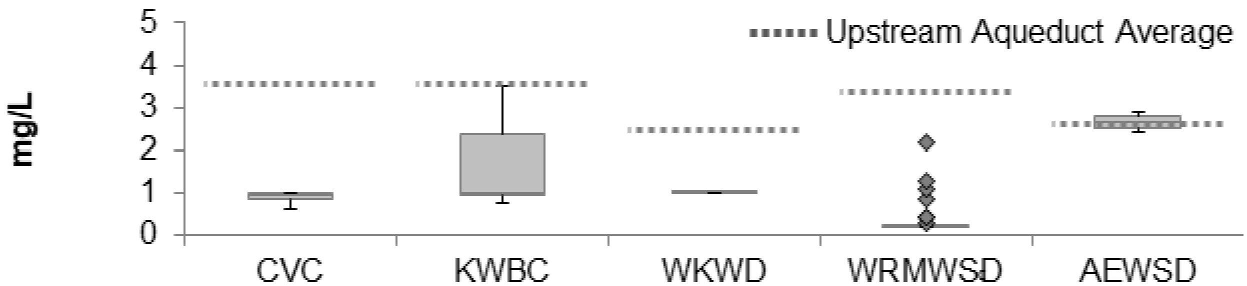


Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
Values < MRL (method reporting limit) are graphed at the MRL and displayed with a thicker light-colored border. The MRL was either 0.096, 0.4, or 1 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).

Organic Carbon

The highest average organic carbon concentration for the year was from AEWSD at 2.65 mg/L, with a small range of 2.4 mg/L–2.9 mg/L (Figure 4-17 and Table 4-11). The lowest average was from WRMWSD at 0.38 mg/L, which was also the only turn-in reporting dissolved organic carbon sample results. Nineteen of the thirty samples for WRMWSD reported below the MRL of 0.2 mg/L. The highest single sample result came from KWBC at 3.5 mg/L, which had an annual average of 1.66 mg/L. All three of WKWD's samples reported below its MRL of 1.00 mg/L. CVC reported an average of 0.89 mg/L with a small range of 0.61 mg/L to 1 mg/L. All turn-ins except AEWSD averaged below their upstream averages, which ranged from 2.48 mg/L to 3.56 mg/L for all turn-ins. There is no MCL for organic carbon in drinking water.

Figure 4-17 Total Organic Carbon Turn-in Statistics and Box-and-Whisker Plot



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
Values < MRL are graphed and calculated at the MRL. The MRL was either 0.2 or 1 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
There is no MCL for organic carbon.
Organic carbon for WRMWSD is dissolved/filtered. All others are unfiltered.

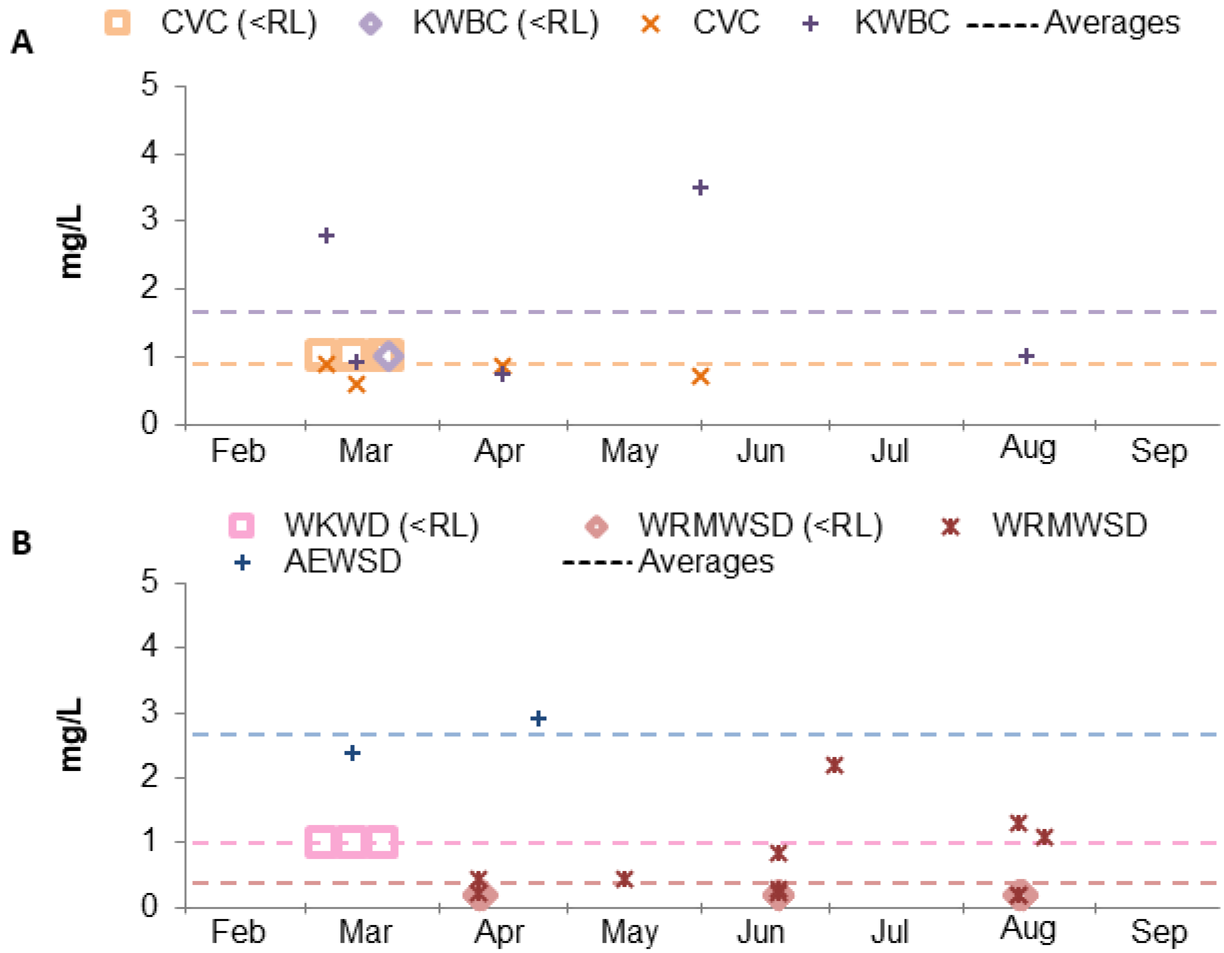
Table 4-11 Total Organic Carbon Turn-in and Upstream Aqueduct Concentration Statistics

Statistic	CVC	KWBC	WKWD	WRMWSD [c]	AEWSD
Count (#)	8	6	3	30	2
< MRL[a] (#)	4	1	3	19	0
> MCL[b] (#)	NA	NA	NA	NA	NA
> MCL[b] (%)	NA	NA	NA	NA	NA
Average (mg/L)	0.89	1.66	< 1	0.38	2.65
RSD (%)	17	71	0	117	13
Minimum (mg/L)	0.61	0.75	< 1	< 0.2	2.4
Median (mg/L)	0.95	1.00	< 1	< 0.2	2.65
Maximum (mg/L)	1	3.5	< 1	2.2	2.9
US Count (#)	5	6	6	2	10
US Average (mg/L)	3.56	3.53	2.48	3.35	2.61
US < MRL[a] (#)	0	0	0	0	0

Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, MCL = maximum contaminate level, mg/L = milligrams per liter, MRL = method reporting limit, NA = not applicable, RSD = relative standard deviation, US = Aqueduct upstream of each turn-in, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
[a] Values < MRL are graphed and calculated at the MRL. The MRL was either 0.2 or 1 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
[b] There is no MCL for organic carbon.
[c] Organic carbon for WRMWSD is dissolved/filtered. All others are unfiltered.

Most sample results from WRMWSD stayed close to the sampling period average of 0.38 mg/L except for four notably higher results, with one at 2.2 mg/L dissolved organic carbon (DOC) during the summer months (Figure 4-18). CVC's samples also stayed close to the annual average with little deviation. Sample concentrations at KWBC peaked significantly in early March and June with other samples remaining close to 1 mg/L. WKWD's samples were all equal to < 1 mg/L. The organic carbon concentration at AEWSD increased from 2.4 mg/L in March to 2.9 mg/L April, caused by the aforementioned switch in water source.

Figure 4-18 Time-Series Plot for Total Organic Carbon in Turn-ins

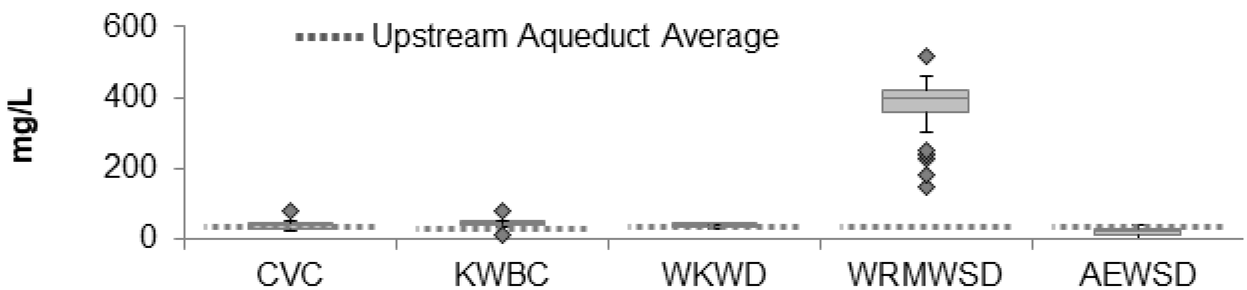


Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
Values < MRL (method reporting limit) are graphed at the MRL and displayed with a thicker light-colored border. The MRL was either 0.2 or 1 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
Organic carbon for WRMWSD is dissolved/filtered. All others are unfiltered.

Sulfate

WRMWSD reported the highest average, highest individual sample, and largest range for sulfate, with an average of 371 mg/L and a range of 150–520 mg/L (Figure 4-19 and Table 4-12). The highest sulfate concentration for WRMWSD occurred at turn-in 9G1W in April. KWBC reported the next highest average of 46 mg/L, with a range of 8.6 to 82 mg/L. CVC and KWBC reported lower averages of 41 mg/L and 37 mg/L, respectively. AEWSD had the lowest average of any of the turn-ins, 21 mg/L, as well as the lowest single sample concentration of 1 mg/L. All turn-ins except AEWSD recorded averages higher than their upstream Aqueduct averages. WRMWSD was the only turn-in to report samples (25 of 30 samples) greater than the recommended secondary MCL of 250 mg/L for sulfate in drinking water.

Figure 4-19 Sulfate Turn-in Statistics and Box-and-Whisker Plot



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
The recommended secondary MCL for sulfate is 250 mg/L.

Table 4-12 Sulfate Turn-in and Upstream Aqueduct Concentration Statistics

Statistic	CVC	KWBC	WKWD	WRMWSD	AEWSD
Count (#)	8	6	3	30	2
< MRL (#)	0	0	0	0	0
> MCL[a] (#)	0	0	0	25	0
> MCL[a] (%)	0	0	0	83	0
Average (mg/L)	41	46	37	371	21
RSD (%)	44	51	13	23	135
Minimum (mg/L)	22	8.6	32	150	1
Median (mg/L)	40	47	39	400	21
Maximum (mg/L)	81	82	41	520	40
US Count (#)	7	8	6	14	12
US Average (mg/L)	32	30	35	32	34
US < MRL[a] (#)	0	0	0	0	0

Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, MCL = maximum contaminate level, mg/L = milligrams per liter, MRL = method reporting limit, RSD = relative standard deviation, US = Aqueduct upstream of each turn-in, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
[a] The recommended secondary MCL for sulfate is 250 mg/L.

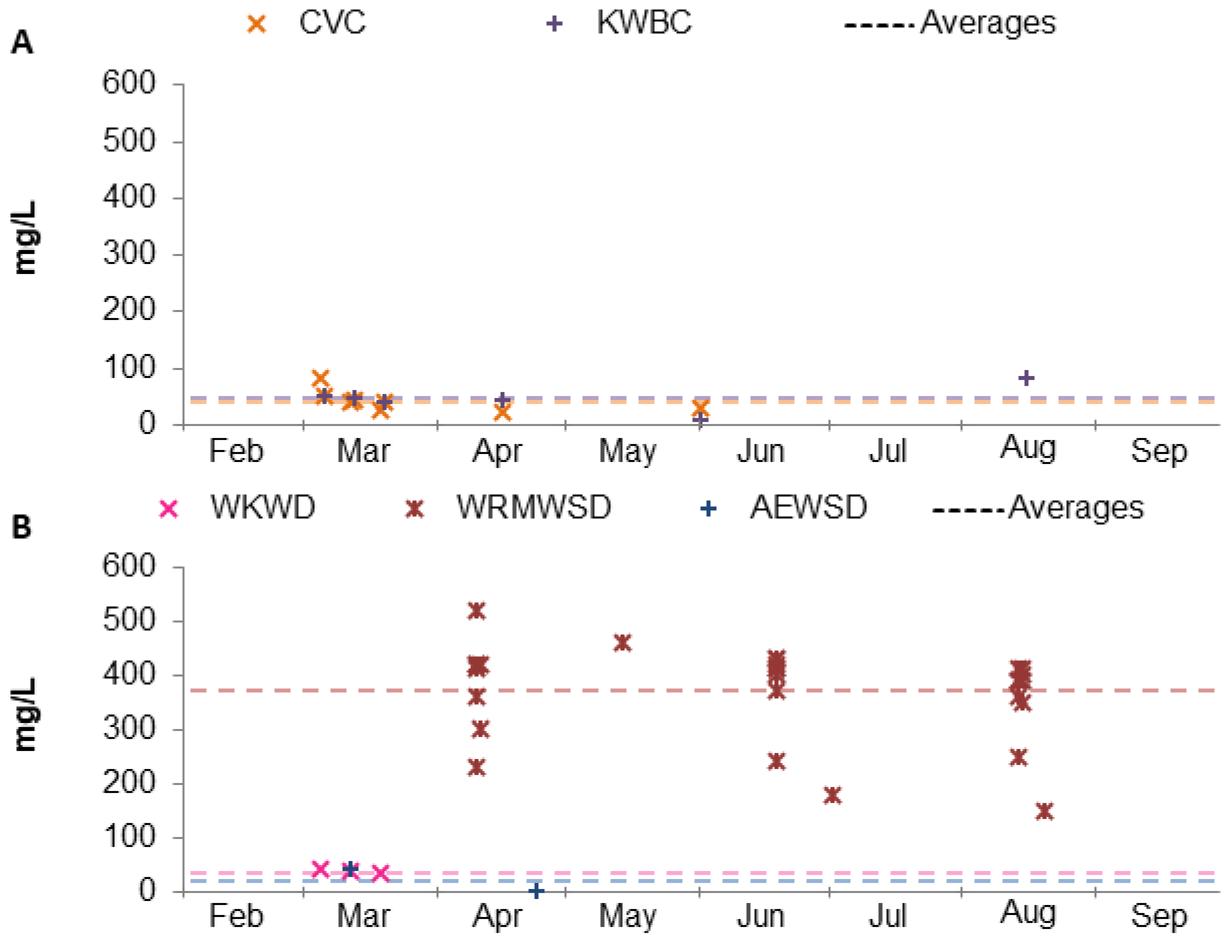
Sulfate concentrations showed a declining trend at CVC in March and then remained less than the annual average in April and June (Figure 4-20). KWBC and WKWD samples also demonstrated declines during March samples. KWBC went on to drop to an annual low in June before increasing to an annual high in August. WRMWSD samples were spaced widely around the annual average, depending on the turn-in structure. All but one WRMWSD turn-ins reported stable concentrations throughout the year, gradually converging toward the annual average in August. The exception being 10P1X, which increased in May before dropping to concentrations lower than other WRMWSD turn-ins during July and August. The sulfate concentration at AEWSD decreased from 40 mg/L in March to 1 mg/L in April, caused by the aforementioned switch in water source.

Total Dissolved Solids

WRMWSD reported the highest average, highest individual sample, and largest range for TDS, with an average of 666 mg/L and a range of 410–1,000 mg/L (Figure 4-21 and Table 4-13). The two highest individual TDS results came from the same structure, 9G1W. WKWD had the second highest average of 283 mg/L and a range of 270 to 310 mg/L. CVC and KWBC had lower averages of 269 mg/L and 278 mg/L, respectively. AEWSD had the lowest average of 105 mg/L and a range of 30 to 150 mg/L. All turn-ins, except for AEWSD, reported higher average TDS concentrations than their upstream Aqueduct averages. WRMWSD was the only turn-in to report samples (25 of 30 samples) greater than the recommended secondary MCL of 500 mg/L for TDS in drinking water.

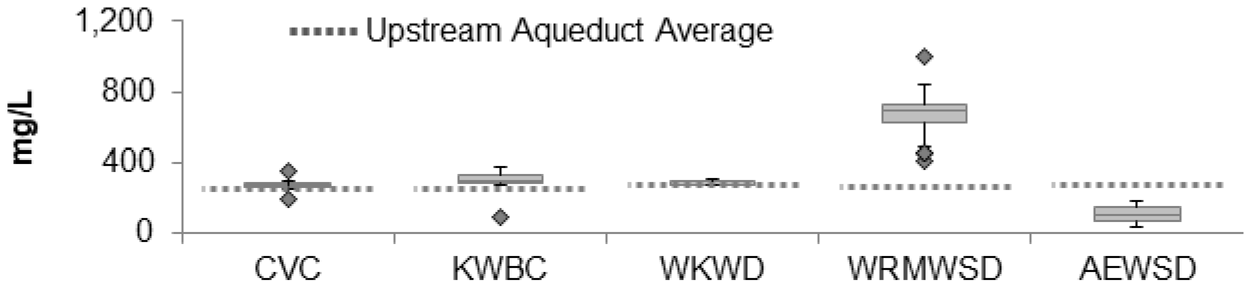
CVC, KWBC, and WKWD all showed declining trends in sample concentrations throughout March (Figure 4-22). Concentrations continued to decline at CVC into April before increasing again near to the annual average in June. KWBC decreased to its annual low in June before increasing to its annual high in August. WRMWSD samples were spaced widely around the annual average, depending on the turn-in structure. Most WRMWSD turn-ins reported stable concentrations throughout the year with a few reporting moderate increases or decreases during the year. The TDS concentration at AEWSD decreased from 180 mg/L in March to 30 mg/L in April, caused by the aforementioned switch in water source.

Figure 4-20 Time-Series Plot for Sulfate in Turn-ins



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.

Figure 4-21 **Total Dissolved Solids Turn-in Statistics and Box-and-Whisker Plot**



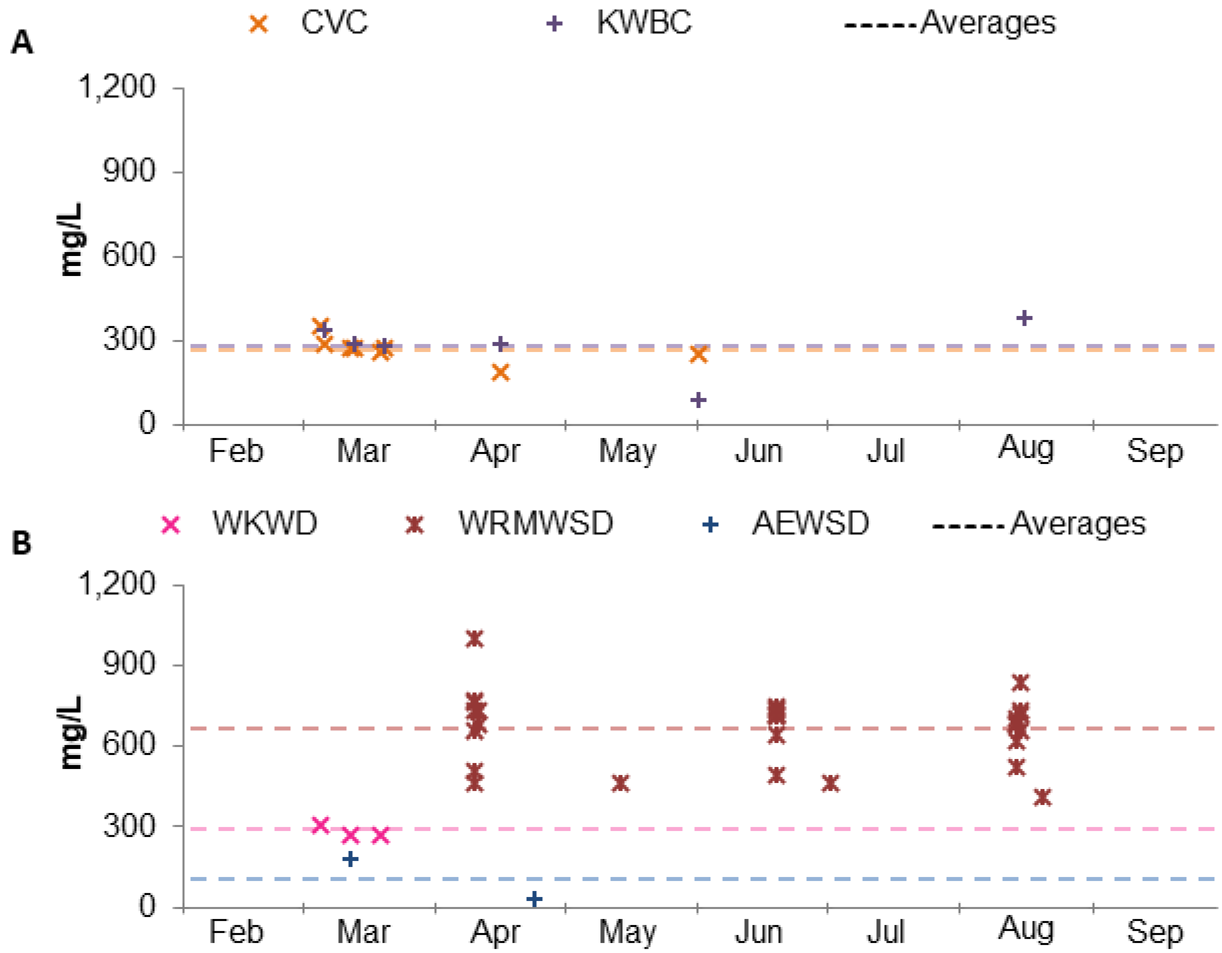
Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
The recommended secondary MCL for total dissolved solids is 500 mg/L.

Table 4-13 **Total Dissolved Solids Turn-in and Upstream Aqueduct Concentration Statistics**

Statistic	CVC	KWBC	WKWD	WRMWSD	AEWSD
Count (#)	8	6	3	30	2
< MRL (#)	0	0	0	0	0
> MCL[a] (#)	0	0	0	25	0
> MCL[a] (%)	0	0	0	83	0
Average (mg/L)	269	278	283	666	105
RSD (%)	16	36	8	19	101
Minimum (mg/L)	190	87	270	410	30
Median (mg/L)	270	290	270	695	105
Maximum (mg/L)	350	380	310	1,000	180
US Count (#)	7	7	6	14	12
US Average (mg/L)	249	249	278	259	267
US < MRL[a] (#)	0	0	0	0	0

Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, MCL = maximum contaminate level, mg/L = milligrams per liter, MRL = method reporting limit, RSD = relative standard deviation, US = Aqueduct upstream of each turn-in, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
[a] The recommended secondary MCL for total dissolved solids is 500 mg/L.

Figure 4-22 **Time-Series Plot for Total Dissolved Solids in Turn-ins**

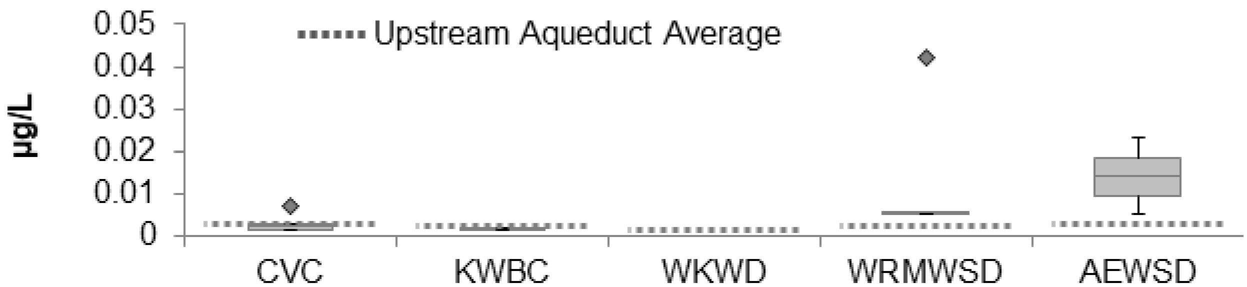


Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.

1,2,3-trichloropropane

AEWSD reported the highest average for 1,2,3-trichloropropane (TCP) at 0.014 µg/L with a range of < 0.005 to 0.023 µg/L. The lowest average reported was from KWBC where all six samples were below the MRL of 0.0015 µg/L (Figure 4-23 and Table 4-14). CVC had the next lowest average, 0.0031 µg/L, with two out of five samples reporting below the MRL, and a range of < 0.0015 to 0.0071 µg/L. Twenty-nine out of thirty samples for WRMWSD reported below its MRL of 0.005 µg/L. The single detectable sample, from 10P1X, was 0.042 µg/L. WKWD has reported all past well samples as non-detectable and is therefore not required to collect TCP in its inflow samples.

Figure 4-23 1,2,3-Trichloropropane Turn-in Statistics and Box-and-Whisker Plot



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal,
KWBC = Kern Water Bank Canal, WKWD = West Kern Water District,
WRMWSD = Wheeler Ridge-Maricopa Water Storage District, µg/L = micrograms per liter.
The upstream sample sites used for each turn-in are shown in Table 4-6.
Values < MRL are graphed and calculated at the MRL. The MRL was either 0.0015 or 0.005 µg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
The MCL for 1,2,3-trichloropropane is 0.005 µg/L.

The averages for WRMWSD and AEWSD though, are skewed upward because of their higher MRL compared with other turn-ins and some upstream Aqueduct samples. In this case, both turn-ins had MRLs equal to the MCL — 0.005 µg/L. When calculating averages using < MRL results equal to the MRL, as has been the standard for the this and past turn-in reports, the average can only be equal to or greater than the MCL. Nevertheless, both turn-ins, along with CVC, each reported one individual sample greater than the MCL.

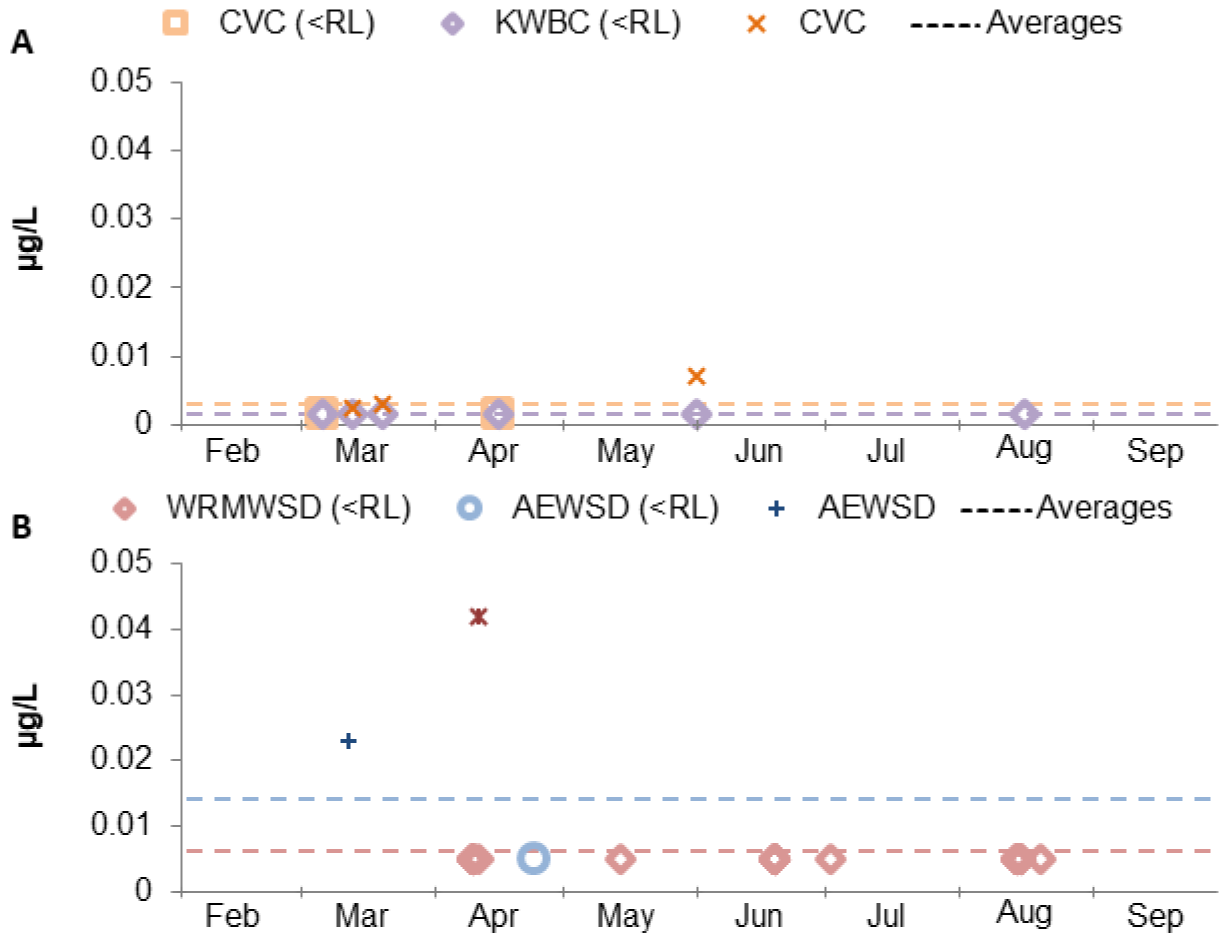
Out of 43 samples collected in total across all turn-ins, 38 reported below their respective MRLs, leaving only five samples across three turn-ins that reported a value above the MRL (Figure 4-24). CVC reported three samples above their MRL (0.0015 µg/L), with two in March and the highest sample of the year in June (0.0071 µg/L). WRMWSD reported one sample above its MRL (0.005 µg/L) in April. This sample was from turn-in 10P1X, whose subsequent concentrations were all less than the MRL. All KWBC's samples reported below the MRL throughout its sampling period spanning from March to August. AEWSD reported its March sample at 0.023 µg/L before decreasing to < 0.005 µg/L in April, caused by the aforementioned switch in water source.

Table 4-14 1,2,3-Trichloropropane Turn-in and Upstream Aqueduct Concentration Statistics

Statistic	CVC	KWBC	WKWD	WRMWSD	AEWSD
Count (#)	5	6	0	30	2
< MRL[a] (#)	2	6	NA	29	1
> MCL[b] (#)	1	0	NA	1	1
> MCL[b] (%)	20	0	NA	3	50
Average (µg/L)	0.0031	< 0.0015	NA	0.0062	0.014
RSD (%)	75	0	NA	108	91
Minimum (µg/L)	< 0.0015	< 0.0015	NA	< 0.005	< 0.005
Median (µg/L)	0.0024	< 0.0015	NA	< 0.005	0.014
Maximum (µg/L)	0.0071	< 0.0015	NA	0.042	0.023
US Count (#)	7	8	3	8	6
US Average (mg/L)	0.0025	0.0024	0.0015	0.0024	0.0027
US < MRL[a] (#)	6	7	3	8	6

Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, MCL = maximum contaminate level, MRL = method reporting limit, NA = not applicable, RSD = relative standard deviation, US = Aqueduct upstream of each turn-in, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District, µg/L = micrograms per liter.
The upstream sample sites used for each turn-in are shown in Table 4-6.
[a] Values < MRL are graphed and calculated at the MRL. The MRL was either 0.0015 or 0.005 µg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
[b] The MCL for 1,2,3-trichloropropane is 0.005 µg/L.

Figure 4-24 Time-Series Plot for 1,2,3-Trichloropropane in Turn-ins

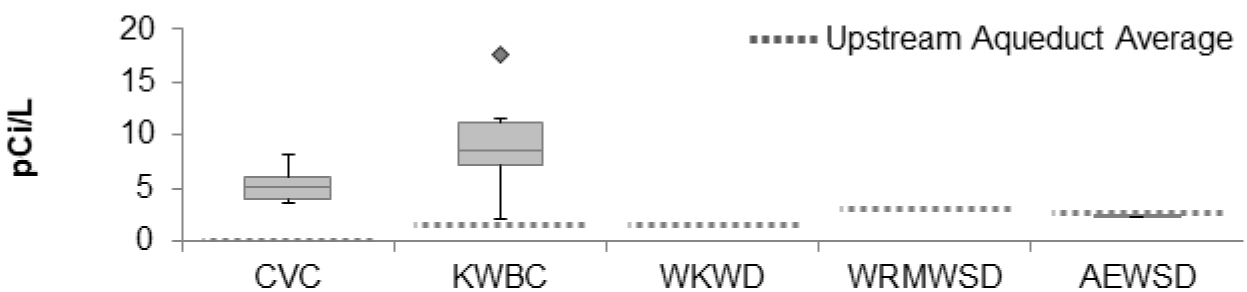


Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District, µg/L = micrograms per liter.

Radiological Constituents

Turn-ins collected samples for either gross alpha or uranium or both. CVC, KWBC, and AEWSD all collected gross alpha samples (Figure 4-25 and Table 4-15). KWBC reported the highest average (9.23 picocuries per liter [pCi/L]), followed by CVC (5.34 pCi/L) and AEWSD's single sample (2.21 pCi/L). CVC samples ranged from 3.52–8.06 pCi/L and KWBC samples ranged from 2.01–17.6 pCi/L. CVC samples decreased during March before fluctuating around its average in April and June (Figure 4-26). KWBC samples peaked in mid-March before declining to a low in June then returning to the average in August. AEWSD's single sample was collected in March when its water was sourced from groundwater, no sample was collected from Friant-Kern Canal water in April. This AEWSD sample was also the only one less than the upstream Aqueduct average for all turn-ins reporting gross alpha data. The maximum sample for KWBC was the only turn-in sample to report greater than the MCL of 15 pCi/L for gross alpha in drinking water.

Figure 4-25 Gross Alpha Turn-in Statistics and Box-and-Whisker Plot



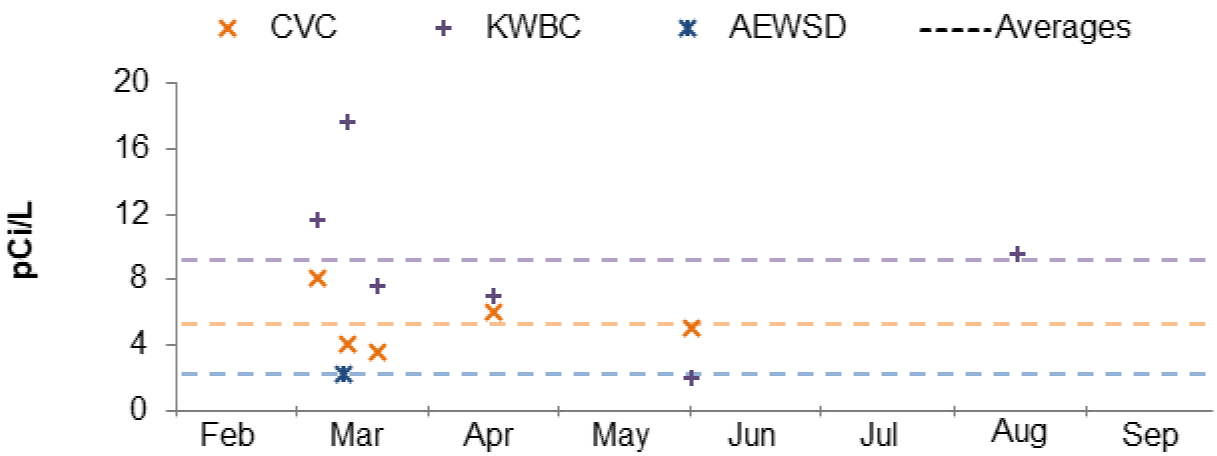
Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, pCi/L = picoCuries per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
The MCL for gross alpha is 15 pCi/L.

Table 4-15 **Gross Alpha Turn-in and Upstream Aqueduct Concentration Statistics**

Statistic	CVC	KWBC	WKWD	WRMWSD	AEWSD
Count (#)	5	6	0	0	1
< MRL (#)	0	0	NA	NA	0
> MCL[a] (#)	0	1	NA	NA	0
> MCL[a] (%)	0	17	NA	NA	0
Average (pCi/L)	5.34	9.23	NA	NA	2.21
RSD (%)	34	56	NA	NA	0
Minimum (pCi/L)	3.52	2.01	NA	NA	2.21
Median (pCi/L)	5.03	8.56	NA	NA	2.21
Maximum (pCi/L)	8.06	17.6	NA	NA	2.21
US Count (#)	7	8	3	8	6
US Average (mg/L)	1.45	1.46	3.04	2.72	3.13
US < MRL[a] (#)	3	4	1	2	1

Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, MCL = maximum contaminate level, MRL = method reporting limit, NA = not applicable, pCi/L = picoCuries per liter, RSD = relative standard deviation, US = Aqueduct upstream of each turn-in, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
[a] The MCL for gross alpha is 15 pCi/L.

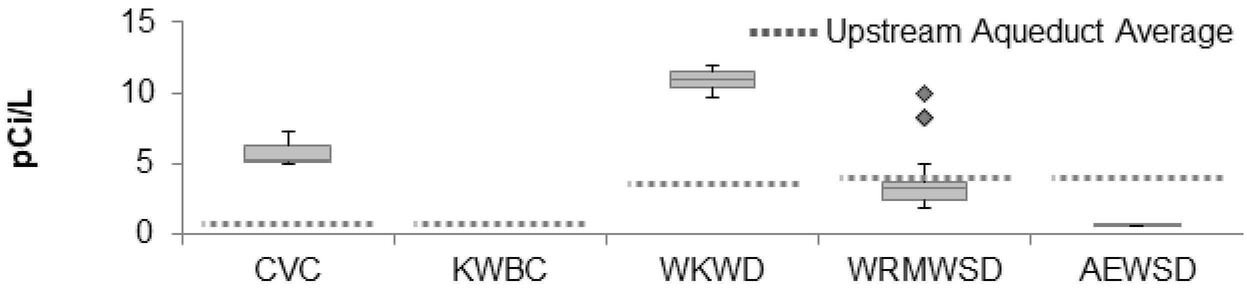
Figure 4-26 Time-Series Plot for Gross Alpha in Turn-ins



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, pCi/L = picoCuries per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.

WKWD, WRMWSD, and AEWSD all collected samples for uranium; additionally, WKWD also collected uranium samples in the CVC (Figure 4-27 and Table 4-16). The highest average for uranium was reported for the WKWD turn-in (10.9 pCi/L), followed by WKWD's samples from CVC (5.9 pCi/L), WRMWSD (3.6 pCi/L), and AEWSD's single sample (0.496 pCi/L). CVC reported the narrowest range (5.1–7.3 pCi/L), followed by a slightly larger range at WKWD (9.7–12 pCi/L) and the largest range at WRMWSD (1.9–10 pCi/L). The WRMWSD range is skewed upwards by two samples in April and August from 9G1W — the two highest concentrations for WRMWSD — as well as a single high value in April for 10P1X — which declined to a concentration near other WRMWSD turn-ins in subsequent samples (Figure 4-28). AEWSD's single sample was collected in March when its water was sourced from groundwater, no sample was collected from Friant-Kern Canal water in April. Both WRMWSD and AEWSD reported averages less than their upstream Aqueduct average. No turn-in samples exceeded the MCL of 20 pCi/L for uranium in drinking water.

Figure 4-27 **Uranium Turn-in Statistics and Box-and-Whisker Plot**



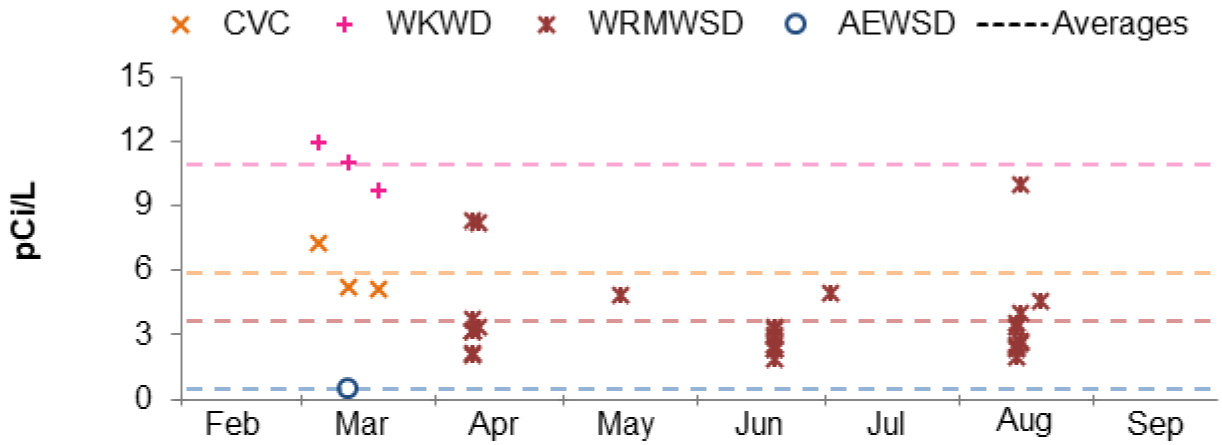
Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, pCi/L = picoCuries per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
The MCL for uranium is 20 pCi/L.

Table 4-16 **Uranium Turn-in and Upstream Aqueduct Concentration Statistics**

Statistic	CVC	KWBC	WKWD	WRMWSD	AEWSD
Count (#)	3	0	3	30	1
< MRL (#)	0	NA	0	0	0
> MCL[a] (#)	0	NA	0	0	0
> MCL[a] (%)	0	NA	0	0	0
Average (pCi/L)	5.9	NA	10.9	3.6	0.496
RSD (%)	21	NA	11	54	0
Minimum (pCi/L)	5.1	NA	9.7	1.9	0.496
Median (pCi/L)	5.2	NA	11.0	3.2	0.496
Maximum (pCi/L)	7.3	NA	12	10	0.496
US Count (#)	3	3	3	3	3
US Average (mg/L)	0.74	0.74	3.54	3.97	3.97
US < MRL[a] (#)	0	0	0	0	0

Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, MCL = maximum contaminate level, MRL = method reporting limit, NA = not applicable, pCi/L = picoCuries per liter, RSD = relative standard deviation, US = Aqueduct upstream of each turn-in, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
The upstream sample sites used for each turn-in are shown in Table 4-6.
[a] The MCL for uranium is 20 pCi/L.

Figure 4-28 Time-Series Plot for Uranium in Turn-ins



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, pCi/L = picoCuries per liter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.

California Aqueduct Water Quality

To determine potential impacts from turn-ins on Aqueduct water quality, an upstream and downstream (us/ds) assessment was performed in the SJFD. When possible, the assessment utilized water quality sampling stations that bracketed one or more turn-ins. These paired samples, collected on or within one or two days of each other, illustrated water quality changes that are possibly attributable to turn-in activity. If several samples are available for pairing, the two samples are chosen based on several criteria — limiting days between samples, limiting collections to one agency, and/or limiting the number of bracketed turn-ins. DWR collected samples at five locations on the Aqueduct. Several turn-in agencies also collected samples at three additional locations. The locations of sampling sites along the Aqueduct naturally divided the SJFD into three sections, each containing one or more turn-ins.

Effects to the SJFD, as a whole, from all turn-ins are analyzed using sample pairs between Check 21 and Check 41. Effects from CVC and KWBC are analyzed using paired samples between Tupman Road and Cole's Levee. Effects from WKWD are analyzed using paired samples between Cole's Levee and Hwy 119. Lastly, effects from WRMWSD and AEWSD are analyzed using paired samples between Hwy 119 and Teerink Pumping Plant (PP) in March when WKWD was active and sampling between Cole's Levee and Teerink PP for March through August when WKWD was not active. In some cases, us/ds paired samples are not available and turn-in influences are inferred from prevailing trends. This method is not determinative because of a lack of direct comparison but it can provide insights to the overall positive and/or negative effects from some turn-ins.

The proximity of most bracketing stations mitigates the influence of travel time and Aqueduct operations on us/ds analysis, but not all paired samples have this benefit. For the analysis of the entire SJFD, which is examining water quality changes from all turn-ins combined, the distance between stations (131 miles) made detailed comparisons difficult. Instead, this broad comparison revealed large trends seen throughout the year, factoring in the influence from all turn-ins and Aqueduct operations. Conversely, the distance between stations bracketing WKWD (approximately 1,500 yards from the turn-in to the downstream sample site) is likely too short to allow complete blending with Aqueduct flows. Consequently, us/ds differences are not deemed reliable indicators of WKWD influence. This is considered a minor concern because of the relatively small turn-in volume from WKWD, the short turn-in period, and the subsequent low potential for influence.

The occurrence of small changes downstream of turn-ins, relative to the total range of concentrations observed upstream of those turn-ins, is common in the analysis presented in this chapter. The majority of sample pairs for all turn-ins report us/ds deviations that are smaller than or similar to the variation in the Aqueduct absent those turn-ins, represented by each turn-in's upstream samples throughout the period of operation. Figures 4-29 to 4-41 show the raw values for us/ds samples in the Aqueduct and for each turn-in. Additionally, the graphs covering the entire SJFD include the total monthly turn-in volume and Check 21 flow (Table 4-1), whereas the graphs covering the three SJFD sections include the monthly POA for each enclosed turn-in (Table 4-2).

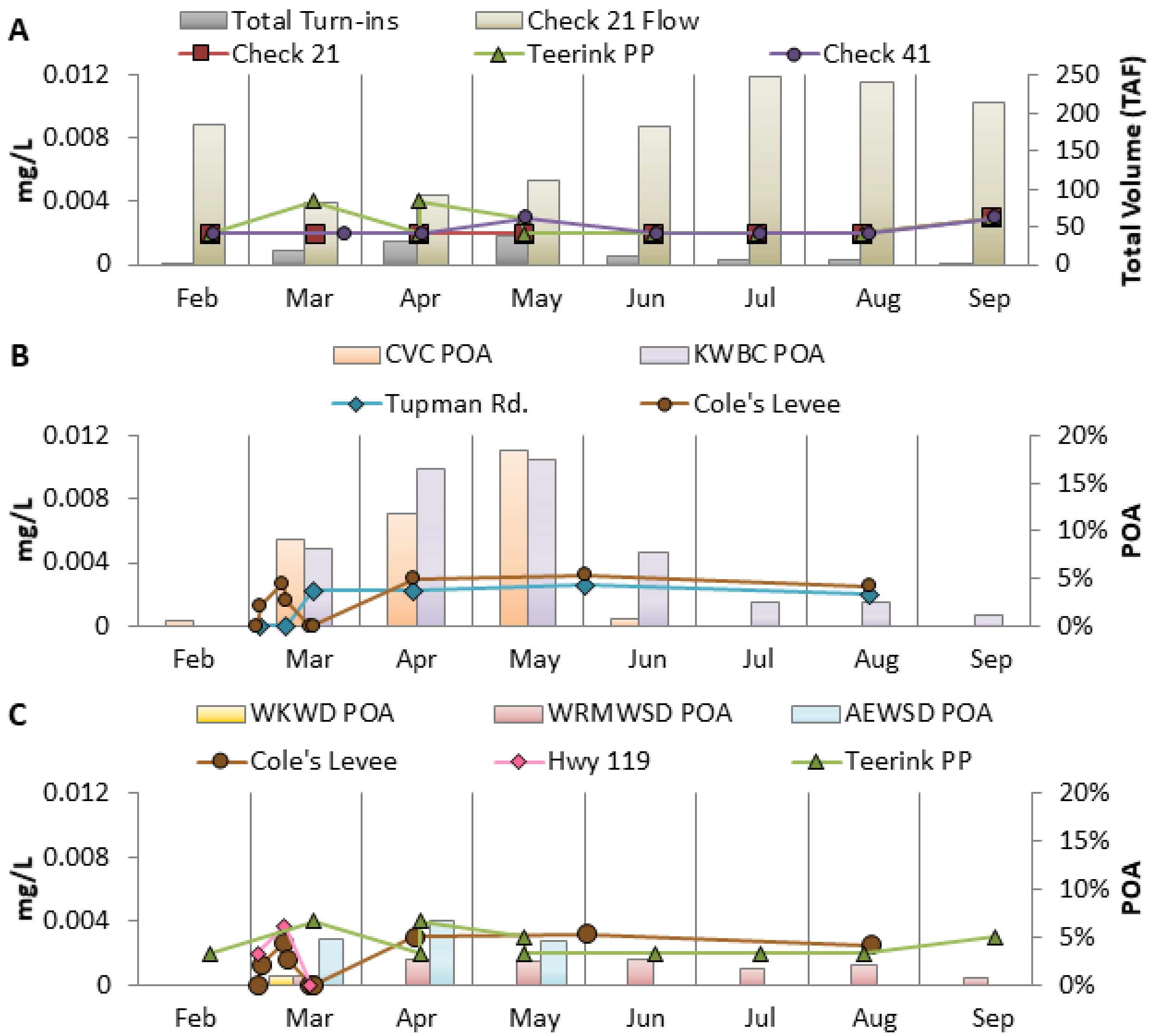
Arsenic

During months of higher turn-in volumes there were slight increases in arsenic observed downstream (Figure 4-29A). In the Aqueduct at Check 21, upstream of all turn-ins, arsenic concentrations remained at 0.002 mg/L until September. At Check 41, downstream of all turn-ins, arsenic concentrations remained equal to those at Check 21 except for a 0.001 mg/L rise in May. Concentrations between these two locations saw more fluctuations. No Aqueduct samples exceeded the MCL for arsenic in drinking water (0.01 mg/L).

For CVC and KWBC, the prevailing trend was for slight increases in arsenic downstream (Figure 4-29B). For these turn-ins, the highest POAs were observed in March through May. In March there were initially increases in arsenic concentrations downstream at Cole's Levee (range of 0.0013–0.0027 mg/L) compared with samples upstream at Tupman Road (< 0.0007 mg/L), followed shortly by a reversal in concentrations and a decrease of 0.003 mg/L. The increases were consistent with higher-than-Aqueduct concentrations reported for both turn-ins at that time. The decrease was less consistent with expected results, as the turn-in concentrations for CVC were still higher than in the Aqueduct, but the KWBC concentration had dropped to < 0.0007 mg/L. In April and June, there were slight increases in arsenic of 0.0008 mg/L and 0.0006 mg/L downstream of CVC and KWBC. These increases were expected because of CVC and KWBC concentrations being higher on average than upstream in the Aqueduct.

WKWD was only active in March, and the Aqueduct trends for arsenic were not always consistent with expected results, likely because of its low POA (Figure 4-29C). The concentration upstream of WKWD, Cole's Levee, was lower than the concentration downstream at Highway 119 for the first two samples. The first downstream increase was consistent with a slightly higher-than-Aqueduct turn-in concentration, but the second increase conflicted with a lower-than-Aqueduct turn-in concentration. The final WKWD sample showed a decrease to < MRL at both sites, despite a higher-than-Aqueduct turn-in concentration.

Figure 4-29 Arsenic Concentrations and Volumes or POA[a] for (A) the San Joaquin Field Division; (B) CVC & KWBC; (C) WKWD, WRMWSD[a,b], & AEWSD



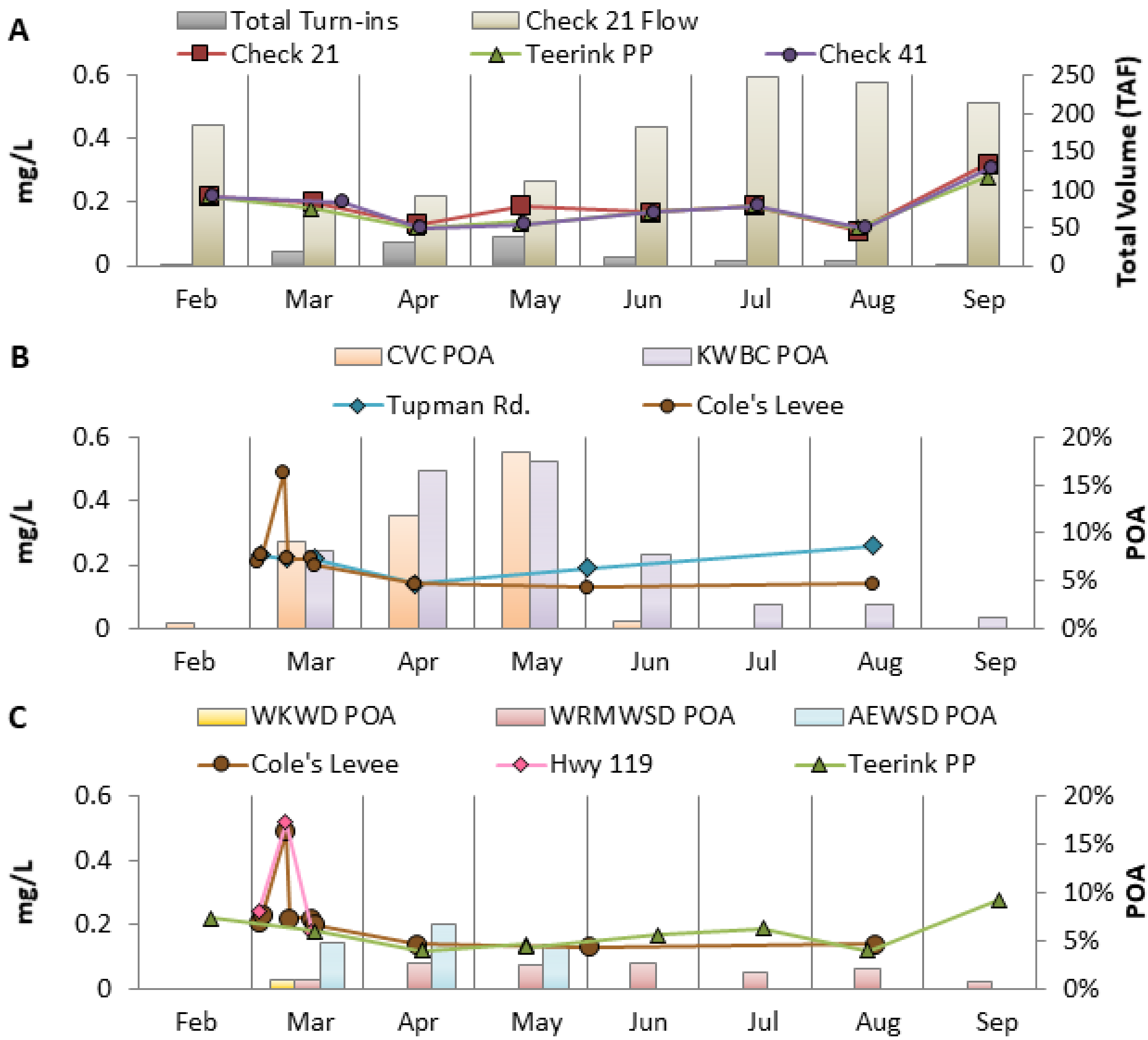
Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, POA = Percent-of-Aqueduct, PP = Pumping Plant, TAF = thousand acre-feet, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
Values < MRL (method reporting limit) are graphed equal to zero. The MRL was either 0.0007 or 0.002 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
[a] WRMWSD data does not include Turn-in 10P1X, which is downstream of Teerink PP.
[b] Arsenic results are for dissolved arsenic rather than total arsenic as for all other sites.

Arsenic concentrations us/ds of WRMWSD and AEWSD fluctuated, which conforms to fluctuating and divergent concentrations coming from these turn-ins (Figure 4-29C). Concentrations downstream of these turn-ins at Teerink PP typically lower than those further upstream at Cole's Levee and Hwy 119, except a slight increase in March and a duplicate sample result in April. The March increase is consistent with the AEWSD concentration (0.007 mg/L) when the turn-in water originated from groundwater sources. The switch to Friant-Kern Canal water in April (0.001 mg/L) may have contributed to the possible us/ds decreases in April and May. Simultaneously, WRMWSD was operating its 11 turn-in structures with some reporting concentrations greater than the Aqueduct and some reporting concentrations equal to or less than the Aqueduct. That trend remained through the end of WRMWSD's operations and resulted in slight decreases downstream at Teerink PP compared with Cole's Levee. The comparison of these two Aqueduct sites includes all WRMWSD turn-ins except 10P1X, which reported concentrations near the median for all WRMWSD turn-ins (Appendix B).

Bromide

Bromide concentrations in the Aqueduct remained moderately consistent from February through September (Figure 4-30A). In the Aqueduct, between Check 21 and Check 41, there were decreases and some slight increases. The largest decrease in bromide was observed in May when POAs were highest — the Check 21 concentration was 0.19 mg/L and decreased to 0.13 mg/L at Check 41. From August to September, us/ds changes ranged between -0.01 mg/L and 0.01 mg/L. POAs at this time were less than 2 percent, which likely limited further influences on bromide. There is no drinking water MCL for bromide.

Figure 4-30 Bromide Concentrations and Volumes or POA[a] for (A) the San Joaquin Field Division; (B) CVC & KWBC; (C) WKWD, WRMWSDa, & AEWSD



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, POA = Percent-of-Aqueduct, PP = Pumping Plant, TAF = thousand acre-feet, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
Values < MRL (method reporting limit) are graphed equal to zero. The MRL was 0.03 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
[a] WRMWSD data does not include Turn-in 10P1X, which is downstream of Teerink PP.

For CVC and KWBC, most sample pairs decreased downstream of turn-ins or remained the same through March and April and diverged later in the year (Figure 4-30B). In March and April, samples collected by KCWA at Tupman Road and Cole's Levee were equal or decreased by 0.02 mg/L for one sample pair. This conforms with turn-in samples collected at this time by KCWA which showed concentration close to or less than the upstream Aqueduct. This finding is complicated by a sample collected by WKWD on March 12 at Cole's Levee that was 0.49 mg/L (0.27 mg/L higher than the KCWA sample collected the next day). This higher Aqueduct concentration coincides with a similarly high CVC sample (0.45 mg/L) collected by WKWD that same day. A second moderately high CVC sample was also collected by WKWD on March 19. These higher concentrations could be the result of single-day slugs of turn-in water that introduced higher-than-normal bromide concentrations. It is also possible these values are a result of differing sample collection and analysis procedures. But it should be noted the higher concentrations found by WKWD was not a universal trend — the Cole's Levee and CVC samples on March 5 and the Cole's Levee sample on March 19 showed very little difference between WKWD and next-day KCWA samples (Appendix B). In June and August, there were us/ds decreases in bromide of 0.06 mg/L and 0.12 mg/L respectively. Based on concentrations and POAs for the turn-ins, these decreases downstream would be expected.

WKWD was only active in March and the Aqueduct trends for bromide were not always consistent with expected results, likely because of its low POA (Figure 4-30C). The first two us/ds sample pairs increased by 0.03 mg/L and the third decreased by -0.4 mg/L. This includes the spike in bromide values previously discussed for WKWD-collected samples, which still showed a downstream increase. The two increases conflict with the average concentration from WKWD, which was less than the average upstream in the Aqueduct.

Minor changes were reported throughout the year us/ds of WRMWSD and AEWSD, which conforms to similar concentrations in these turn-ins and the Aqueduct (Figure 4-30C). The March pair showed no us/ds change while the April and August pairs each had decreases of -0.02 mg/L. The March pair was taken after the previously discussed spike in bromide concentrations from WKWD samples. March and April results were consistent with expected results as turn-in concentrations were less than the upstream average for AEWSD and near the average for WRMWSD. The turn-in concentration in

August was same as upstream but had a low POA so the slight decrease in bromide is in line with expected results. The comparison of these two Aqueduct sites includes all WRMWSD turn-ins except 10P1X, which reported concentrations near the median for all WRMWSD turn-ins (Appendix B).

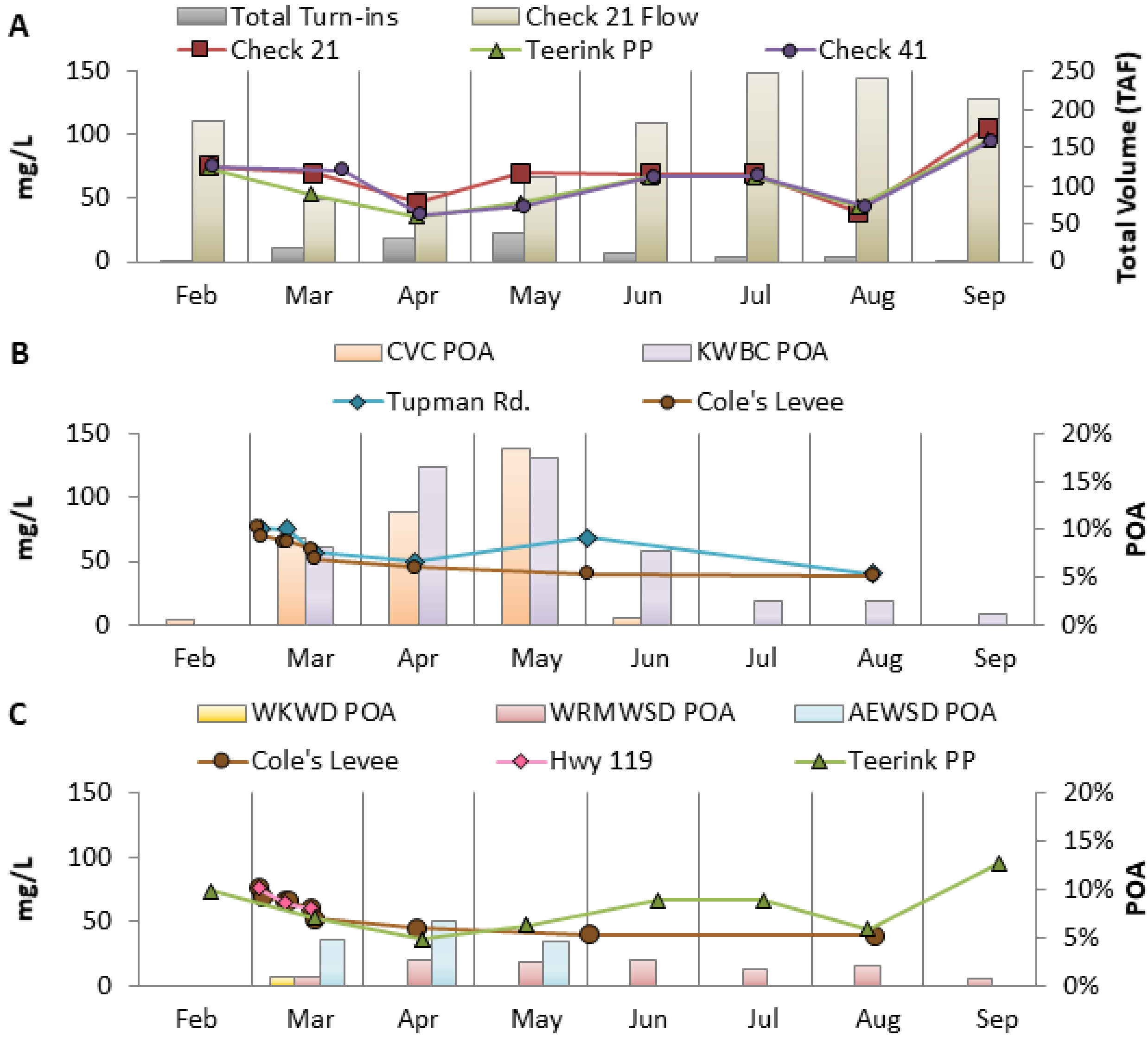
Chloride

Most chloride samples showed decreases downstream of the turn-ins, with larger decreases coinciding with larger POA values (Figure 4-31A). Smaller decreases and a single increase occurred from June to September. During this time, POAs were especially low, indicating that factors other than turn-ins were affecting chloride concentrations in the Aqueduct. No Aqueduct samples exceeded the secondary MCL for chloride in drinking water.

For CVC and KWBC, all us/ds samples decreased (Figure 4-31B). This is consistent with averages for both turn-ins that were lower than the Aqueduct averages. The largest decrease (-29 mg/L) coincided with a higher-than-Aqueduct CVC concentration but a much lower-than-Aqueduct concentration for KWBC. Conversely, a higher-than-Aqueduct concentration was reported for KWBC in August, which coincided with a slight downstream decrease. With a low POA of 2 percent, the higher concentration in the turn-in did not have any observable effect on the Aqueduct concentration downstream.

WKWD was only active in March, and us/ds samples showed little to no change, likely because of its low POA (Figure 4-31C). The first two us/ds sample pairs decreased by -1 mg/L and the third did not change. The lack of larger decreases conflicts with the much lower average at WKWD compared to upstream in the Aqueduct — 41 mg/L and 65 mg/L, respectively (Table 4-7).

Figure 4-31 Chloride Concentrations and Volumes or POA[a] for (A) the San Joaquin Field Division; (B) CVC & KWBC; (C) WKWD, WRMWSD[a], & AEWSD



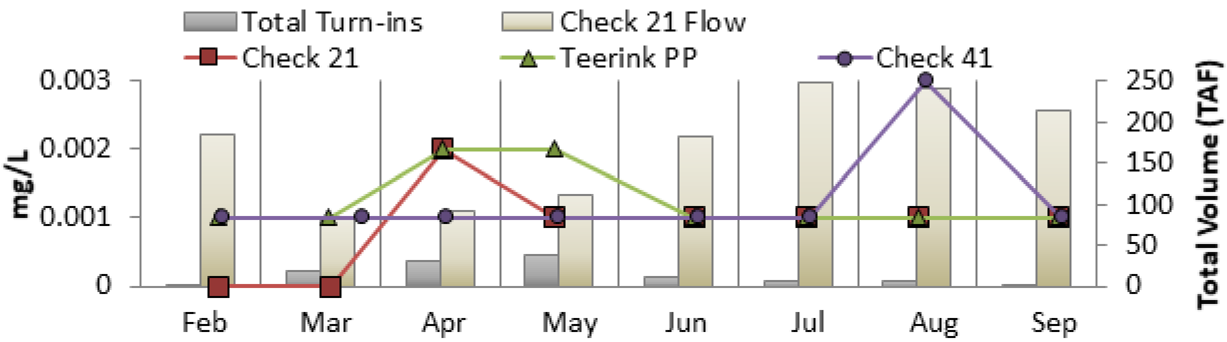
Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, POA = Percent-of-Aqueduct, PP = Pumping Plant, TAF = thousand acre-feet, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
[a] WRMWSD data does not include Turn-in 10P1X, which is downstream of Teerink PP.

Most downstream samples showed decreases below WRMWSD and AEWSD, which is consistent with less-than-Aqueduct turn-in concentrations (Figure 4-31C). Paired samples reported slight decreases in March (-7 mg/L) and April (-9 mg/L), which was consistent with expected results based on turn-in concentrations at that time. In June and July, there was an apparent increase in downstream chloride based on the trends shown by unpaired samples. This may, in fact, be a product of the lack of immediate upstream samples at that time. When comparing Teerink PP chloride to far upstream concentrations at Check 21, there was apparently an upstream increase based on factors unrelated to turn-ins that shows up in the unpaired samples at Teerink PP. The low POA values at that time further support the lack of turn-in influence. The comparison of these two Aqueduct sites includes all WRMWSD turn-ins except 10P1X, which reported concentrations above the median for all WRMWSD turn-ins, but these were also at or below Aqueduct values (Appendix B).

Total Chromium

Total chromium (trivalent plus hexavalent chromium) was not as widely monitored in the Aqueduct as hexavalent chromium alone. Nevertheless, there were several instances of increasing concentrations downstream of the turn-ins (Figure 4-32). In February, March, and May there were increases of 0.001 mg/L from Check 21 to Teerink PP — bracketing all turn-ins except one WRMWSD inlet. The May increase coincides with the highest POA value for all turn-ins combined, but there is limited total chromium data to compare with Aqueduct concentrations. AEWSD’s sample in March was the only turn-in sample reported higher than the upstream Aqueduct samples (Appendix B), but no samples were required or sampled for CVC, KWBC, or WKWD. WRMWSD also collected samples, but at a much higher MRL of 0.01 mg/L, which was higher than all Aqueduct samples, making comparisons difficult. Additionally, the downstream increases were within the range of variation at the upstream site, indicating downstream changes may have been the result of similar natural variations rather than from turn-in influence. No Aqueduct samples exceeded the MCL for total chromium in drinking water.

Figure 4-32 Chromium Concentrations and Volumes the San Joaquin Field Division



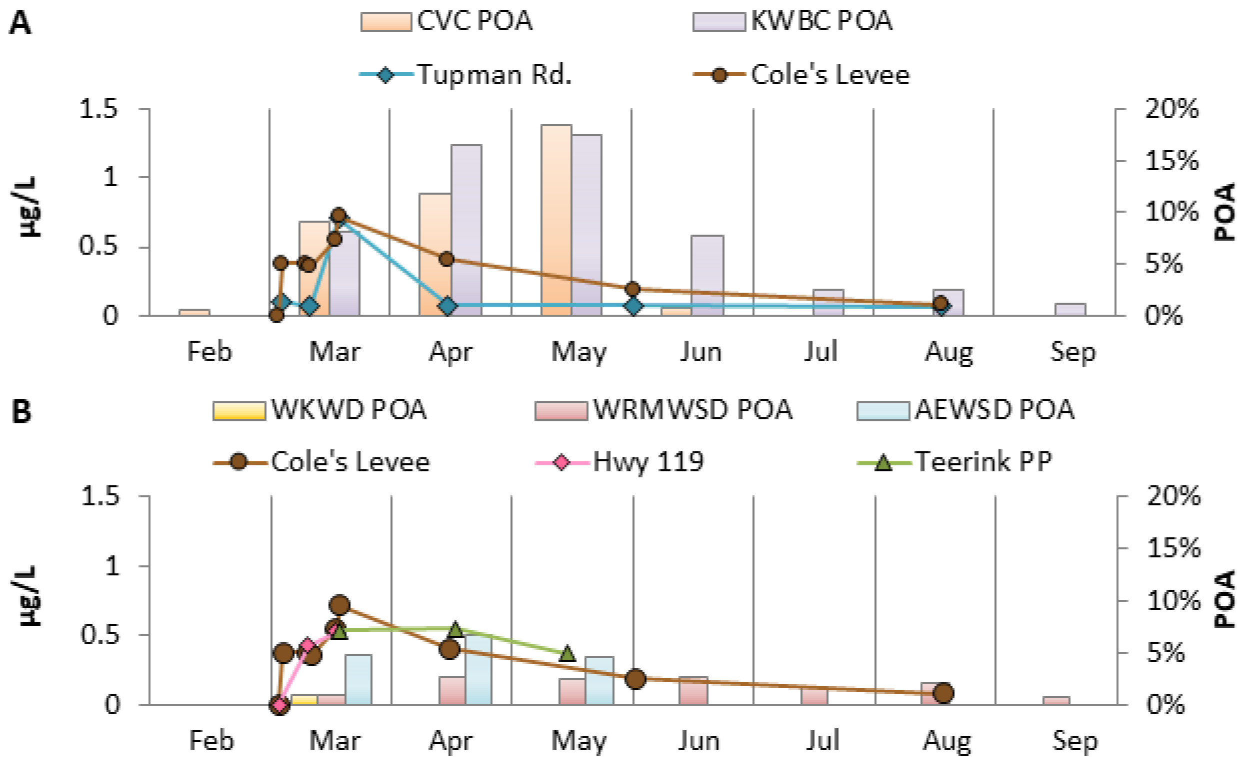
Notes:
mg/L = milligrams per liter, TAF = thousand acre-feet.
Values < MRL (method reporting limit) are graphed equal to zero. The MRL was 0.001 mg/L.

Hexavalent Chromium

Hexavalent chromium was not as widely monitored in the Aqueduct, but more so than total chromium. There were seven us/ds sample pairs bracketing CVC and KWBC and all showed increases downstream (Figure 4-33A). The largest increases (0.28–0.337 µg/L) occurred in early March and April, while the smallest increase (0.01 µg/L) occurred in late March. This sample did report the highest total downstream concentration; however, any increase was offset by a simultaneous rise in upstream concentrations. Nevertheless, the overall trend for increasing us/ds samples is consistent with higher-than-Aqueduct concentrations for both CVC and KWBC for all samples except the June KWBC sample.

WKWD had three paired us/ds samples, of which one increased (0.05 µg/L), one decreased (-0.02 µg/L), and one stayed the same (at < 0.2 µg/L) despite much higher-than-Aqueduct samples from the turn-in (Figure 4-33B). The lack of significant increase downstream is likely attributable to the small POA from this turn-in.

Figure 4-33 **Hexavalent Chromium Concentrations and POA[a] for (A) CVC & KWBC and (B) WKWD, WRMWSD[a], & AEWSD**



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, POA = Percent-of-Aqueduct, PP = Pumping Plant, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District, µg/L = micrograms per liter.
Values < MRL (method reporting limit) are graphed equal to zero. The MRL was either 0.001 or 0.01 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
[a] WRMWSD data does not include Turn-in 10P1X, which is downstream of Teerink PP.

WRMWSD and AESWD only had two paired us/ds samples — increases in March (0.001 µg/L) and in April (0.14 µg/L), while an unpaired sample in May indicates an increase over the trend upstream (Figure 4-33B). These results are counterintuitive to reported turn-in concentrations in those months. The March increase is consistent with the higher-than-Aqueduct AEWSD sample and higher POA that month; however, the April and May increases conflict with the < MRL for almost all WRMWSD and AEWSD samples in those months and beyond. The comparison of these two Aqueduct sites includes all WRMWSD turn-ins except 10P1X, which reported concentrations higher than other WRMWSD turn-ins but still at or slightly above Aqueduct values (Appendix B). No Aqueduct samples exceeded the MCL for hexavalent chromium in drinking water.

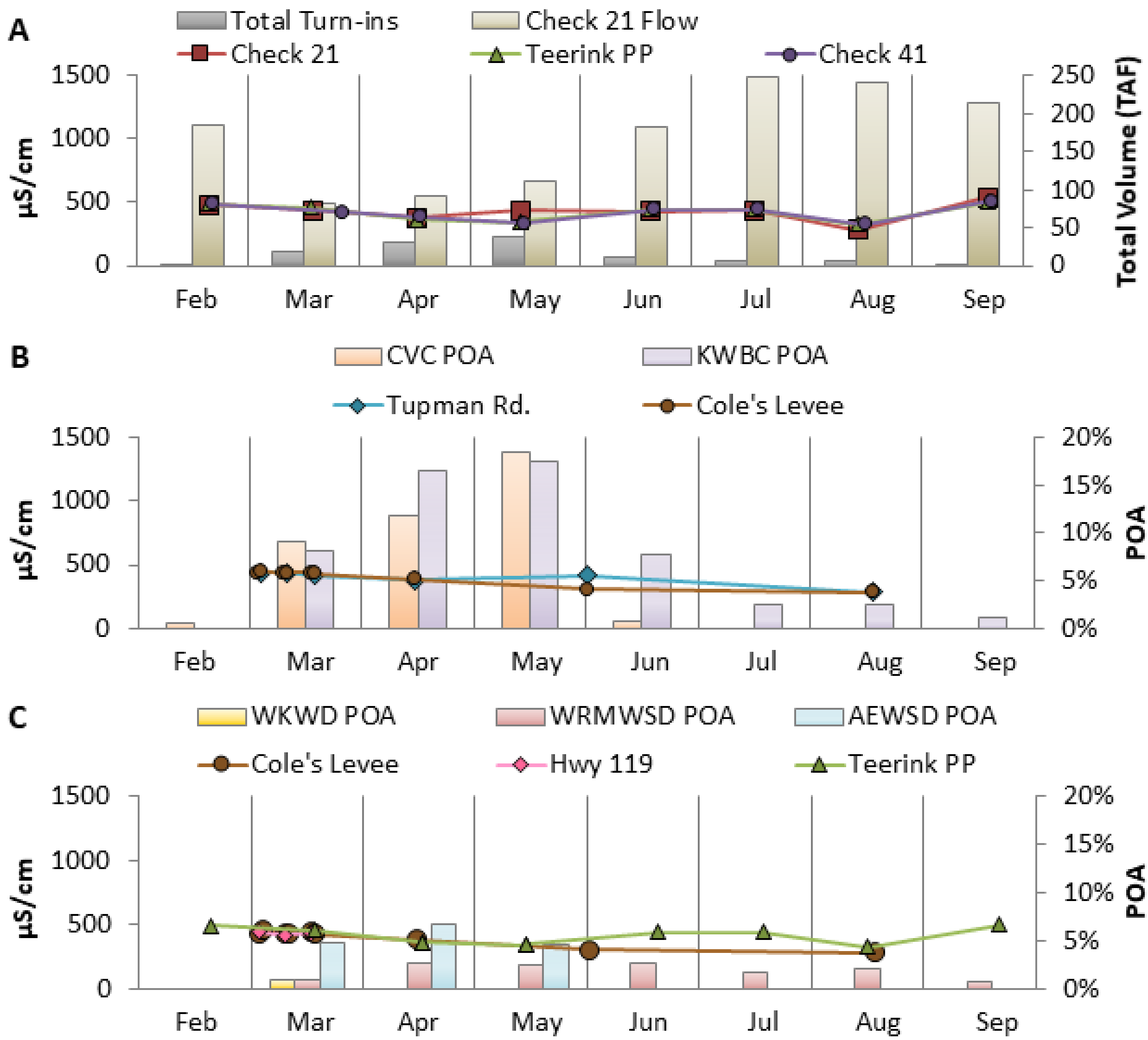
Conductivity

Most conductivity samples fluctuated between increases and decreases in their us/ds pairs, which is consistent with turn-in averages (Figure 4-34A). Between Check 21 and Check 41, five pairs increased by 5 to 47 μS/cm and three decreased by -12 to -102 μS/cm. Overall, the more consistent and larger decreases occurred during March–May when POAs were higher. No Aqueduct samples exceeded the secondary recommended MCL for conductivity in drinking water.

Samples us/ds of CVC and KWBC reported five increasing pairs (1–16 μS/cm) and one decease (-114 μS/cm), which is consistent with turn-in concentrations (Figure 4-34B). This decrease is consistent with the conductivity reported for KWBC, which was much lower than the Aqueduct, and a concurrent CVC sample, which was slightly lower than the Aqueduct. The increases coincided with months of higher POAs and turn-in conductivity values at or near the upstream values; however, August had increases of 2 μS/cm, which conflicts with the much higher conductivity at KWBC. The low POA for August makes it more difficult to determine the influence of the turn-in on the Aqueduct conductivity but likely limited its influence.

The Aqueduct sample pairs for WKWD decreased in two pairs (-7 to -10 μS/cm) and increased in one (4 μS/cm), which is constant with the lower-than-Aqueduct values for WKWD (Figure 4-34C). But, the POA for WKWD was 1 percent, so the decrease observed could be a product of other factors as well.

Figure 4-34 Conductivity Concentrations and Volumes or POA[a] for (A) the San Joaquin Field Division; (B) CVC & KWBC; (C) WKWD, WRMWSD[a], & AEWSD



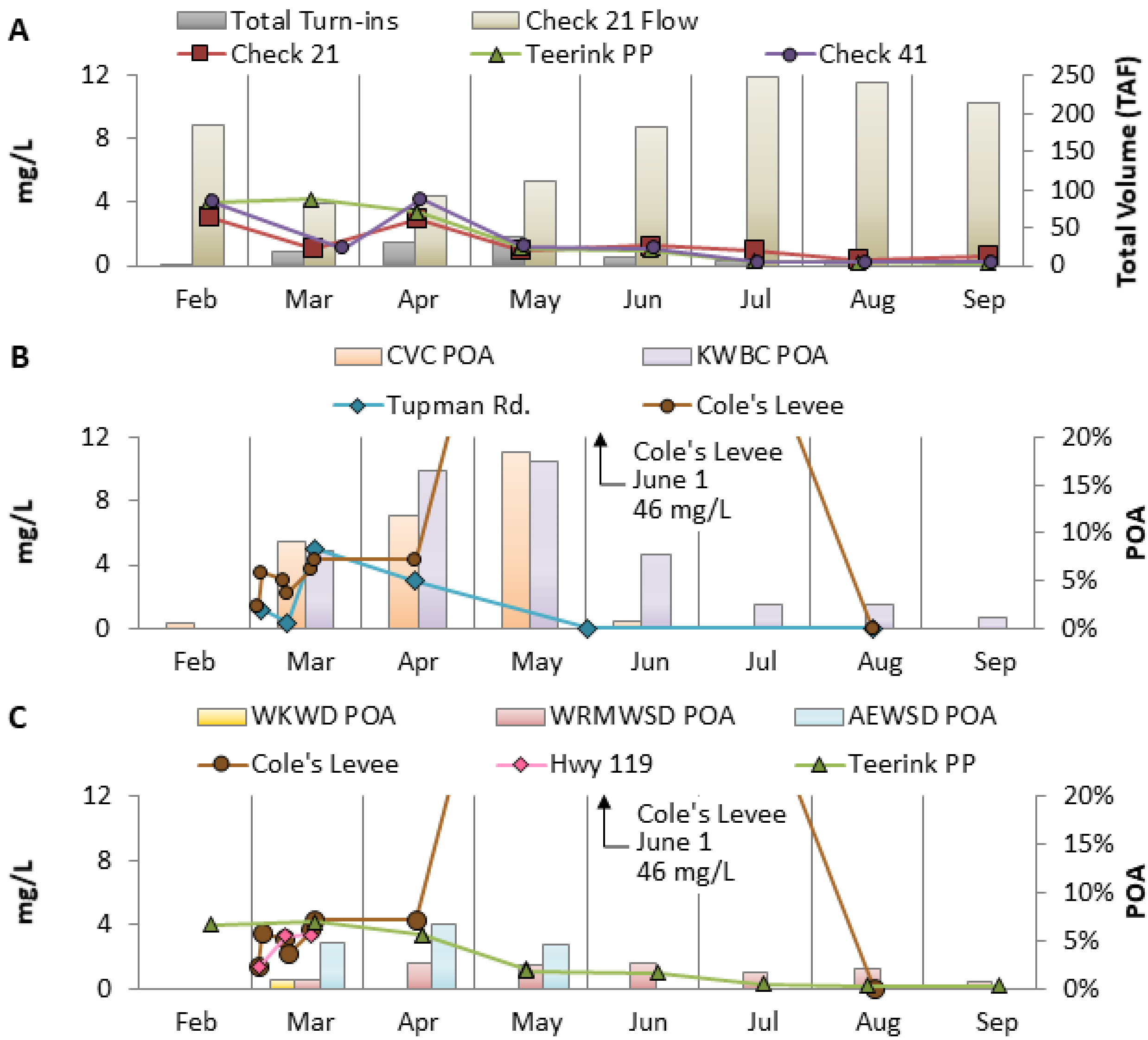
Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, POA = Percent-of-Aqueduct, PP = Pumping Plant, TAF = thousand acre-feet, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District, µg/L = micrograms per liter.
Values < MRL (method reporting limit) are graphed equal to zero. The MRL was either 0.001 or 0.01 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
[a] WRMWSD data does not include Turn-in 10P1X, which is downstream of Teerink PP.

For WRMWSD and AEWSD, the us/ds changes fluctuated with throughout the year (Figure 4-34C). In March there was an us/ds increase of 25 µS/cm; the only turn-in sample that month was a slightly lower-than-Aqueduct reading for AEWSD. But, later WRMWSD samples show a higher-than-Aqueduct trend for that agency, suggesting its March operations may have contributed to the us/ds increase. The only decrease was in April, when conductivity dropped by -24 µS/cm. The average conductivity for WRMWSD was 1,025 µS/cm and its POA was 3 percent in that month. AEWSD had an average conductivity of 43 µS/cm and a higher POA of 7 percent, which is more consistent with the decrease in conductivity observed that month. In June and July there were downstream increases compared to the unpaired trend seen upstream as well as an increase in a paired us/ds sample in August. These results are consistent with the higher-than-Aqueduct results for WRMWSD. The comparison of these two Aqueduct sites included all WRMWSD turn-ins except 10P1X, which reported concentrations lower than other WRMWSD turn-ins but still greater than Aqueduct values (Appendix B).

Nitrate

Nitrate downstream of all SJFD turn-ins had increases and decreases observed throughout the turn-in period, with more increases occurring in months of higher turn-in volumes (Figure 4-35A). Some, but not all, of the increases in nitrate are consistent with turn-in concentrations. One sample in June did exceed the MCL for nitrate (45 mg/L), with a concentration of 46 mg/L at Cole’s Levee. This sample was re-run and confirmed by the lab, but its validity is questioned as the concentration is magnitudes larger than seen elsewhere on the Aqueduct around that time.

Figure 4-35 Nitrate Concentrations and Volumes or POA[a] for (A) the San Joaquin Field Division; (B) CVC & KWBC; (C) WKWD, WRMWSD[a], & AEWSD



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, POA = Percent-of-Aqueduct, PP = Pumping Plant, TAF = thousand acre-feet, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
Values < MRL (method reporting limit) are graphed equal to zero. The MRL was either 0.092, 0.4, or 0.1 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
[a] WRMWSD data does not include Turn-in 10P1X, which is downstream of Teerink PP.

For CVC and KWBC, there were four increases, one decrease, and a month with no change; the predominance of increases is consistent with higher-than-Aqueduct averages from these turn-ins (Figure 4-35B). The decrease (-0.7 mg/L) was observed in late March and was not consistent with expected results based on higher-than-Aqueduct concentrations. The increases observed in early March and April (1.3–2.3 mg/L) matched the expected results. In June, there was an apparent increase from < 0.092 mg/L at Tupman Road to the aforementioned 46 mg/L at Cole’s Levee. As discussed, this sample’s validity is questionable when considering other Aqueduct concentrations and when comparing it to the highest turn-in concentration of 9.7 mg/L (CVC). An increase in nitrate could be expected downstream of the turn-ins; however, it would not be expected to be as high as was seen. The final us/ds pair, in August, was at the MRL at both sites despite the higher-than-Aqueduct concentration reported for KWBC. This month had one of the lower POA values seen, which may have limited its impact.

WKWD had two decreasing pairs (-0.04 and -0.31 mg/L) and one increasing pair (0.27 mg/L), which is inconsistent with concurrent WKWD samples that were all higher than their respective upstream concentrations (Figure 4-35C). Overall, the magnitude of these changes was very small compared to Aqueduct concentrations, indicating the low POA probably mitigated any influence of higher turn-in concentrations.

For WRMWSD and AEWSD, nitrate fluctuated between us/ds pairs, but monthly trends matched expected results based on turn-in concentrations (Figure 4-35C). In March there was an us/ds increase of 0.83 mg/L between Hwy 119 and Teerink PP, which is consistent with the only turn-in sample (AEWSD) for that month, which was much higher than the Aqueduct. The trend in later WRMWSD samples showed concentrations lower than the upstream Aqueduct concentration in March, indicating those turn-in operations in March may have limited any possible increase in March. April had an us/ds decrease of -0.9 mg/L, which was consistent with expected results as all but one turn-in sample that month was lower than upstream concentration. In June, there was an apparent decrease from the previously discussed 46 mg/L sample at Cole’s Levee. A decrease would be expected because of lower nitrate concentrations from turn-ins, but the degree to which the turn-ins affected this concentration is unclear because of the sample’s questionable validity. In August, there was an increase in nitrate from < 0.092 mg/L at Cole's Levee to 0.2 mg/L at Teerink PP. Also, in August, WRMWSD turn-in reported concentrations above and below the upstream concentration but with larger deviations on the greater-than-Aqueduct side, likely contributing to the slight increase. The comparison of these two Aqueduct sites includes all WRMWSD turn-ins except 10P1X, which initially reported a high nitrate concentration (33 mg/L) followed by concentrations closer to the median of other WRMWSD samples (Appendix B).

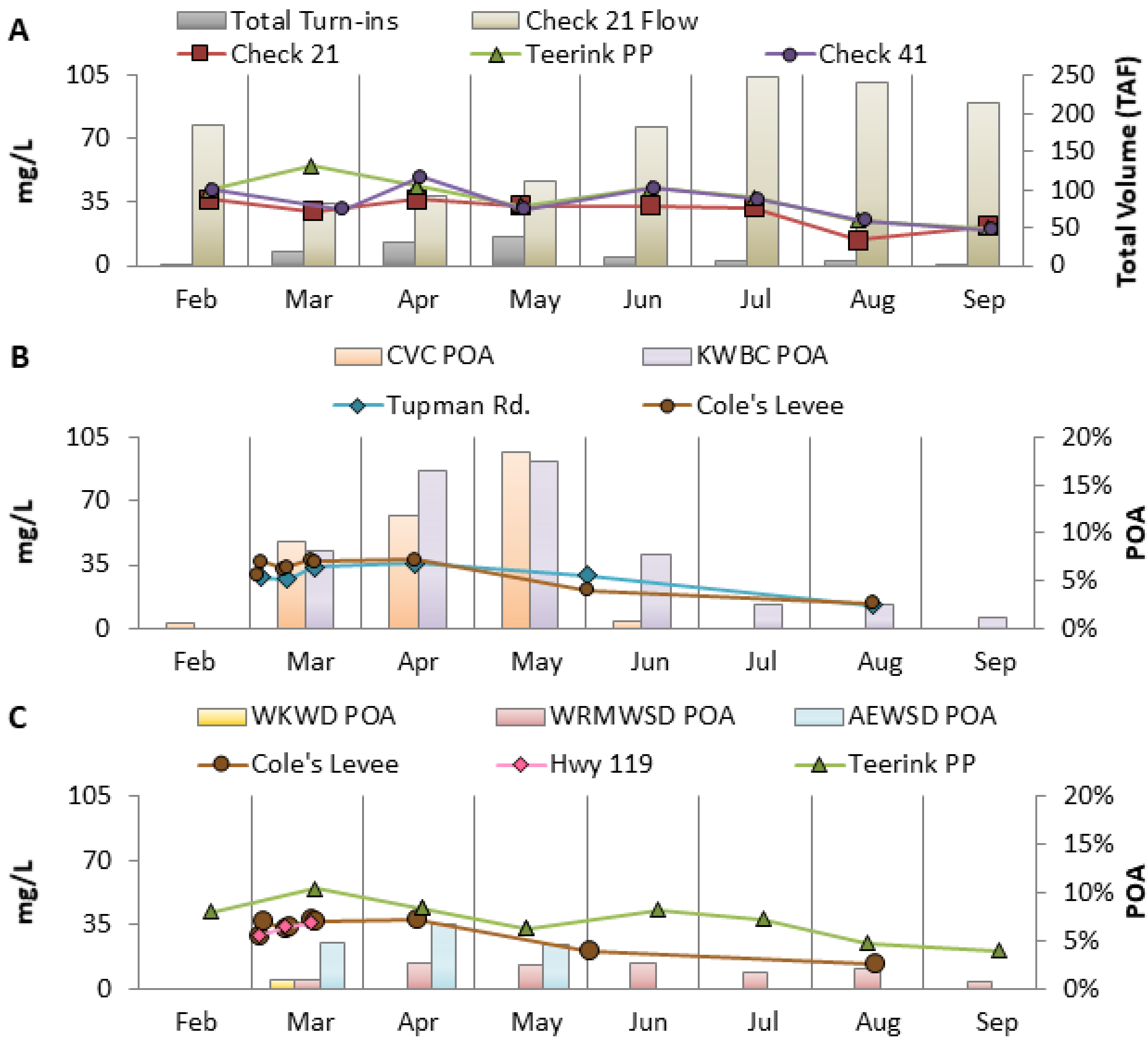
Sulfate

Sulfate downstream of all SJFD turn-ins were generally higher than upstream concentrations, with a few exceptions (Figure 4-36A). Increases in sulfate occurred during months with high or moderate POAs. This conforms to the expected trend based on turn-in averages that were almost all greater than Aqueduct averages. Overall, trends from Check 21 to Check 41 show increases in sulfate except for May and September, which had small decreases in sulfate. No Aqueduct samples exceeded the secondary recommended MCL for sulfate in drinking water.

For CVC and KWBC, all us/ds sample pairs except one increased, which is consistent with the turn-in samples (Figure 4-36B). The largest increase was in early March, where sulfate increased by 9 mg/L. Smaller increases occurred in mid- to late-March and April. These results are expected because all but one turn-in sample at this time was greater than the upstream Aqueduct. June was the only month where there was a decrease in sulfate (-8 mg/L), which is consistent with a slightly higher-than-Aqueduct concentration from CVC and a much lower-than-Aqueduct concentration from KWBC. The us/ds pair in August reported an increase of 1 mg/L, which is counter to the much higher-than-Aqueduct concentration from KWBC. The turn-in effects for this month were likely subdued by the lower POA.

The WKWD samples were very close in concentration between us/ds locations, with differences of 0 mg/L, 1 mg/L, and -2 mg/L, chronologically (Figure 4-36C). These results roughly coincide with the expected results based on the first two WKWD samples greater than the Aqueduct and the final sample less than the Aqueduct. The low POA likely limited these turn-in effects.

Figure 4-36 Sulfate Concentrations and Volumes or POA[a] for (A) the San Joaquin Field Division; (B) CVC & KWBC; (C) WKWD, WRMWSD[a], & AEWSD



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, POA = Percent-of-Aqueduct, PP = Pumping Plant, TAF = thousand acre-feet, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
[a] WRMWSD data does not include Turn-in 10P1X, which is downstream of Teerink PP.

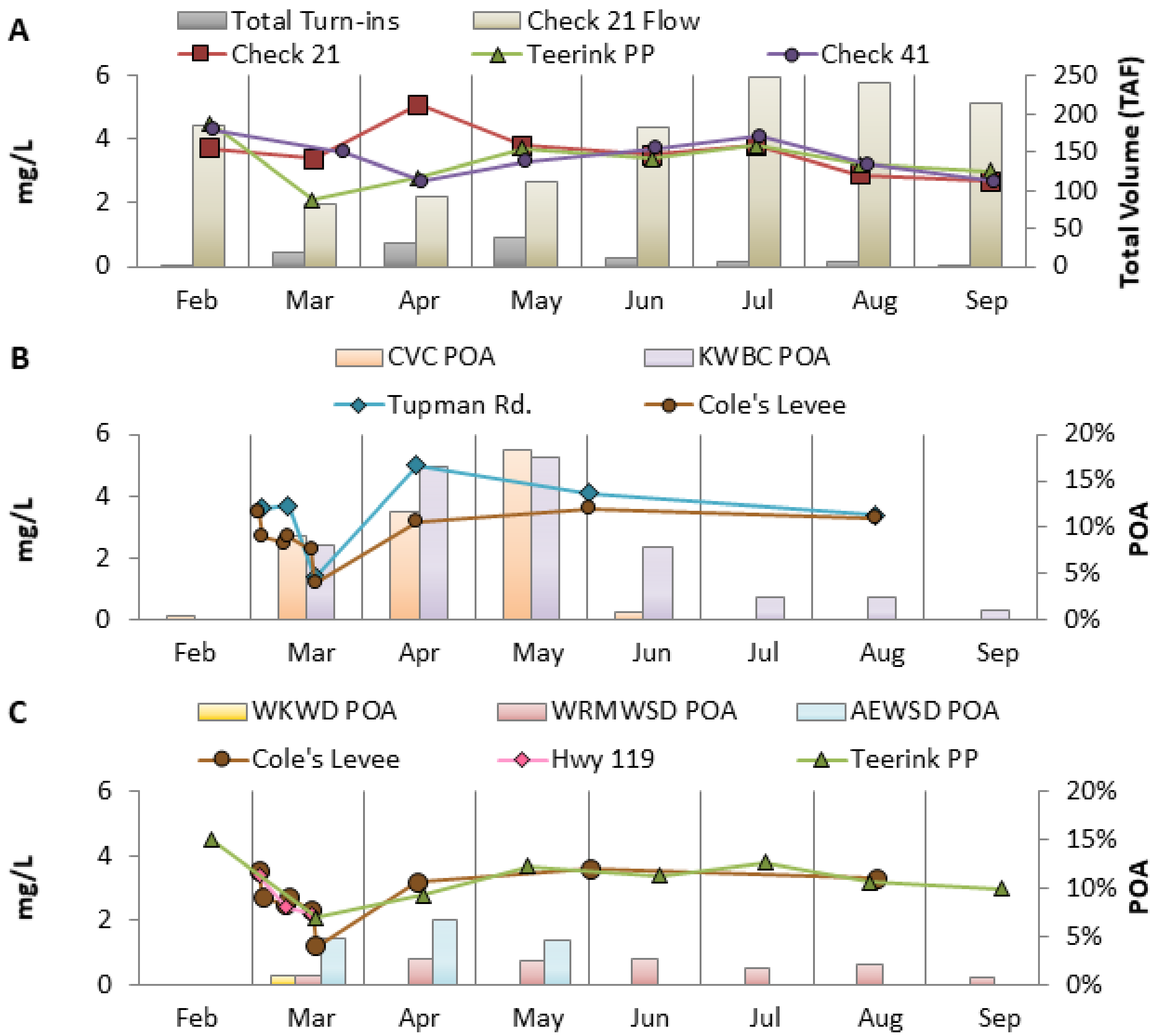
For WRMWSD and AEWSD, all us/ds pairs increased (6–19 mg/L), which matches expected results based on turn-in samples (Figure 4-36C). The March AEWSD sample reported slightly higher than the Aqueduct, and the April sample was much lower than the Aqueduct. But any effects here were likely offset by the much higher-than-Aqueduct concentrations for WRMWSD, which were more than 175 mg/L higher than the maximum in the Aqueduct (Figure 4-19 and Table 4-12). The comparison of these two Aqueduct sites includes all WRMWSD turn-ins except 10P1X, which reported a median less than that for other WRMWSD samples (Appendix B).

Total Organic Carbon

For nearly all Check 21 to Check 41 sample pairs, total organic carbon (TOC) slightly increased, with the notable exception of two decreases during the months of higher turn-in volumes (Figure 4-37A). February had a 0.6 mg/L increase, but it is unlikely turn-ins had an influence because of the low volume that month and their short operational time before those samples were taken. The largest decrease (-2.4 mg/L) occurred in April, which had the second highest turn-in volume. Changes between all other pairs ranged from 0–0.3 mg/L. It is likely the cause of these slight increases was natural variation in the Aqueduct or sample timing rather than from turn-ins, as explained in the following discussion. There is no drinking water MCL for organic carbon.

For CVC and KWBC, TOC decreased in all us/ds sample pairs, which is consistent with expected results based on turn-in concentrations (Figure 4-37B). The largest decrease in TOC (-1.8 mg/L) occurred in April, when the POAs at CVC and KWBC were large and their TOC concentrations were much lower than in the Aqueduct. Similar results are seen for other sample pairs, which reported decreases ranging from -0.2 to -1 mg/L. During all months, both turn-ins had lower TOC values than upstream in the Aqueduct. March and June had higher POAs and some of the larger decreases, while the August POA was much smaller (2.4 percent) and, in turn, had one of the smallest decreases.

Figure 4-37 Total Organic Carbon Concentrations and Volumes or POA[a] for (A) the San Joaquin Field Division; (B) CVC & KWBC; (C) WKWD, WRMWSD[a,b], & AEWSD



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, POA = Percent-of-Aqueduct, PP = Pumping Plant, TAF = thousand acre-feet, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
Values < MRL (method reporting limit) are graphed equal to zero. The MRL was either 0.2 or 1 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
[a] WRMWSD data does not include Turn-in 10P1X, which is downstream of Teerink PP.
[b] Organic carbon results are dissolved rather than total as for all other sites.

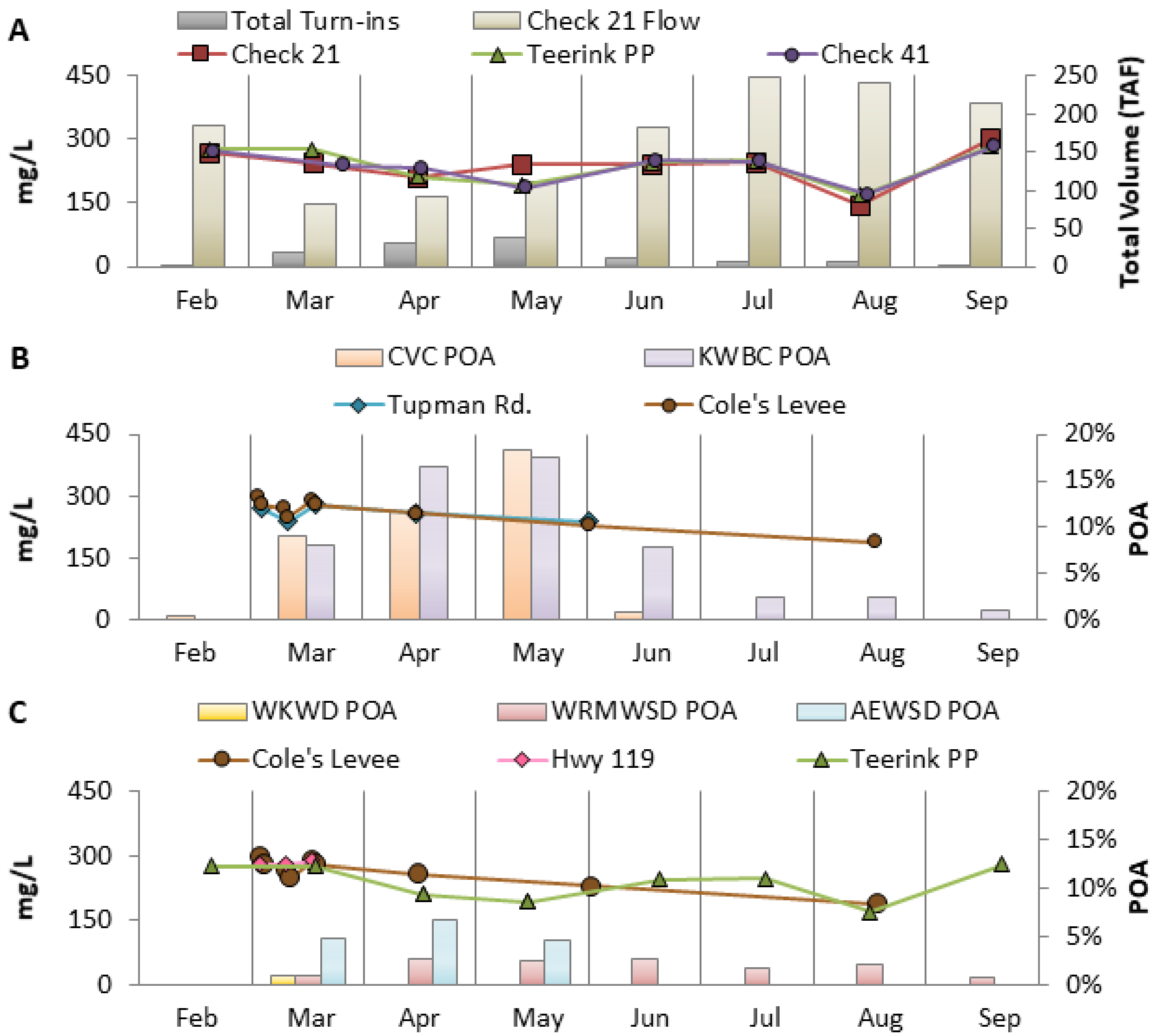
For WKWD, all three us/ds sample pairs decreased by -0.1 mg/L, which is consistent with the expected results, based on turn-in concentrations (Figure 4-37C). In March — WKWD's only active month — upstream concentrations at Cole's Levee ranged from 1.2–3.5 mg/L, whereas all WKWD samples were < 1 mg/L. Therefore, it is likely WKWD contributed to the consistent decline of TOC between these sites, but the magnitude of influence was limited by its low POA.

For WRMWSD and AEWSD, all us/ds sample pairs decreased, which is consistent with turn-in concentrations (Figure 4-37C). Decreases ranged between -0.1 mg/L and -0.4 mg/L. The largest paired sample decrease occurred in April when POAs were high. This coincides with an April AEWSD turn-in sample slightly less than the upstream Aqueduct and much lower-than-Aqueduct concentrations for WRMWSD. All samples for WRMWSD are analyzed for DOC so there is not a direct comparison for TOC. All subsequent sample pairs and site trends show very small deviations between sites, likely limited by the lower POAs in these months. The comparison of these two Aqueduct sites includes all WRMWSD turn-ins except 10P1X, which reported DOC higher than most other WRMWSD samples but still less than the DOC and TOC reported for Aqueduct sites (Appendix B).

Total Dissolved Solids

TDS varied between increases and decreases downstream of the SJFD turn-ins, which is consistent with the variable results from the turn-ins (Figure 4-38A). Large and conflicting us/ds changes occurred between Check 21 and Check 41 for April (23 mg/L increase) and May (-55 mg/L decrease) when the turn-in volumes were high. Large and conflicting us/ds changes also occurred in August (27 mg/L increase) and September (-18 mg/L decrease) when turn-in volumes were low. These variable results are likely because of the disparate concentrations between turn-ins, as discussed below. No Aqueduct samples exceeded the secondary recommended MCL for TDS in drinking water.

Figure 4-38 Total Dissolved Solids Concentrations and Volumes or POA[a] for (A) the San Joaquin Field Division; (B) CVC & KWBC; (C) WKWD, WRMWSD[a], & AEWSD



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, mg/L = milligrams per liter, POA = Percent-of-Aqueduct, PP = Pumping Plant, TAF = thousand acre-feet, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
[a] WRMWSD data does not include Turn-in 10P1X, which is downstream of Teerink PP.

For CVC and KWBC, increasing or equal us/ds pairs were observed in March and August and a decrease occurred in June; both trends are consistent with turn-in samples from those months (Figure 4-38B). March us/ds changes were 10 mg/L, 10 mg/L, then 0 mg/L, chronologically. This coincides with turn-in concentrations on those sample pairs that were initially greater than the Aqueduct then decreased with respect to the upstream Aqueduct concentrations. The single April us/ds pair showed no change, which is consistent with the slightly higher-than-Aqueduct concentration and higher POA for KWBC and the much lower-than-Aqueduct but lower POA for CVC; thus, likely canceling out each other's effect. Conversely, the -10 mg/L decrease in June is expected given the much lower-than-Aqueduct concentration and higher POA from KWBC compared to the slightly higher-than-Aqueduct concentration and lower POA for CVC that month. There is no us/ds sample pair available for TDS in August, as TDS was not sampled by KCWA at Tupman Road that month. The nearest upstream sample that month (geographically and temporally) was a sample at Check 21 (65 miles upstream and two days prior), which showed an upstream concentration of 144 mg/L. The comparison between this sample and the Cole's Levee sample in August would represent a 46 mg/L increase, which is consistent with the much higher-than-Aqueduct concentration reported for KWBC in that month — 380 mg/L, the highest of the year for these two turn-ins.

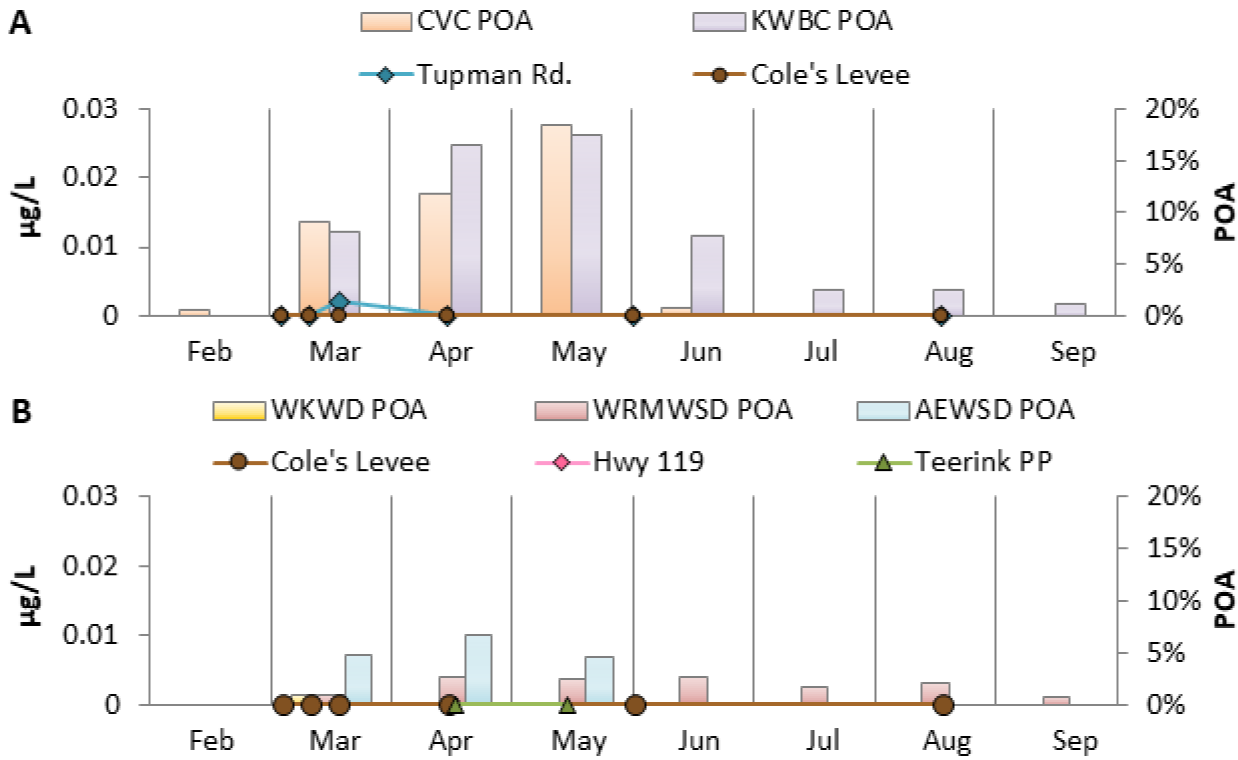
For WKWD, us/ds changes were inconsistent with respect to the expected results based on turn-in concentrations (Figure 4-38C). Sample pairs showed variable change throughout March (-20 mg/L, 10 mg/L, and 0 mg/L, chronologically), which conflict with the turn-in concentrations that were higher than, equal to, and lower than the Aqueduct, respectively. The lack of influence of WKWD on TDS, as with the other previously discussed COCs, is likely because of the low POA from this turn-in.

For WRMWSD and AEWSD, all US/D sample pairs decreased, which conforms to expected results for some months but not for others (Figure 4-38C). Decreases of -14 mg/L and -48 mg/L in March and April, respectively, are expected based on the lower-than-Aqueduct concentrations and higher POAs for AEWSD in those months. WRMWSD had lower POAs but much higher TDS concentrations — all samples were greater than 410 mg/L compared to a Cole's Levee maximum of 300 mg/L during the turn-in period (Figure 4-21 and Table 4-13). In June and July, when only WRMWSD was active, there was a month-to-month increase at Teerink PP. But no upstream samples are available for pairing. It is possible that this increasing trend at Teerink PP was because of the much higher-than-Aqueduct concentrations from WRMWSD, but it is also possible that concentrations upstream of WRMWSD also affected this trend. Along this line, a result contrary to expected results downstream of WRMWSD was reported in August when there was a paired sample decrease of -21 mg/L despite much higher-than-Aqueduct concentrations from WRMWSD that month. As noted elsewhere, the POAs for WRMWSD in August and surrounding months were low, which likely limited the total impact these higher-than-Aqueduct turn-ins had on downstream concentrations. The comparison of Cole's Levee and Teerink PP includes all WRMWSD turn-ins except 10P1X, which reported TDS lower than most other WRMWSD samples but still higher than TDS reported in the Aqueduct (Appendix B).

1,2,3-trichloropropane

TCP was not widely monitored in the Aqueduct, but there are seven us/ds sample pairs available for analysis. For CVC and KWBC, all samples were equal to < 0.0015 µg/L, apart from a decrease from 0.002 µg/L at Tupman Road to < 0.0015 µg/L at Cole's Levee in late March (Figure 4-39A). These results can be expected despite mixed results from the turn-ins compared to the Aqueduct. In this case, CVC reported three of five samples greater than the Aqueduct (including one much higher sample in June), whereas the KWBC reported all samples < 0.0015 µg/L. The normally larger POAs from KWBC likely contributed to its less-than-MRL concentrations dominating the downstream effects.

Figure 4-39 **1,2,3-Trichloropropane POA[a] for (A) CVC & KWBC and (B) WKWD, WRMWSD[a], & AEWSD**



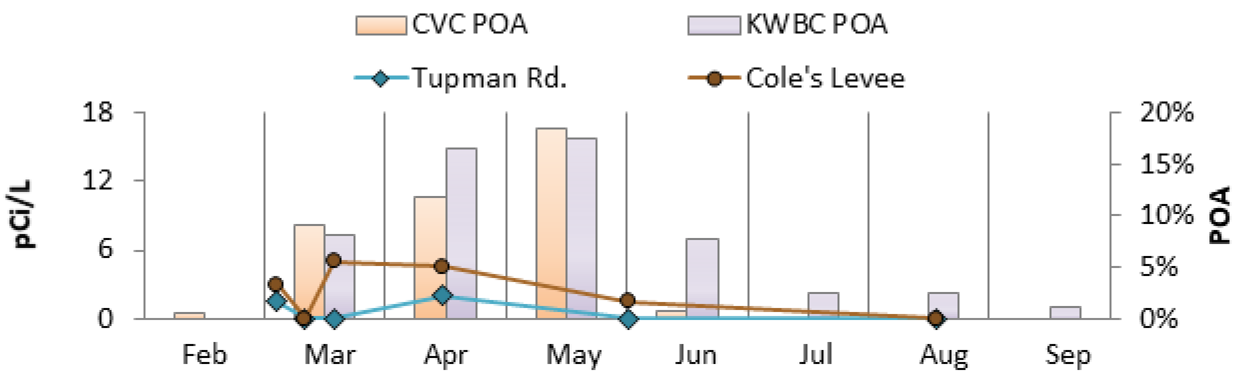
Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, POA = Percent-of-Aqueduct, PP = Pumping Plant, TAF = thousand acre-feet, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District, µg/L = micrograms per liter.
Values < MRL (method reporting limit) are graphed equal to zero. The MRL was either 0.0015 or 0.005 mg/L and some results reported concentration less than the MRL of other samples (see Appendix B).
[a] WRMWSD data does not include Turn-in 10P1X, which is downstream of Teerink PP.

Aqueduct data is less available for WRMWSD and AEWSD, but all samples in the Aqueduct were less than their MRL (either 0.0015 or 0.005 µg/L), including one paired sample (Figure 4-39B). The lack of change is consistent with expected results as turn-ins from WRMWSD and AEWSD both had all but one sample reported as < 0.005 µg/L. AEWSD's March sample was much higher than upstream in the Aqueduct, but there is no paired sample downstream for comparison. Therefore, it is possible this higher-than-Aqueduct concentration and the predominant POA for AEWSD that month might have caused increases in TCP, but such an influence cannot be proven. WRMWSD also had one sample greater than the MRL (0.042 µg/L) reported at the turn-in 10P1X in April. This structure is downstream of Teerink PP and is therefore not included in the comparison graphs between Cole's Levee and Teerink PP. All subsequent samples from this structure were < 0.005 µg/L and it is unlikely its small inflow volume compared to the Aqueduct resulted in any significant increases not observed here. WKWD has reported TCP samples for all its wells as non-detectable and is therefore not required to collect inflow TCP samples.

Radiological Constituents

Gross alpha was not widely monitored in the Aqueduct and is not a required COC for several turn-ins. CVC and KWBC both had samples collected as well as us/ds samples. Four of six us/ds pairs increased while two had no change (Figure 4-40). The larger increases in March and April coincided with higher POAs and are consistent with expected results based on higher-than-Aqueduct concentrations from these turn-ins. One of the two pairs without change occurred in early March when both us/ds samples were < 1.06 pCi/L. This result conflicts with high POAs and turn-in concentrations that month, including the highest turn-in concentration of 17.6 pCi/L from KWBC. The final unchanging sample pair occurred in August. This pair coincides with a higher-than-Aqueduct result for KWBC, but its effects were likely limited by the lower POA that month. No Aqueduct samples exceeded the MCL for gross alpha in drinking water.

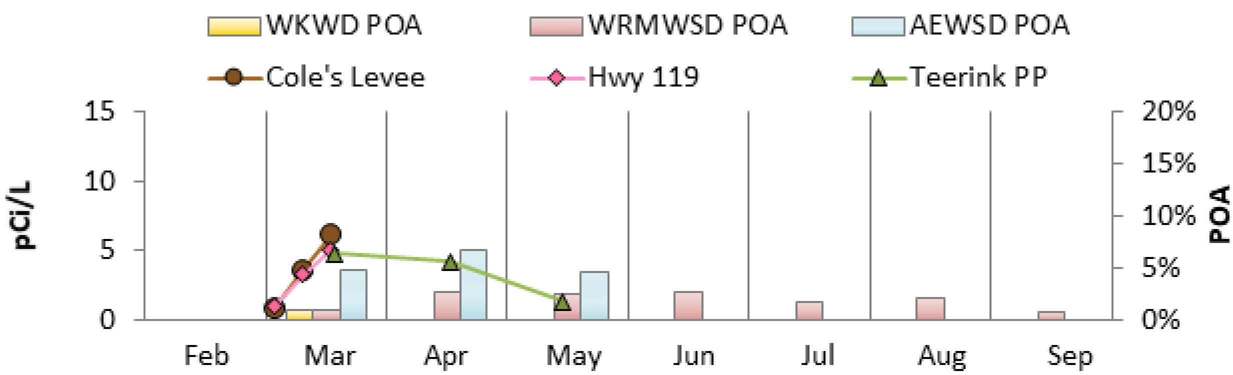
Figure 4-40 **Gross Alpha Concentrations and POA[a] for CVC & KWBC**



Notes:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KWBC = Kern Water Bank Canal, pCi/L = picoCuries per liter, POA = Percent-of-Aqueduct, PP = Pumping Plant, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
Values < MRL (method reporting limit) are graphed equal to zero. The MRL was either 1.06 or 1.49 pCi/L and some results reported concentration less than the MRL of other samples (see Appendix B).
[a] WRMWSD data does not include Turn-in 10P1X, which is downstream of Teerink PP.

Like gross alpha, uranium was not widely monitored in the Aqueduct and is not required for several turn-ins. WKWD collected three paired us/ds samples, the first of which slightly increased followed by a small decline and then a larger decline (Figure 4-41). These results run counter to the expected results based on higher-than-Aqueduct samples from this turn-in. As discussed previously, the low POA of this turn-in likely limited the effects of the higher-than-Aqueduct inflows. For WRMWSD and AEWSD, only one us/ds pair exists — a decrease in March (Figure 4-41). This is consistent with the much lower-than-Aqueduct sample for AEWSD that month. WRMWSD did not have samples in March but subsequent samples were consistently less than 5 pCi/L. This suggests they likely contributed to the decrease in March as well as the subsequent month-to-month decrease downstream through May; however, there is no paired sample upstream with which to compare, so this likelihood cannot be stated definitively. The comparison of Cole's Levee and Teerink PP includes all WRMWSD turn-ins except 10P1X, which reported uranium higher than most other WRMWSD samples, but it is unlikely its low inflow volumes negatively affected Aqueduct uranium concentrations downstream of Teerink PP (Appendix B). No Aqueduct samples exceeded the MCL for uranium in drinking water.

Figure 4-41 Uranium Concentrations and POA[a] for WKWD, WRMWSD[a], & AEWSD



Notes:
AEWSD = Arvin-Edison Water Storage District, pCi/L = picoCuries per liter,
POA = Percent-of-Aqueduct, PP = Pumping Plant, WKWD = West Kern Water District,
WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
[a] WRMWSD data does not include Turn-in 10P1X, which is downstream of Teerink PP.

V. Conclusions

In 2018, a total of 115,595 af of non-Project water was admitted to the Aqueduct. Non-Project waters originate from sources other than the Sacramento-San Joaquin Delta. These inflows can aid in supplying water to areas experiencing shortages or as a means of moving excess surface water. The majority of turn-in water was admitted into the Aqueduct in the San Joaquin Field Division (SJFD). This volume totaled 115,142 af in 2018. Most of this water originated from groundwater in the lower San Joaquin Valley. A small portion of water turned in by Arvin-Edison Water Storage District (AEWSD) originated from the Friant-Kern Canal (FKC). In addition to the large volume admitted in SJFD, a smaller amount (453 af) was admitted over two days from floodwater inflows in the San Luis Field Division (SLFD).

San Luis Field Division Inflow Volume and Water Quality

The inflows into the Aqueduct in the SLFD came from excess surface flows from two creeks draining the east side of the Coast Ranges. Influences on these waters also include drainage from farmland adjacent to the creeks and Aqueduct. The inflows themselves occurred on two days in March, with most inflows occurring on the first day. No water quality samples could be collected during this period of inflows from either the inflow water or the Aqueduct. High-frequency conductivity and turbidity data were collected during this period. These data showed no significant change in the former and a short, brief increase downstream for the latter. While floodwater inflows are known to be high in concentration for several parameters, it is unlikely these sources had significant long-term impact on Aqueduct water quality because of their short duration and small volume compared to the Aqueduct as a whole.

San Joaquin Field Division Turn-in Volumes

Inflows to the Aqueduct totaled 115,142 af, which is greater than the turn-in volume in 2017 but less than the turn-in volumes in 2012–2016. Five turn-ins operated during the year. Cross Valley Canal (CVC) operated from February through June with a total of 31,899 af (27.7 percent of the total turn-in volume). Kern Water Bank Canal (KWBC) operated from March through September with a total of 55,692 af (48.4 percent). West Kern Water District (WKWD) operated in March only, with a total of 748 af

(0.6 percent). Wheeler Ridge-Maricopa Water Storage District (WRMWSD) operated from March through September with a total of 12,910 af (11.2 percent). AEWSD operated in March through May with a total of 13,893 af (12.1 percent). March was the only month with all five turn-ins operating; however, the total volume that month (19,755 af) was less than the totals in April and May (31,692 af and 37,157 af, respectively).

Inflows to the SJFD from the Aqueduct upstream of Check 21 totaled 1,356,560 af for the turn-in period, February–September. For these eight months, the percentage of total flow in SJFD comprised from flow at Check 21 and inflows from turn-ins equaled 7.8 percent. For each individual turn-in, the monthly percentage of flow at that point contributed by the turn-in was calculated and termed the *percentage-of-Aqueduct* flow or POA. POA values ranged from less than 1 percent to 18 percent at CVC in May. KWBC reported two POAs of 17 percent in April and May, WMWSD reported its maximum of 2.6 percent in April and June, AEWSD reported its maximum of 6.7 percent in April, and the WKWD turn-in in March reported at 0.89 percent.

San Joaquin Field Division Turn-in and Aqueduct Water Quality Assessment

Inflows from turn-ins were sampled similar to previous turn-in programs, with grab samples collected upstream and downstream (us/ds) of the turn-ins and from the turn-ins themselves. Overall, the majority of us/ds sample pairs for all turn-ins reported deviations that are smaller than or similar to the variation in the Aqueduct absent the turn-ins' influences. Increases that were observed downstream of the turn-ins typically occurred for arsenic, chromium, nitrate, and sulfate, while decreases were observed for bromide, chloride, and organic carbon. Additionally, downstream changes were minor and often inconsistent with expected results for WKWD. This is attributed to the low inflow volume for this turn-in compared to the Aqueduct. The only Aqueduct sample to exceed a primary or secondary drinking water MCL was for a single nitrate sample, but the validity of this sample is questioned (and discussed in the previous chapter) because of its concentration compared to surrounding samples. Findings specific to individual constituents are described below.

Arsenic

The majority of turn-in samples for arsenic were greater than their corresponding Aqueduct averages. Most Aqueduct samples us/ds of CVC and KWBC showed slight increases of less than 0.001 mg/L. Aqueduct samples us/ds of WRMWSD and AEWSD were more variable, with slight increases in March and April and decreasing trends later in the year, corresponding to variable turn-in source concentrations.

Bromide

Concentrations for turn-ins were primarily less than their corresponding Aqueduct averages, except for samples from CVC. Aqueduct samples us/ds of CVC and KWBC showed either no change or slight decreases during March and April, when both turn-ins had high POAs, and larger decreases after May when most inflows came from KWBC. Aqueduct samples us/ds of WRMWSD and AEWSD primarily decreased in paired samples.

Chloride

All turn-in samples were less than their corresponding Aqueduct averages. Additionally, all samples us/ds of CVC and KWBC showed decreases, with the larger decreases occurring during higher POA months. Aqueduct samples us/ds of WRMWSD and AEWSD primarily decreased, which is expected based on turn-in concentrations. An increasing trend was observed in downstream samples in June and July; however, there was no upstream samples available for comparison at this time and this trend conflicts with less-than-Aqueduct samples from WRMWSD at that time.

Total Chromium

Total chromium was not widely sampled in the turn-ins, and those samples that were collected differed in MRL (minimum reporting limit) to an extent that made comparisons difficult. Total chromium was sampled more consistently at some Aqueduct sites, which showed small increases downstream of the turn-ins during months of higher POAs, with the exception of April. These increases were within the range of variation observed at the upstream site and therefore are not necessarily attributable to turn-ins.

Hexavalent Chromium

Most turn-in samples were greater in hexavalent chromium than their corresponding Aqueduct averages, except for WRMWSD samples. All samples us/ds of CVC and KWBC reported increases, with larger increases occurring during months of higher POAs. Samples us/ds of WRMWSD and AEWSD reported slight increases and decreases, with mixed coincidence with expected results based on turn-in concentrations at various times of the year.

Conductivity

Conductivity readings for CVC and KWBC were close to their corresponding Aqueduct averages. Samples us/ds of these turn-ins reported slight increases during months of higher POAs and reported a large decrease in June. Both trends coincide with expected results based on turn-in conductivities in those months. WRMWSD reported conductivities much higher than those in the Aqueduct, while AEWSD reported lower conductivities than in the Aqueduct. As such, both increases and decreases were reported in us/ds samples during months of higher POAs.

Nitrate

Most turn-in samples were higher in nitrate than their corresponding Aqueduct averages, except for WRMWSD samples. Samples us/ds of CVC and KWBC showed increases or a slight decrease during months of higher POAs. Whereas, samples us/ds of WRMWSD and AEWSD showed decreases or a slight increase. That increase coincided with the single higher-than-Aqueduct sample reported for AEWSD.

Organic Carbon

Almost all turn-in samples were lower in organic carbon (either total or dissolved organic carbon) than their corresponding Aqueduct averages. Consequently, almost all us/ds samples for all turn-ins reported decreases. These decreases, and a single increase, tended to be small in magnitude, with slightly larger decreases occurring in periods of higher POAs.

Sulfate

Most turn-in samples were higher in sulfate than their corresponding Aqueduct averages, with the exception of AEWSD. Most samples us/ds of CVC and KWBC reported increases occurring during periods of higher POAs.

Similarly, all samples us/ds of WRMWSD and AEWSD reported increases. Despite the lower-than-Aqueduct samples for AEWSD, the much higher-than-Aqueduct samples for WRMWSD likely contributed to these increases.

Total Dissolved Solids

Turn-in samples for CVC and KWBC remained close in total dissolved solids (TDS) concentration compared to the Aqueduct, with averages only slightly higher than their corresponding Aqueduct averages. Paired samples us/ds of these turn-ins reported slight increases and decreases throughout the turn-in period, with increases occurring during periods of higher POAs. Samples for WRMWSD were all higher than, and AEWSD samples were lower than, their corresponding Aqueduct averages. In concurrence with expected results during the period of higher POAs from AEWSD, the us/ds samples reported decreasing TDS downstream. But, in contrast to the expected results, decreases were again seen in August when only WRMWSD was operational in this area.

1,2,3-trichloropropane

CVC reported three of five samples for 1,2,3-trichloropropane (TCP) greater than the MRL of 0.0015 μg/L, while KWCB reported all six samples less than the same MRL. Samples us/ds of these turn-ins remained less than this MRL, with the exception of a single decrease in March, which coincides with a higher POA from KWBC. WRMWSD and AEWSD each reported only one sample higher than their MRL of 0.005 μg/L. Samples us/ds of these turn-ins were all less than their MRL, but comparison is hindered by differing MRLs — either 0.0015 μg/L or 0.005 μg/L. CVC, WRMWSD, and AEWSD each reported one sample greater than the MCL of 0.005 μg/L.

Radiological Constituents

Both CVC and KWBC reported all their gross alpha samples greater than their corresponding Aqueduct averages. Consequently, four of six us/ds samples for these turn-ins reported increases, with larger increases occurring during periods of higher POAs. WRMWSD and AEWSD both reported uranium samples less than their Aqueduct averages, while CVC reported uranium greater than its Aqueduct average. A limited number of uranium samples in the Aqueduct make comparisons and impact analysis difficult.

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Data review and comments were provided by the following participants:

Nick Gatti, Kern County Water Agency

Jon Parker, Kern Water Bank Authority

Wendy Adams-Rosenberger, West Kern Water District

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———. 2018. *Water Quality Assessment of Surface Water Introductions to the California Aqueduct, 2017*. Sacramento (CA): Technical Memorandum Report. California Department of Water Resources. Division of Operations and Maintenance. Environmental Assessment Branch.

Appendix A. Department of Water Resources Water Quality Policy and Implementation Process for Acceptance of Non-Project Water into the State Water Project (October 2012)

Errata: This policy was written in 2012. References and links to Department of Public Health have been ~~struckthrough~~ and replaced with references the State Water Resources Control Board. The latter assumed the responsibilities for managing drinking water regulations after this draft of the document was completed. Additional editorial corrections have also been made since completion.

It is the Department of Water Resources (DWR) policy to assist with the conveyance of water to provide water supply, and to protect the State Water Project (SWP) water quality within the California Aqueduct. To facilitate this policy DWR provides the following implementation process for accepting non-project water into the SWP (Policy). For purposes of this document, SWP and California Aqueduct are interchangeable and the same.

POLICY PROVISIONS

DWR shall consider and evaluate all requests for Non-Project (NP) water input directly into the SWP conveyance facilities based upon the criteria established in this document. NP water shall be considered to be any water input into the SWP for conveyance by the SWP that is not directly diverted from the Sacramento-San Joaquin Delta or natural inflow into SWP reservoirs.

The proponent of any NP water input proposal shall demonstrate that the water is of consistent, predictable, and acceptable quality.

DWR will consult with State Water Project Contractors, existing NP participants, and the ~~Department of Public Health (DPH)~~ State Water Resources Control Board (SWRCB) on drinking water quality issues relating to NP water, as needed, to assure the protection of SWP water quality.

Nothing in this document shall be construed as authorizing the objectives of Article 19 of the SWP water supply contracts or ~~DPH~~ SWRCB drinking water maximum contaminant levels to be exceeded.

This policy shall not constrain the ability of DWR to operate the SWP for its intended purposes and shall not adversely impact SWP water deliveries, operation or facilities.

EVALUATING NP WATER PROPOSALS

DWR shall use a two-tiered approach for evaluating NP water for input into the California Aqueduct.

NP Tier 1

Tier 1 NP pump-in proposals (PIP) shall exhibit water quality that is essentially the same, or better, than what occurs in the California Aqueduct. PIP's considered to be tier 1 shall be approved by DWR (see baseline water quality tables 1 through 4).

NP Tier 2

Tier 2 PIP's are those that exhibit water quality that is different and possibly worse than in the California Aqueduct and/or have the potential to cause adverse impacts to the Contractors. Tier 2 PIP's shall be referred to a NP Facilitation Group (FG), which would review the project and if needed make recommendations to DWR in consideration of the PIP.

SWC Facilitation Group

This advisory group consists of representatives from each Contractor that chooses to participate and DWR. The group shall review tier 2 PIP's based on the merits, impacts, mitigation, water quality monitoring, cost/benefits or other issues of each PIP and provide recommendations to DWR. Upon initial review of tier 2 PIP by DWR, it shall then be submitted to the FG for review. A consensus recommendation from the FG would be sought regarding approval of the PIP. DWR shall base its decision on the merits of the PIP, recommendations of the FG and the PIP's ability to provide overall benefits to the SWP and the State of California.

Blending Water Sources

Blending of multiple water sources prior to inflow into the SWP is acceptable and may be preferred depending upon water quality of the PIP. Blending of water in this manner may be used to quality a project as NP Tier 1.

Mixing (blending) within the California aqueduct can be considered but shall not be adjacent to municipal and industrial (M&I) delivery locations. PIP's that are coordinating water discharged to maintain or improve SWP water quality are an example of the mixing approach. The PIP shall demonstrate by model or an approach acceptable to DWR and the FG that the water is adequately mixed before reaching the first M&I customer. Generally, NP PIP's that involve mixing with SWP water shall be considered NP Tier 2.

Baseline Water Quality

To aid in developing and evaluating PIP's both historical and current SWP water quality levels shall be considered. A representative baseline water quality summary is shown in Tables 1 through 4, using historical SWP water quality records at O'Neill Forebay.

NP IMPLEMENTATION PROCESS

Project Proposals

The NP project proponent requesting to introduce water into the SWP shall submit a detailed PIP to DWR. The proponent shall demonstrate that the NP water is of consistent, predictable and reliable quality, and is responsible for preparing and complying with any and all contracts, environmental documents, permits or licenses that are necessary consistent with applicable laws, regulations, agreements, procedures, or policies.

Project Description

The proponent will submit to DWR a PIP describing the proposed program, identifying the water source(s), planned operation, characterizing the inflow water quality and any anticipated impacts to SWP water quality and/or operations. The PIP should be submitted at least one month prior to proposed start up to allow for DWR and FG review. The PIP shall include:

- Project proponent names, locations, addresses, and contact person(s).
- Maps identifying all sources of water, point of inflow to the SWP and ultimate fate of the introduced water.
- Terms and conditions of inflow, timing, rates and volumes of inflow, pumping, conveyance and storage requirements.
- Construction details of any facilities located adjacent to the SWP including valves, meters, and pump and piping size.
- All potential impacts and/or benefits to downstream SWP water contractors.
- Detailed water quality data for all sources of water and any blend of sources that will be introduced into the SWP.
- Identify anticipated water quality changes within the SWP.
- Identify other relevant environmental issues such as subsidence, ground water overdraft or, presents of endangered species.
- Provide performance measures and remedial actions that will be taken in the event projected SWP water quality levels are not met.
- Reference an existing contract or indicate that one is in process with DWR to conduct a PIP.

Water Quality Monitoring

In order to demonstrate that the water source(s) are of consistent, predictable, and acceptable quality the NP proponent shall monitor water quality. The proponent shall, for the duration of the program, regularly report on operations as they affect water quality, monitoring data and water quality changes. Both DPH title 22 and a short list of Constituents of Concern (COC) shall be monitored for based upon one of the following water quality monitoring options.

<u>Constituents of Concern:</u> Current COC are Arsenic, Bromide, Chloride, Nitrate, Sulfate, Organic Carbon, and Total Dissolved Solids. These COC’s may be changed as needed.

Water Quality Monitoring Options: NP proponents shall select one of the testing options below and perform all water quality testing and provide analytical results in a timely manner as described herein. Monitoring shall be conducted for initial well start-up, periodic well re-testing and on-going testing during operation. Well data should be no more than three years old. Title 22 results should be provided to DWR and the FG within two weeks of testing and COC results within one week of testing, unless other schedules are agreed upon by DWR and the FG.

Option 1 — Baseline tests for Individual Wells

Well Start-up: Title 22 tests are required for all wells participating in the program prior to start-up. An existing title 22 test that is no more than three years old may be used. A Title 22 test may be substituted for any well near a similar well with a Title 22 test of record.

Well Re-testing: Title 22 test for all wells participating every three years.

Ongoing Monitoring: COC tests are required for all discharge locations to the SWP at start up and quarterly thereafter for new programs and resumption of established programs. New programs or those with constituents that may potentially degrade the SWP shall conduct at least weekly COC sampling of all discharge locations until the proponent demonstrates that the NP water is of consistent, predictable and reliable quality. Once the nature of the discharge has been clearly established, the COC tests are required quarterly for each discharge point.

Option 2 — Baseline tests for Representative Wells

Well Start-up: COC tests of record are required for all wells participating in the program and Title 22 tests of record are required for representative wells comprising a subset of all wells. This would typically be a group of wells that are manifold together and discharge to one pipe. Representative wells shall be identified on a case-by-case basis to be representative of the manifold area, well proximity, and water levels.

Well Re-testing: Same as required in Option 1.

On-going Monitoring: COC tests are required for all discharge locations to the SWP at start up and monthly thereafter for the duration of the program and annually at each well. New programs or those with constituents that may potentially degrade the SWP shall conduct weekly COC sampling of all discharge locations until the proponent demonstrates that the NP water is of consistent, predictable and reliable quality.

Option 3 — Self Directed

A PIP may propose a water quality monitoring program for approval by DWR and the FG that is different from options 1 or 2. It must include COC and title 22 testing that will fully characterize water pumped into the SWP and be at an interval to show a consistent, predictable and reliable quality.

Analytical Methods

Analytical laboratories used by project proponents shall be DPH certified by the Environmental Laboratory Accreditation Program (ELAP) and use EPA prescribed and ELAP accredited methods for drinking water analysis. Minimum Reporting Levels must be at least as low as the DPH required detection limits for purposes of reporting (DLR). The current DLRs are listed on the DPH website at Http://www.cdph.ca.gov/certlic/drinkingwater/Pages/MCLsandPHGs. DWR shall continue to use Bryte Chemical Laboratory as it's analytical and reference lab.

Flow Measurements

The project proponent shall maintain current, accurate records of water production rate and volume from each source, as well as, each point of discharge into the SWP. All flow measurements shall be submitted to regularly to DWR.

RECONSIDERATION

If an NP proponent disagrees with the FG or DWR decision or feels that there is an overriding benefit of the proposal, the proponent may request reconsideration from DWR on the basis of overriding public benefit or water supply deficiency. DWR shall consider these requests on a case-by-case basis.

ONGOING PROGRAM

Any NP Proponent who has successfully established a NP water inflow program (Including existing Kern Fan Banking Projects, Kern Water Bank, Pioneer and Berrenda Mesa Projects, Semitropic Water Storage District Wheeler Ridge Mariposa Water Storage District and Arvin Edison Water Storage District) may reinitiate the program by notifying DWR at least ten days before inflow is scheduled to begin and provide the following information:

- Updated water quality data and/or updated modeling that adequately reflects the quality of water to be introduced into the SWP.
- Turn-in location.
- Expected rate and duration of inflow. DWR shall notify the FG of this reinitiating of inflow.
- Water quality monitoring schedule that meets the objective of this policy.

FUTURE NP PROGRAMS

Future NP projects should be planned and designed considering the following items:

- Projects involving water quality exceeding primary drinking water standards shall show that the water shall be treated or blended before it enters the SWP to prevent water quality impacts.
- The project proponent of a Tier 2 proposal should clearly identify and establish that water inflow shall be managed and operated such that poor quality water will be blended with better quality water so that SWP water quality will not be degraded upon acceptable levels as determined by the FG and DWR.
- If a significant water supply deficiency exists and it is recommended by the FG that raw water quality criteria be set aside to ensure adequate supply, such action shall be subject to approval by the DPH.
- The project proponent of a NP inflow program which degrades SWP water quality shall identify mitigation to downstream water contractors for water quality impacts associated with increased water supply or treatment costs.

DWR ROLE

DWR shall seek, as needed, DPH or SWC recommendations on changes or additions to this document governing the NP water quality projects. The FG shall review proposed changes or additions prior to implementation by DWR, as needed.

DWR and or the United States Bureau of Reclamation (for San Luis Canal inflow) shall have ultimate responsibility for approving the water quality of all NP inflow, as well as, the oversight of monitoring and tracking the water quality of operating programs. DWR shall also ensure that the proponents of the NP inflow program perform according to their proposals, and will take appropriate action in the event of non-conformance.

Project Proposal Review Process

Upon receipt of a proposal for PIP, DWR shall review it for adequacy. DWR shall consider all PIPs based upon these guidelines. Review shall take no more than one month after receiving a complete program proposal. If necessary, DWR will convene timely meetings with the FG during the review. At a minimum the review will include

- Examination of all documents and data for completeness of the PIP.
- Notification of the affected Field Divisions, and the FG has been received by DWR.
- Consideration by DWR of comments from all parties before the final decision.
- Upon completion of the review DWR will notify the proponent and FG of the acceptance of the PIP or explain the reason(s) for rejecting it.
- DWR may reconsider a decision on a PIP based upon a recommendation from the FG. Reconsideration by DWR will be on a case-by-case basis.

Periodic Review

DWR may schedule periodic reviews of each operating NP inflow with input from the FG. As part of the review, program proponents shall provide the following information:

- Summary of deliveries to the Aqueduct.
- Water quality monitoring results.
- Proposed changes in the program operation.

The review may result in changes in monitoring and testing required of the program proponent as a result of:

- New constituents being added to the EPA /DPH list of drinking water standards.
- Changes in the maximum contaminant levels for the EPA/DPH list of drinking water standards.
- Identification of new constituents of concern.
- Changes in the water quality provided by the program.
- Changes in constituent background levels in the California Aqueduct.

This procedure shall recognize emerging contaminants and/or those detrimental to agricultural viability as they are identified by the regulatory agencies and shall set appropriate standards for water introduction based upon ambient levels in the California Aqueduct or State Notification Levels. Emerging contaminants are those that may pose significant risk to public health, but as yet do not have an MCL. Currently the Office of Environmental Health Hazard Assessment and the DPH establish Public Health Goals and Notification Levels, respectively. These levels, though not regulated, do provide health-based guidance to water utilities and can require public notification if exceeded.

Water Quality Review

DWR shall track and periodically report to the FG on water quality monitoring results on the SWP from NP water inflow and make all water quality data available to the public upon request.

- DWR shall review analyze and maintain all records of water quality testing conducted by the proponent of the well(s), source(s) and discharge(s) into the SWP.
- DWR shall determine what additional water quality monitoring, if any, is necessary within the SWP to ensure adequate protection of SWP water quality. DWR shall conduct all water quality monitoring within the SWP.
- DWR may prepare periodic reports of NP projects.

On-site Surveillance

The appropriate Field Division within DWR will be responsible for review and approval of all construction activities within the SWP right-of-way. Plans showing the discharge system piping, valves, sampling point, meters and locations must be submitted and approved prior to any construction. In addition, the appropriate Field Division will be responsible for confirmation of all meter readings and water quality monitoring conducted by the proponent.

- Field division staff may visit, inspect, and calibrate meters and measure flow conditions at each source or point of inflow into the SWP.
- Flow meters, sampling ports and anti-siphon valves must be conveniently located near the SWP right-of-way.
- Field division staff may collect water samples at each source or point of discharge into the SWP.
- The appropriate Field Division shall conduct additional water quality monitoring within the SWP, if deemed necessary, to assure compliance with the NP Inflow Criteria.
- DWR shall monitor aqueduct water quality and analyze several “split samples” of the water at the point of introduction into the aqueduct to ensure consistent analytical results.

Table A-1 Historical Water Quality Conditions 1988–2011 at O'Neill Forebay Outlet (mg/L)

Parameter	Mean	Minimum	Maximum	Standard Deviation
Aluminum	0.03	0.01	0.527	0.05
Antimony	0.002	0.001[a]	0.005	0.002
Arsenic	0.002	0.001	0.004	0.001
Barium	0.05	0.05	0.068	0.002
Beryllium	0.001[a]	0.001[a]	0.001[a]	0.000
Bromide	0.22	0.04	0.54	0.16
Cadmium	0.003	0.001	0.005	0.002
Chromium	0.004	0.001	0.011	0.002
Copper	0.004	0.001	0.028	0.003
Fluoride	0.1	0.1	0.5	0.1
Iron	0.037	0.005	0.416	0.050
Manganese	0.009	0.005	0.06	0.007
Mercury	0.001	0.0002	0.001	0.0004
Nickel	0.001	0.001	0.004	0.0005
Nitrate	2.9	0.2	8.1	1.6
Selenium	0.001	0.001	0.002	0.0001
Silver	0.003	0.001	0.005	0.002
Sulfate	42	14	99	15
Total Organic Carbon	4.0	0.8	12.6	1.6
Zinc	0.007	0.005	0.21	0.01

Note:
mg/L = milligrams per liter.
[a] These values represent reporting limits. Actual values would be lower.

Table A-2 **O'Neill Forebay Outlet Total Dissolved Solids Criteria by Water Year Classification,1988–2011 (mg/L)**

YT[a]	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep
W	227.2	262.5	295.4	228.9	213.8	231.2	184.4	226.5	181.5	171.4	195.7	157.3
NN	317.9	324.7	351.7	295.4	268.1	302.7	270.0	285.1	230.1	211.9	170.9	202.6
D	286.4	319.6	370.0	362.0	344.2	305.2	240.4	278.2	307.3	234.8	269.0	336.6
C	256.6	312.9	372.9	367.0	361.0	335.0	307.1	291.8	335.1	325.7	339.4	328.8

Note:

C = critical, D = dry, mg/L = milligrams per liter, NN = near normal, YT = year type, W = wet.

[a] Year type is based on water year classification. Below normal and above normal year types have been combined into one designation called "near normal."

Table A-3 **O'Neill Forebay Outlet Bromide Criteria by Water Year Classification, 1988–2011 (mg/L)**

YT[a]	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep
W	0.19	0.24	0.28	0.13	0.10	0.12	0.12	0.17	0.12	0.12	0.13	0.10
NN	0.31	0.31	0.34	0.21	0.15	0.15	0.18	0.22	0.15	0.15	0.14	0.19
D	0.25	0.29	0.35	0.35	0.24	0.20	0.17	0.24	0.27	0.13	0.29	0.41
C	0.26	0.28	0.32	0.37	0.33	0.27	0.22	0.22	0.28	0.28	0.32	0.37

Note:

C = critical, D = dry, mg/L = milligrams per liter, NN = near normal, YT = year type, W = wet.

[a] Year type is based on water year classification. Below normal and above normal year types have been combined into one designation called "near normal."

Table A-4 O'Neill Forebay Outlet Total Organic Carbon Criteria by Water Year Classification, 1988–2011 (mg/L)

YT[a]	Year Type[a]	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep
W	Wet	2.8	2.9	3.9	5.2	4.8	3.8	3.9	3.4	3.1	3.2	3.1	2.7
NN	Near Normal	3.7	4.1	4.0	7.0	6.3	5.6	4.7	4.4	4.0	3.3	3.3	3.4
D	Dry	3.0	3.0	4.0	5.7	4.8	5.7	4.5	3.6	3.7	2.9	2.9	2.7
C	Critical	2.8	3.1	3.3	4.9	6.0	5.7	4.7	4.0	3.8	3.9	4.0	3.5

Note:

C = critical, D = dry, mg/L = milligrams per liter, NN = near normal, YT = year type, W = wet.

[a] Year type is based on water year classification. Below normal and above normal year types have been combined into one designation called "near normal."

Appendix B. San Joaquin Field Division Water Quality Grab Sample Results

Table B-1 Water Quality Data for Groundwater Turn-ins to the California Aqueduct in the San Joaquin Field Division, Arsenic to Nitrate, 2018

Source Inflow	Milepost	Data Source	Date	Arsenic[a]	Bromide	Chloride	Cr	Cr6+ (µg/L)	EC (µS/cm)	NO_3
CVC	238.04	WKWD	3/5/2018	0.0023	0.23	57	NS	0.81	514	1.7
CVC	238.04	KCWA	3/6/2018	0.0038	0.25	56	NS	0.94	451	7.3
CVC	238.04	WKWD	3/12/2018	0.0065	0.45	54	NS	1.1	417	1.8
CVC	238.04	KCWA	3/13/2018	0.0045	0.23	50	NS	1.1	414	6.5
CVC	238.04	WKWD	3/19/2018	0.0067	0.31	51	NS	1.2	383	1.9
CVC	238.04	KCWA	3/20/2018	0.0038	0.23	52	NS	1.1	417	7.5
CVC	238.04	KCWA	4/16/2018	0.0044	0.11	26	NS	0.66	282	4.1
CVC	238.04	KCWA	6/1/2018	0.0098	0.27	60	NS	1.5	412	9.7
KWBC	238.19	KCWA	3/6/2018	0.0011	0.18	58	NS	0.44	498	3.9
KWBC	238.19	KCWA	3/13/2018	0.0022	0.18	45	NS	0.81	470	4.7
KWBC	238.19	KCWA	3/20/2018	< 0.0007	0.15	38	NS	0.8	421	5.7
KWBC	238.19	KCWA	4/16/2018	0.0035	0.16	43	NS	0.85	428	5.5
KWBC	238.19	KCWA	6/1/2018	0.0047	0.012	3	NS	< 0.031	132	0.12
KWBC	238.19	KCWA	8/16/2018	0.0015	0.17	54	NS	0.76	537	5.5
WKWD	240.2	WKWD	3/5/2018	0.0022	0.15	43	NS	1	436	0.9
WKWD	240.2	WKWD	3/12/2018	0.0022	0.34	43	NS	0.9	421	0.8
WKWD	240.2	WKWD	3/19/2018	0.003	0.18	37	NS	0.99	399	0.86

Source Inflow	Milepost	Data Source	Date	Arsenic[a]	Bromide	Chloride	Cr	Cr6+ (µg/L)	EC (µS/cm)	NO_3
WRMWSD 7G3W	269.66	WRMWSD	4/10/2018	< 0.002	0.21	35.0	< 0.01	< 0.050	1100	< 1
WRMWSD 7G3W	269.66	WRMWSD	6/19/2018	0.0024	0.18	37.0	< 0.01	< 0.050	1100	< 1
WRMWSD 7G3W	269.66	WRMWSD	8/14/2018	0.0025	0.21	38.0	< 0.01	< 0.050	1100	< 1
WRMWSD 7P6W	269.66	WRMWSD	4/10/2018	0.0021	0.2	35.0	< 0.01	< 0.050	1100	< 1
WRMWSD 7P6W	269.66	WRMWSD	6/19/2018	0.0022	0.18	37.0	< 0.01	< 0.20	1100	< 1
WRMWSD 7P6W	269.66	WRMWSD	8/14/2018	0.0023	0.21	37.0	< 0.01	< 0.20	1000	< 1
WRMWSD WRM-7 / 7P5W	270.24	WRMWSD	4/10/2018	0.008	0.13	24.0	< 0.01	< 0.050	770	< 1
WRMWSD WRM-7 / 7P5W	270.24	WRMWSD	6/19/2018	0.0064	0.14	25.0	< 0.01	< 0.20	770	< 1
WRMWSD WRM-7 / 7P5W	270.24	WRMWSD	8/14/2018	0.0083	0.17	28.0	< 0.01	< 0.050	830	< 1
WRMWSD 8G3W	272.1	WRMWSD	4/11/2018	0.0056	0.14	31.0	< 0.01	< 0.050	1000	2.5
WRMWSD 8G3W	272.1	WRMWSD	6/19/2018	0.0033	0.11	30.0	< 0.01	< 0.20	1000	2.4

Source Inflow	Milepost	Data Source	Date	Arsenic[a]	Bromide	Chloride	Cr	Cr6+ (µg/L)	EC (µS/cm)	NO_3
WRMWSD 8G3W	272.1	WRMWSD	8/14/2018	0.0033	0.14	30.0	< 0.01	< 0.050	1000	2.7
WRMWSD 8P1W	272.31	WRMWSD	4/10/2018	0.0067	0.097	19.0	< 0.01	< 0.050	930	< 1
WRMWSD 8P1W	272.31	WRMWSD	6/19/2018	0.007	0.07	16.0	< 0.01	< 0.050	950	< 1
WRMWSD 8P1W	272.31	WRMWSD	8/14/2018	0.0071	0.09	16.0	< 0.01	< 0.050	930	< 1
WRMWSD 8P2W	272.53	WRMWSD	6/19/2018	0.0061	0.13	23.0	< 0.01	< 0.20	750	1.1
WRMWSD 8P2W	272.53	WRMWSD	8/15/2018	0.0076	0.13	23.0	< 0.01	< 0.050	1000	< 1
WRMWSD 8P3W	272.80	WRMWSD	6/19/2018	0.0066	0.13	23.0	< 0.01	< 0.20	1100	1.1
WRMWSD 8P3W	272.80	WRMWSD	8/15/2018	0.0074	0.12	23.0	< 0.01	< 0.050	1000	< 1
WRMWSD 8P4W	273.75	WRMWSD	4/10/2018	0.0072	0.14	30.0	< 0.01	< 0.050	1000	2.6
WRMWSD 8P4W	273.75	WRMWSD	6/19/2018	0.0069	0.12	30.0	< 0.01	< 0.20	1000	2.6
WRMWSD 8P4W	273.75	WRMWSD	8/14/2018	0.0075	0.14	30.0	< 0.01	0.092	1000	2.8
WRMWSD 9G4W	276.09	WRMWSD	4/10/2018	0.0021	0.14	33.0	< 0.01	< 0.050	1000	3.2

Source Inflow	Milepost	Data Source	Date	Arsenic[a]	Bromide	Chloride	Cr	Cr6+ (µg/L)	EC (µS/cm)	NO_3
WRMWSD 9G4W	276.09	WRMWSD	8/15/2018	0.003	0.1	30.0	< 0.01	< 0.050	920	1.9
WRMWSD 9G1W	277.28	WRMWSD	4/10/2018	0.0024	0.22	43.0	< 0.01	< 0.050	1300	11.1
WRMWSD 9G1W	277.28	WRMWSD	8/15/2018	0.0022	0.12	34.0	< 0.01	< 0.050	1200	6.7
WRMWSD 10P1X	280.14	WRMWSD	4/11/2018	0.0035	0.18	39.0	< 0.01	0.38	1000	33
WRMWSD 10P1X	280.14	WRMWSD	5/14/2018	0.0072	0.14	31.0	< 0.01	0.18	720	3.2
WRMWSD 10P1X	280.14	WRMWSD	7/2/2018	0.0045	0.15	48.0	< 0.01	< 0.20	750	1.1
WRMWSD 10P1X	280.14	WRMWSD	8/20/2018	0.0068	0.12	32.0	< 0.01	0.33	650	< 1
AEWSD	277.3	AEWSD	3/12/2018	0.007	0.13	28	0.002	1	392	9
AEWSD	277.3	AEWSD	4/24/2018	0.001	< 0.03	NS	< 0.001	< 0.1	43	< 0.4

Note:
AEWSD = Arvin-Edison Water Storage District, Cr = chromium, Cr^{6+} = hexavalent chromium, CVC = Cross Valley Canal, EC = electrical conductivity, KCWA = Kern County Water Agency, KWBC = Kern Water Bank Canal, NO_3 = nitrate, NS = no sample, µg/L = micrograms per liter, µS/cm = microsiemens per centimeter, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge-Maricopa Water Storage District.
All units in milligrams per liter unless otherwise noted.
[a] All arsenic values are total (unfiltered) arsenic except WRMWSD, which is dissolved (filtered).

Table B-2 **Water Quality Data for Groundwater Turn-ins to the California Aqueduct in the San Joaquin Field Division, Organic Carbon to 1,2,3-trichloropropane, 2018**

Source Inflow	Milepost	Data Source	Date	OC[a]	SO_4	TDS	U (pCi/L)	Gross Alpha (pCi/L)	1,2,3-TCP (µg/L)
CVC	238.04	WKWD	3/5/2018	< 1	81	350	7.3	NS	NS
CVC	238.04	KCWA	3/6/2018	0.89	49	290	NS	8.06 +/- 0.479	< 0.0015
CVC	238.04	WKWD	3/12/2018	< 1	40	270	5.2	NS	NS
CVC	238.04	KCWA	3/13/2018	0.61	42	270	NS	4.03 +/- 0.348	0.0024
CVC	238.04	WKWD	3/19/2018	< 1	27	260	5.1	NS	NS
CVC	238.04	KCWA	3/20/2018	< 1	39	270	NS	3.52 +/- 0.365	0.003
CVC	238.04	KCWA	4/16/2018	0.87	22	190	NS	6.04 +/- 0.426	< 0.0015
CVC	238.04	KCWA	6/1/2018	0.71	31	250	NS	5.03 +/- 0.365	0.0071
KWBC	238.19	KCWA	3/6/2018	2.8	49	340	NS	11.6 +/- 0.561	< 0.0015
KWBC	238.19	KCWA	3/13/2018	0.92	48	290	NS	17.6 +/- 0.669	< 0.0015
KWBC	238.19	KCWA	3/20/2018	< 1	41	280	NS	7.55 +/- 0.479	< 0.0015
KWBC	238.19	KCWA	4/16/2018	0.75	45	290	NS	7.05 +/- 0.454	< 0.0015
KWBC	238.19	KCWA	6/1/2018	3.5	8.6	87	NS	2.01 +/- 0.246	< 0.0015
KWBC	238.19	KCWA	8/16/2018	1	82	380	NS	9.57 +/- 0.492	< 0.0015
WKWD	240.2	WKWD	3/5/2018	< 1	41	310	12	NS	NS
WKWD	240.2	WKWD	3/12/2018	< 1	39	270	11	NS	NS
WKWD	240.2	WKWD	3/19/2018	< 1	32	270	9.7	NS	NS
WRMWSD 7G3W	269.66	WRMWSD	4/10/2018	< 0.20	420	460	3.2	NS	< 0.0050
WRMWSD 7G3W	269.66	WRMWSD	6/19/2018	< 0.20	410	720	2.5	NS	< 0.0050

Source Inflow	Milepost	Data Source	Date	OC[a]	SO_4	TDS	U (pCi/L)	Gross Alpha (pCi/L)	1,2,3-TCP (µg/L)
WRMWSD 7G3W	269.66	WRMWSD	8/14/2018	< 0.20	390	700	2.5	NS	< 0.0050
WRMWSD 7P6W	269.66	WRMWSD	4/10/2018	< 0.20	420	760	3.2	NS	< 0.0050
WRMWSD 7P6W	269.66	WRMWSD	6/19/2018	< 0.20	410	730	2.3	NS	< 0.0050
WRMWSD 7P6W	269.66	WRMWSD	8/14/2018	< 0.20	390	680	2.4	NS	< 0.0050
WRMWSD WRM-7 / 7P5W	270.24	WRMWSD	4/10/2018	0.44	230	510	2.2	NS	< 0.0050
WRMWSD WRM-7 / 7P5W	270.24	WRMWSD	6/19/2018	0.84	240	490	2.3	NS	< 0.0050
WRMWSD WRM-7 / 7P5W	270.24	WRMWSD	8/14/2018	1.3	250	520	2.3	NS	< 0.0050
WRMWSD 8G3W	272.1	WRMWSD	4/11/2018	< 0.20	420	730	3.4	NS	< 0.0050
WRMWSD 8G3W	272.1	WRMWSD	6/19/2018	< 0.20	400	710	3.4	NS	< 0.0050
WRMWSD 8G3W	272.1	WRMWSD	8/14/2018	0.2	390	680	3.6	NS	< 0.0050
WRMWSD 8P1W	272.31	WRMWSD	4/10/2018	0.23	360	660	2.1	NS	< 0.0050

Source Inflow	Milepost	Data Source	Date	OC[a]	SO_4	TDS	U (pCi/L)	Gross Alpha (pCi/L)	1,2,3-TCP (µg/L)
WRMWSD 8P1W	272.31	WRMWSD	6/19/2018	0.28	370	640	1.9	NS	< 0.0050
WRMWSD 8P1W	272.31	WRMWSD	8/14/2018	0.2	360	620	2	NS	< 0.0050
WRMWSD 8P2W	272.53	WRMWSD	6/19/2018	0.23	430	750	2.9	NS	< 0.0050
WRMWSD 8P2W	272.53	WRMWSD	8/15/2018	< 0.20	400	730	2.7	NS	< 0.0050
WRMWSD 8P3W	272.80	WRMWSD	6/19/2018	< 0.20	430	740	3	NS	< 0.0050
WRMWSD 8P3W	272.80	WRMWSD	8/15/2018	< 0.20	390	720	2.6	NS	< 0.0050
WRMWSD 8P4W	273.75	WRMWSD	4/10/2018	< 0.20	410	730	3.2	NS	< 0.0050
WRMWSD 8P4W	273.75	WRMWSD	6/19/2018	< 0.20	420	720	3.3	NS	< 0.0050
WRMWSD 8P4W	273.75	WRMWSD	8/14/2018	< 0.20	410	690	3.4	NS	< 0.0050
WRMWSD 9G4W	276.09	WRMWSD	4/10/2018	< 0.20	420	770	3.7	NS	< 0.0050
WRMWSD 9G4W	276.09	WRMWSD	8/15/2018	< 0.20	350	660	4	NS	< 0.0050
WRMWSD 9G1W	277.28	WRMWSD	4/10/2018	< 0.20	520	1000	8.3	NS	< 0.0050

Source Inflow	Milepost	Data Source	Date	OC[a]	SO_4	TDS	U (pCi/L)	Gross Alpha (pCi/L)	1,2,3-TCP (µg/L)
WRMWSD 9G1W	277.28	WRMWSD	8/15/2018	< 0.20	410	840	10	NS	< 0.0050
WRMWSD 10P1X	280.14	WRMWSD	4/11/2018	< 0.20	300	680	8.2	NS	0.042
WRMWSD 10P1X	280.14	WRMWSD	5/14/2018	0.44	460	460	4.9	NS	< 0.0050
WRMWSD 10P1X	280.14	WRMWSD	7/2/2018	2.2	180	460	5	NS	< 0.0050
WRMWSD 10P1X	280.14	WRMWSD	8/20/2018	1.1	150	410	4.6	NS	< 0.0050
AEWSD	277.3	AEWSD	3/12/2018	2.4	40	180	0.496	2.21 ± 1.10	0.023
AEWSD	277.3	AEWSD	4/24/2018	2.9	1	30	NS	NS	< 0.0050

Note:
AEWSD = Arvin-Edison Water Storage District, CVC = Cross Valley Canal, KCWA = Kern County Water Agency, KWBC = Kern Water Bank Canal, NS = no sample, OC = organic carbon, pCi/L = picoCuries per liter, SO_4 = sulfate, TDS = total dissolved solids, U = uranium, WKWD = West Kern Water District, WRMWSD = Wheeler Ridge Maricopa Water Storage District, µg/L = micrograms per liter, 1,2,3-TCP = 1,2,3-trichloropropane.
All units in milligrams per liter unless otherwise noted.
[a] All organic carbon values are total (unfiltered) organic carbon except WRMWSD, which is dissolved (filtered).

Table B-3 **Water Quality Data for California Aqueduct Locations in the San Joaquin Field Division, Arsenic to Electrical Conductivity, 2018**

Source	Mile-post	Data Source	Date	Diss. As	Total As	Br	Cl	Diss. Cr	Total Cr	Cr^{6+} (µg/L)	EC (µS/cm)
Check 21	172.26	DWR	1/16/2018	0.001	0.002	0.27	85	< 0.001	< 0.001	NS	493
Check 21	172.26	DWR	2/20/2018	0.001	0.002	0.22	75	< 0.001	< 0.001	NS	478
Check 21	172.26	DWR	3/20/2018	0.002	0.002	0.2	70	< 0.001	< 0.001	NS	438
Check 21	172.26	DWR	4/17/2018	0.002	0.002	0.13	47	0.002	0.002	NS	377
Check 21	172.26	DWR	5/15/2018	0.002	0.002	0.19	70	0.001	0.001	NS	439
Check 21	172.26	DWR	6/19/2018	0.002	0.002	0.17	69	0.001	0.001	NS	433
Check 21	172.26	DWR	7/17/2018	0.001	0.002	0.19	69	0.001	0.001	NS	437
Check 21	172.26	DWR	8/14/2018	0.002	0.002	0.11	39	0.001	0.001	NS	281
Check 21	172.26	DWR	9/18/2018	0.003	0.003	0.32	105	0.001	0.001	NS	539
Check 21	172.26	DWR	10/16/2018	0.002	0.002	0.34	106	0.001	0.001	NS	538
Check 21	172.26	DWR	11/13/2018	0.002	0.002	0.34	102	0.001	0.001	NS	522
Check 21	172.26	DWR	12/18/2018	0.002	0.002	0.3	95.2	0.001	0.001	NS	548
Check 27	231.73	DWR	3/20/2018	NS	NS	NS	NS	NS	NS	0.088	NS
Check 27	231.73	DWR	4/17/2018	0.002	0.002	0.12	46	0.001	NS	0.31	368
Check 27	231.73	DWR	5/15/2018	0.002	0.002	0.19	69	0.002	NS	0.3	434
Tupman Rd.	236.43	KCWA	3/6/2018	NS	< 0.0007	0.23	76	NS	NS	0.1	439
Tupman Rd.	236.43	KCWA	3/13/2018	NS	< 0.0007	0.22	75	NS	NS	0.065	438
Tupman Rd.	236.43	KCWA	3/20/2018	NS	0.0022	0.22	57	NS	NS	0.71	418
Tupman Rd.	236.43	KCWA	4/16/2018	NS	0.0022	0.14	50	NS	NS	0.073	383
Tupman Rd.	236.43	KCWA	6/1/2018	NS	0.0026	0.19	69	NS	NS	0.074	419
Tupman Rd.	236.43	KCWA	8/16/2018	NS	0.002	0.26	40	NS	NS	0.068	282
Cole's Levee	240.14	WKWD	3/5/2018	NS	< 0.002	0.21	77	NS	NS	< 0.20	437
Cole's Levee	240.14	KCWA	3/6/2018	NS	0.0013	0.23	70	NS	NS	0.38	455

Source	Mile-post	Data Source	Date	Diss. As	Total As	Br	Cl	Diss. Cr	Total Cr	Cr^{6+} (µg/L)	EC (µS/cm)
Cole's Levee	240.14	WKWD	3/12/2018	NS	0.0027	0.49	66	NS	NS	0.38	435
Cole's Levee	240.14	KCWA	3/13/2018	NS	0.0016	0.22	66	NS	NS	0.36	439
Cole's Levee	240.14	WKWD	3/19/2018	NS	< 0.002	0.22	60	NS	NS	0.55	442
Cole's Levee	240.14	KCWA	3/20/2018	NS	< 0.0007	0.2	52	NS	NS	0.72	429
Cole's Levee	240.14	KCWA	4/16/2018	NS	0.003	0.14	45	NS	NS	0.41	387
Cole's Levee	240.14	KCWA	6/1/2018	NS	0.0032	0.13	40	NS	NS	0.19	305
Cole's Levee	240.14	KCWA	8/16/2018	NS	0.0025	0.14	39	NS	NS	0.084	284
Hwy 119	241.06	WKWD	3/5/2018	NS	0.002	0.24	76	NS	NS	< 0.20	441
Hwy 119	241.06	WKWD	3/12/2018	NS	0.0037	0.52	65	NS	NS	0.43	425
Hwy 119	241.06	WKWD	3/19/2018	NS	< 0.002	0.18	60	NS	NS	0.53	435
Check 29	244.54	DWR	3/20/2018	NS	NS	NS	NS	NS	NS	0.63	NS
Check 29	244.54	DWR	4/17/2018	0.002	0.003	0.13	41	0.003	NS	0.68	374
Check 29	244.54	DWR	5/15/2018	0.002	0.003	0.16	55	0.002	NS	0.42	378
Teerink PP	278.13	DWR	1/16/2018	0.001	0.002	0.27	86	< 0.001	0.001	NS	494
Teerink PP	278.13	DWR	2/20/2018	0.001	0.002	0.22	74	< 0.001	0.001	NS	492
Teerink PP	278.13	DWR	3/20/2018	NS	0.004	0.18	53	NS	0.001	0.54	460
Teerink PP	278.13	DWR	4/17/2018	0.002	0.002	0.12	36	0.002	0.002	0.55	363
Teerink PP	278.13	DWR	4/17/2018	0.004	0.004	0.12	36	0.005	NS	NS	363
Teerink PP	278.13	DWR	5/15/2018	0.003	0.003	0.14	47	0.002	0.002	0.37	345
Teerink PP	278.13	DWR	5/15/2018	0.002	0.002	0.13	47	0.002	NS	NS	349
Teerink PP	278.13	DWR	6/19/2018	0.002	0.002	0.17	67	< 0.001	0.001	NS	446
Teerink PP	278.13	DWR	7/17/2018	0.001	0.002	0.19	67	0.001	0.001	NS	441
Teerink PP	278.13	DWR	8/14/2018	0.002	0.002	0.12	44	0.001	0.001	NS	326
Teerink PP	278.13	DWR	9/18/2018	0.003	0.003	0.28	96	0.001	0.001	NS	502
Teerink PP	278.13	DWR	10/16/2018	0.002	0.002	0.34	106	0.001	0.001	NS	539

Source	Mile-post	Data Source	Date	Diss. As	Total As	Br	Cl	Diss. Cr	Total Cr	Cr^{6+} (µg/L)	EC (µS/cm)
Teerink PP	278.13	DWR	11/13/2018	0.002	0.002	0.35	104	0.002	0.002	NS	532
Teerink PP	278.13	DWR	12/18/2018	0.002	0.002	0.29	92.1	0.001	0.001	NS	513
Check 41	303.41	DWR	1/17/2018	0.001	0.001	0.28	88	< 0.001	< 0.001	NS	499
Check 41	303.41	DWR	2/21/2018	0.001	0.002	0.22	75	< 0.001	0.001	NS	491
Check 41	303.41	DWR	3/28/2018	0.002	0.002	0.2	72	0.001	0.001	NS	426
Check 41	303.41	DWR	4/18/2018	0.002	0.002	0.12	37	0.001	0.001	NS	383
Check 41	303.41	DWR	5/16/2018	0.002	0.003	0.13	44	0.001	0.001	NS	337
Check 41	303.41	DWR	6/20/2018	0.002	0.002	0.17	67	< 0.001	0.001	NS	448
Check 41	303.41	DWR	7/18/2018	0.001	0.002	0.19	68	0.001	0.001	NS	442
Check 41	303.41	DWR	8/16/2018	0.002	0.002	0.12	44	0.002	0.003	NS	328
Check 41	303.41	DWR	9/19/2018	0.003	0.003	0.31	95	< 0.001	0.001	NS	507
Check 41	303.41	DWR	10/17/2018	0.002	0.003	0.29	108	0.001	0.001	NS	546
Check 41	303.41	DWR	11/14/2018	0.002	0.003	0.36	105	0.001	0.001	NS	535
Check 41	303.41	DWR	12/19/2018	0.002	0.002	0.28	91	0.001	0.001	NS	508

Note:
As = arsenic, Br = bromide, Cl = chloride, Cr = chromium, Cr^{6+} = hexavalent chromium, Diss. = dissolved,
DWR = California Department of Water Resources, EC = electrical conductivity, KCWA = Kern County Water Agency,
NS = no sample, PP = pumping plant, µg/L = micrograms per liter, µS/cm = microsiemens per centimeter, WKWD = West Kern Water District.
All units in milligrams per liter unless otherwise noted.

Table B-4 Water Quality Data for California Aqueduct Locations in the San Joaquin Field Division, Nitrate to 1,2,3-trichloropropane, 2018

Source	Mile-post	Data Source	Date	NO_3	SO_4	DOC	TOC	TDS	U (pCi/L)	Gross Alpha (pCi/L)	1,2,3-TCP (µg/L)
Check 21	172.26	DWR	1/16/2018	3.3	34	3.2	3.2	274	NS	NS	NS
Check 21	172.26	DWR	2/20/2018	3.1	37	3.6	3.7	268	NS	NS	NS
Check 21	172.26	DWR	3/20/2018	1.1	30	3.4	3.4	244	NS	NS	NS
Check 21	172.26	DWR	4/17/2018	3	37	5.1	5.1	210	NS	NS	NS
Check 21	172.26	DWR	5/15/2018	1	33	3.8	3.8	242	NS	NS	NS
Check 21	172.26	DWR	6/19/2018	1.3	33	3.4	3.5	240	NS	NS	NS
Check 21	172.26	DWR	7/17/2018	1	32	3.6	3.8	246	NS	NS	NS
Check 21	172.26	DWR	8/14/2018	0.4	14	2.9	2.9	144	NS	NS	NS
Check 21	172.26	DWR	9/18/2018	0.6	22	2.7	2.7	301	NS	NS	NS
Check 21	172.26	DWR	10/16/2018	1.2	22	2.5	2.5	300	NS	NS	NS
Check 21	172.26	DWR	11/13/2018	2.2	25.4	2.4	2.4	294	NS	NS	NS
Check 21	172.26	DWR	12/18/2018	3.4	36.2	2.6	2.7	305	NS	NS	NS
Check 27	231.73	DWR	3/20/2018	NS	NS	NS	NS	NS	0.64	NS	NS
Check 27	231.73	DWR	4/17/2018	3	37	5.6	NS	211	0.91	1.25	< 0.005
Check 27	231.73	DWR	5/15/2018	0.2	32	4.3	NS	240	0.66	1.8	< 0.005
Tupman Rd.	236.43	KCWA	3/6/2018	1.2	28	NS	3.6	270	NS	1.51	< 0.0015
Tupman Rd.	236.43	KCWA	3/13/2018	0.36	27	NS	3.7	240	NS	< 1.06	< 0.0015
Tupman Rd.	236.43	KCWA	3/20/2018	5	34	NS	1.4	280	NS	< 1.49	0.002
Tupman Rd.	236.43	KCWA	4/16/2018	3	36	NS	5	260	NS	2.01	< 0.0015
Tupman Rd.	236.43	KCWA	6/1/2018	< 0.092	29	NS	4.1	240	NS	< 1.06	< 0.0015
Tupman Rd.	236.43	KCWA	8/16/2018	< 0.092	13	NS	3.4	NS	NS	< 1.49	< 0.0015
Cole's Levee	240.14	WKWD	3/5/2018	0.31	29	NS	3.5	300	0.81	NS	NS

Source	Mile-post	Data Source	Date	NO_3	SO_4	DOC	TOC	TDS	U (pCi/L)	Gross Alpha (pCi/L)	1,2,3-TCP (µg/L)
Cole's Levee	240.14	KCWA	3/6/2018	3.5	37	NS	2.7	280	NS	3.02	< 0.0015
Cole's Levee	240.14	WKWD	3/12/2018	0.69	33	NS	2.5	270	3.6	NS	NS
Cole's Levee	240.14	KCWA	3/13/2018	2.2	34	NS	2.7	250	NS	< 1.06	< 0.0015
Cole's Levee	240.14	WKWD	3/19/2018	0.83	38	NS	2.3	290	6.2	NS	NS
Cole's Levee	240.14	KCWA	3/20/2018	4.3	37	NS	1.2	280	NS	5.03	< 0.0015
Cole's Levee	240.14	KCWA	4/16/2018	4.3	38	NS	3.2	260	NS	4.53	< 0.0015
Cole's Levee	240.14	KCWA	6/1/2018	46	21	NS	3.6	230	NS	1.51	< 0.0015
Cole's Levee	240.14	KCWA	8/16/2018	< 0.092	14	NS	3.3	190	NS	< 1.49	< 0.0015
Hwy 119	241.06	WKWD	3/5/2018	0.3	29	NS	3.4	280	0.96	NS	NS
Hwy 119	241.06	WKWD	3/12/2018	0.75	34	NS	2.4	280	3.3	NS	NS
Hwy 119	241.06	WKWD	3/19/2018	0.76	36	NS	2.2	290	5.1	NS	NS
Check 29	244.54	DWR	3/20/2018	NS	NS	NS	NS	NS	5.8	NS	NS
Check 29	244.54	DWR	4/17/2018	4	38	3	NS	213	4.6	3.03	< 0.005
Check 29	244.54	DWR	5/15/2018	1.1	29	3.7	NS	210	1.5	2.1	< 0.005
Teerink PP	278.13	DWR	1/16/2018	3.1	33	3.3	3.4	276	NS	NS	NS
Teerink PP	278.13	DWR	2/20/2018	4	42	4.5	4.5	277	NS	NS	NS
Teerink PP	278.13	DWR	3/20/2018	4.2	55	2.1	2.1	276	4.8	NS	NS
Teerink PP	278.13	DWR	4/17/2018	3.4	44	2.8	2.8	212	4.2	6.13	< 0.005
Teerink PP	278.13	DWR	4/17/2018	3.4	44	2.8	N/A	212	NS	NS	NS
Teerink PP	278.13	DWR	5/15/2018	1.2	33	3.2	3.7	193	1.3	2.3	< 0.005
Teerink PP	278.13	DWR	5/15/2018	1.1	33	3.6	N/A	193	NS	NS	NS
Teerink PP	278.13	DWR	6/19/2018	1	43	3.4	3.4	246	NS	NS	NS
Teerink PP	278.13	DWR	7/17/2018	0.3	38	3.8	3.8	249	NS	NS	NS
Teerink PP	278.13	DWR	8/14/2018	0.2	25	3.5	3.2	169	NS	NS	NS

Source	Mile-post	Data Source	Date	NO_3	SO_4	DOC	TOC	TDS	U (pCi/L)	Gross Alpha (pCi/L)	1,2,3-TCP (µg/L)
Teerink PP	278.13	DWR	9/18/2018	0.186	21	2.8	3	282	NS	NS	NS
Teerink PP	278.13	DWR	10/16/2018	0.8	21	2.4	2.4	297	NS	NS	NS
Teerink PP	278.13	DWR	11/13/2018	2.02	25	2.3	2.5	295	NS	NS	NS
Teerink PP	278.13	DWR	12/18/2018	2.16	29.2	2.6	2.8	289	NS	NS	NS
Check 41	303.41	DWR	1/17/2018	3	32	3.6	3.6	276	NS	NS	NS
Check 41	303.41	DWR	2/21/2018	4	42	4.3	4.3	272	NS	NS	NS
Check 41	303.41	DWR	3/28/2018	1.1	31	3.4	3.6	238	NS	NS	NS
Check 41	303.41	DWR	4/18/2018	4.2	49	2.6	2.7	233	NS	NS	NS
Check 41	303.41	DWR	5/16/2018	1.2	31	3.3	3.3	187	NS	NS	NS
Check 41	303.41	DWR	6/20/2018	1.1	43	3.7	3.7	249	NS	NS	NS
Check 41	303.41	DWR	7/18/2018	0.2	37	3.8	4.1	247	NS	NS	NS
Check 41	303.41	DWR	8/16/2018	0.22	25	3.2	3.2	171	NS	NS	NS
Check 41	303.41	DWR	9/19/2018	0.2	20	2.7	2.7	283	NS	NS	NS
Check 41	303.41	DWR	10/17/2018	0.8	21	2.6	2.6	303	NS	NS	NS
Check 41	303.41	DWR	11/14/2018	2.05	25	2.5	2.5	297	NS	NS	NS
Check 41	303.41	DWR	12/19/2018	1.95	29	2.8	2.8	280	NS	NS	NS

Note:
DOC = dissolved organic carbon, DWR = California Department of Water Resources, KCWA = Kern County Water Agency, NO_3 = nitrate, NS = no sample, pCi/L = picoCuries per liter, PP = pumping plant, SO_4 = sulfate, TDS = total dissolved solids, TOC = total organic carbon, U = uranium, WKWD = West Kern Water District, µg/L = micrograms per liter, 1,2,3-TCP = 1,2,3-trichloropropane.
All units in milligrams per liter unless otherwise noted.