Friant-Kern Canal Pump-Back Project Environmental Impact Report

Appendix F: Hydrology and Water Resources Modeling

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Abbreviations and Acronyms

µmhos/cm	Micromhos per Centimeter
µS/cm	Microsiemens per Centimeter
AEWSD	Arvin-Edison Water Storage District
AF	acre-feet
B	boron
C2VsimFG_v1	Fine Grid California Central Valley Groundwater-Surface Water Simulation Model
CDFA	California Department of Food and Agriculture
CEQA	California Environmental Quality Act
cfs	cubic feet per second
Check 21	Check 21 of the California Aqueduct
Cl	chloride
COA	Coordinated Operation Agreement
CVC	Cross Valley Canal
CVHM	Central Valley Hydrologic Model
CVP	Central Valley Project
CV-RASA	Central Valley Regional Aquifer System and Analysis
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
CVSC	Central Valley Salinity Coalition
DCR	Delivery Capability Report
DDW	Division of Drinking Water
DEID	Delano-Earlimart Irrigation District
Delta	Sacramento-San Joaquin Delta
Distribution Module	Surface Water Distribution Module
DPR	California Department of Pesticide Regulation
dS/m	Decisiemens per Meter
DTW	depth to water
DWR	California Department of Water Resources
EC	Electrical Conductivity
EIR	Environmental Impact Report
ET	evapotranspiration
FKC	Friant-Kern Canal
Friant Contractors	Friant Division long-term contractors
Friant Division	Friant Division of the CVP
ft	feet
FWA	Friant Water Authority
GAMA	Groundwater Ambient Monitoring and Assessment
Groundwater Model	Groundwater Balance Calculation Model
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan

Guidelines	Guidelines for Accepting Water into the Friant-Kern Canal
ID	Irrigation District
Intertie	Friant-Kern Canal-Cross Valley Canal Intertie
ITP	Incidental Take Permit for Long Term Operations of the State Water Project
ITRC	California Polytechnic State University, San Luis Obispo, Irrigation Training & Research Center
KTWD	Kern-Tulare Water District
Ledger	Water Quality Ledger
LTO	Long-Term Operations
LTRID	Lower Tule River Irrigation District
M&I	Municipal and Industrial
MCL	Maximum Contaminant Level
mg/L	Milligrams per Liter
mg/L/yr	Milligrams per Liter per Year
MP	mile post
MUN	municipal and domestic supply
NEPA	National Environmental Policy Act
NO_3	Nitrate as nitrogen
NWIS	National Water Information System
PID	Porterville Irrigation District
Project	Friant-Kern Canal Reverse Pump-Back Project
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
Restoration Flows	San Joaquin River Restoration Program Restoration Flows
ROC	Reinitiation of Consultation
SAGBI	Soil Agricultural Groundwater Banking Index
SGMA	Sustainable Groundwater Management Act
SID	Saucelito Irrigation District
SJR	San Joaquin River
SJRRP	San Joaquin River Restoration Program
SNMP	Central Valley Salt and Nitrate Management Plan
SSJMUD	Southern San Joaquin Municipal Utility District
SWAT	Central Valley Soil and Water Assessment Tool
SWID	Shafter-Wasco Irrigation District
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
TBID	Terra Bella Irrigation District
TDS	Total dissolved solids
TPDWD	Tea Pot Dome Water District
UC Davis	University of California, Davis
USGS	United States Geological Survey

Water Board	Central Valley Regional Water Quality Control Board
Water Quality Module	Surface Water Quality Module
WRIMS	Water Resources Integrated Modeling System
Year Type	San Joaquin Valley Water Year Type

Chapter 1 Introduction and Background

This document presents information on modeling and analysis methods and results performed for the Friant-Kern Canal Reverse Pump-Back Project (Project) Draft Environmental Impact Report (EIR). It includes alternative names but does not refer specifically to the "proposed project" or other terms specific to California Environmental Quality Act (CEQA) requirements because this document will be incorporated by reference in other documents with potentially different terminology if/when a National Environmental Policy Act (NEPA) document is prepared for a federal action associated with the Project. For example, the "High Flow Alternative" in this document is the "proposed project" in the EIR, but only referred to as the "High Flow Alternative" here so that results can be easily referenced in future documents.

1.1 Project Background

The Friant-Kern Canal (FKC) was constructed in 1951 by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation), as a key component of the Central Valley Project (CVP). The FKC stretches approximately 152 miles from Millerton Lake behind Friant Dam to the Kern River near Bakersfield and provides a conveyance mechanism for supplying over 75 percent of water to contractors within the Friant Division of the CVP (Friant Division). The Friant Water Authority (FWA) is a California Joint Powers Authority that operates and maintains the FKC through an agreement with Reclamation. Members of FWA include agricultural irrigation districts, water districts, water storage districts, municipal utility districts, and municipalities. Friant Division long-term contractors (Friant Contractors) possess water rights on the San Joaquin River through contracts with the Friant Division.

CVP water is delivered from Millerton Lake to the headworks of the FKC and then conveyed via the FKC to individual contractor turnouts. In addition, surface water supplies from the Cross Valley Canal (CVC) are delivered through the Friant-Kern Canal-Cross Valley Canal Intertie (Intertie) located at the terminus of the FKC. In an operational scenario referred to as "reverse-flow pump-back", this water is then pumped upstream into the FKC and over check structures to contractor turnouts along the FKC. Specifically, for reverse-flow pump-back operations, Kern-Tulare Water District (KTWD) has an electrical pump with a capacity of 30 cubic feet per second (cfs) permanently installed at the FKC's Shafter-Wasco Check structure, which is the first check structure upstream of the Intertie. Additionally, FWA, on behalf of KTWD and other Friant Contractors, installed temporary reverse-flow pump-back facilities with 50 cfs pumping capacities at the Shafter-Wasco and Lake Woollomes Check structures. The reverse-flow structures are used to convey water supplies accessible via the Intertie including water purchased from Reclamation pursuant to CVC contracts, recaptured San Joaquin River Restoration Program (SJRRP) Restoration Flows (Restoration Flows), water from the California Aqueduct, water from groundwater banking projects, and other CVC supplies.

Reclamation studied installing and operating permanent pump-back facilities at the check structures along the southern portion of the FKC as part of the SJRRP. The San Joaquin River Settlement Act directs Reclamation to explore the feasibility of reverse-flow pump-back facilities on the FKC, with reverse-flow capacity of approximately 500 cfs at the Poso Creek and Shafter-Wasco Check structures and approximately 300 cfs at the Lake Woollomes Check structure. Water supply and economic analyses were performed for this alternative in 2011 and show that much of the proposed pump-back capacity was unused due to limited conveyance capacity, availability of recaptured Restoration Flows, demands, and downstream pump-back capacities.

In 2014, FWA proposed an alternative that would permanently increase the pumping capacities to 200 cfs at the Shafter-Wasco Check structure and 75 cfs at the Lake Woollomes and Deer Creek check structures for the additional benefit of accessing water banks and other water supplies available via the CVC (e.g., Kern River, local Kern banking projects, California Aqueduct) during times of drought. This alternative was evaluated to an appraisal level as part of the SJRRP Water Management Goal Investment Strategy (SJRRP, 2015).

This Project builds from these previous studies and is a significant component of the water management actions needed in the San Joaquin Valley and the Friant Division to improve water management flexibility and water supply reliability for Friant Contractors. Ongoing and increasing drought conditions have led to groundwater overdraft and land subsidence in the San Joaquin Valley causing damage to the FKC and other local infrastructure. The Project proposes three operational alternatives that will lessen the reliance on local groundwater by increasing access to water banks and other supplies that can be delivered via the CVC, in addition to recaptured Restoration Flows, that would be conveyed in and delivered from the CVC.

The study area is defined as the lower portion of the FKC, below the Tule River check structure. This portion of the FKC can receive direct deliveries from reverse-flow pump-back facilities under the Project alternatives. A map of the study area is provided in Figure 1-1.

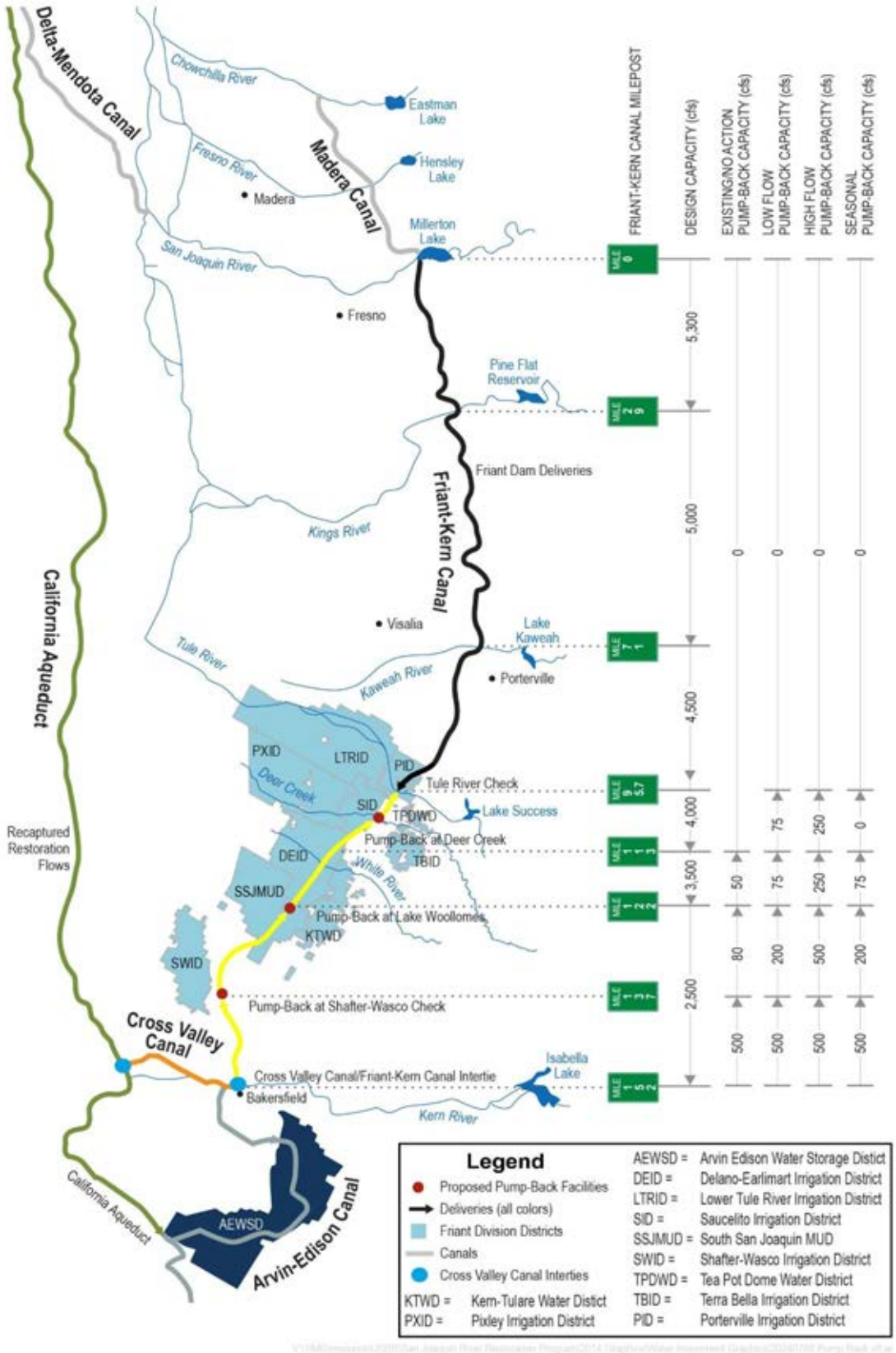


Figure 1-1. Friant-Kern Canal Pump-Back Facilities and Capacities

1.2 Purpose of Appendix

This document describes the approach, assumptions, tools, models, and methodology applied to analyze the range of effects of Project alternatives within the Project EIR. It also presents detailed results and interpretation of the results. The overall analysis process encompasses surface water operations, surface water quality analysis, and groundwater quality analysis.

1.3 Appendix Organization

- Chapter 1, Introduction and Background – provides background on the Project, purpose of this appendix, and organization of this appendix.
- Chapter 2, Modeling and Analysis Overview – provides an overview of the modeling and analysis process applied for the Project, descriptions of the proposed Project alternatives, along with key terms and definitions.
- Chapter 3, Surface Water Modeling – describes the surface water operations and surface water quality modeling tools and assumptions applied for analyses, as well as results of surface water modeling analyses.
- Chapter 4, Groundwater Modeling – describes the groundwater volume and groundwater quality modeling tools and assumptions applied for analyses, and results of groundwater modeling analyses.
- Chapter 5, References – contains sources of information used to prepare the appendix.

Chapter 2 Modeling and Analysis Overview

2.1 Process Overview

A multi-objective modeling process was applied to develop a comprehensive analysis of water resources conditions for the analyzed alternatives. Modeling tools used for evaluations in this EIR include a suite of models and other tools to evaluate the range of alternatives and the potential impacts of Project implementation. These models and tools include the following:

- **Surface Water Distribution Module** – This model utilizes CalSim II outputs to quantify available CVP supplies from Millerton Lake. From there, the model allocates water to Friant Contractors within the study area along the FKC considering water supplies available from Millerton Lake, existing pump-in and groundwater banking program supplies, and reverse-flow pump-back supply in the FKC. The output of this model is monthly surface water deliveries to each FKC reach and Friant Contractor within the study area by source of supply.
- **Surface Water Quality Module** – This model uses the output of the Surface Water Distribution Module (Distribution Module) and water quality data from respective water sources to quantify the quality of water delivered to each Project reach and Friant Contractor in the study area using a mass-balance approach. The output of this model is monthly water quality (i.e., concentration of various constituents) for total deliveries to each Project reach and Friant Contractor in the study area.
- **Groundwater Module** – This model considers the outputs from the Distribution Module and Surface Water Quality Module (Water Quality Module), as well as Friant Contractor demands and precipitation, to determine the amount of groundwater needed to be extracted from the subsurface and delivered to meet Friant Contractor demand. The model then uses the surface water quantity and quality outputs and the groundwater extraction scenarios to assess the change in quantity and quality of groundwater over a 50-year period to estimate potential long-term effects of operations on groundwater conditions in the study area.

The applied modeling and analysis tools collectively consider surface water deliveries, surface water quality, and groundwater quantity and quality to produce statistical and quantitative metrics that can be used to inform and evaluate Project operations.

Subsequent chapters of this Modeling Appendix describe and document, in greater detail, each of these tools, associated utilities required to apply the tools, analysis assumptions, and application to this Project. Selected results from the application of the tools are also presented.

2.2 Terms and Definitions

The following terms and associated definitions are used in the Project operations analysis.

- Additional Pump-Back Supply – A color of water in the surface water modules meant to represent any supplies that can be introduced to the Friant Division via the Intertie. This is used to represent a generic supply of water that would utilize additional pump back capacity at the check structures and benefit Friant Contractors equally.
- Existing Programs – Programs that introduce non-Millerton water supplies into the FKC.
- Friant Contract Year and Water Year Definitions:
  - "Contract Year" starts March 1 of the current calendar year and ends February 28/29 of the following calendar year. For example, Contract Year 1997 starts March 1, 1997, and ends February 28, 1998.
  - "Water Year" starts October 1 of the preceding calendar year and ends September 30 of the current calendar year. For example, Water Year 1997 starts October 1, 1996, and ends September 30, 1997.
- Interface – Location where gravity flow on the FKC (e.g., north to south, from Millerton Lake) and reverse-flow through existing or proposed pump-back facilities (e.g., south to north, from the CVC) meet.
- Intertie – Location at the terminus of the FKC where water supplies are conveyed between the CVC and FKC.
- Monthly – Monthly refers to the average condition for a particular month, except storage, which is the end of the month.
- San Joaquin Valley Water Year Type – This is a water supply availability classification, determined using an index that considers unimpaired runoff, surface water storage reserves, and antecedent conditions in the San Joaquin Valley. The five different Year Types are Wet, Above Normal, Below Normal, Dry, and Critical. Published annually by DWR in Bulletin 120.
- State Water Project Delivery Capability Report (DCR) – Report published by the California Department of Water Resources (DWR) that estimates the delivery capability of the State Water Project (SWP) under current (2019) and future (2040) conditions (DWR, 2020a).

2.3 Alternatives

Both California Environmental Quality Act (CEQA) Guidelines (Section 15126.6) and National Environmental Policy Act (NEPA) regulations (40 CFR 1502.14(d)) require the evaluation of a No Action/No Project Alternative, which presents the reasonably foreseeable future conditions in the absence of the proposed project. The purpose of the No Project Alternative is to allow decision makers to compare the impacts of approving the proposed project to the impacts of not approving the proposed project. Under CEQA, existing conditions (conditions at the time of the Notice of Preparation) serve as the baseline to determine the potential impacts of the alternatives. This is referred to herein as the Existing Conditions and differs from NEPA, where the No Project

Alternative under future conditions serves as the baseline to which action alternatives are compared to determine potential impacts (referred to herein as the No Project Alternative or Future Conditions). The No Project Alternative may differ from the Existing Conditions if there are actions that could occur in the study area in the future, that 1) currently do not exist and 2) do not rely on approval or implementation of the proposed project.

Table 2-1 provides details regarding the definitions of the Existing Conditions and the No Project Alternative for this Project. The Existing Conditions and the No Project Alternative definitions differ because of the changing regulatory and water supply conditions affecting Friant Contractors in the study area. The differences are related to future changes in the operational and regulatory environment and are all independent of implementation of the proposed Project. Specifically, the Existing Conditions and No Project Alternative assumptions differ in the following ways:

- **Hydrology:** In determining the volume of water available to the Friant Division from Millerton Lake, the Existing Conditions assumes hydrology based on a historical dataset and the No Project Alternative assumes hydrology considering climate change and sea level rise (DWR, 2020b).
- **SJRRP Implementation:** In determining demands on the San Joaquin River, which affects the volume of water available to the Friant Division from Millerton Lake, the Existing Conditions assumes constrained Restoration Flows consistent with the 2022 channel capacity condition, and the No Project Alternative assumes full implementation of the Restoration Flows.
- **Existing Programs:** In determining the volume of water introduced to the FKC at the Intertie, the Existing Conditions includes only programs that have introduced water via the Intertie in the past, and the No Project Alternative includes additional programs that have compliance and intend to introduce water via the Intertie in the future.

In addition to the Existing Conditions and No Project Alternative, three Project alternatives were formulated and evaluated to assess the potential range of impacts for the Project.

- **Permanent Pump-Back Facilities – Low Flow Capacity (Low Flow Alternative):** the Low Flow Alternative reflects implementation of the Project. Permanent pump stations are constructed at the Shafter-Wasco, Lake Woollomes, and Deer Creek check structures with respective capacities of 200 cfs, 75 cfs, and 75 cfs.
- **Permanent Pump-Back Facilities – High Flow Capacity (High Flow Alternative):** the High Flow Alternative represents the upper-bookend for impacts analysis. The Project is implemented with increased permanent pump capacities at each of the check structures. The Shafter-Wasco Check has a capacity of 500 cfs, the Lake Woollomes Check has a capacity of 250 cfs, and the Deer Creek Check has a 250 cfs capacity.
- **Seasonal Pump-Back Facilities – Seasonal Flow Capacity (Seasonal Alternative):** the Seasonal Alternative reflects implementation of the Project with seasonal pumping facilities at two of the check structures. The capacities of the facilities would be the same as the Low Flow Alternative, except pump back capacity would not be included at the Deer Creek check structure. The capacities at the Shafter-Wasco and Lake Woollomes check structures would be 200 cfs and 75 cfs, respectively. Operational impacts under the Seasonal Alternative would be

nearly identical to those described under the Low Flow Alternative. As such, the Low Flow Alternative and Seasonal Alternative were modeled concurrently, and the results are presented together in this document.

Table 2-1 summarizes definitions and assumptions of the Low Flow Alternative, High Flow Alternative, and Seasonal Alternative (as well as the Existing Conditions and No Project Alternative, as described earlier). Specific assumptions related to each topic are detailed within the respective sections for each analysis module in Chapters 3 and 4 below. The three Project alternatives were evaluated against both the Existing Conditions and the Future Conditions. As such, a total of six modeling scenarios were evaluated:

- Existing Conditions
- No Project Alternative (Future Conditions)
- Low Flow Alternative and Seasonal Alternative under Existing Conditions
- Low Flow Alternative and Seasonal Alternative under Future Conditions
- High Flow Alternative under Existing Conditions
- High Flow Alternative under Future Conditions

Table 2-1. Description of Existing Conditions, No Project Alternative, and Project Alternatives

Topic	Existing Conditions	No Project Alternative (Future Conditions)	Low Flow Alternative and Seasonal Alternative	High Flow Alternative
Delta Operations Regulatory Environment	• 2018 Coordinated Operation Agreement (COA) addendum • Reinitiation of Consultation on the Long-Term Operations of the Central Valley Project (CVP) and State Water Project (SWP) (ROC on LTO) • Incidental Take Permit for Long-Term Operation of the State Water Project (ITP) CVP and SWP operation updates: ROC on LTO and ITP reconciliation	• Same as Existing Conditions	• Same as Existing Conditions	• Same as Existing Conditions
Hydrology	• DCR 2019	• DCR 2019; 2040 Planning Horizon	• Same as Existing Conditions/Future Conditions	• Same as Existing Conditions/Future Conditions
San Joaquin River Restoration Program Implementation	• Assume a 2022 condition consistent with Reclamation's estimated 2022 SJR flow capacities. • 2022 Constrained Restoration flows with a ramp-up schedule for implementation	• Full Restoration Flows are considered to occur in 2025 as represented in Exhibit B of the Settlement Act.	• Same as Existing Conditions/Future Conditions	• Same as Existing Conditions/Future Conditions

Topic	Existing Conditions	No Project Alternative (Future Conditions)	Low Flow Alternative and Seasonal Alternative	High Flow Alternative
Pump-Back Capacity	Pump-back facilities and capacities at the following check structures: • Shafter-Wasco – 80 cfs • Lake Woollomes – 50 cfs	• Same as Existing Conditions	Pump-back facilities and capacities at the following check structures: Shafter-Wasco – 200 cfs Lake Woollomes – 75 cfs Deer Creek Check – 75 cfs (Low Flow Alternative only) Deer Creek Check – 0 cfs (Seasonal Alternative only)	Pump-back facilities and capacities at the following check structures: • Shafter-Wasco – 500 cfs Lake Woollomes – 250 cfs • Deer Creek Check – 250 cfs
CVC Capacity Availability	• 500 cfs limited by historical pump-back operations. • Annual pump-back delivery developed based on historical deliveries from the Existing Programs	• Same as Existing Conditions	• Same as Existing Conditions	• Same as Existing Conditions
Implementation of the Sustainable Groundwater Management Act	• Assume existing level of groundwater pumping for all Friant Division Contractors is equivalent to baseline amounts included In the GSPs projected out to 2070.	• Same as Existing Conditions	• Same as Existing Conditions	• Same as Existing Conditions
Implementation of the Guidelines for Accepting Water into the FKC	• Water Quality Guidelines are implemented	• Same as Existing Conditions	• Same as Existing Conditions	• Same as Existing Conditions

Topic	Existing Conditions	No Project Alternative (Future Conditions)	Low Flow Alternative and Seasonal Alternative	High Flow Alternative
Existing Programs, Introducing non-Millerton Water into the FKC	CVC Programs • KTWD Rosedale Banking Program • KTWD • DEID West Kern Banking Program • KTWD FKC Groundwater Pump-Ins • DEID • Saucelito ID • SSJMUD • TBID	CVC Programs • KTWD • LTRID • Pixley ID Rosedale Banking Program • KTWD • DEID West Kern Banking Program • KTWD FKC Groundwater Pump-Ins • DEID • Saucelito ID • SSJMUD • TBID	• Same as Existing Conditions/Future Conditions	• Same as Existing Conditions/Future Conditions

Key:
COA = Coordinated Operation Agreement
cfs = cubic feet per second
CVC = Cross Valley Canal
CVP = Central Valley Project
DCR = Delivery Capability Report
DEID = Delano-Earlimart Irrigation District
FKC = Friant-Kern Canal
GSP = Groundwater Sustainability Plan
ID = Irrigation District
ITP = Incidental Take Permit
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
ROC on LTO = Reinitiation of Consultation on the Long-Term Operations
SGMA = Sustainable Groundwater Management Act
SJR = San Joaquin River
SJRRP = San Joaquin River Restoration Program
SSJMUD = Southern San Joaquin Municipal Utility District
SWP = State Water Project
TBID = Terra Bella Irrigation District

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Chapter 3 Surface Water Modeling

A suite of models was used to simulate system operations within the Friant Division. The CalSim II model was used to simulate CVP operations and water deliveries into the FKC from Millerton Lake. The Distribution Module was then used to allocate deliveries from Millerton Lake (Millerton deliveries), as well as deliveries available via existing pump-in programs, to Friant Contractors in the lower portion of the FKC below the Tule River check structure (i.e., the study area). The portion of the FKC within the study area is divided into four reaches based on proposed facility locations. Deliveries of local supplies (i.e., local, non-FKC supplies) were also quantified, where applicable. The Surface Water Quality Module (Water Quality Module) was used to simulate the total blended surface water quality delivered to each reach and Friant Contractor within the study area. This chapter describes the models and assumptions in detail.

3.1 Model Descriptions and Assumptions

3.1.1 CalSim II Model

The CalSim II model was used to simulate CVP Class 1 and Class 2/other (Class 2, Section 215, etc.) deliveries from Millerton Lake into the FKC.

3.1.1.1 Model Description

CalSim II is an application of the Water Resources Integrated Modeling System (WRIMS) software jointly developed by Reclamation and DWR to simulate CVP and SWP operations. WRIMS is a generalized water resources modeling software platform developed by the DWR San Francisco Bay/Sacramento-San Joaquin Delta Bay-Delta Office. CalSim II is an application of the WRIMS software that represents the physical system of the CVP and SWP (reservoirs, streams, canals, pumping stations) using a network of nodes and arcs. A solver is used to simulate flow routing and system operation decisions using user-defined operational priorities and constraints. Using these methods, CalSim II simulates the water supply reliability of the CVP and SWP at existing and future levels of development, with and without various assumed future facilities, and with different modes of facility operations. CalSim II simulates system operations and deliveries over an 82-year hydrologic period (1921 to 2003) on a monthly time step, running historical hydrology through the level of development described in the DWR Delivery Capability Report 2019 framework (DWR, 2020a).

3.1.1.2 Model Assumptions

The CalSim II model was used to simulate Millerton deliveries into the FKC. These simulated deliveries were used in the Distribution Module as the baseline Millerton deliveries to the Friant Division. As noted in Chapter 2, the Low Flow Alternative, High Flow Alternative, and Seasonal Alternative were evaluated under both the Existing Conditions and the No Project Alternative. There were two main differences between the CalSim II model runs for the Existing Conditions and the No Project Alternative. The first is the hydrology affecting CVP and SWP supplies, and the second is the implementation status of the SJRRP Restoration Flows.

The Existing Conditions and No Project Alternative assumptions for hydrology are consistent with those presented in the DCR 2019. The Existing Conditions includes hydrology based on a historical dataset and the No Project Alternative includes future hydrology considering climate change and sea level rise (DWR, 2020b). This future hydrology is defined as a 2040 condition. Furthermore, the CalSim II simulation for the No Project Alternative does not consider any adaptation measure that would result in managing SWP and CVP facilities to reduce impacts of climate change and sea level rise.

The Existing Conditions and No Project Alternative assumptions for the implementation of SJRRP are slightly different than assumptions used in the DCR 2019. Specifically, the Existing Conditions for this project used a constrained San Joaquin River Restoration Flow capacity consistent with that observed and reported by Reclamation in 2022 (Reclamation, 2022). The No Project Alternative assumed ability to meet full San Joaquin River Restoration Flows by 2025 as represented in Exhibit B of the San Joaquin River Restoration Settlement Act.

A summary of the simulated average annual CVP Class 1 and Class 2/other deliveries for all years and by San Joaquin Valley Water Year Type (Year Type) for the Existing Conditions and No Project Alternative are listed in Table 3-1 and Table 3-2, respectively. Simulated average annual deliveries are lower in the No Project Alternative compared to the Existing Conditions.

Table 3-1. Existing Conditions CalSim II CVP Class 1 and Class 2/Other Average Annual Deliveries (thousand acre-feet)

Year Type[1]	Number of Years	Class 1	Class 2/Other
Wet	24	800	772
Above Normal	16	800	408
Below Normal	13	781	123
Dry	13	770	27
Critical	16	441	0
All Years	82	722	329

Notes: Year Types are based on the San Joaquin Valley Water Year Type
Key: CVP = Central Valley Project

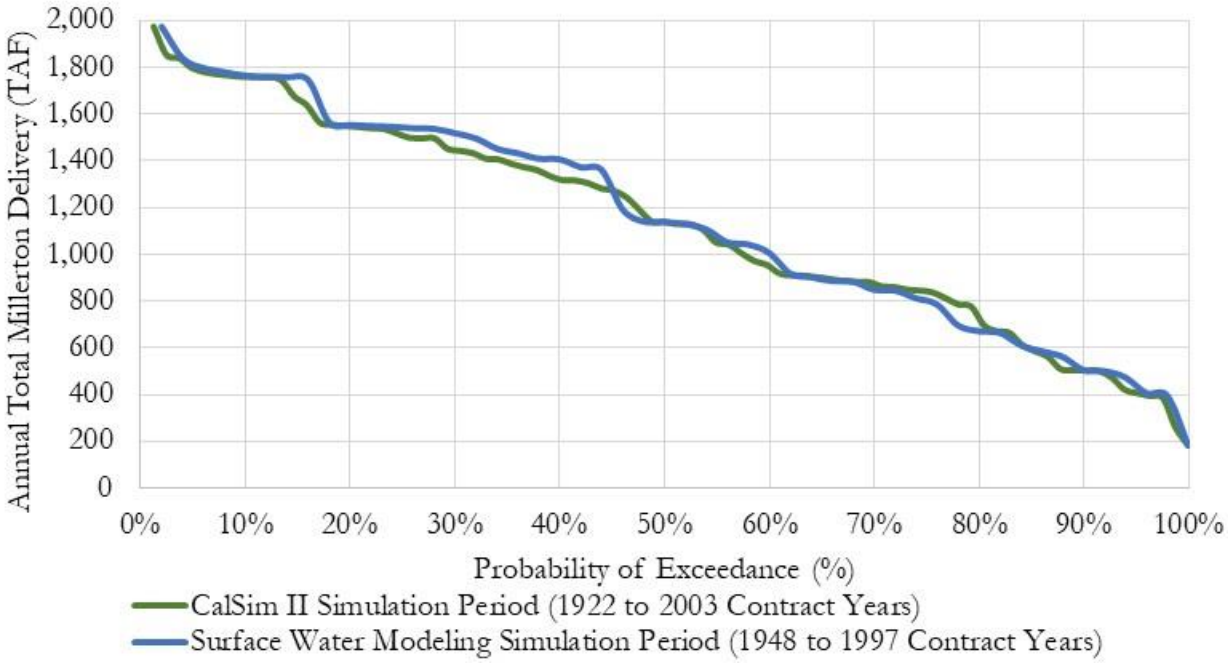
Table 3-2. No Project Alternative CalSim II CVP Class 1 and Class 2/Other Average Annual Deliveries (thousand acre-feet)

Year Type[1]	Number of Years	Class 1	Class 2/Other
Wet	24	800	535
Above Normal	16	800	297
Below Normal	13	736	75
Dry	13	719	20
Critical	16	405	0
All Years	82	700	229

Notes: Year Types are based on the San Joaquin Valley Water Year Type
Key: CVP = Central Valley Project

3.1.2 Period of Analysis

The CalSim II model simulates deliveries over an 82-year hydrologic period from contract years 1922 to 2003. Model outputs are used as the baseline for the Distribution Module, which is ultimately used to develop inputs for the Groundwater Module. The Groundwater Module is based on a 50-year simulation period. Therefore, a representative 50-year period of CalSim II outputs was selected for simulation in the Distribution Module. The 50-year period selected was contract years 1948 to 1997. This period was selected because it most closely represented the distribution of deliveries from the 82-year simulation period. Figure 3-1 shows the probability of exceedance of annual total Millerton deliveries for the 82-year simulation period (1922 to 2003 contract years) and the selected 50-year period of simulation for the surface water modeling (1948 to 1997 contract years).



Key: TAF = thousand acre-feet

Figure 3-1. Probability of Exceedance for Total Annual Millerton Deliveries (thousand acre-feet) for the 82-year CalSim II Simulation Period and the 50-year Simulation Period for the Surface Water Modeling

Table 3-3 and Table 3-4 shows the average annual Millerton deliveries (for the Existing Conditions) for all years and by San Joaquin Valley Water Year Type for the CalSim II 82-year period of simulation (1922 to 2003 contract years) and the 50-year simulation period (1948 to 1997 contract years) for the Distribution Module. This comparison shows that the distribution of water year types is very similar in both simulation periods and the difference in the average annual total Millerton delivery is less than one percent.

Table 3-3. Existing Conditions CalSim II Average Annual Millerton Delivery (thousand acre-feet) for the 82-year Simulation Period (1922 to 2003 Contract Years)

Year Type[1]	Number of Years	Percentage of Years	Total Millerton Delivery
Wet	24	30%	1,636
Above Normal	16	20%	1,343
Below Normal	13	15%	1,007
Dry	13	16%	863
Critical	16	20%	488
All Years	82	-	1,134

Notes: Year Types are based on the San Joaquin Valley Water Year Type.

Table 3-4. Existing Conditions CalSim II Average Annual Millerton Delivery (thousand acre-feet) for the 50-year Simulation Period (1948 to 1997 Contract Years)

Year Type[1]	Number of Years	Percentage of Years	Total Millerton Delivery
Wet	17	34%	1,650
Above Normal	6	12%	1,326
Below Normal	9	18%	1,030
Dry	7	14%	865
Critical	11	22%	521
All Years	50	-	1,142

Notes: Year Types are based on the San Joaquin Valley Water Year Type.

3.1.3 Surface Water Distribution Module

3.1.3.1 Module Description

The Distribution Module is a spreadsheet-based optimization tool that utilizes the CalSim II outputs for the Existing Conditions and No Project Alternative to allocate available CVP supplies from Millerton Lake. These supplies are allocated to Friant Contractors based on their CVP Class 1 and Class 2 contract amounts and are delivered via the FKC. In addition, the Distribution Module considers deliveries from existing Cross Valley Contract supply and existing groundwater banking programs (collectively referred to as existing program supplies). The existing program supplies are introduced into the FKC at the Intertie where they are exchanged up the FKC (e.g., south to north) with Friant Contractors to augment Millerton deliveries (Figure 3-2). These existing program supplies are allocated to Friant Contractors based on contract volumes and existing reverse-flow pump-back capacity at the Intertie and relevant check structures.

This exchange process is limited by the available exchangeable demand in the study area. Exchangeable demand is limited by the following factors: the amount of available Millerton supply in the study area; the amount of existing program supplies introduced at the Intertie; and the available pump-back capacity at the check structures. The most limiting factor determines the exchangeable demand. The "demand" is the available Millerton supply in the study area and the

"exchangeable" supply is the available non-Millerton supplies that can be delivered into the FKC considering Intertie capacity and check structure capacity.

For the Low Flow Alternative, High Flow Alternative, and Seasonal Alternative, in addition to Millerton supplies and existing program supplies, an additional pump-back supply is introduced to the FKC via the Intertie. The additional pump-back supply is meant to represent any supplies that can be introduced to the Friant Division via the Intertie. It is assumed this water is introduced to the CVC from the California Aqueduct. The Intertie, when possible, is filled with additional pump-back supply after existing programs have been delivered. The additional pump-back supply is allocated to Friant Contractors based on CVP Class 1 and Class 2 contract amounts and is constrained by the capacities of the pump-back facilities at the Intertie and at each check structure, and exchangeable demand on the FKC (Figure 3-2). The additional pump-back supply supplements Millerton deliveries starting at the Intertie and moving up the canal.

In the case of the Low Flow Alternative, High Flow Alternative, and Seasonal Alternative, the introduction of the additional pump-back supply can, at times, meet all the exchangeable demand in the study area. The amount Millerton supply exchanged for non-Millerton supply in the study area is then allocated to the Friant Contractors upstream of the study area based on CVP Class 1 and Class 2 contract amounts. For the Existing Conditions and No Project Alternative, the exchangeable demand increases the total supply within the study area. For the Low Flow Alternative, High Flow Alternative, and Seasonal Alternative exchangeable demand increases the total supply to both the study area and upstream of the study area. The outputs of the Distribution Module are monthly surface water deliveries to Friant Contractors within the study area by source. The Distribution Module simulates the delivery of three sources of surface water: Millerton deliveries, existing program deliveries, and additional pump-back supply.

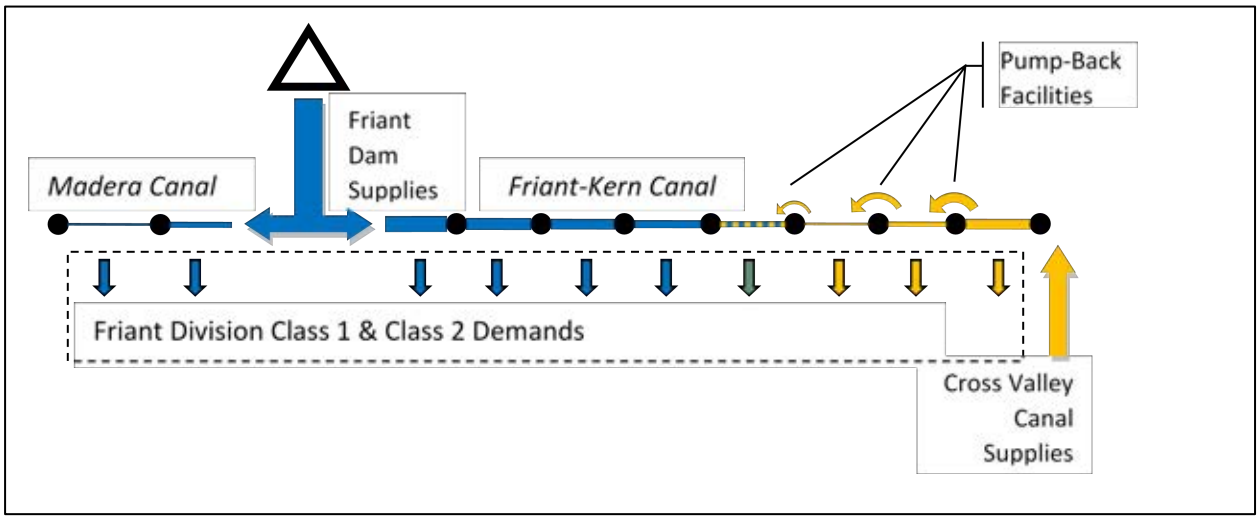


Figure 3-2. Surface Water Distribution Module Schematic

3.1.3.2 Module Assumptions

The Distribution Module allocates water supplies to Friant Contractors using a reach-by-reach approach as detailed in the subsections below.

Module Reaches

The study area, defined from the Tule River check structure (milepost (MP) 95.7 to the terminus of the FKC at the Intertie and Kern River Wasteway (MP 152) is divided into four Project reaches (Reach A, Reach B, Reach C, and Reach D). The portion of the FKC north of the study area, from Friant Dam to the Tule River check structure, is referred to as the Upper Reach in this document. The four Project reaches in the study area are defined by the location of check structures, and/or associated mileposts, that allow for reverse-flow pump-back operations as shown in Figure 1-1. The reverse-flow pump-back capacity of the check structures/reaches are summarized for each of the scenarios in Table 3-5.

Table 3-5. Check Structure and Reach Capacity (cubic feet per second) for the Four Reaches in the Study Area by Scenario

Reach	Reach Name	Existing Conditions	No Project Alternative (Future Conditions)	Low Flow Alternative and Seasonal Alternative	High Flow Alternative
A	Intertie to Shafter-Wasco Check	500	500	500	500
B	Shafter-Wasco Check to Lake Woollomes Check	80	80	200	500
C	Lake Woollomes Check to Deer Creek Check	50	50	75	250
D	Deer Creek Check to Tule River Check	0	0	75/0*	250

Note: *For Low Flow Alternative, the Deer Creek Check capacity is 75 cfs. For Seasonal Alternative, the Deer Creek Check capacity is 0 cfs.
Key: Intertie = Friant-Kern Canal and Cross Valley Canal Intertie

Friant Contractors receiving deliveries from each Project reach are shown below. For Friant Contractors receiving deliveries within multiple reaches, the deliveries were split between Project reaches based on the number of turnouts and estimated capacity in each respective Project reach. The specific Friant Contractors receiving water deliveries within each Project reach are listed in Table 3-6.

Table 3-6. Friant Contractors Receiving Deliveries from the Four Reaches in the Study Area

Reach	Reach Name	Friant Contractors Receiving Deliveries
A	Intertie to Shafter-Wasco check structure	• Arvin-Edison Water Storage District
B	Shafter-Wasco check structure to Lake Woollomes check structure	• Shafter-Wasco Irrigation District • Southern San Joaquin Municipal Utility District (78 percent)
C	Lake Woollomes check structure to Deer Creek check structure	• Southern San Joaquin Municipal Utility District (22 percent) • Kern-Tulare Water District • Delano-Earlimart Irrigation District • Saucelito Irrigation District (50 percent) • Terra Bella Irrigation District (67 percent)
D	Deer Creek check structure to Tule River check structure	• Saucelito Irrigation District (50 percent) • Terra Bella Irrigation District (33 percent) • Teapot Dome Water District • Pixley Irrigation District • Lower Tule River Irrigation District (75 percent) • Porterville Irrigation District (67 percent)

Note: Intertie = Friant-Kern Canal and Cross Valley Canal Intertie

CVC Intertie Capacity

The Distribution Module limits deliveries to the FKC from the Intertie to 500 cfs, which is the capacity of the pump-back facility at the Intertie. Project operations are assumed to be able to operate continuously throughout an entire month and year and are limited to a total volume of 361,981 acre-feet per year (or about 30,165 acre-feet per month). For the Existing Conditions and No Project Alternative, only existing program supplies are delivered through the Intertie and are limited by contract amount and reverse-flow pump-back capacity at the upstream check structures. For the Low Flow Alternative, High Flow Alternative, and Seasonal Alternative, first the existing program supplies are delivered through the Intertie, and then the additional pump-back supply is delivered through the Intertie. The additional pump-back supply is limited by the pump-back capacity at the Intertie remaining after existing program supplies have been delivered, reverse-flow pump-back capacity at the upstream check structures after existing programs have been delivered, and exchangeable demand on the FKC.

CVP Millerton Supply

CalSim II simulates delivery of CVP Class 1 and Class 2/other (Section 215, etc.) supplies into the FKC as a total volume to the Friant Division. CalSim II does not allocate supplies to Project reaches or individual Friant Contractors. The Distribution Module allocates monthly volumes delivered to the individual Friant Contractors via the FKC based on Class 1 and Class 2 contract amounts. For example, a Friant Contractor who has a Class 1 contract that is 10 percent of the total Class 1 allocation will receive 10 percent of the total monthly delivery of Class 1 supplies. This same logic was applied to delivery of Class 2 supplies and 215/other supplies in years with a Class 2 allocation.

Existing Program Supply

Existing programs are defined as pump-in programs and banking programs resulting in pump-in deliveries of non-Millerton supplies into the FKC. There is a long list of existing programs with environmental certification and approval from Reclamation to introduce water to the FKC. The Distribution Module simulates the operation of a select number of existing programs to best represent how existing programs affect Project operations and changes in surface water conditions. Table 3-7 catalogs all existing programs simulated in the Distribution Model noting program name, Friant Contractor, contract duration, introduction points, and defined source water quality. As noted, existing programs are included for KTWD, Lower Tule River Irrigation District (LTRID), Pixley Irrigation District (Pixley ID), Delano-Earlimart Irrigation District (DEID), Saucelito Irrigation District (Saucelito ID), South San Joaquin Municipal Utility District (SSJMUD), and Terra Bella Irrigation District (TBID).

Table 3-7. Existing Programs Simulated in the Distribution Model that Introduce Non-Millerton Water into the Friant-Kern Canal

Program	Friant Contractor	Contract Duration	Introduction Point	Water Quality
CVC Programs	• KTWD • LTRID • Pixley ID	• KTWD operates under Existing Conditions and No Project Alternative for all years • LTRID and Pixley ID operate under No Project Alternative for all years	• Intertie	• CVC/Check 21
Rosedale Banking Program	• KTWD • DEID	• KTWD and DEID operates under Existing Conditions and No Project Alternative under Dry and Critical water years	• Intertie	• CVC/Check 21
West Kern Banking Program	• KTWD	• KTWD operates under Existing Conditions and No Project Alternative under Dry and Critical water years	• Intertie	• CVC/Check 21
FKC Groundwater Pump-Ins	• DEID • Saucelito ID • SSJMUD • TBID	• Pump-in programs operate under Existing Conditions and No Project Alternative in Dry and Critical water years	• Various locations on FKC in study area	• Various

Note:
Intertie = Friant-Kern Canal and Cross Valley Canal Intertie
Water years based on the San Joaquin Valley Water Year Type
Key:
CVC = Cross Valley Canal
DEID = Delano-Earlimart Irrigation District
FKC = Friant-Kern Canal
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
TBID = Terra Bella Irrigation District

The Distribution Module does not simulate the operations of existing program supplies or programs that introduce supply of generally equivalent water quality to Sierra or Millerton water. Cross Valley Contract supply was simulated only for Friant Contractors that currently, or plan to in the future, take direct delivery of supply from the FKC. North Kern Banking operations for KTWD and DEID were not simulated because North Kern Banking operations utilize multiple wells, at multiple discharge locations, with unknown mixed water quality. Considering the applied logic of the Distribution Module, North Kern Banking supplies would essentially replace additional pump-back supply and because the assumptions for pump-back operations have multiple layers of conservatism built in, it is assumed that the specific effects related to the operation of the North Kern Banking program fall within the range of effects simulated. Finally, programs with supply equivalent to Sierra water quality are not simulated on an individual basis, because the Distribution Module simulates maximum operations and deliveries based on available supply and capacities.

Existing program supply volume data were provided by Friant Contractors. Friant Contractors provided program operations data including monthly deliveries by water year type. Friant Contractors were asked to provide data for "drier" and "wetter" years. "Drier" year data represents approximate conditions when CVP Class 1 allocation is approximately 50 percent, CVP Class 2 allocation is approximately 0 percent, and CVC Contract allocation is approximately 20 percent. "Wetter" year data represents conditions when CVP Class 1 allocation is approximately 100 percent, CVP Class 2 allocation is greater than 25 percent, and CVC Contract allocation is approximately 50 percent. In the Distribution Module, it was then assumed that the "drier" year deliveries are representative of Dry and Critical water years based on San Joaquin Valley Water Year Types, and "wetter" year deliveries are representative of Wet, Above Normal, and Below Normal water years based on San Joaquin Valley Water Year Types.

Cross Valley Contract Supply

Three out of the seven Cross Valley Contractors (KTWD, LTRID, and Pixley ID) hold three-party contracts with Reclamation and DWR to deliver and convey CVP supply from the Sacramento-San Joaquin Delta (Delta), pumped and conveyed south via the California Aqueduct and then east via the CVC, and introduced to the FKC via the Intertie. Based on historical operations and discussions with Cross Valley Contractors regarding historical operations and intended operations for the future, it was determined that the KTWD program would be included in the Existing Conditions and No Project Alternative, and the LTRID and Pixley ID programs would only be included in the No Project Alternative. Table 3-8, Table 3-9, and Table 3-10 summarize the Cross Valley Contractor program deliveries to KTWD, LTRID, and Pixley ID, respectively, by month and San Joaquin Valley Water Year Type for the Existing Conditions and No Project Alternative.

Existing Groundwater Banking Programs via the CVC Intertie

The Rosedale Banking and West Kern Banking programs are groundwater banking programs located off the CVC within the Kern Fan region. KTWD and DEID both having agreements with the Rosedale Banking program and KTWD has an agreement with the West Kern Banking program. KTWD and DEID bank CVP water during wet years and extract previous banked CVP supply during drier years to meet demand deficits. Rosedale Banking and West Kern Banking operations are included in the Existing Conditions and No Project Alternative. Table 3-11 and Table 3-12

summarize the Rosedale Banking deliveries to KTWD and DEID, respectively, and Table 3-13 summarizes West Kern Banking deliveries to KTWD.

Friant-Kern Canal Groundwater Pump-In Programs

The FKC groundwater pump-in program is a Dry and Critical water year type program where non-CVP water is pumped into and conveyed via the FKC to be delivered to an individual Friant Contractor or to other Friant Contractors. Several Friant Contractors in the study area participate in this program including DEID, Saucelito ID, SSJMUD, and TBID. For this Project, it is assumed that program deliveries only occur under Dry and Critical water year types based on San Joaquin River Water Year Type and deliveries are made to individual Friant Contractors and not to other Friant Contractors. This program was assumed to be in operation under both Existing Conditions and No Project Alternative. Table 3-14 summarizes the FKC Groundwater Pump-in Program delivery per participating Friant Contractor.

Table 3-8. Cross Valley Contractor Monthly Supply (acre-feet) for Kern Tulare Water District under Existing Conditions and No Project Alternative by San Joaquin Valley Water Year Type

Year Type	# Years	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Wet	17	900	1,840	3,470	4,470	4,640	4,420	3,220	1,900	900	900	0	0
Above Normal	6	900	1,840	3,470	4,470	4,640	4,420	3,220	1,900	900	900	0	0
Below Normal	9	900	1,840	3,470	4,470	4,640	4,420	3,220	1,900	900	900	0	0
Dry	7	0	940	1,570	2,070	2,240	2,020	820	1,000	0	0	0	0
Critical	11	0	940	1,570	2,070	2,240	2,020	820	1,000	0	0	0	0

Notes: Year Types are based on the San Joaquin Valley Water Year Type.

Table 3-9. Cross Valley Contractor Monthly Supply (acre-feet) for Lower Tule River Irrigation District under No Project Alternative by San Joaquin Valley Water Year Type

Year Type	# Years	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Wet	17	0	0	0	0	7,776	7,776	7,776	7,776	0	0	0	0
Above Normal	6	0	0	0	0	7,776	7,776	7,776	7,776	0	0	0	0
Below Normal	9	0	0	0	0	7,776	7,776	7,776	7,776	0	0	0	0
Dry	7	0	0	0	0	3,110	3,110	3,110	3,110	0	0	0	0
Critical	11	0	0	0	0	3,110	3,110	3,110	3,110	0	0	0	0

Notes: Year Types are based on the San Joaquin Valley Water Year Type.

Table 3-10. Cross Valley Contractor Monthly Supply (acre-feet) for Pixley Irrigation District under No Project Alternative by San Joaquin Valley Water Year Type

Year Type	# Years	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Wet	17	0	0	0	0	7,776	7,776	7,776	7,776	0	0	0	0
Above Normal	6	0	0	0	0	7,776	7,776	7,776	7,776	0	0	0	0
Below Normal	9	0	0	0	0	7,776	7,776	7,776	7,776	0	0	0	0
Dry	7	0	0	0	0	3,110	3,110	3,110	3,110	0	0	0	0
Critical	11	0	0	0	0	3,110	3,110	3,110	3,110	0	0	0	0

Notes: Year Types are based on the San Joaquin Valley Water Year Type.

Table 3-11. Rosedale Banking Program Monthly Supply (acre-feet) for Kern Tulare Water District under Existing Conditions and No Project Alternative by San Joaquin Valley Water Year Type

Year Type	# Years	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Wet	17	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal	6	0	0	0	0	0	0	0	0	0	0	0	0
Below Normal	9	0	0	0	0	0	0	0	0	0	0	0	0
Dry	7	900	900	900	900	900	900	900	900	900	900	0	0
Critical	11	900	900	900	900	900	900	900	900	900	900	0	0

Notes: Year Types are based on the San Joaquin Valley Water Year Type.

Table 3-12. Rosedale Banking Program Monthly Supply (acre-feet) for Delano-Earlimart Irrigation District under Existing Conditions and No Project Alternative by San Joaquin Valley Water Year Type

Year Type	# Years	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Wet	17	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	0	0	0	400
Above Normal	6	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	0	0	0	400
Below Normal	9	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	0	0	0	400
Dry	7	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	0	0	0	400
Critical	11	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	0	0	0	400

Notes: Year Types are based on the San Joaquin Valley Water Year Type.

Table 3-13. West Kern Banking Program Monthly Supply (acre-feet) for Kern Tulare Water District under Existing Conditions and No Project Alternative by San Joaquin Valley Water Year Type

Year Type	# Years	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Wet	17	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal	6	0	0	0	0	0	0	0	0	0	0	0	0
Below Normal	9	0	0	0	0	0	0	0	0	0	0	0	0
Dry	7	0	0	0	500	500	500	500	0	0	0	0	0
Critical	11	0	0	0	500	500	500	500	0	0	0	0	0

Notes: Year Types are based on the San Joaquin Valley Water Year Type.

Table 3-14. Friant-Kern Canal Groundwater Pump-In Program Delivery (acre-feet) by Friant Contractor and Project Reach

Friant Contractor	Reach	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
SSJMUD	B	0	0	193	193	193	193	193	193	0	0	0	0
SSJMUD	C	0	0	55	55	55	55	55	55	0	0	0	0
DEID	C	0	0	484	484	484	484	484	484	0	0	0	0
Saucelito ID	C	0	0	83	83	83	83	83	83	0	0	0	0
TBID	C	0	0	83	83	83	83	83	83	0	0	0	0
Saucelito ID	D	0	0	84	84	84	84	84	84	0	0	0	0
TBID	D	0	0	42	42	42	42	42	42	0	0	0	0

Notes:
Only operates during Dry and Critical San Joaquin Valley Water Year Types.
Reach B is from Shafter-Wasco Check to Lake Woollomes Check
Reach C is from Lake Woollomes Check to Deer Creek Check
Reach D is from Deer Creek Check to Tule River Check

Key:
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
TBID = Terra Bella Irrigation District

Additional Pump-Back Supply

Additional pump-back supply is used in the Distribution Module to simulate delivery of additional supplies that can be introduced to the FKC via the Intertie for the benefit of the Friant Division under the three Project alternatives. This supply is only modeled in the Low Flow Alternative, High Flow Alternative, and Seasonal Alternative and is meant to represent surface water supplies that could be available via the CVC in the future, including, but not limited to, recirculated SJRRP Restoration Flows, supplies from banking projects, Delta exports, or other supply sources that could utilize the California Aqueduct and/or CVC for conveyance and delivery. As such, in the Distribution Module, additional pump-back supplies are brought into the system and benefit all Friant Contractors with Class 1 and/or Class 2 contracts.

In the Distribution Module, delivery of existing program supply is prioritized at the Intertie. Any remaining capacity at the Intertie is used to simulate delivery of additional pump-back supply to the study area. The additional pump-back supply is allocated based on Class 1 and Class 2 contract amounts. For example, additional pump-back supply is allocated based on Class 1 contract amounts during years with a Class 1 allocation less than 100 percent and additional pump-back supply is allocated based on Class 2 contract amounts during years with a Class 1 allocation equal to 100 percent. The additional pump-back supply is then moved up the FKC considering reverse-flow pump-back capacity at each check structure and exchangeable demand. Specifically, the additional pump-back supply replaces Millerton deliveries starting at the Intertie and moving up the FKC such that each Friant Contractor's deliveries are increased proportionally based on their Class 1 and/or Class 2 contract amounts, either via exchanging Millerton supply with additional pump-back supply or an increase in Millerton supply.

Local Supply

Some Friant Contractors within the study area receive surface water supplies from sources other than the FKC and/or CVC (referred to herein as local supply). Examples include deliveries from the Kern River, Tule River, and other local sources. Local supplies were considered in this analysis for several Friant Contractors. AEWSD receives deliveries from the Kern River and directly from the California Aqueduct. Porterville ID, LTRID, and TBID receive deliveries from the Tule River.

The Distribution Module simulates the delivery of Millerton supply, existing program supply, and additional pump-back supply. The local supplies are added to the individual Friant Contractors total surface water delivery after the Distribution Module deliveries. Specifically, local supply data as provided by the Friant Contractors (spanning from 1993 to 2017) were averaged by San Joaquin Valley Water Year Type and applied accordingly, based on water year type, to the 50-year simulated hydrologic period. If monthly data were not available, annual delivery volumes were distributed using United States Geological Survey (USGS) monthly percent flow data. Table 3-15 exemplifies how delivery data for the Tule River was sorted and applied for the analysis.

Table 3-15. Local Water Supply Distribution Example for Tule River Supply to Porterville Irrigation District and Lower Tule River Irrigation District

Tule River Water Supply				Tule River Water Supply, Sorted by WY Type				Average Delivery by WY Type[1]		
Year	WY Type	Porterville Annual Deliveries (AF)	Lower Tule Annual Deliveries (AF)	Year	WY Type	Porterville Annual Deliveries (AF)	Lower Tule Annual Deliveries (AF)	WY Type	Porterville Annual Deliveries (AF)	Lower Tule Annual Deliveries (AF)
2001	Dry	10,346	N/A	2010	AB	6,978	89,215	Wet	6,313	156,676
2002	Dry	13,151	N/A	2003	BN	6,069	N/A	AN	6,978	89,215
2003	BN	6,069	N/A	2009	BN	5,047	30,835	BN	5,558	30,835
2004	Dry	4,820	N/A	2007	Critical	2,933	19,847	Dry	9,439	101,173
2005	Wet	6,288	112,596	2008	Critical	4,845	41,614	Critical	3,889	21,354
2006	Wet	6,338	130,141	2013	Critical	N/A	26,510	Applied Monthly Percentage[2]		
2007	Critical	2,933	19,847	2014	Critical	N/A	15,062	1	January	13%
2008	Critical	4,845	41,614	2015	Critical	N/A	3,737	2	February	17%
2009	BN	5,047	30,835	2001	Dry	10,346	N/A	3	March	16%
2010	AN	6,978	89,215	2002	Dry	13,151	N/A	4	April	17%
2011	Wet	N/A	227,290	2004	Dry	4,820	N/A	5	May	10%
2012	Dry	N/A	80,940	2012	Dry	N/A	80,940	6	June	5%
2013	Critical	N/A	26,510	2016	Dry	N/A	121,405	7	July	1%
2014	Critical	N/A	15,062	2005	Wet	6,288	112,596	8	August	1%
2015	Critical	N/A	3,737	2006	Wet	6,338	130,141	9	September	1%
2016	Dry	N/A	121,405	2011	Wet	N/A	227,290	10	October	2%
-	-	-	-	-	-	-	-	11	November	3%
-	-	-	-	-	-	-	-	12	December	14%

Note:
1. Average delivery taken for each Friant Contractor by San Joaquin Valley Water Year Type
2. Monthly percent flow determined from USGS Site 11204100 SF Tule R Nr. Res Bndry Nr Porterville (2010 to 2017)

Key:
AN = Above Normal
AF = acre-feet
BN = Below Normal
N/A = not available
WY = Water Year, based on San Joaquin Valley Water Year Type

Guidelines for Accepting Water into the Friant-Kern Canal

The Guidelines for Accepting Water into the Friant-Kern Canal (Guidelines) are in place to manage water quality in the FKC as to protect domestic and agricultural beneficial uses (FWA, 2023). The Guidelines are implemented by FWA and acknowledged by Reclamation and, specifically, define water quality thresholds, monitoring requirements, and management actions used to protect water quality in the FKC. Several components of the Guidelines are represented in the Distribution Module as described below.

Water Quality Monitoring and Management

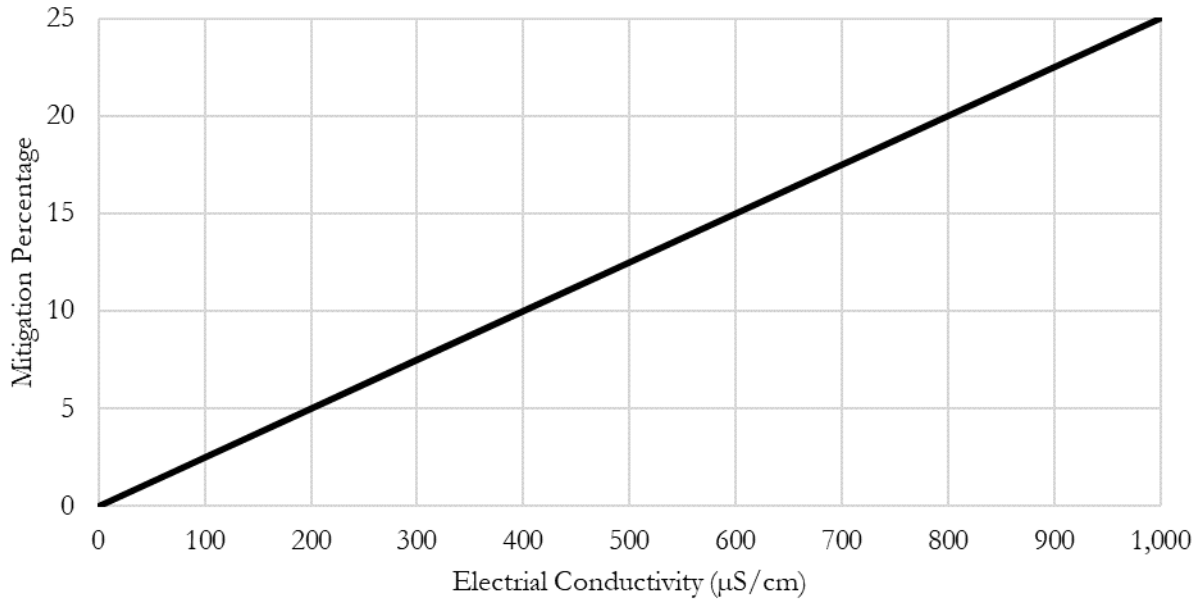
The Guidelines define a robust water quality monitoring campaign and associated management actions for programs introducing non-Millerton water into the FKC. Specifically, the quality of non-Millerton water is monitored at its introduction point and water in the FKC (in-prism) is monitored at various check structures. The frequency of monitoring varies based on real-time conditions, except for ongoing (i.e., every 15 minutes) monitoring of electrical conductivity (EC) at the check structures. If it is determined that water quality thresholds are exceeded or are likely to be imminently exceeded, FWA retains the right to impose management actions on the introduction of non-Millerton water including reductions and/or shutoffs. However, the Distribution Module does not simulate reductions and/or shutoffs based on water quality to maintain a level of conservatism with respect to mass loading of constituents into the FKC. Details and consequences of this assumption (including a sensitivity analysis) are expanded upon in Chapter 3.1.4.

Leaching Fraction

In addition to the robust monitoring campaign and associated management actions described above, the Guidelines define a water leave-behind program. Specifically referred to as "mitigation" in the Guidelines (but not in this document as to avoid confusion with mitigation as related to environmental compliance for the Project, if applicable), the leave-behind volume represents a leaching fraction paid by Friant Contractors introducing water of lesser quality to Friant Contractors physically taking water of lesser quality because of exchanges and canal operations. The leaching fraction owed and received is based on the quality of water introduced and is designed to offset the negative impacts of not receiving water consistent with quality conditions of Millerton Lake.

Leaching fraction volumes are quantified using an accounting tool known as the Water Quality Ledger (Ledger). The Ledger uses a leaching fraction curve, shown in Figure 3-3, to quantify a percent leaching fraction owed by a contractor introducing water to the FKC based on the measured EC of the introduced water above an established baseline. The established baseline was developed using assumptions of current leaching practices by water users in the region and, consistent with good agricultural practices, is assumed to be 5 percent. It is assumed that growers are currently applying at least a 5 percent leaching fraction on their farms. Under the leaching fraction rating curve, this corresponds to an approximate EC of 200 microsiemens per centimeter (μS/cm) (Figure 3-3). Consequently, it is assumed that growers are already managing the effects of applied water quality conditions up to 200 μS/cm of EC and, therefore, leaching fraction is only required for water quality conditions with incremental EC that exceeds this baseline of 200 μS/cm.

The Distribution Module considers leaching fraction and applies the leaching fraction curve in the Ledger when allocating non-Millerton supplies (i.e., existing programs and additional pump-back supply). The leaching fraction curve is applied to all non-Millerton supplies in the Existing Conditions, No Project Alternative, and the three Project alternatives. In every modeled scenario, for purposes of modeling the distribution of leaching fraction, supplies introduced via the Intertie (Cross Valley Contract, Rosedale Banking, West Kern Banking, and additional pump-back supplies) are assumed to have water quality consistent with measured California Aqueduct water quality as measured at Check 21, and leaching fraction percentages are applied accordingly using monthly averages for different water year types (Table 3-16). Leaching fraction for FKC groundwater pump-ins was quantified based on limited water quality data provided by Friant Contractors (Table 3-17, Table 3-18, Table 3-19, Table 3-20).



Key: µS/cm = microsiemens per centimeter (1 µS/cm = 1 µmhos/cm = 1/1,000 dS/m)

Figure 3-3. Leaching Fraction Percentage Curve (referred to in curve as Mitigation Percentage) in the Friant Kern Canal Water Quality Guidelines Defining Leaching Fraction Percentage Based on Electrical Conductivity

Table 3-16. California Aqueduct Check 21 Monthly Water Quality for Electrical Conductivity (microsiemens per centimeter) and Associated Monthly Leaching Requirement by San Joaquin Valley Water Year Type

Year Type	Number of Years	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Water Quality as EC in (µS/cm)													
Non-Dry/Critical	32	479	458	473	426	365	400	456	498	509	555	525	512
Dry/Critical	18	480	483	453	453	332	425	573	552	515	566	560	686
Monthly Leaching Requirement													
Non-Dry/Critical	32	7%	6%	7%	6%	4%	5%	6%	7%	8%	9%	8%	8%
Dry/Critical	18	7%	7%	6%	6%	3%	6%	9%	9%	8%	9%	9%	12%

Notes:
Leaching requirement based on the water quality ledger.
Year Types are based on the San Joaquin Valley Water Year Types.
Dry/Critical year types are Dry and Critical water years based on San Joaquin Valley Water Year Types.
Non-Dry/Critical year types are Wet, Above Normal, and Below Normal water years based on San Joaquin Valley Water Year Types.
Key:
µS/cm = microsiemens per centimeter (1 µS/cm = 1 µmhos/cm = 1/1,000 dS/m)
EC = Electrical Conductivity

Table 3-17. Friant-Kern Canal Groundwater Pump-In Program Monthly Water Quality for Electrical Conductivity (microsiemens per centimeter) and Leaching Requirement (percent) for Delano-Earlimart Irrigation District

Parameter	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Water Quality as EC in (µS/cm)	510	510	510	510	510	510	510	510	510	510	510	510
Monthly Leaching Requirement	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%

Key:µS/cm = microsiemens per centimeter (1 µS/cm = 1 µmhos/cm = 1/1,000 dS/m)

Table 3-18. Friant-Kern Canal Groundwater Pump-In Program Monthly Water Quality for Electrical Conductivity (microsiemens per centimeter) and Leaching Requirement (percent) for Saucelito Irrigation District

Parameter	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Water Quality as EC in (µS/cm)	420	420	420	420	420	420	420	420	420	420	420	420
Monthly Leaching Requirement	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%

Key: µS/cm = microsiemens per centimeter (1 µS/cm = 1 µmhos/cm = 1/1,000 dS/m)

Table 3-19. Friant-Kern Canal Groundwater Pump-In Program Monthly Water Quality for Electrical Conductivity (microsiemens per centimeter) and Leaching Requirement (percent) for Southern San Joaquin Municipal Utility District

Parameter	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Water Quality as EC in (µS/cm)	540	540	540	540	540	540	540	540	540	540	540	540
Monthly Leaching Requirement	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%

Key: µS/cm = microsiemens per centimeter (1 µS/cm = 1 µmhos/cm = 1/1,000 dS/m)

Table 3-20. Friant-Kern Canal Groundwater Pump-In Program Monthly Water Quality for Electrical Conductivity (microsiemens per centimeter) and Leaching Requirement (percent) for Terra Bella Irrigation District

Parameter	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Water Quality as EC in (µS/cm)	580	580	580	580	580	580	580	580	580	580	580	580
Monthly Leaching Requirement	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%

Notes: µS/cm = microsiemens per centimeter (1 µS/cm = 1 µmhos/cm = 1/1,000 dS/m)

Uncontrolled Season

Uncontrolled Season is a flood management action utilized by Reclamation that could result in the availability of water to Friant Contractors above and beyond the strict CVP Class 1 and Class 2 volumes set forth in long–term contracts. The Guidelines stipulate that when an Uncontrolled Season is declared by Reclamation, with few exceptions, pump-back projects (including existing programs and additional pump-back supply) will not operate.

To simulate Uncontrolled Season in the Distribution Module, historical data were considered, including 2004 to 2019 water year natural runoff, Uncontrolled Season Class 2 allocation, and the number of months with Uncontrolled Season. Uncontrolled Season deliveries typically occur between March to July during wetter years (Wet, Above Normal, and Below Normal San Joaquin Water Year Types). Furthermore, to extrapolate to the entire period of analysis, unimpaired flow data for San Joaquin River at Friant (California Data Exchange Center, station ID SJF) from October 1921 to September 2003 was analyzed. Based on the annual water year natural river runoff, months where Uncontrolled Season was anticipated to occur were identified. Table 3-21 summarizes the months where reverse-flow pump-back operations are turned off for most existing programs in the Distribution Module based on unimpaired flow to simulate an Uncontrolled Season.

Table 3-21. Months Where Pump-Back Supply Would be Turned Off due to Flow Conditions at Millerton Lake during Uncontrolled Season Periods

Natural River Runoff at Millerton Lake[1] (Acre-Feet)	March	April	May	June	July
Less than 1,300,000	-	-	-	-	-
Greater than 1,300,000 to 1,450,000	-	No Pump-Back	No Pump-Back	-	-
Greater than 1,450,000 to 2,500,000	-	No Pump-Back	No Pump-Back	No Pump-Back	-
Greater than 2,500,000	No Pump-Back	No Pump-Back	No Pump-Back	No Pump-Back	No Pump-Back

Note:
1. California Data Exchange Center Station ID SJR (San Joaquin River Below Friant).

Summary of Assumptions for Surface Water Distribution Module

- The monthly outflow from Millerton Lake does not change under Project operations, this is to avoid impacts to Friant Division water supply. This outflow includes CVP deliveries to Friant Contractors, flood releases, and spills.
- Under Project operations, the monthly volumetric water balance around Millerton Lake is maintained from CalSim II simulations. The Project focuses on operations in the FKC and not on re-operating Millerton Lake.
- In any month, a Friant Contractor in the study area can take delivery of water from Millerton, from existing programs, and/or additional pump-back supply. These three sources of supply are allocated to Friant Contractors based on their CVP Class 1 and/or Class 2 contract amounts and are constrained by capacities of the pump-back facilities and exchangeable demand in the FKC.

- Existing programs and additional pump-back supply delivered via the Intertie are used to meet Friant Contractor contract volumes in the lowest reaches of the study area first, then remaining existing program and additional pump-back supply would be delivered to the next upper reach, and so on until all the contract volumes are met in the lower portion of the study area or supply is exhausted.
- If existing programs and additional pump-back supply cannot fully meet the contract volume of a Friant Contractor, it is assumed that CVP water from Millerton Lake would be delivered to meet the remaining volume.
- FKC groundwater pump-in program supply is assumed to be put in and delivered from the same portion of the Project reach that the owning Friant Contractor takes delivery from the FKC. These supplies were not simulated to be delivered to other Project reaches and other Friant Contractors.
- Some Friant Contractors within the study area receive delivery from local sources of supply other than those from the FKC. These local supplies were not quantified in the Distribution Module, but instead added to the individual Friant Contractors total delivered surface water after Millerton supply, existing programs, and additional pump-back supply deliveries were simulated.
- Friant Contractors that introduce program water of a lesser quality than Millerton supply are required to pay leaching fraction volumes to those Friant Contractors that take delivery of those program supplies in exchange for Millerton water. These leaching fraction volumes are calculated based on the guidelines in the Ledger. Leaching fraction was calculated for existing programs and additional pump-back supply.
- The Project simulates months where Uncontrolled Season was anticipated to occur based on unimpaired flow to Millerton Lake. During these months, with few exceptions, reverse-flow pump-back operations are turned off in the Distribution Module.

3.1.4 Surface Water Quality Module

3.1.4.1 Model Description

The Surface Water Quality Module (Water Quality Module) is a tool used to determine average monthly surface water quality in the FKC. The Water Quality Module uses water supply delivery data from the Distribution Module and applies representative water quality data for each water source (i.e., Millerton, CVC, California Aqueduct, etc.) to determine mixed water quality in each of the Project reaches of the FKC. Mixed water quality is calculated using a mass-balance approach considering the volume of water from each supply source in a Project reach, and assuming complete mixing within a Project reach. Supplies are then allocated to each Friant Contractor within each Project reach.

3.1.4.2 Module Assumptions

The Water Quality Module is used to simulate average monthly water quality conditions in the FKC and, as a result, average monthly water quality conditions of deliveries from the FKC considering four constituents: salinity as total dissolved solids (TDS), nitrate, boron, and chloride. It should be noted that even though salinity is measured as EC in the Guidelines, it is expressed and measured as TDS in the Water Quality Module and Groundwater Module. The Water Quality Module specifically uses a mass balance approach to estimate water quality of deliveries from each of the Project reaches

of the FKC in the study area considering the source of the water in each Project reach (i.e., Millerton, existing program, and additional pump-back supply). It also considers the quality of local supplies, when applicable.

Specifically, concentrations of the four constituents from the different sources of water considered in the Distribution Module are quantified for different months and by San Joaquin Valley Water Year Types. These monthly water quality statistics are then used to calculate the average water quality conditions in each Project reach of the FKC in the study area assuming complete mixing within a Project reach. This mass balance approach simulates a range of water quality conditions in the FKC that vary by month and represent changes due to the various hydrologic conditions (and resulting Project operations) in the study area. For any given month, Friant Contractors receive water quality consistent with that of the Project reach (or Project reaches) of the FKC from which they take deliveries. Water quality assumptions for the sources of surface water considered in the simulations are provided in the following subsections. Because this analysis is performed on a monthly time scale, water within each Project reach is considered to be completely mixed.

CVP Millerton Supply
The water quality conditions for CVP Millerton supply are represented by measured water quality in Millerton Lake. The period of record of available data are relatively short and only has a small sample size of various water year types. Therefore, the historical water quality measurements were averaged by San Joaquin Valley Water Year Type. Dry and Critical water year types are averaged together, and Wet, Above Normal and Below Normal water year types (referred together as Non-Dry/Critical) are averaged together. Table 3-22 summarizes the monthly water quality data used to represent CVP Millerton supplies in the Water Quality Module. These data were applied accordingly to deliveries over the simulation period.

Existing Program Supply
The water quality conditions for existing program supplies are represented by measured water quality in either the CVC, California Aqueduct at Check 21, or from local FKC groundwater pump-in programs. Existing program supplies introduced to the FKC via the Intertie are represented by measured water quality in the CVC in the Existing Conditions and No Project Alternative, and by measured water quality in the California Aqueduct in the Low Flow Alternative, High Flow Alternative, and Seasonal Alternative. The three Project alternatives would bring in more water into the FKC from the California Aqueduct. In these cases, CVC supplies would be mixed with California Aqueduct supplies. California Aqueduct at Check 21 water quality was used to promote conservatism in the approach with respect to mass loading in the FKC, as it is generally of the poorest quality.

Similar to the CVP Millerton Supply, the period of record of available water quality data for CVC is relatively short and only has small sample size of various water year types. Therefore, the historical water quality measurements were averaged by San Joaquin Valley Water Year Type. Dry and Critical water year types are averaged together, and Wet, Above Normal and Below Normal water year types (referred together as Non-Dry/Critical) are averaged together. Table 3-23 summarizes the monthly water quality data used to represent CVC supplies in the Water Quality Module. These data were applied accordingly to deliveries over the simulation period.

Historical water quality measurements for the California Aqueduct at Check 21 were averaged by San Joaquin Valley Water Year Type. Table 3-24 summarizes the monthly water quality data used to represent California Aqueduct supplies in the Water Quality Module. These data were applied accordingly to deliveries over the simulation period.

Limited water quality data were available for the FKC groundwater pump-in programs. An average monthly water quality was applied to all months. These FKC groundwater pump-in programs supplies were assumed to only occur in Dry and Critical water year types. Table 3-25 summarizes the monthly water quality data for FKC groundwater pump-in programs.

Additional Pump-Back Supply
Additional pump-back supply would be introduced via the Intertie and is assumed to have water quality conditions consistent with those presented for the California Aqueduct at Check 21 in Table 3-24.

Local Supply
Several Friant Contractors have local supplies available from supply sources other than the FKC. These supplies are included in the total surface water deliveries to the respective Friant Contractor but are not considered in the Distribution Module and the Water Quality Module because these local supplies are not delivered via the FKC. Each local source has an assumed water quality. Considered local sources of water supply are local deliveries available via the California Aqueduct, Kern River, and Tule River. Summaries of the monthly water quality data used to represent local deliveries via the California Aqueduct and the Kern River in the Water Quality Module are shown in Table 3-26 and Table 3-27, respectively. Tule River was assumed to have water quality consistent with that of CVP Millerton supplies (Table 3-22).

Table 3-22. Monthly Millerton Water Quality Conditions in milligrams per liter (mg/L) by San Joaquin Valley Water Year Type

Constituent	Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
TDS	Non-Dry/Critical	16.50	20.00	29.00	29.50	25.67	24.33	28.00	21.33	21.00	13.00	13.75	13.00
TDS	Dry and Critical	13.67	18.00	28.00	31.60	22.00	25.00	26.50	27.00	61.00	47.00	27.67	19.00
Nitrate	Non-Dry/Critical	0.11	0.08	0.20	1.80	0.70	0.18	0.16	0.03	0.08	0.04	0.09	0.08
Nitrate	Dry and Critical	0.09	0.09	0.13	0.27	0.17	0.10	1.00	0.13	2.27	1.10	0.44	0.20
Boron	Non-Dry/Critical	0.02	0.01	0.02	0.02	0.34	0.02	0.02	0.02	0.02	0.01	0.01	0.02
Boron	Dry and Critical	0.01	0.01	0.05	0.02	0.02	0.02	0.02	0.01	0.04	0.02	0.03	0.01
Chloride	Non-Dry/Critical	1.27	1.75	3.05	2.20	1.90	2.10	2.23	1.30	1.08	0.66	0.74	0.72
Chloride	Dry and Critical	0.94	1.20	2.01	2.02	1.60	1.50	3.10	2.70	5.75	4.25	2.13	2.00

Notes:
Dry and Critical are water years based on San Joaquin Valley Water Year Types.
Non-Dry/Critical year types are Wet, Above Normal, and Below Normal water years based on San Joaquin Valley Water Year Types.

Key:
mg/L = milligrams per liter
TDS = total dissolved solids

Table 3-23. Monthly Cross Valley Canal Water Quality Conditions in milligrams per liter (mg/L) by San Joaquin Valley Water Year Type

Constituent	Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
TDS	Non-Dry/Critical	230.00	226.67	210.00	236.67	390.00	200.91	200.91	200.91	210.00	140.00	137.50	140.00
TDS	Dry and Critical	165.71	178.57	170.00	180.00	218.57	147.14	238.33	161.67	190.00	150.00	170.00	185.00
Nitrate	Non-Dry/Critical	3.12	4.20	3.17	3.27	3.80	2.45	2.45	2.45	3.20	0.06	0.78	0.82
Nitrate	Dry and Critical	2.84	3.40	4.03	4.88	4.81	6.84	4.73	5.82	4.34	4.40	4.98	4.76
Boron	Non-Dry/Critical	0.11	0.11	0.12	0.13	0.16	0.11	0.11	0.11	0.19	0.12	0.09	0.08
Boron	Dry and Critical	0.09	0.11	0.11	0.10	0.14	0.11	0.12	0.12	0.13	0.11	0.11	0.11
Chloride	Non-Dry/Critical	83.33	73.00	63.00	72.67	140.00	61.95	61.95	61.95	53.00	33.00	35.50	39.67
Chloride	Dry and Critical	42.86	47.00	39.71	45.60	51.29	21.57	21.00	29.83	41.71	32.29	39.67	48.50

Notes:
Dry and Critical are water years based on San Joaquin Valley Water Year Types.
Non-Dry/Critical year types are Wet, Above Normal, and Below Normal water years based on San Joaquin Valley Water Year Types.

Key:
mg/L = milligrams per liter
TDS = total dissolved solids

Table 3-24. Monthly California Aqueduct at Check 21 Water Quality Conditions in milligrams per liter (mg/L) by San Joaquin Valley Water Year Type

Constituent	Year Types	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
TDS	Wet	260.20	281.00	307.80	228.40	285.80	221.60	185.40	184.80	127.40	147.00	176.80	172.00
TDS	Above Normal	238.67	219.00	276.00	274.67	249.67	238.00	245.00	265.67	247.33	196.00	172.00	196.33
TDS	Below Normal	340.50	314.50	335.00	378.50	343.00	311.50	276.00	327.50	278.50	171.00	222.00	235.50
TDS	Dry	286.00	305.00	302.60	325.00	299.40	263.80	284.80	279.00	285.00	215.00	218.20	296.20
TDS	Critical	300.20	300.00	320.20	331.00	366.20	333.80	321.20	300.80	304.60	272.00	322.60	368.00
Nitrate	Wet	1.30	2.53	3.33	4.08	4.28	3.73	1.63	1.63	1.85	1.85	1.53	1.53
Nitrate	Above Normal	1.00	3.10	3.30	3.70	3.60	5.90	3.30	2.50	2.50	2.40	0.60	0.80
Nitrate	Below Normal	1.45	2.20	3.55	5.40	4.15	3.10	2.80	3.15	2.80	1.65	1.00	0.80
Nitrate	Dry	1.93	2.68	3.00	4.90	4.45	4.52	3.30	3.00	2.46	1.32	1.03	1.03
Nitrate	Critical	1.04	1.76	2.90	3.12	4.10	3.32	2.24	2.02	1.62	1.68	0.48	0.80
Boron	Wet	0.10	0.10	0.18	0.15	0.22	0.28	0.20	0.15	0.13	0.10	0.13	0.13
Boron	Above Normal	0.13	0.13	0.17	0.23	0.20	0.23	0.23	0.20	0.20	0.13	0.10	0.10
Boron	Below Normal	0.20	0.20	0.20	0.25	0.25	0.20	0.20	0.20	0.15	0.10	0.10	0.10
Boron	Dry	0.16	0.18	0.18	0.20	0.20	0.20	0.26	0.20	0.20	0.12	0.10	0.10
Boron	Critical	0.20	0.18	0.24	0.18	0.24	0.26	0.24	0.22	0.18	0.18	0.20	0.25
Chloride	Wet	81.20	93.00	100.80	60.60	42.40	43.00	39.20	43.80	25.40	33.20	42.60	41.00
Chloride	Above Normal	64.33	60.00	79.00	67.67	61.00	55.67	50.33	69.67	63.00	46.00	38.33	53.00
Chloride	Below Normal	109.50	100.50	98.50	115.00	92.50	86.00	58.50	87.00	75.50	35.00	66.00	75.00
Chloride	Dry	90.80	92.00	92.60	96.20	81.80	60.80	64.40	74.40	74.60	51.20	63.20	99.80
Chloride	Critical	88.40	83.00	94.60	101.60	100.40	89.00	88.40	84.80	91.20	73.00	96.80	113.80

Notes:
Year Types are based on the San Joaquin Valley Water Year Type.

Key:
mg/L = milligrams per liter
TDS = total dissolved solids

Table 3-25. Friant-Kern Canal Groundwater Pump-In Programs Water Quality Conditions in milligrams per liter (mg/L)

Friant Contractor	Year Types*	Month	TDS	Nitrate	Boron	Chloride
SSJMUD	All	All	343	13	0.04	246
DEID	All	All	327	9	0.03	29
TBID	All	All	370	11	0.06	27
Saucelito ID	All	All	266	7	0.03	15

Notes:
Year Types are based on the San Joaquin Valley Water Year Type

Key:
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
mg/L = milligrams per liter
SSJMUD = Southern San Joaquin Municipal Utility District
TBID = Terra Bella Irrigation District
TDS = total dissolved solids

Table 3-26. Monthly California Aqueduct Water Quality (Local Supply) Conditions in milligrams per liter (mg/L) by San Joaquin Valley Water Year Type

Constituent	Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
TDS	Non-Dry/Critical	303.33	263.33	333.33	220.00	130.00	126.67	158.33	104.67	144.25	141.50	130.00	147.50
TDS	Dry and Critical	258.57	222.86	271.43	287.14	270.00	244.29	264.29	277.14	264.29	221.43	251.43	291.43
Nitrate	Non-Dry/Critical	1.30	2.13	3.73	3.40	2.60	1.75	1.66	1.02	1.64	1.30	0.94	1.13
Nitrate	Dry and Critical	2.41	4.84	4.16	6.63	5.66	4.47	4.13	2.30	1.88	1.21	0.66	0.60
Boron	Non-Dry/Critical	0.11	0.11	0.16	0.12	0.11	0.11	0.11	0.07	0.10	0.10	0.08	0.08
Boron	Dry and Critical	0.14	0.15	0.14	0.19	0.21	0.17	0.20	0.21	0.19	0.14	0.14	0.15
Chloride	Non-Dry/Critical	116.67	94.00	115.67	65.00	27.33	26.67	41.60	24.13	36.23	35.50	33.50	41.50
Chloride	Dry and Critical	76.86	55.29	81.29	73.29	66.57	51.57	61.00	70.86	70.14	62.71	78.71	102.43

Notes:
Dry and Critical are water years based on San Joaquin Valley Water Year Types.
Non-Dry/Critical year types are Wet, Above Normal, and Below Normal water years based on San Joaquin Valley Water Year Types.

Key:
mg/L = milligrams per liter
TDS = total dissolved solids

Table 3-27. Monthly Kern River (Local Supply) Conditions in milligrams per liter (mg/L) by San Joaquin Valley Water Year Type

Constituent	Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
TDS	Non-Dry/Critical	101.67	105.33	110.67	109.00	127.00	92.00	73.33	49.67	46.50	36.50	43.50	51.75
TDS	Dry and Critical	118.71	130.00	124.67	117.17	132.57	119.14	109.00	99.43	76.71	86.43	102.14	128.86
Nitrate	Non-Dry/Critical	0.91	0.82	1.02	3.32	2.16	1.44	0.55	0.26	0.18	0.29	0.64	0.51
Nitrate	Dry and Critical	1.27	1.57	1.13	0.85	0.87	0.36	0.42	0.32	0.35	0.45	0.72	1.14
Boron	Non-Dry/Critical	0.14	0.13	0.13	0.11	0.13	0.09	0.08	0.06	0.05	0.03	0.05	0.06
Boron	Dry and Critical	0.15	0.16	0.16	0.14	0.18	0.16	0.16	0.13	0.10	0.11	0.13	0.17
Chloride	Non-Dry/Critical	5.37	6.43	5.90	6.00	6.73	4.77	3.47	2.03	1.80	1.43	1.68	2.23
Chloride	Dry and Critical	6.51	7.56	7.42	6.58	7.67	7.11	6.49	5.61	4.34	4.49	5.73	7.06

Notes:
Dry and Critical are water years based on San Joaquin Valley Water Year Types.
Non-Dry/Critical year types are Wet, Above Normal, and Below Normal water years based on San Joaquin Valley Water Year Types.

Key:
mg/L = milligrams per liter
TDS = total dissolved solids

3.1.4.3 Sensitivity Analysis

The assumptions in the Water Quality Module are designed to promote a conservative assumption when considering mass loading of constituents in the FKC (and to the Friant Contractors). Specifically, when considering existing program supply introduced through the Intertie, using water quality statistics from the CVC, California Aqueduct, and/or a blend of the two sources could be appropriate. As mentioned, this analysis uses California Aqueduct at Check 21 water quality to promote a conservative assumption with regards to mass loading into the FKC and to the Friant Contractors. Furthermore, shutoffs to introductions of water via the Intertie are not considered for this same reason. As a result, the simulation results shown in Chapter 3.2 contain some exceedances to thresholds defined in the Guidelines during certain months and operational scenarios. The sensitivity of this assumption was tested by running all modules for scenarios that included using CVC water quality or shutoffs. Results confirm that this assumption is conservative but would generally not change results and conclusions reached in the environmental documents.

3.2 Surface Water Modeling Results

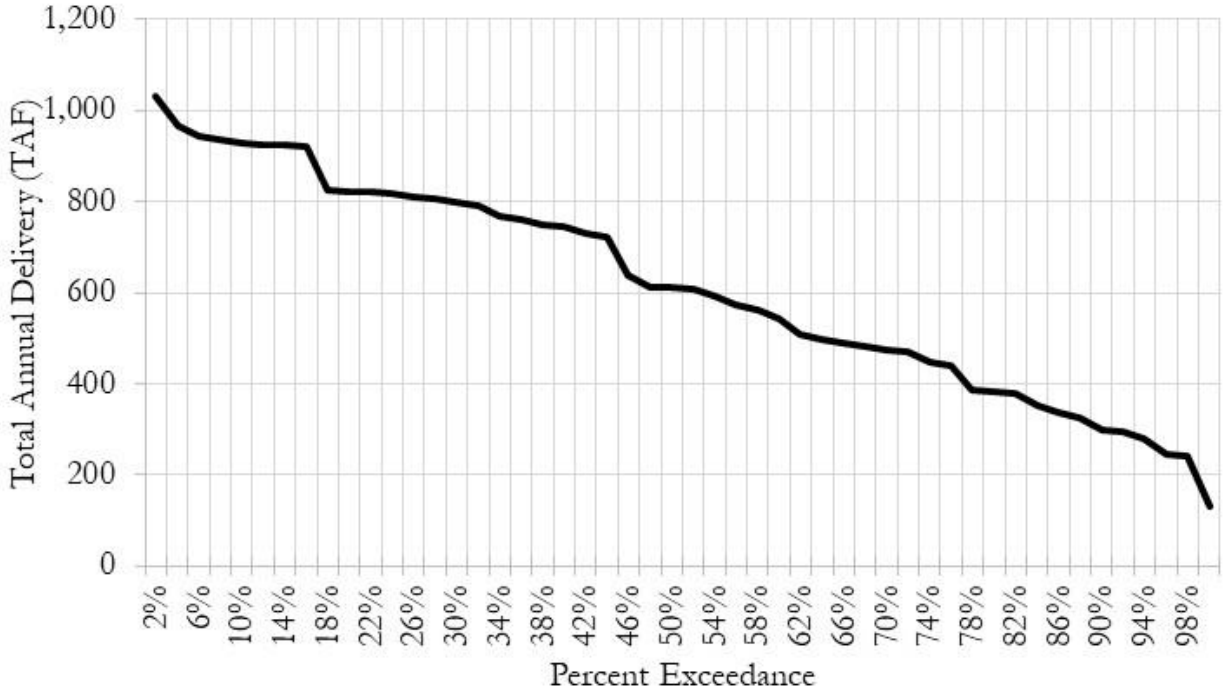
The following subsections summarize the Distribution Module results for the Existing Conditions, No Project Alternative, the Low Flow Alternative, High Flow Alternative, and Seasonal Alternative. The three Project alternatives are simulated under the Existing Conditions and Future Conditions. For each of the scenarios considered, water supply and water quality results are presented in an absolute form (i.e., absolute volumes and concentrations) and in a relative form (i.e., comparing absolute volumes for each Project alternative to the baseline Existing Conditions and Future Conditions) to show how the proposed Project impacts water supply and water quality. Results are provided for each Project reach showing an average of all years and an average of Wet and Critical water year types, as defined by San Joaquin Valley Water Year Type, to show the range of operational changes. Additionally, the total annual surface water delivery (including local supply) is summarized for each Friant Contractor in the study area over the 50-year simulation period.

3.2.1 Existing Conditions

Under the Existing Conditions, temporary pumps are installed at the Shafter-Wasco and Lake Woollomes check structures (80 cfs and 50 cfs, respectfully) and zero pump capacity is assumed at the Deer Creek check structure. Figure 3-4 shows the probability of exceedance of total annual delivery to Friant Contractors in the study area under the Existing Conditions. Figure 3-5 shows the probability of exceedance of total annual delivery via reverse-flow pump-back operations to Friant Contractors in the study area by San Joaquin Valley Water Year Type under the Existing Conditions. These pump-back operational volumes represent all supply being delivered via reverse-flow pump-back operations at the Intertie and includes the following existing programs: Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC at different locations along the Project reaches and not at the Intertie.

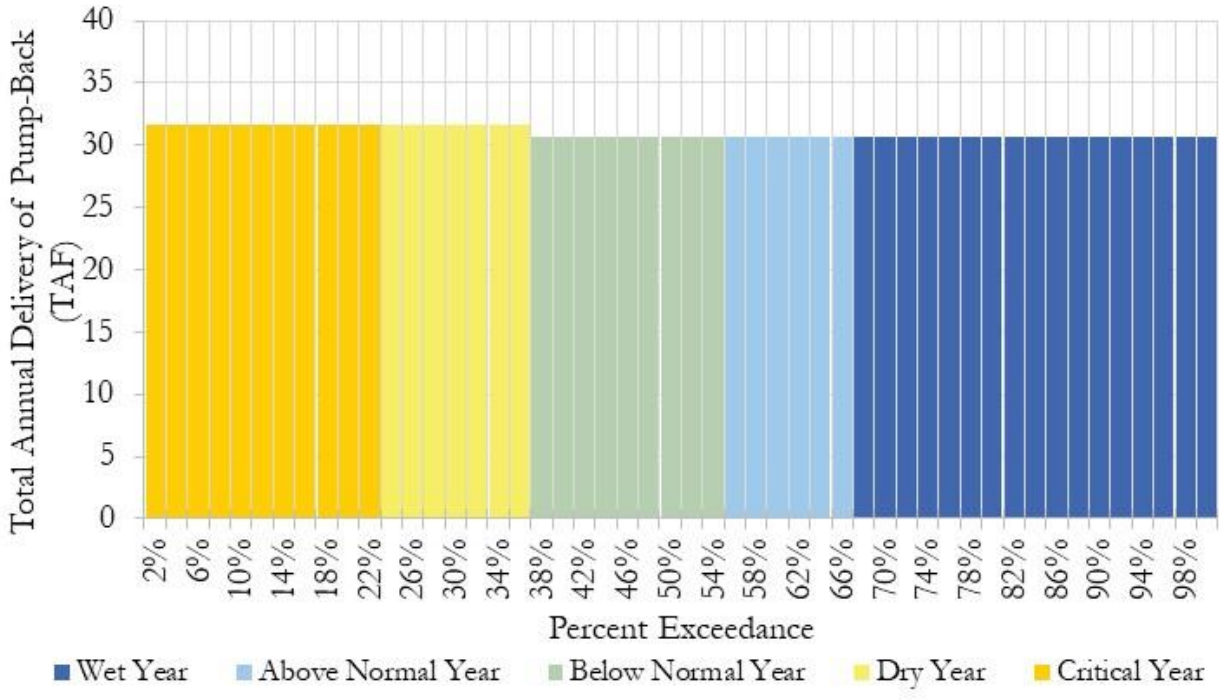
Table 3-28 summarizes the average total annual delivery to Friant Contractors in the study area by source for an average of all years and by San Joaquin Valley Water Year Type under the Existing Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back

operations (Cross Valley Contract supply for KTWD, and for Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the total average delivery is 615 TAF with 5 percent from existing programs. For an average Wet water year, the total delivery is 835 TAF with 4 percent from existing programs. For an average Critical water year, the total delivery is 310 TAF with 12 percent from existing programs.



Key: TAF = thousand acre-feet

Figure 3-4. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to Friant Contractors in the Study Area under Existing Conditions



Key: TAF = thousand acre-feet

Figure 3-5. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to Friant Contractors in the Study Area by San Joaquin Valley Water Year Type under Existing Conditions

Table 3-28. Average Annual Delivery (thousand acre-feet) to Friant Contractors in the Study Area by Source for an Average of All Years and by San Joaquin Valley Water Year Type under the Existing Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	581	804	752	517	462	272
Existing Programs	34	31	31	31	37	38
Total Supply	615	835	782	547	499	310

3.2.1.1 Location of Interface

Table 3-29 summarizes the average monthly location of the interface between the reverse-flow pump-back operations and gravity operations (i.e., Millerton supply) for an average of all years and by San Joaquin Valley Water Year Type under the Existing Conditions. Because there is limited supply being conveyed via reverse-flow pump-back, the interface location remains in either Reach A, Reach B, or Reach C and is not observed beyond the Deer Creek check structure (Reach D) as there is zero pump-back capacity at this check structure in the Existing Conditions. Reverse-flow pump-back operations mainly occur during the irrigation season and there is no mixing interface during January.

Table 3-29. Average Monthly Project Reach Location of Pump-Back Interface for an Average of All Years and by San Joaquin Valley Water Year Type under Existing Conditions

Year Type	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Wet	C	A	A	A	A	A	A	B	B	B	-	A
Above Normal	A	A	A	A	A	A	A	B	B	B	-	A
Below Normal	A	A	A	A	A	A	B	B	C	C	-	A
Dry	B	B	A	A	A	A	B	B	C	C	-	A
Critical	C	C	C	B	B	B	B	C	C	C	-	A
Average	A	A	A	A	A	A	B	B	C	C	-	A

Notes:
Year Type is based on San Joaquin Valley Water Year Types
Reach A is the Intertie to Shafter-Wasco Check
Reach B is from Shafter-Wasco Check to Lake Woollomes Check
Reach C is from Lake Woollomes Check to Deer Creek Check

3.2.1.2 Reach A

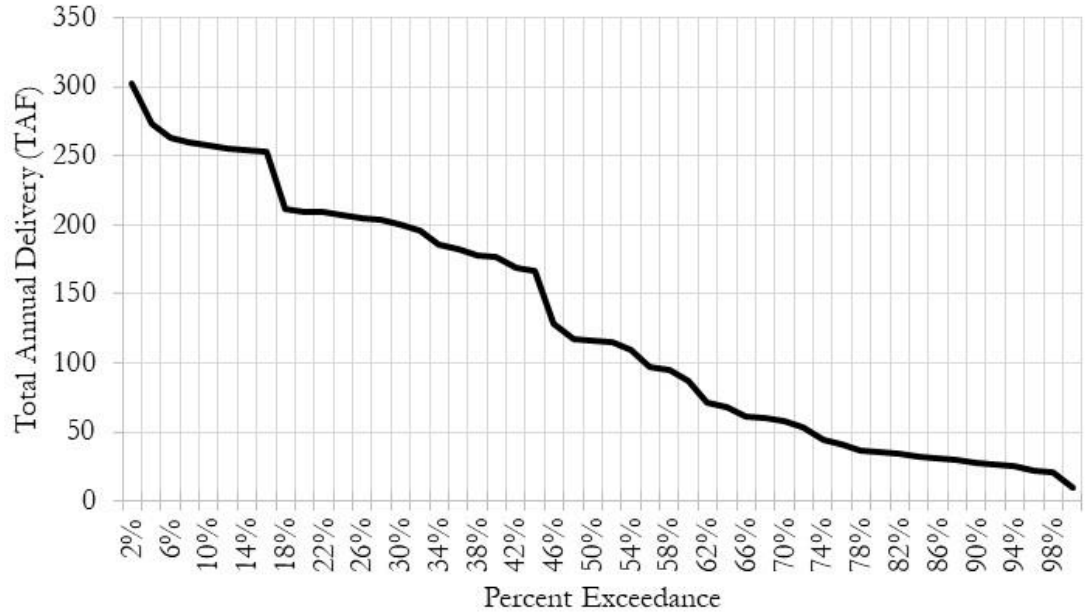
This section summarizes the total water supply delivery and the total water quality to the Friant Contractors in Reach A. The only Friant Contractor within Reach A is AEWSD.

Water Supply

Figure 3-6 shows the probability of exceedance of total annual delivery to the Friant Contractor in Reach A under the Existing Conditions. Figure 3-7 shows the probability of exceedance of total annual supply delivered to the Friant Contractor in Reach A via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the Existing Conditions. These volumes represent all supply being delivered via reverse-flow pump-back operations at the Intertie and includes the following existing programs: Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs. There are no FKC groundwater pump-in program deliveries in Reach A.

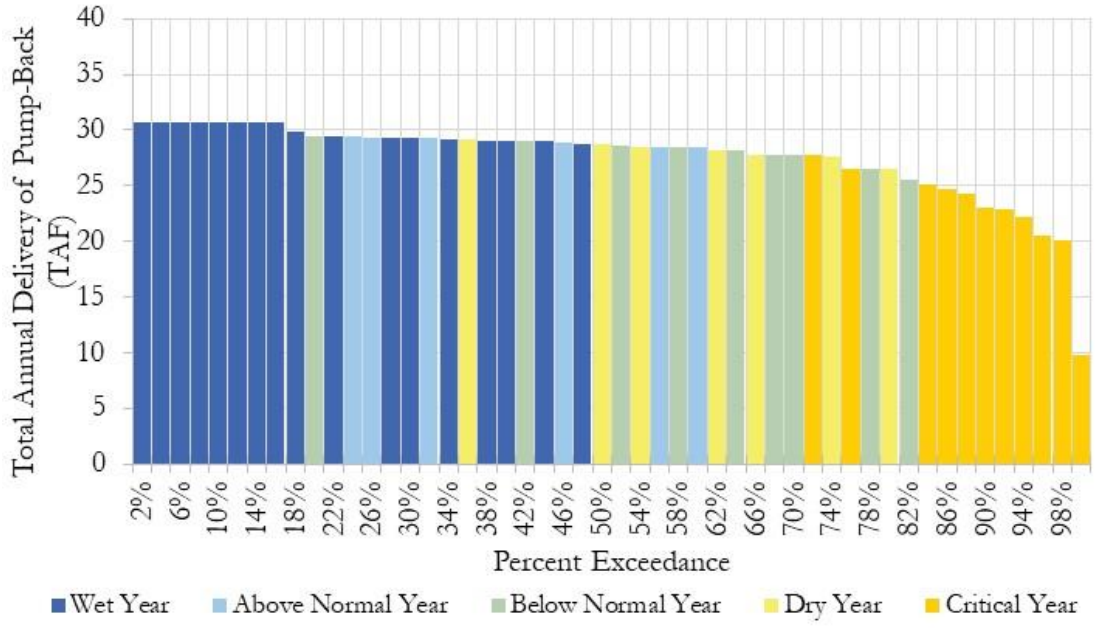
Table 3-30 summarizes the average total annual delivery to the Reach A Friant Contactor by source for an average of all years and by San Joaquin Valley Water Year Type under the Existing Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs). Across all years, the total average delivery is 130 TAF with 21 percent from existing programs (total mitigation is 1 percent of total delivery). For an average Wet water year, the total delivery is 221 TAF with 13 percent from existing programs (total mitigation is 1 percent of total delivery). For an average Critical water year, the total delivery is 29 TAF with 79 percent from existing programs (total mitigation is 5 percent of total delivery).

Table 3-31 to Table 3-33 and Figure 3-8 summarizes the average monthly delivery to the Friant Contractor in Reach A by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-6. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to the Friant Contractor in Reach A under Existing Conditions



Key: TAF = thousand acre-feet

Figure 3-7. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to the Friant Contractor in Reach A by San Joaquin Valley Water Year Type under Existing Conditions

Table 3-30. Average Annual Delivery (thousand acre-feet) to the Friant Contractor in Reach A by Source for an Average of All Years and by San Joaquin Valley Water Year Type under Existing Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	102	193	158	61	34	6
Existing Programs	28	28	30	28	30	23
Total Supply	130	221	188	89	64	29

Table 3-31. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source under Existing Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	6,792	12,145	17,355	19,937	15,765	11,807	5,164	1,741	850	826	2,756	6,818	101,955
Existing Programs	1,076	1,932	3,287	4,488	4,668	5,129	3,731	2,043	421	358	0	400	27,533
Total Supply	7,868	14,077	20,641	24,425	20,432	16,937	8,895	3,784	1,271	1,184	2,756	7,218	129,487

Table 3-32. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source under Existing Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	13,752	23,581	35,528	40,354	30,124	23,118	11,903	1,954	1,081	302	2,481	9,159	193,338
Existing Programs	855	1,840	3,470	4,470	4,640	5,620	4,420	1,981	345	310	0	400	28,350
Total Supply	14,608	25,421	38,998	44,824	34,764	28,738	16,323	3,935	1,426	612	2,481	9,559	221,688

Table 3-33. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source under Existing Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	0	0	177	1,287	2,292	591	0	0	0	0	126	1,681	6,154
Existing Programs	1,134	1,534	2,510	4,423	4,639	4,026	2,163	1,613	394	139	0	400	22,976
Total Supply	1,134	1,534	2,687	5,711	6,931	4,617	2,163	1,613	394	139	126	2,081	29,130

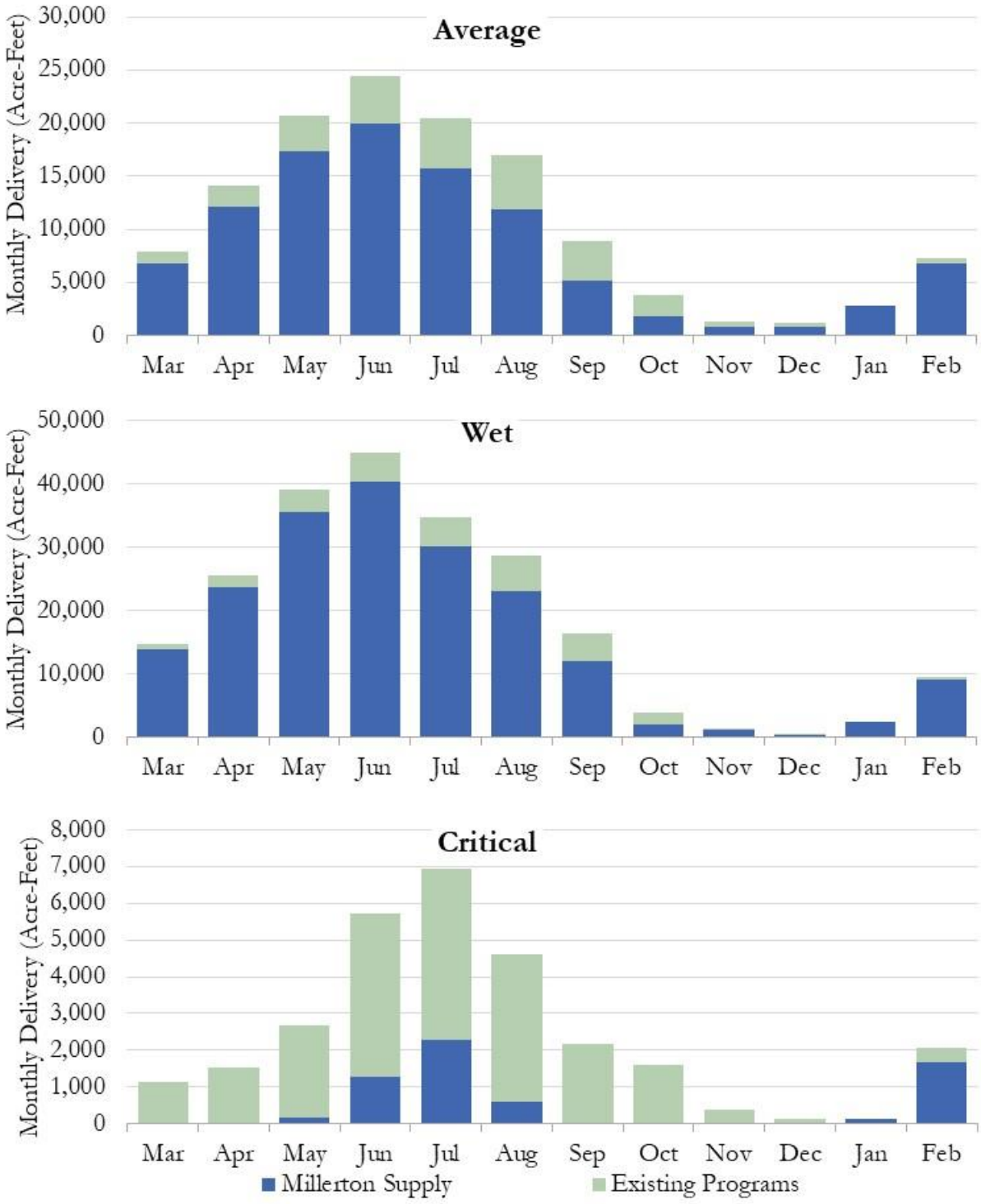


Figure 3-8. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source under Existing Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach A deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-34 to Table 3-37 show the monthly average and monthly maximum water quality trends for individual constituents under the Existing Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply being delivered via reverse-flow pump-back operations (i.e., existing programs), water quality concentrations tend to increase. For TDS, nitrate, chloride, and boron, there is generally a correlation between reverse-flow pump-back supply and higher concentrations, but concentration trends are also influenced by seasonal water quality trends of the source water.

Table 3-34. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	87.27	116.10	83.99	89.40	64.78	80.93	108.98	183.26	184.20	140.22	24.69	84.37
Maximum	200.91	238.33	161.67	190.00	150.00	170.00	185.00	230.00	226.67	210.00	31.60	291.16
Wet Water Years												
Average	53.82	52.79	38.20	41.02	31.02	38.82	51.42	209.88	194.12	177.98	26.22	84.38
Maximum	200.91	170.32	49.11	60.66	41.22	49.69	67.76	230.00	226.67	210.00	29.50	215.06
Critical Water Years												
Average	147.14	238.33	156.61	165.31	119.30	157.19	185.00	165.71	178.57	77.27	14.36	106.24
Maximum	147.14	238.33	161.67	190.00	150.00	170.00	185.00	165.71	178.57	170.00	31.60	192.83

Key: mg/L = milligrams per liter

Table 3-35. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	2.68	1.93	2.03	1.75	1.15	1.59	1.89	2.67	3.41	2.38	1.11	1.34
Maximum	6.84	4.73	5.82	4.34	4.40	4.98	4.76	3.12	4.20	4.03	1.80	4.20
Wet Water Years												
Average	0.56	0.49	0.26	0.41	0.04	0.23	0.30	2.83	3.57	2.68	1.60	1.20
Maximum	2.45	2.04	0.40	0.73	0.04	0.29	0.39	3.12	4.20	3.17	1.80	2.31
Critical Water Years												
Average	6.84	4.73	5.60	3.95	3.41	4.57	4.76	2.84	3.40	1.83	0.12	2.16
Maximum	6.84	4.73	5.82	4.34	4.40	4.98	4.76	2.84	3.40	4.03	0.27	4.20

Key: mg/L = milligrams per liter

Table 3-36. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.06	0.06	0.06	0.07	0.05	0.05	0.07	0.09	0.10	0.08	0.01	0.22
Maximum	0.11	0.12	0.12	0.13	0.11	0.11	0.11	0.11	0.11	0.12	0.02	0.34
Wet Water Years												
Average	0.03	0.03	0.03	0.04	0.02	0.03	0.03	0.10	0.09	0.10	0.01	0.31
Maximum	0.11	0.09	0.03	0.05	0.03	0.03	0.04	0.11	0.11	0.12	0.02	0.34
Critical Water Years												
Average	0.11	0.12	0.11	0.11	0.08	0.10	0.11	0.09	0.11	0.05	0.01	0.07
Maximum	0.11	0.12	0.12	0.13	0.11	0.11	0.11	0.09	0.11	0.11	0.02	0.13

Key: mg/L = milligrams per liter

Table 3-37. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	16.04	15.24	16.86	17.73	12.42	18.03	28.45	60.21	55.25	39.00	1.76	21.86
Maximum	61.95	51.39	47.99	41.71	32.29	39.67	48.50	83.33	73.00	63.00	2.20	102.53
Wet Water Years												
Average	12.09	10.80	7.00	6.58	5.24	7.78	12.50	75.60	62.06	53.12	1.96	24.16
Maximum	61.95	51.39	10.68	11.98	7.84	10.83	17.51	83.33	73.00	63.00	2.20	73.69
Critical Water Years												
Average	21.57	21.00	28.81	34.83	23.93	36.29	48.50	42.86	47.00	18.05	0.92	22.89
Maximum	21.57	21.00	29.83	41.71	32.29	39.67	48.50	42.86	47.00	39.71	2.02	44.78

Key: mg/L = milligrams per liter

3.2.1.3 Reach B

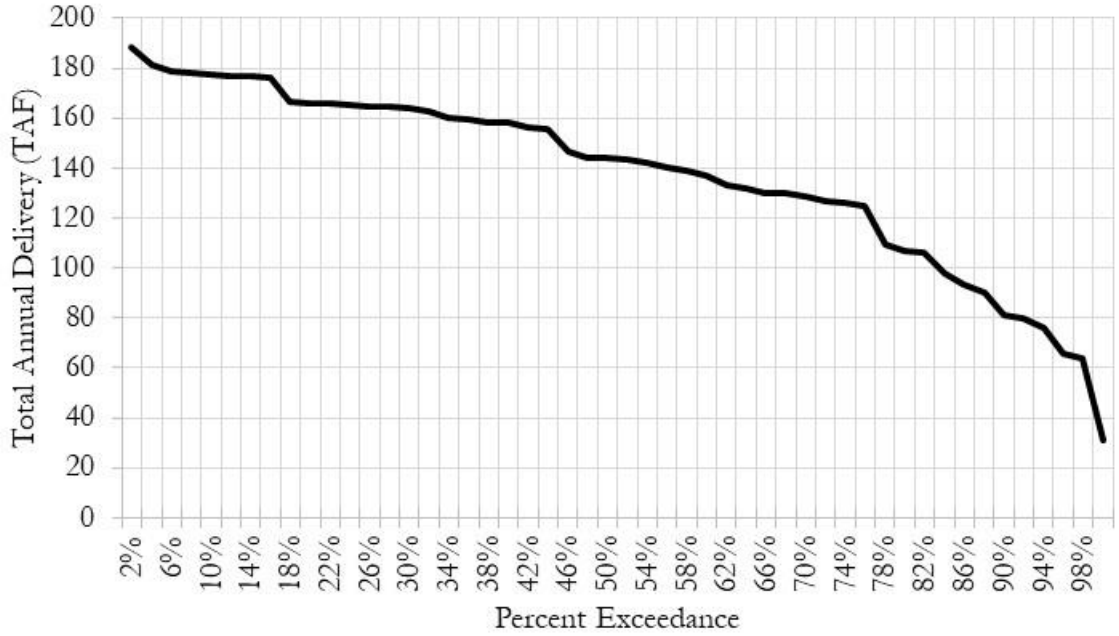
This section summarizes the total water supply delivery and the total water quality to the Reach B Friant Contractors. The Friant Contractors within Reach B include Shafter-Wasco Irrigation District and South San Joaquin Municipal Utility District.

Water Supply

Under the Existing Conditions, the Reach B Shafter-Wasco check structure capacity is assumed to be 80 cfs. Figure 3-9 shows the probability of exceedance of total annual delivery to the Reach B Friant Contractors under the Existing Conditions. Figure 3-10 shows the probability of exceedance of total annual supply delivered to the Friant Contractors in Reach B via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the Existing Conditions. These volumes represent all supply being delivered via reverse-flow pump-back operations at the Intertie and includes the following existing programs: Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach B and not at the Intertie.

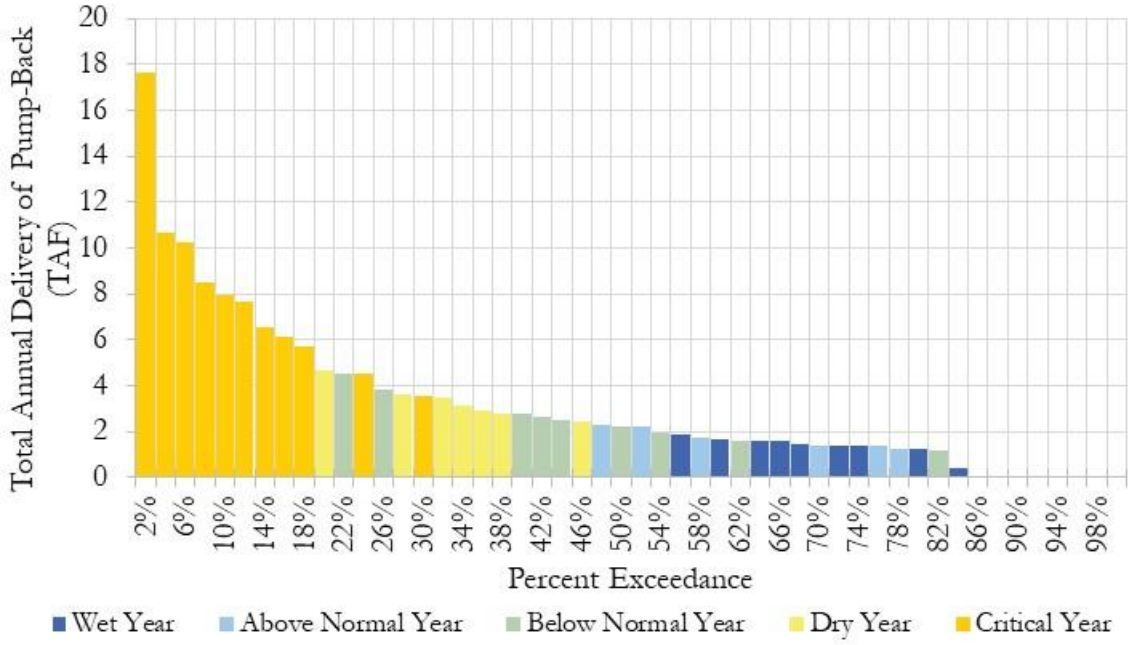
Table 3-38 summarizes the average total delivery to the Friant Contractors in Reach B by source for an average of all years and by San Joaquin Valley Water Year Type under the Existing Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the total average delivery is 138 TAF with 3 percent from existing programs (total mitigation is less than 1 percent of total delivery). For an average Wet water year, the total delivery is 164 TAF with less than 1 percent from existing programs (total mitigation is less than 1 percent of total delivery). For an average Critical water year, the total delivery is 85 TAF with 11 percent from existing programs (total mitigation is 1 percent of total delivery).

Table 3-39 to Table 3-41 and Figure 3-11 summarizes the average monthly delivery to the Friant Contractors in Reach B by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-9. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach B under Existing Conditions



Key: TAF = thousand acre-feet

Figure 3-10. Probability of Exceedance for Total Annual Pump-Back Delivery (thousand acre-feet) to the Friant Contractors in Reach B by San Joaquin Valley Water Year Type under Existing Conditions

Table 3-38. Average Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach B by Source for an Average of All Years and by San Joaquin Valley Water Year Type under Existing Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	134	162	164	135	130	75
Existing Programs	4	2	1	2	3	9
Total Supply	138	164	165	137	133	85

Table 3-39. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source under Existing Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	5,238	9,108	14,910	25,583	30,101	25,131	12,348	4,106	845	503	1,187	4,735	133,796
Existing Programs	241	319	331	130	120	207	405	1,112	417	338	0	0	3,620
Total Supply	5,479	9,427	15,240	25,713	30,221	25,338	12,753	5,218	1,263	841	1,187	4,735	137,416

Table 3-40. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source under Existing Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	6,251	10,928	17,848	29,672	35,787	32,436	18,334	3,590	645	265	1,107	5,110	161,973
Existing Programs	26	0	0	0	0	0	0	1,062	453	433	0	0	1,974
Total Supply	6,277	10,928	17,848	29,672	35,787	32,436	18,334	4,652	1,099	698	1,107	5,110	163,947

Table 3-41. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source under Existing Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	2,450	3,167	6,856	16,829	21,100	13,232	5,020	2,783	617	89	300	2,863	75,305
Existing Programs	928	1,412	1,369	457	411	805	1,468	1,640	465	232	0	0	9,188
Total Supply	3,377	4,579	8,225	17,286	21,511	14,037	6,488	4,423	1,083	321	300	2,863	84,493

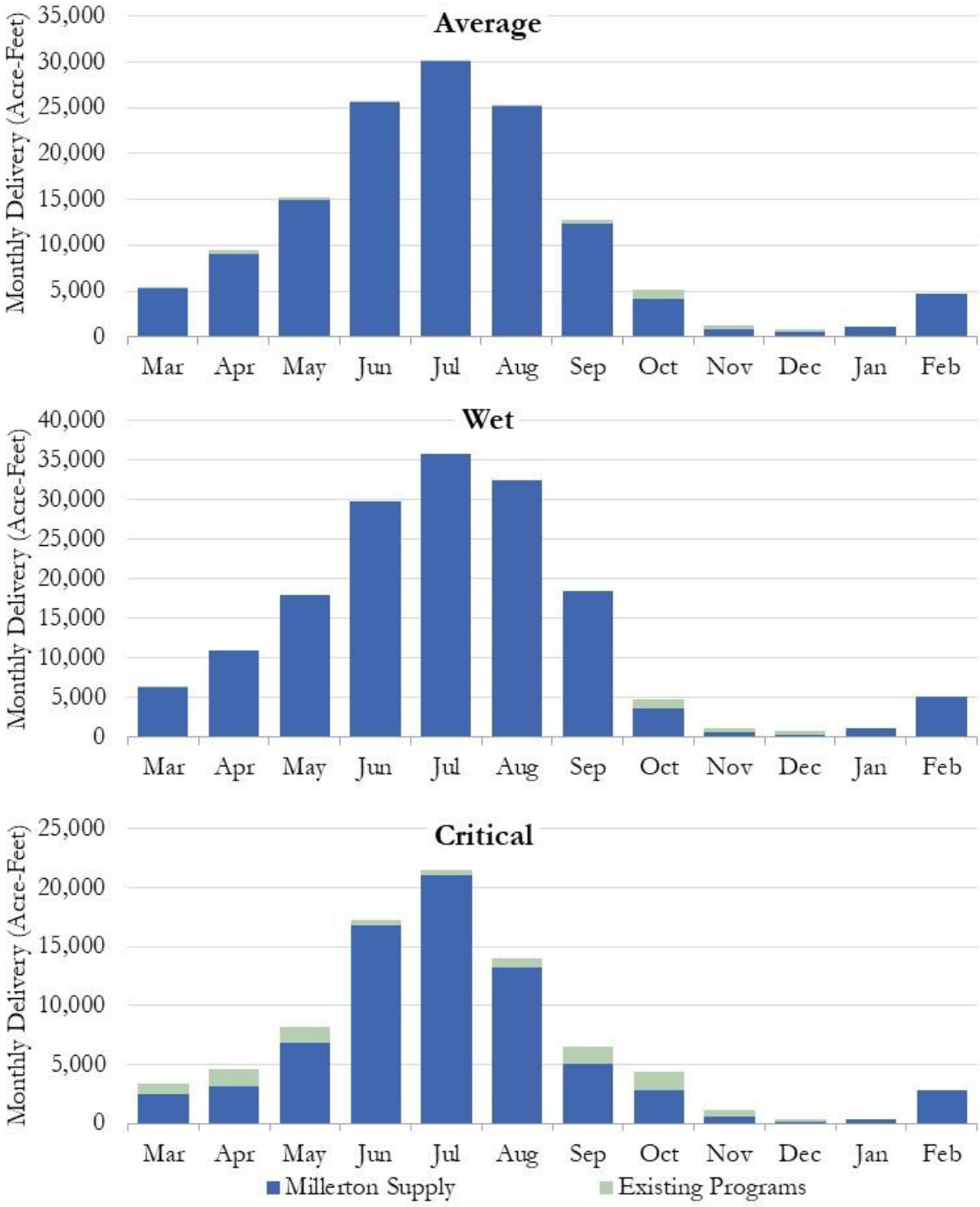


Figure 3-11. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source under Existing Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach B deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-42 to Table 3-45 show the monthly average and monthly maximum water quality trends for individual constituents under the Existing Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply being delivered via reverse-flow pump-back operations (i.e., existing programs) and FKC groundwater pump-in programs, water quality concentrations generally increase. For TDS, nitrate, chloride, and boron, there is a correlation between reverse-flow pump-back supply and higher concentrations, but concentration trends are also influenced by seasonal water quality trends of the source water.

Table 3-42. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	37.92	47.03	32.28	37.55	26.75	23.75	27.66	78.10	132.23	111.80	24.69	24.35
Maximum	200.91	238.33	173.31	119.63	81.53	175.63	134.49	241.48	226.67	210.00	31.60	25.67
Wet Water Years												
Average	34.72	28.00	21.33	21.00	13.00	13.75	13.00	95.54	164.60	150.84	26.22	25.67
Maximum	200.91	28.00	21.33	21.00	13.00	13.75	13.00	241.48	226.67	210.00	29.50	25.67
Critical Water Years												
Average	66.23	114.43	64.89	69.32	52.54	48.64	68.27	81.90	101.10	62.19	14.36	22.00
Maximum	147.14	238.33	173.31	119.63	81.53	175.63	134.49	147.09	178.57	170.00	31.60	22.00

Key: mg/L = milligrams per liter

Table 3-43. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.74	0.80	0.41	0.91	0.47	0.37	0.45	1.15	2.36	1.82	1.11	0.50
Maximum	6.84	4.73	6.04	3.29	2.18	5.10	3.39	3.82	4.20	4.03	1.80	0.70
Wet Water Years												
Average	0.32	0.16	0.03	0.08	0.04	0.09	0.08	1.36	2.98	2.23	1.60	0.70
Maximum	2.45	0.16	0.03	0.08	0.04	0.09	0.08	3.82	4.20	3.17	1.80	0.70
Critical Water Years												
Average	2.38	2.55	1.61	2.44	1.26	1.09	1.56	1.45	1.80	1.42	0.12	0.17
Maximum	6.84	4.73	6.04	3.29	2.18	5.10	3.39	2.73	3.40	4.03	0.27	0.17

Key: mg/L = milligrams per liter

Table 3-44. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B under the Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.03	0.03	0.02	0.03	0.01	0.02	0.02	0.04	0.07	0.07	0.01	0.23
Maximum	0.11	0.12	0.11	0.07	0.04	0.10	0.07	0.10	0.11	0.12	0.02	0.34
Wet Water Years												
Average	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.05	0.08	0.08	0.01	0.34
Maximum	0.11	0.02	0.02	0.02	0.01	0.01	0.02	0.10	0.11	0.12	0.02	0.34
Critical Water Years												
Average	0.05	0.06	0.04	0.04	0.02	0.03	0.03	0.04	0.06	0.04	0.01	0.02
Maximum	0.11	0.12	0.11	0.07	0.04	0.10	0.07	0.07	0.11	0.11	0.02	0.02

Key: mg/L = milligrams per liter

Table 3-45. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	4.69	4.20	3.31	3.15	2.19	2.28	4.08	21.54	38.90	30.16	1.76	1.79
Maximum	61.95	21.00	29.80	20.48	12.35	38.28	31.08	76.93	73.00	63.00	2.20	1.90
Wet Water Years												
Average	5.62	2.23	1.30	1.08	0.66	0.74	0.72	28.89	51.89	44.13	1.96	1.90
Maximum	61.95	2.23	1.30	1.08	0.66	0.74	0.72	76.93	73.00	63.00	2.20	1.90
Critical Water Years												
Average	8.28	10.53	9.32	7.38	5.20	6.71	13.76	17.53	24.90	14.05	0.92	1.60
Maximum	21.57	21.00	29.80	20.48	12.35	38.28	31.08	33.66	47.00	39.71	2.02	1.60

Key: mg/L = milligrams per liter

3.2.1.4 Reach C

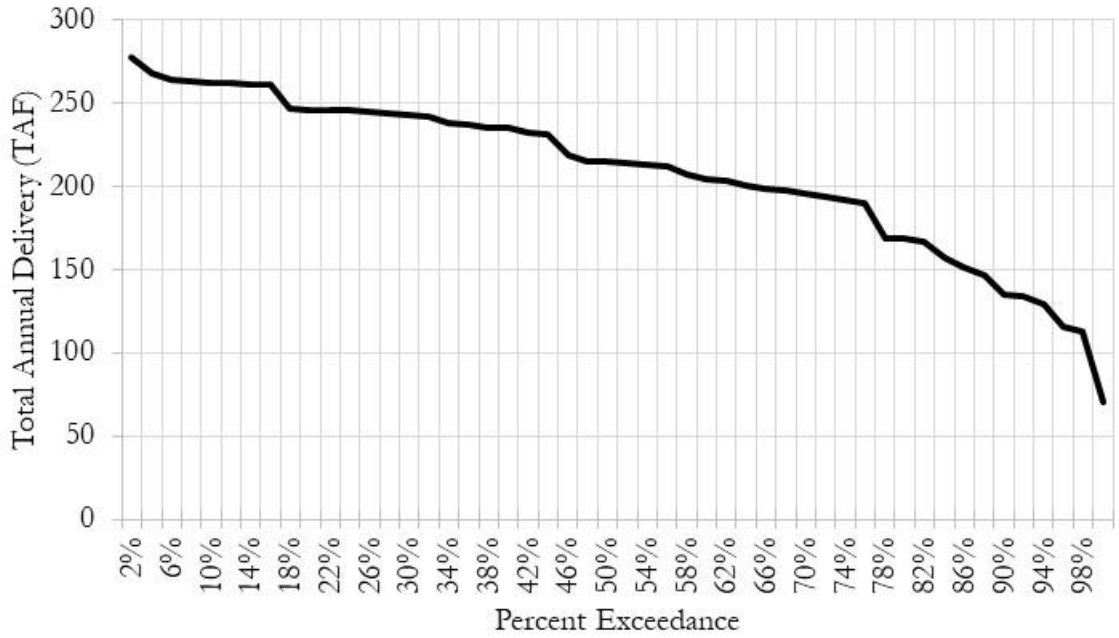
This section summarizes the total water supply delivery and the total water quality to the Friant Contractors in Reach C. The Friant Contractors within Reach C include Southern San Joaquin Municipal Utility District, Kern-Tulare Water District, Delano-Earlimart Irrigation District, Saucelito Irrigation District, and Terra Bella Irrigation District.

Water Supply

Under the Existing Conditions, the Reach C Lake Woollomes check structure capacity is assumed to be 50 cfs. Figure 3-12 shows the probability of exceedance of total annual delivery to the Friant Contractors in Reach C under the Existing Conditions. Figure 3-13 shows the probability of exceedance of total annual supply delivered to the Friant Contractors in Reach C via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the Existing Conditions. These volumes represent all supply being delivered via reverse-flow pump-back operations at the Intertie and includes the following existing programs: Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach C and not at the Intertie.

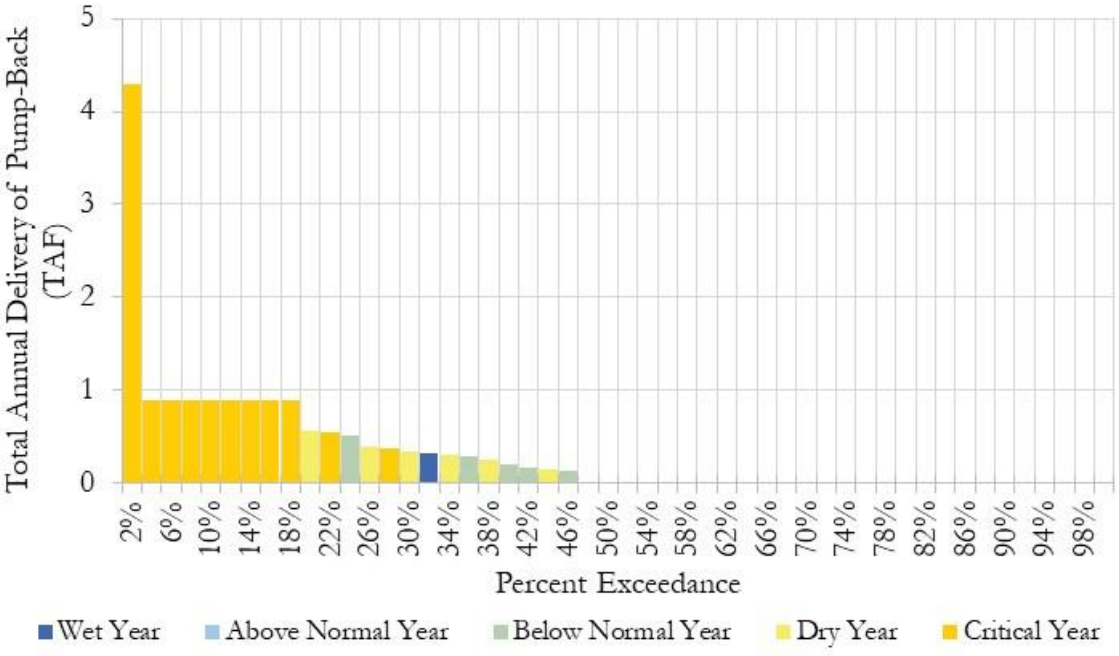
Table 3-46 summarizes the average total annual delivery to the Friant Contractors in Reach C by source for an average of all years and by San Joaquin Valley Water Year Type under the Existing Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the total average delivery is 208 TAF with 1 percent from existing programs (total mitigation is less than 1 percent of total delivery). For an average Wet water year, the total delivery is 244 TAF with less than 1 percent from existing programs (total mitigation is less than 1 percent of total delivery). For an average Critical water year, the total delivery is 140 TAF with 4 percent from existing programs (total mitigation is less than 1 percent of total delivery).

Table 3-47 to Table 3-49 and Figure 3-14 summarizes the average monthly delivery to the Friant Contractors in Reach C by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-12. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach C under Existing Conditions



Key: TAF = thousand acre-feet

Figure 3-13. Probability of Exceedance for Total Annual Pump-Back Delivery (thousand acre-feet) to the Friant Contractors in Reach C by San Joaquin Valley Water Year Type under Existing Conditions

Table 3-46. Average Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach C by Source for an Average of All Years and by San Joaquin Valley Water Year Type under Existing Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	206	244	244	205	198	135
Existing Programs	2	<1	<1	<1	4	5
Total Supply	208	244	244	205	202	140

Table 3-47. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source under Existing Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	8,415	14,498	23,202	37,562	43,379	37,522	20,068	9,360	2,373	1,701	1,602	6,610	206,291
Existing Programs	15	21	276	275	275	275	275	296	62	203	0	0	1,974
Total Supply	8,429	14,519	23,477	37,838	43,654	37,798	20,343	9,656	2,435	1,905	1,602	6,610	208,265

Table 3-48. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source under Existing Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	9,283	16,460	27,209	43,355	50,951	47,383	27,900	8,703	2,131	1,530	1,490	7,169	243,564
Existing Programs	19	0	0	0	0	0	0	58	102	157	0	0	336
Total Supply	9,302	16,460	27,209	43,355	50,951	47,383	27,900	8,761	2,233	1,688	1,490	7,169	243,900

Table 3-49. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source under Existing Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	6,143	8,453	13,568	26,140	31,847	21,957	10,960	8,128	2,129	722	384	4,050	134,481
Existing Programs	38	93	766	765	765	765	765	556	40	529	0	0	5,083
Total Supply	6,182	8,547	14,334	26,904	32,612	22,722	11,725	8,685	2,169	1,251	384	4,050	139,564

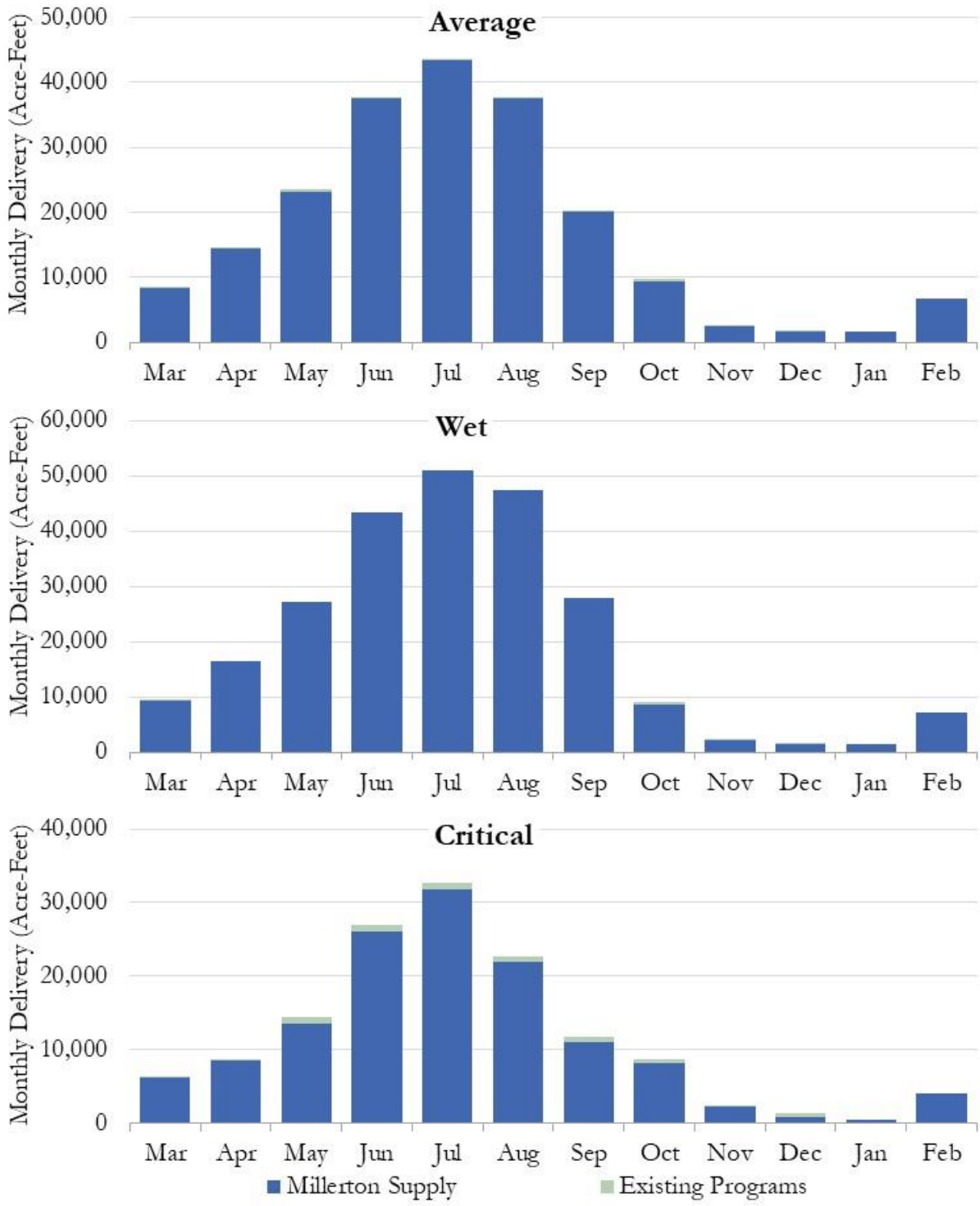


Figure 3-14. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source under Existing Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach C deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-50 to Table 3-53 show the monthly average and monthly maximum water quality trends for individual constituents under the Existing Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply being delivered via reverse-flow pump-back operations (i.e., existing programs) and FKC groundwater pump-in programs, water quality concentrations tend to increase. For TDS, nitrate, chloride, and boron, there is a correlation between reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-50. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	25.68	28.38	28.54	37.95	27.51	22.13	21.72	27.44	29.32	61.46	24.69	24.35
Maximum	64.68	72.64	57.76	76.55	60.66	51.93	47.86	99.94	226.67	210.00	31.60	25.67
Wet Water Years												
Average	26.71	28.00	21.33	21.00	13.00	13.75	13.00	33.34	38.87	56.26	26.22	25.67
Maximum	64.68	28.00	21.33	21.00	13.00	13.75	13.00	99.94	226.67	210.00	29.50	25.67
Critical Water Years												
Average	26.34	30.69	44.37	69.09	54.00	38.84	39.78	34.76	22.48	109.27	14.36	22.00
Maximum	39.79	72.64	57.76	76.55	60.66	51.93	47.86	48.37	50.27	170.00	31.60	22.00

Key: mg/L = milligrams per liter

Table 3-51. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.18	0.48	0.22	0.93	0.49	0.31	0.31	0.43	0.28	0.91	1.11	0.50
Maximum	0.92	1.81	1.04	2.66	1.48	1.13	1.03	1.91	4.20	4.03	1.80	0.70
Wet Water Years												
Average	0.21	0.16	0.03	0.08	0.04	0.09	0.08	0.56	0.45	0.65	1.60	0.70
Maximum	0.70	0.16	0.03	0.08	0.04	0.09	0.08	1.91	4.20	3.17	1.80	0.70
Critical Water Years												
Average	0.17	1.07	0.64	2.47	1.30	0.76	0.79	0.69	0.18	2.36	0.12	0.17
Maximum	0.92	1.81	1.04	2.66	1.48	1.13	1.03	1.08	0.75	4.03	0.27	0.17

Key: mg/L = milligrams per liter

Table 3-52. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.02	0.02	0.05	0.01	0.23
Maximum	0.04	0.04	0.02	0.04	0.02	0.03	0.02	0.04	0.11	0.12	0.02	0.34
Wet Water Years												
Average	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.03	0.02	0.04	0.01	0.34
Maximum	0.04	0.02	0.02	0.02	0.01	0.01	0.02	0.04	0.11	0.12	0.02	0.34
Critical Water Years												
Average	0.02	0.02	0.01	0.04	0.02	0.03	0.01	0.01	0.01	0.08	0.01	0.02
Maximum	0.03	0.04	0.01	0.04	0.02	0.03	0.01	0.01	0.03	0.11	0.02	0.02

Key: mg/L = milligrams per liter

Table 3-53. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	2.21	2.62	2.26	2.99	2.15	1.55	1.76	2.47	4.95	12.36	1.76	1.79
Maximum	15.78	7.00	5.47	7.13	5.48	4.35	4.57	20.68	73.00	63.00	2.20	1.90
Wet Water Years												
Average	2.90	2.23	1.30	1.08	0.66	0.74	0.72	3.45	8.25	12.08	1.96	1.90
Maximum	15.78	2.23	1.30	1.08	0.66	0.74	0.72	20.68	73.00	63.00	2.20	1.90
Critical Water Years												
Average	1.72	3.45	4.25	6.47	4.88	3.15	3.85	2.86	2.48	23.59	0.92	1.60
Maximum	3.93	7.00	5.47	7.13	5.48	4.35	4.57	4.10	10.41	39.71	2.02	1.60

Key: mg/L = milligrams per liter

3.2.1.5 Reach D

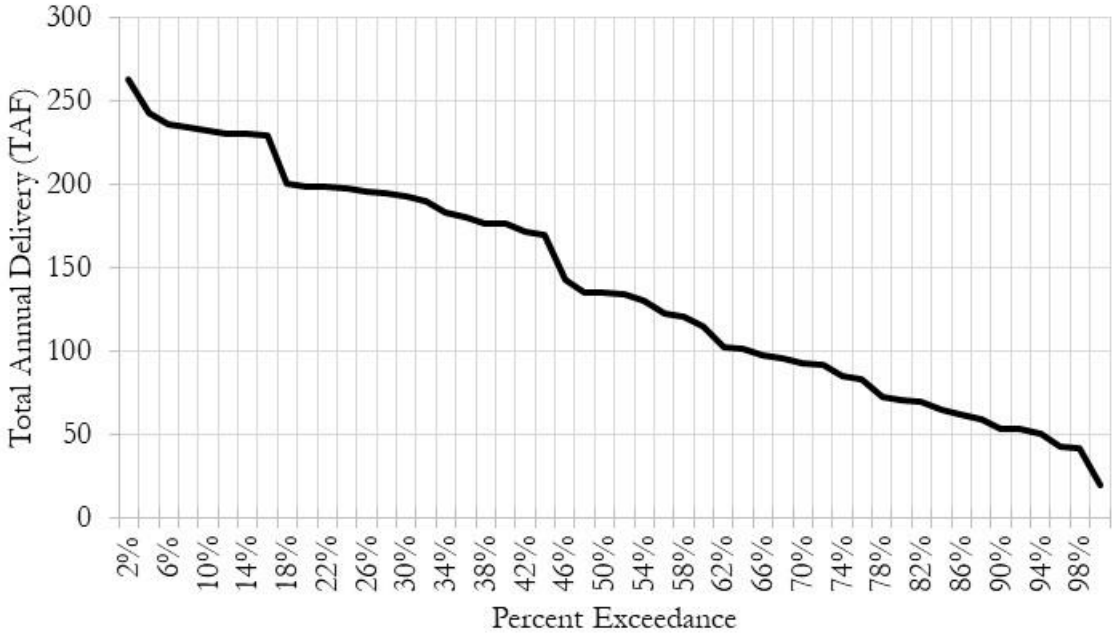
This section summarizes the total water supply delivery and the total water quality to Friant Contractors in Reach D. The Friant Contractors within Reach D include Saucelito Irrigation District, Terra Bella Irrigation District, Tea Pot Dome Water District (TPDWD), Pixley Irrigation District, Lower Tule River Irrigation District, and Porterville Irrigation District.

Water Supply

Under Existing Conditions, the Reach D Deer Creek check structure capacity is assumed to be 0 cfs. Since the check structure has zero capacity no supply from reverse-flow pump-back operations is delivered to the Friant Contractors in Reach D. The delivery to the Friant Contractors in Reach D is composed of Millerton Supply and FKC groundwater pump-in program supply. Figure 3-15 shows the percent exceedance of total annual delivery to the Friant Contractors in Reach D under Existing Conditions. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach D and not at the Intertie.

Table 3-54 summarizes the average total annual delivery to the Friant Contractors in Reach D by source for an average of all years and by San Joaquin Valley Water Year Type under Existing Conditions. In this table, existing programs include the water delivered from FKC groundwater pump-in programs. Across all years, the total average delivery is 140 TAF with less than 1 percent from FKC groundwater pump-in program supply (total mitigation is less than 1 percent of total delivery). For an average Wet water year, the total delivery is 205 TAF all from Millerton supply. For an average Critical water year, the total delivery is 57 TAF with 1 percent from FKC groundwater pump-in program supply (total mitigation is less than 1 percent of total delivery).

Table 3-55 to Table 3-57 and Figure 3-16 summarizes the average monthly delivery to the Friant Contractors in Reach D by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-15. Probability of Exceedance for Total Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach D under Existing Conditions

Table 3-54. Average Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach D by Source for an Average of All Years and by San Joaquin Valley Water Year Type under Existing Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	139	205	186	116	99	56
Existing Programs	<1	0	0	0	<1	<1
Total Supply	140	205	186	116	100	57

Table 3-55. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source under Existing Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	7,106	12,540	19,024	26,219	26,146	21,734	11,045	4,517	1,303	1,052	2,154	6,404	139,245
Existing Programs	0	0	48	48	48	48	48	48	0	0	0	0	291
Total Supply	7,106	12,540	19,072	26,268	26,194	21,783	11,094	4,565	1,303	1,052	2,154	6,404	139,535

Table 3-56. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source under Existing Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	11,378	19,796	30,858	39,888	37,087	31,962	18,040	4,368	1,316	653	1,958	7,929	205,232
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Supply	11,378	19,796	30,858	39,888	37,087	31,962	18,040	4,368	1,316	653	1,958	7,929	205,232

Table 3-57. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source under Existing Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	2,200	2,975	5,275	11,332	14,144	9,162	4,092	2,844	713	217	217	2,548	55,720
Existing Programs	0	0	135	135	135	135	135	98	0	0	0	0	771
Total Supply	2,200	2,975	5,410	11,467	14,279	9,296	4,227	2,942	713	217	217	2,548	56,491

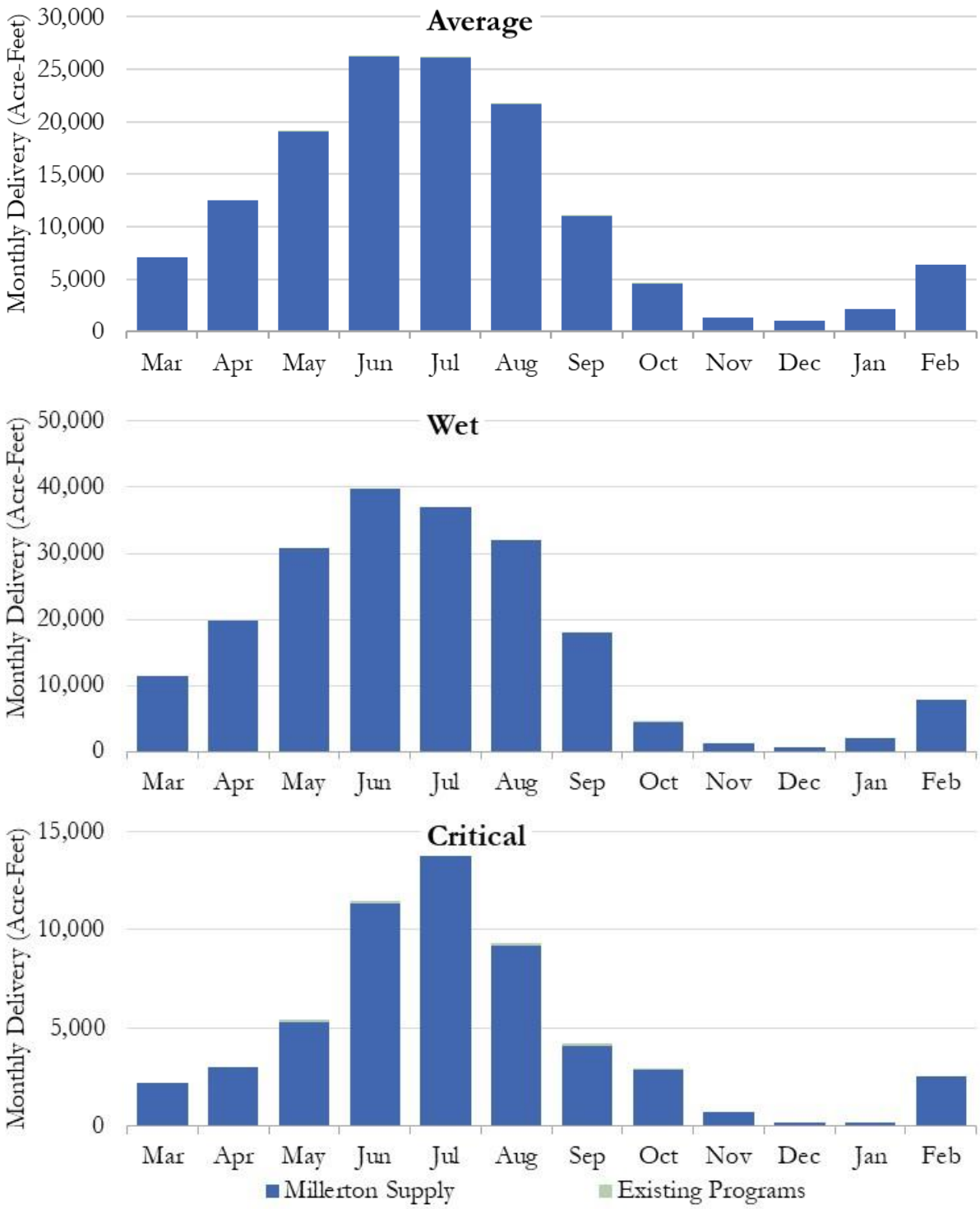


Figure 3-16. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source under Existing Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach D deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-58 to Table 3-61 show the monthly average and monthly maximum water quality trends for individual constituents under the Existing Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. For months where there is FKC groundwater pump-in program supply being delivered, water quality concentrations also increase. For TDS, nitrate, chloride, and boron, the concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-58. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	24.57	27.46	25.84	36.46	26.16	20.30	18.31	22.26	18.88	23.54	24.69	24.35
Maximum	25.00	28.00	48.68	69.39	53.90	44.62	36.49	55.09	20.00	29.00	31.60	25.67
Wet Water Years												
Average	24.33	28.00	21.33	21.00	13.00	13.75	13.00	25.80	18.89	25.78	26.22	25.67
Maximum	24.33	28.00	21.33	21.00	13.00	13.75	13.00	55.09	20.00	29.00	29.50	25.67
Critical Water Years												
Average	25.00	26.50	35.91	64.52	49.94	33.08	29.56	25.79	18.00	12.73	14.36	22.00
Maximum	25.00	26.50	48.68	69.39	53.90	44.62	36.49	36.36	18.00	28.00	31.60	22.00

Key: mg/L = milligrams per liter

Table 3-59. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.15	0.46	0.14	0.90	0.45	0.26	0.21	0.30	0.08	0.15	1.11	0.50
Maximum	0.18	1.00	0.77	2.48	1.29	0.92	0.70	1.22	0.09	0.20	1.80	0.70
Wet Water Years												
Average	0.18	0.16	0.03	0.08	0.04	0.09	0.08	0.38	0.07	0.18	1.60	0.70
Maximum	0.18	0.16	0.03	0.08	0.04	0.09	0.08	1.22	0.08	0.20	1.80	0.70
Critical Water Years												
Average	0.10	1.00	0.39	2.36	1.18	0.59	0.50	0.44	0.09	0.06	0.12	0.17
Maximum	0.10	1.00	0.77	2.48	1.29	0.92	0.70	0.74	0.09	0.13	0.27	0.17

Key: mg/L = milligrams per liter

Table 3-60. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.23
Maximum	0.02	0.02	0.02	0.04	0.02	0.03	0.02	0.03	0.01	0.05	0.02	0.34
Wet Water Years												
Average	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.34
Maximum	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.03	0.01	0.02	0.02	0.34
Critical Water Years												
Average	0.02	0.02	0.01	0.04	0.02	0.03	0.01	0.01	0.01	0.02	0.01	0.02
Maximum	0.02	0.02	0.01	0.04	0.02	0.03	0.01	0.01	0.01	0.05	0.02	0.02

Key: mg/L = milligrams per liter

Table 3-61. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	1.88	2.55	2.02	2.86	2.03	1.38	1.46	1.76	1.52	2.25	1.76	1.79
Maximum	2.10	3.10	4.63	6.50	4.87	3.68	3.56	4.77	1.75	3.05	2.20	1.90
Wet Water Years												
Average	2.10	2.23	1.30	1.08	0.66	0.74	0.72	2.11	1.65	2.71	1.96	1.90
Maximum	2.10	2.23	1.30	1.08	0.66	0.74	0.72	4.77	1.75	3.05	2.20	1.90
Critical Water Years												
Average	1.50	3.10	3.49	6.06	4.51	2.63	2.94	2.04	1.20	0.91	0.92	1.60
Maximum	1.50	3.10	4.63	6.50	4.87	3.68	3.56	3.00	1.20	2.01	2.02	1.60

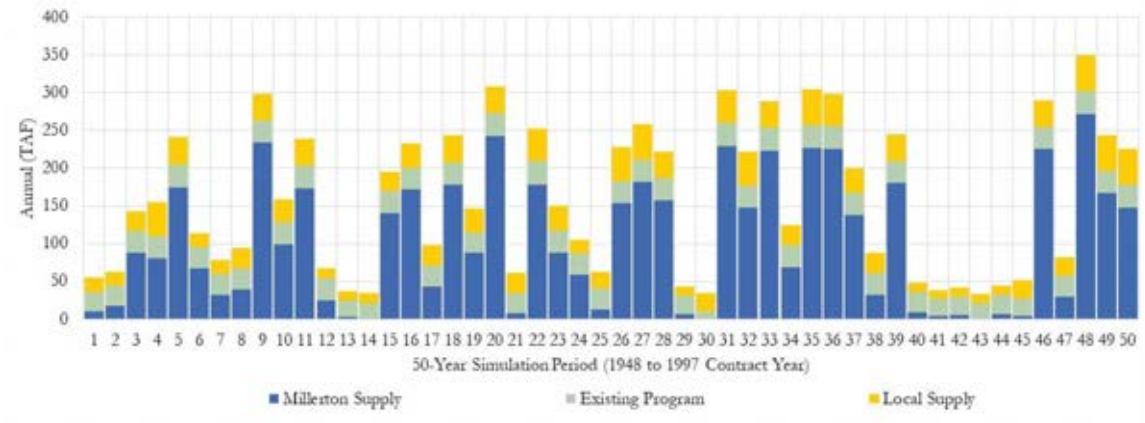
Key: mg/L = milligrams per liter

3.2.1.6 Total Surface Water Delivery to Friant Contractors

This section summarizes the annual total surface water delivery to the Friant Contractors in the study area under the Existing Conditions. The Distribution Module simulates the delivery of Millerton supply and existing program supply. The local supplies are added to the individual Friant Contractors after the Distribution Module deliveries. Local supplies were considered in this analysis for several Friant Contractors. AEWSD receives deliveries from the Kern River and directly from the California Aqueduct. Porterville ID, LTRID, and TBID all receive deliveries from the Tule River.

Arvin-Edison Water Storage District

Figure 3-17 summarizes the total annual surface water delivery to AEWSD in the Existing Conditions. AEWSD receives local sources of water supply directly from the Kern River and directly from the California Aqueduct.

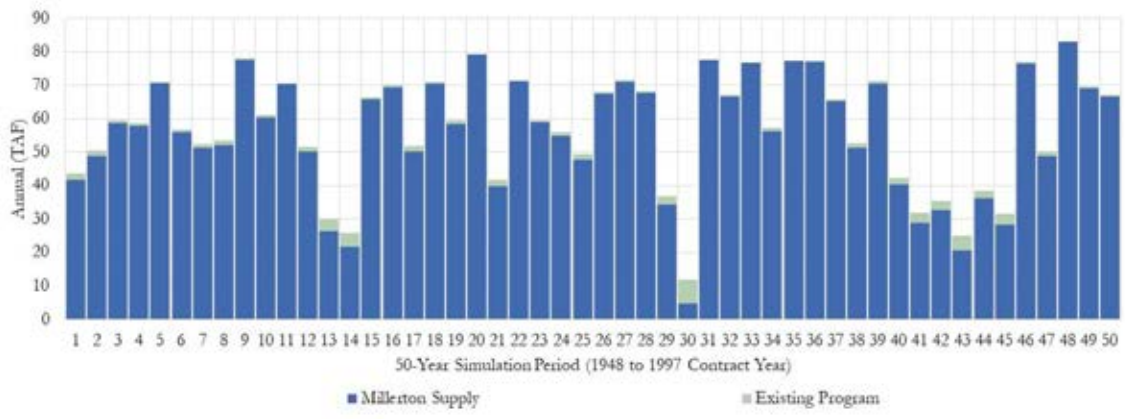


Key: TAF = thousand acre-feet

Figure 3-17. Total Annual Surface Water Delivery (thousand acre-feet) to Arvin-Edison Water Storage District under Existing Conditions

Shafter-Wasco Irrigation District

Figure 3-18 summarizes the total annual surface water delivery to SWID in the Existing Conditions.

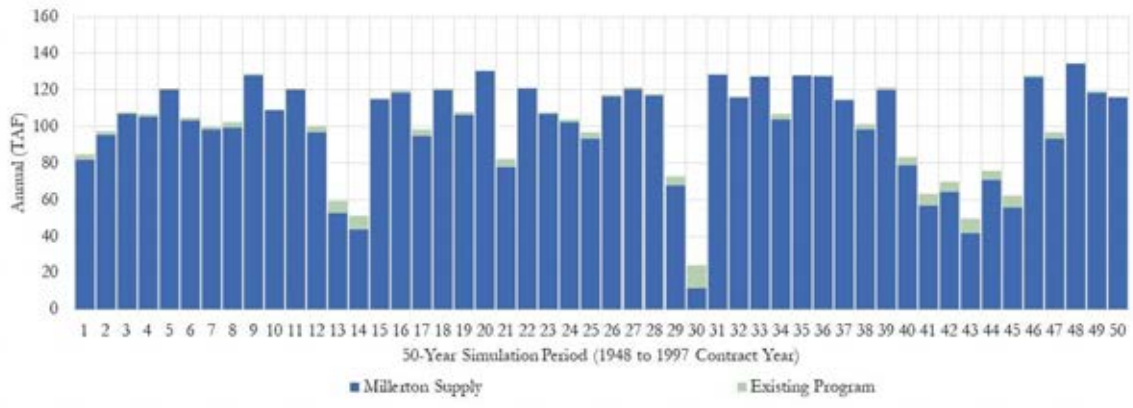


Key: TAF = thousand acre-feet

Figure 3-18. Total Annual Surface Water Delivery (thousand acre-feet) to Shafter-Wasco Irrigation District under Existing Conditions

Southern San Joaquin Municipal Utility District

Figure 3-19 summarizes the total annual surface water delivery to SSJMUD in the Existing Conditions.

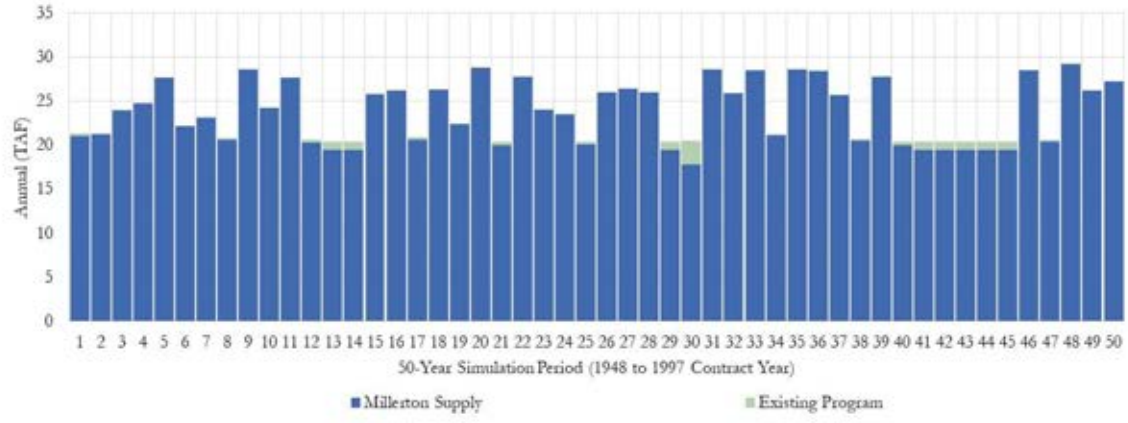


Key: TAF = thousand acre-feet

Figure 3-19. Total Annual Surface Water Delivery (thousand acre-feet) to Southern San Joaquin Municipal Utility District under Existing Conditions

Kern-Tulare Water District

Figure 3-20 summarizes the total annual surface water delivery to KTWD in the Existing Conditions.

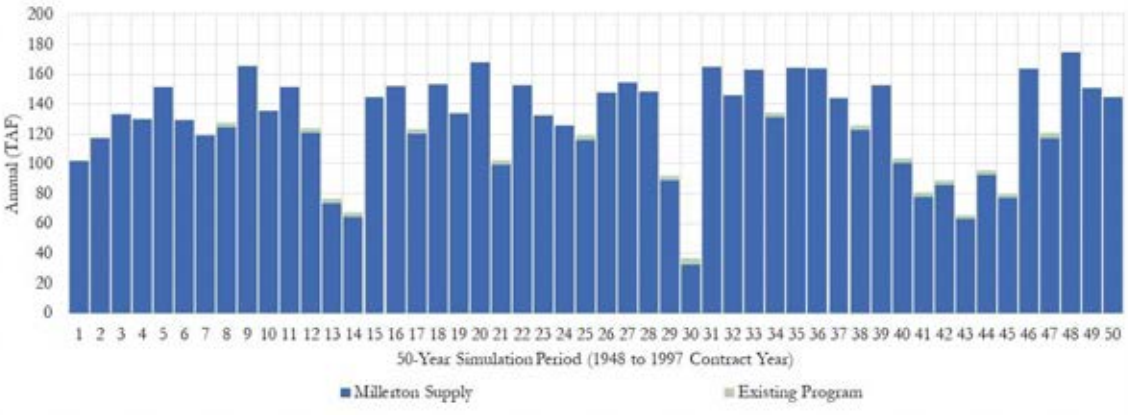


Key: TAF = thousand acre-feet

Figure 3-20. Total Annual Surface Water Delivery (thousand acre-feet) to Kern-Tulare Water District under Existing Conditions

Delano-Earlimart Irrigation District

Figure 3-21 summarizes the total annual surface water delivery to DEID in the Existing Conditions.

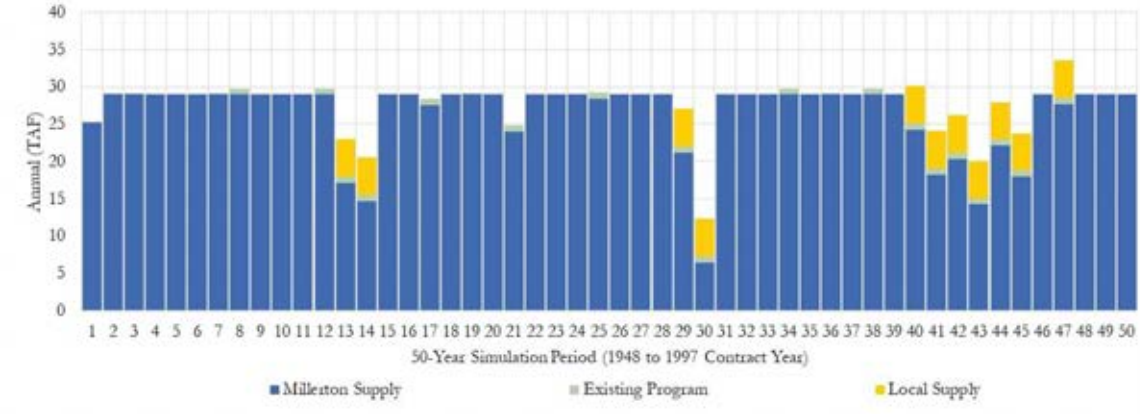


Key: TAF = thousand acre-feet

Figure 3-21. Total Annual Surface Water Delivery (thousand acre-feet) to Delano-Earlimart Irrigation District under Existing Conditions

Terra Bella Irrigation District

Figure 3-22 summarizes the total annual surface water delivery to TBID in the Existing Conditions. TBID receives local sources of water supply directly from the Tule River.

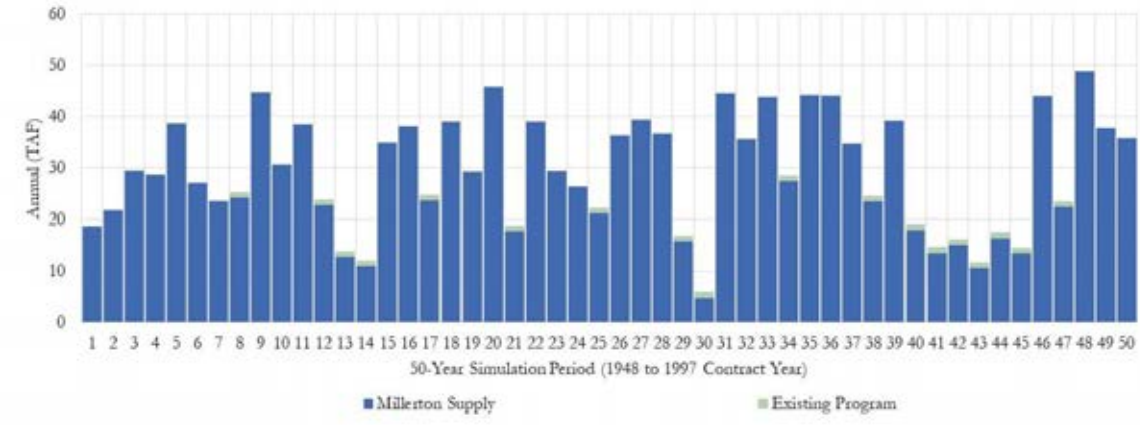


Key: TAF = thousand acre-feet

Figure 3-22. Total Annual Surface Water Delivery (thousand acre-feet) to Terra Bella Irrigation District under Existing Conditions

Saucelito Irrigation District

Figure 3-23 summarizes the total annual surface water delivery to Saucelito ID in the Existing Conditions.



Key: TAF = thousand acre-feet

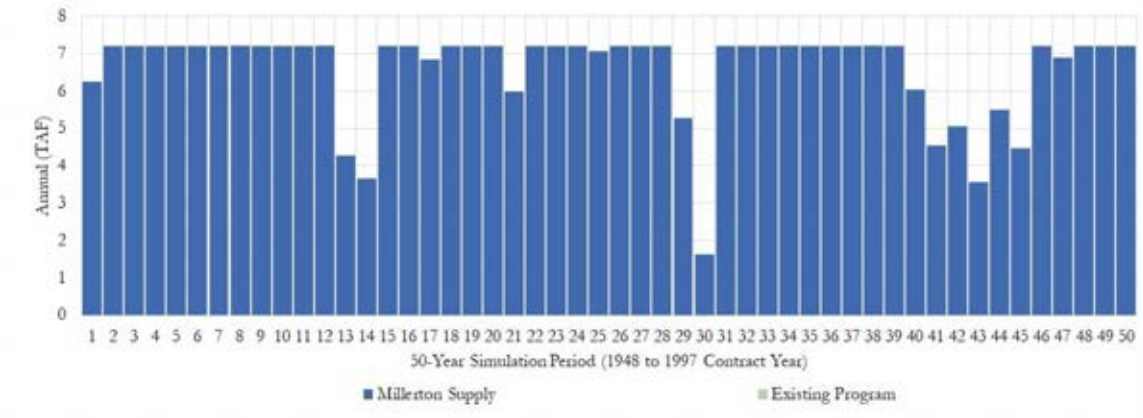
Figure 3-23. Total Annual Surface Water Delivery (thousand acre-feet) to Saucelito Irrigation District under Existing Conditions

Pixley Irrigation District

Under the Existing Conditions, Pixley ID does not receive delivery of Millerton supply and/or exiting program supply.

Tea Pot Dome Water District

Figure 3-24 summarizes the total annual surface water delivery to TPDWD in the Existing Conditions.

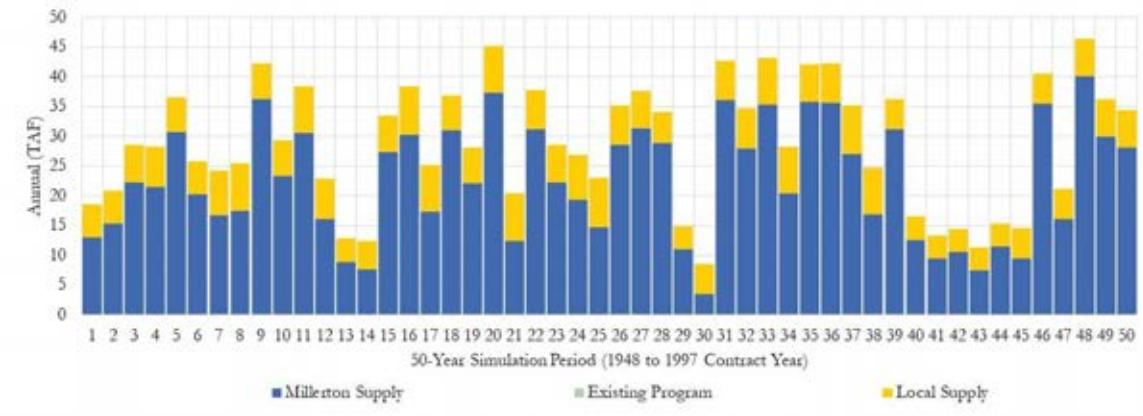


Key: TAF = thousand acre-feet

Figure 3-24. Total Annual Surface Water Delivery (thousand acre-feet) to Tea Pot Dome Water District under Existing Conditions

Porterville Irrigation District

Figure 3-25 summarizes the total annual surface water delivery to Porterville ID in the Existing Conditions. Porterville ID receives local sources of water supply directly from the Tule River.

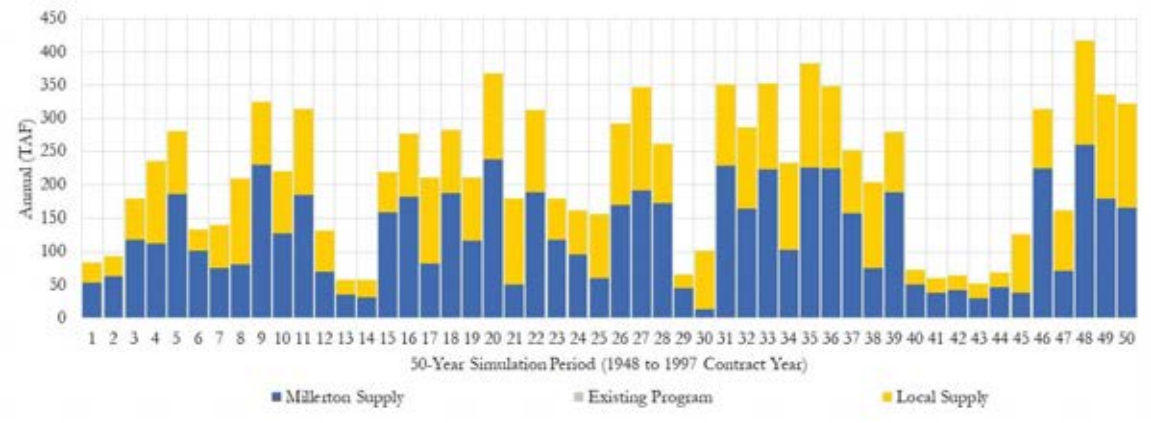


Key: TAF = thousand acre-feet

Figure 3-25. Total Annual Surface Water Delivery (thousand acre-feet) to Porterville Irrigation District under Existing Conditions

Lower Tule River Irrigation District

Figure 3-26 summarizes the total annual surface water delivery to LTRID in the Existing Conditions. LTRID receives local sources of water supply directly from the Tule River.



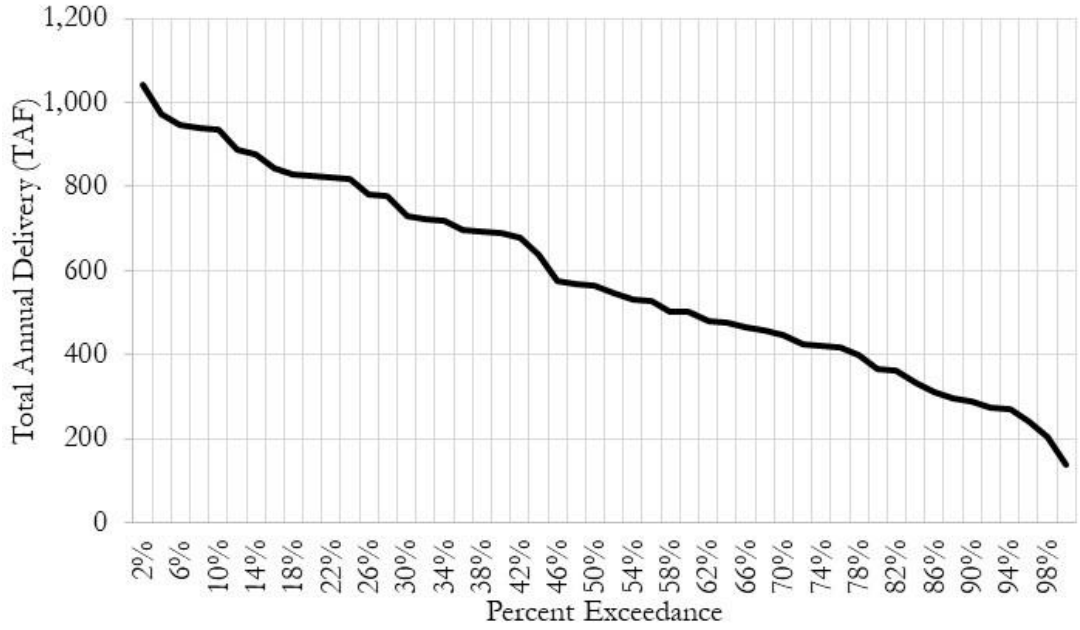
Key: TAF = thousand acre-feet

Figure 3-26. Total Annual Surface Water Delivery (thousand acre-feet) to Lower Tule River Irrigation District under Existing Conditions

3.2.2 No Project Alternative

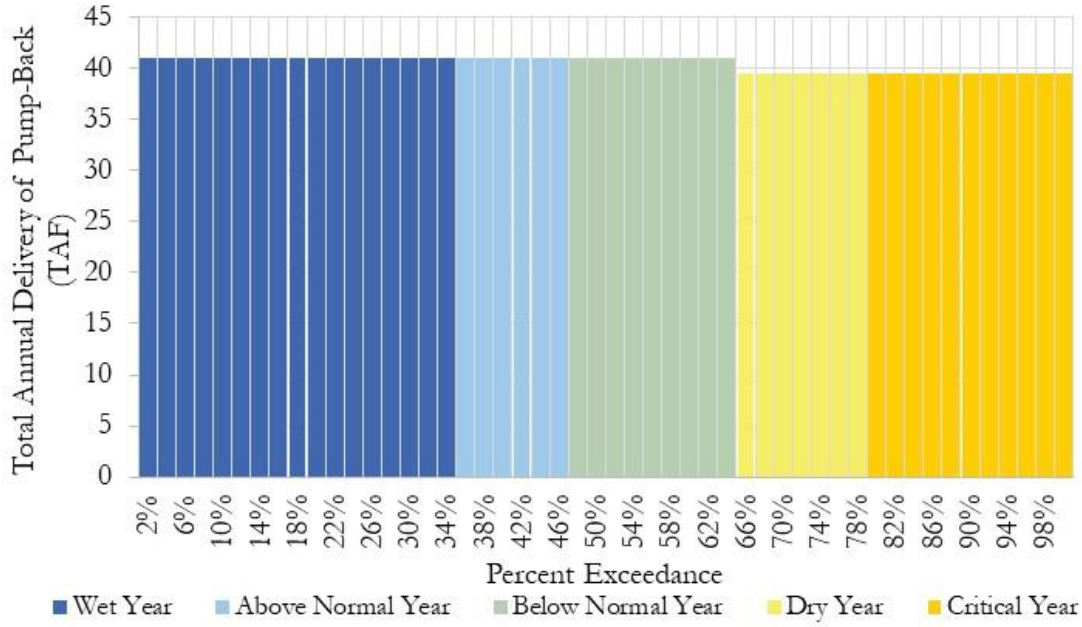
Under the No Project Alternative, temporary pumps are installed at the Shafter-Wasco and Lake Woollomes check structures (80 cfs and 50 cfs, respectfully) and zero pump capacity is assumed at the Deer Creek check structure. Figure 3-27 shows the probability of exceedance of total annual delivery to Friant Contractors in the study area under the No Project Alternative. Figure 3-28 shows the probability of exceedance of total annual delivery via reverse-flow pump-back operations to Friant Contractors in the study area by San Joaquin Valley Water Year Type under the No Project Alternative. These pump-back operational volumes represent all supply being delivered via reverse-flow pump-back operations at the Intertie and includes the following existing programs: Cross Valley Contract supplies for KTWD, LTRID and Pixley ID, and the Rosedale Banking and West Kern Banking programs. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC at different locations along the Project reaches and not at the Intertie.

Table 3-62 summarizes the average total annual delivery to Friant Contractors in the study area by source for an average of all years and by San Joaquin Valley Water Year Type under the No Project Alternative. In this table, existing programs include the water delivered via reverse-flow pump-back and from FKC groundwater pump-in programs. Across all years, the average total delivery is 586 TAF with 7 percent from existing programs. For an average Wet water year, the total delivery is 809 TAF with 5 percent from existing programs. For an average Critical water year, the total delivery is 295 TAF with 16 percent from existing programs.



Key: TAF = thousand acre-feet

Figure 3-27. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to Friant Contractors in the Study Area under the No Project Alternative



Key: TAF = thousand acre-feet

Figure 3-28. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to Friant Contractors in the Study Area by San Joaquin Valley Water Year Type under the No Project Alternative

Table 3-62. Average Annual Delivery (thousand acre-feet) to Friant Contractors in the Study Area by Source for an Average of All Years and by San Joaquin Valley Water Year Type under the No Project Alternative

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	543	768	685	467	430	249
Existing Programs	43	41	41	41	46	46
Total Supply	586	809	725	508	476	295

3.2.2.1 Location of Interface

Table 3-63 summarizes the average monthly location of the interface between the reverse-flow pump-back operations and gravity operations (i.e., Millerton supply) for an average of all years and by San Joaquin Valley Water Year Type under the No Project Alternative. Because there is limited supply being conveyed via reverse flow pump-back, the interface location remains in either Reach A, Reach B, or Reach C and is not observed beyond the Deer Creek check structure (Reach D) as there is zero pump-back capacity assumed. Reverse-flow pump-back operations mainly occur during the irrigation season and there is no mixing interface during January.

Table 3-63. Average Monthly Project Reach Location of Pump-Back Interface for an Average of All Years and by San Joaquin Valley Water Year Type under the No Project Alternative

Year Type	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Wet	C	A	A	A	A	A	A	B	B	B	-	A
Above Normal	A	A	A	A	A	A	B	C	C	C	-	A
Below Normal	A	B	B	A	A	B	B	C	C	C	-	A
Dry	B	B	B	A	A	B	B	C	C	C	-	A
Critical	C	C	C	B	B	C	C	C	C	C	-	A
Average	A	B	B	A	A	B	B	C	C	C	-	A

Notes:
Year Type is based on San Joaquin Valley Water Year Types
Reach A is the Intertie to Shafter-Wasco Check
Reach B is from Shafter-Wasco Check to Lake Woollomes Check
Reach C is from Lake Woollomes Check to Deer Creek Check

3.2.2.2 Reach A

This section summarizes the total water supply delivery and the total water quality to the Friant Contractors in Reach A. The only Friant Contractor within Reach A is AEWSD.

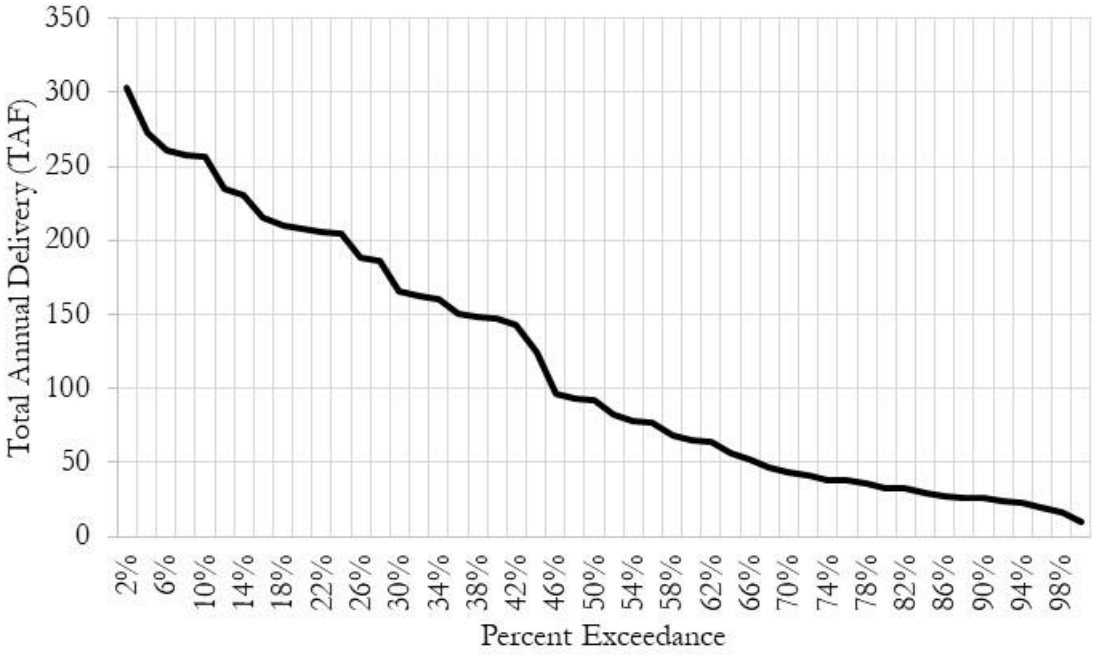
Water Supply

Figure 3-29 shows the probability of exceedance of total annual delivery to the Friant Contractor in Reach A under the No Project Alternative. Figure 3-30 shows the probability of exceedance of total annual supply delivered to the Friant Contractor in Reach A via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the No Project Alternative. These volumes represent

all supply being delivered via reverse-flow pump-back operations at the Intertie and includes the following existing programs: Cross Valley Contract supplies for KTWD, LTRID and Pixley ID, and the Rosedale Banking and West Kern Banking programs. There are no FKC groundwater pump-in program deliveries in Reach A.

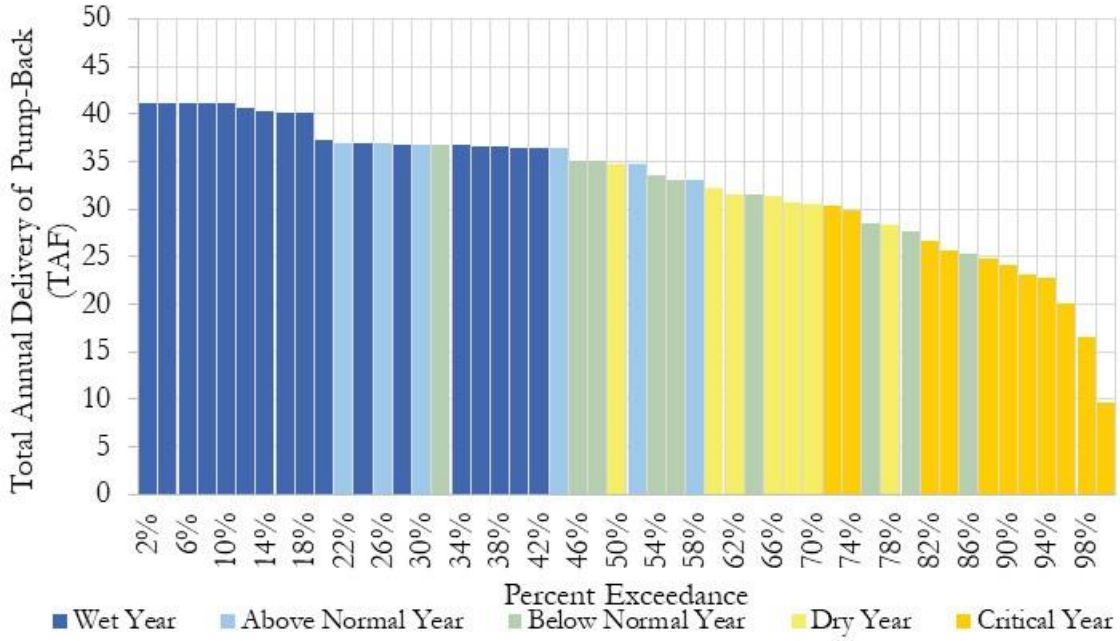
Table 3-64 summarizes the average total annual delivery to the Friant Contractor in Reach A by source for an average of all years and by San Joaquin Valley Water Year Type under the No Project Alternative. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs). Across all years, the total average delivery is 116 TAF with 28 percent from existing programs (total mitigation is 2 percent of total delivery). For an average Wet water year, the total delivery is 206 TAF with 18 percent from existing programs (total mitigation is 1 percent of total delivery). For an average Critical water year, the total delivery is 27 TAF with 89 percent from existing programs (total mitigation is 5 percent of total delivery).

Table 3-65 to Table 3-67 and Figure 3-31 summarizes the average monthly delivery to the Friant Contractor in Reach A by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-29. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to the Friant Contractor in Reach A under No Project Alternative



Key: TAF = thousand acre-feet

Figure 3-30. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to the Friant Contractor in Reach A by San Joaquin Valley Water Year Type under No Project Alternative

Table 3-64. Average Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach A by Source for an Average of All Years and by San Joaquin Valley Water Year Type under No Project Alternative

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	83	170	120	38	21	3
Existing Programs	33	36	38	33	34	24
Total Supply	116	206	158	71	55	27

Table 3-65. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source under No Project Alternative for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	5,312	8,331	14,276	17,864	13,988	7,858	3,401	1,317	850	824	2,693	6,067	82,780
Existing Programs	1,028	1,869	3,224	4,461	5,289	8,157	5,052	2,427	432	341	0	400	32,682
Total Supply	6,340	10,200	17,500	22,325	19,277	16,015	8,453	3,743	1,282	1,166	2,693	6,467	115,462

Table 3-66. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source under No Project Alternative for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	11,730	17,867	31,829	38,685	29,365	18,112	9,046	1,667	1,081	302	2,471	7,409	169,564
Existing Programs	855	1,840	3,470	4,470	4,640	10,431	7,206	2,174	359	288	0	400	36,134
Total Supply	12,586	19,707	35,299	43,155	34,005	28,543	16,253	3,841	1,441	591	2,471	7,809	205,699

Table 3-67. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source under No Project Alternative for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	0	0	108	910	388	68	0	0	0	0	113	1,650	3,238
Existing Programs	1,024	1,387	2,325	4,304	6,078	4,049	1,931	1,614	409	124	0	400	23,645
Total Supply	1,024	1,387	2,433	5,214	6,466	4,117	1,931	1,614	409	124	113	2,050	26,883

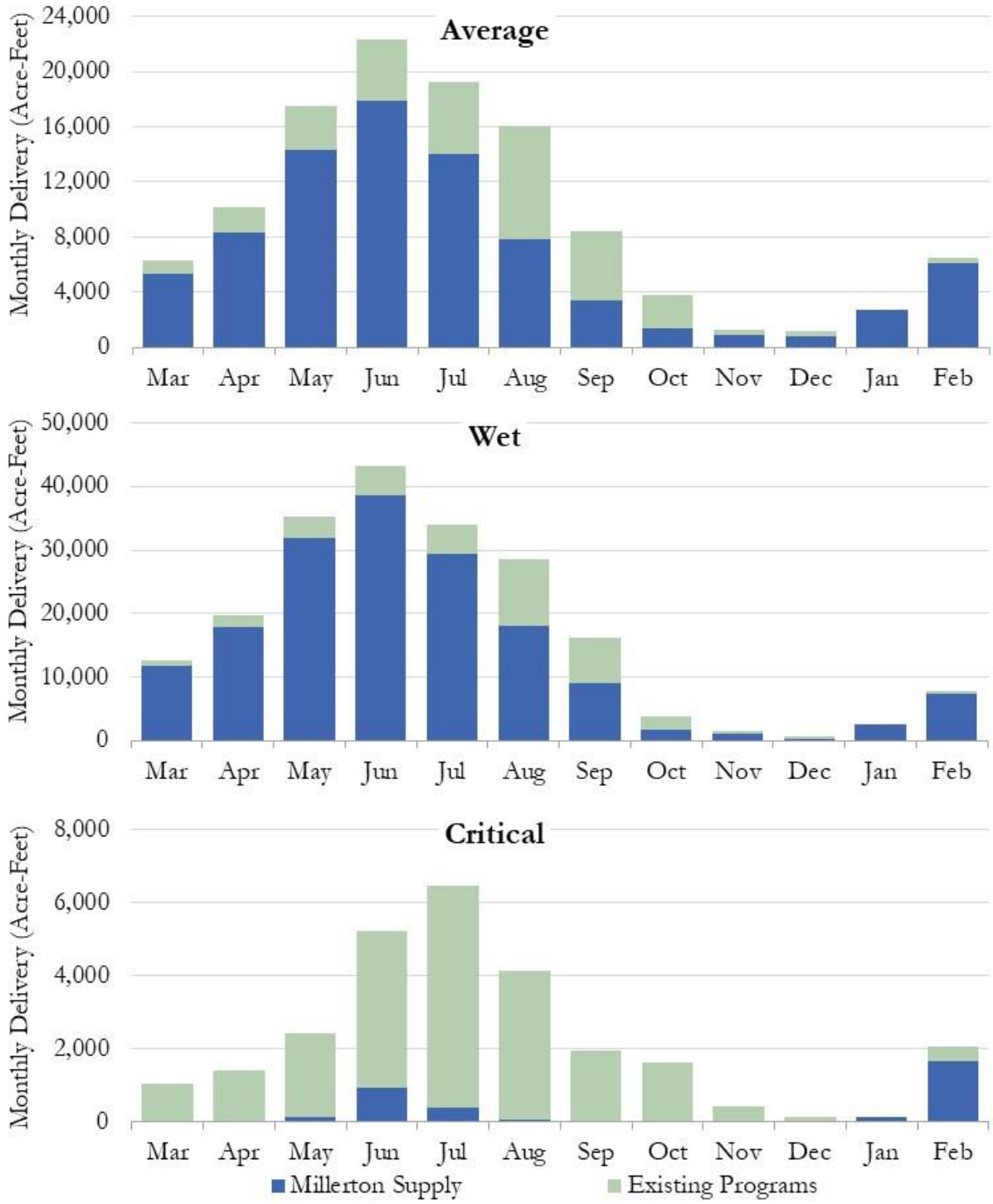


Figure 3-31. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source under No Project Alternative for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach A deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-68 to Table 3-71 show the monthly average and monthly maximum water quality trends for individual constituents under the No Project Alternative. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply being delivered via reverse-flow pump-back operations (i.e., existing programs), water quality concentrations tend to increase. For TDS, nitrate, chloride, and boron, there is a correlation between reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-68. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A under No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	96.06	127.24	93.32	95.59	75.97	108.73	130.93	191.29	188.74	128.42	22.88	91.62
Maximum	200.91	238.33	200.91	190.00	150.00	170.00	185.00	230.00	226.67	210.00	31.60	362.27
Wet Water Years												
Average	54.90	55.63	40.09	42.09	31.39	60.68	77.26	213.06	206.71	166.31	24.58	89.71
Maximum	200.91	170.32	49.11	60.91	40.10	80.99	133.33	230.00	226.67	210.00	29.50	216.02
Critical Water Years												
Average	147.14	238.33	158.26	171.48	145.27	168.54	185.00	165.71	178.57	61.82	11.49	110.29
Maximum	147.14	238.33	161.67	190.00	150.00	170.00	185.00	165.71	178.57	170.00	31.60	174.94

Key: mg/L = milligrams per liter

Table 3-69. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A under No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	2.93	2.10	2.23	1.85	1.45	1.93	2.09	2.79	3.50	2.18	1.03	1.43
Maximum	6.84	4.73	5.82	4.34	4.40	4.98	4.76	3.12	4.20	4.03	1.80	3.78
Wet Water Years												
Average	0.58	0.52	0.28	0.43	0.04	0.35	0.45	2.88	3.80	2.50	1.50	1.24
Maximum	2.45	2.04	0.40	0.74	0.04	0.47	0.78	3.12	4.20	3.17	1.80	2.32
Critical Water Years												
Average	6.84	4.73	5.67	4.05	4.25	4.93	4.76	2.84	3.40	1.46	0.10	2.25
Maximum	6.84	4.73	5.82	4.34	4.40	4.98	4.76	2.84	3.40	4.03	0.27	3.78

Key: mg/L = milligrams per liter

Table 3-70. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A under No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.06	0.07	0.06	0.07	0.06	0.07	0.08	0.10	0.10	0.08	0.01	0.22
Maximum	0.11	0.12	0.12	0.13	0.11	0.11	0.11	0.11	0.11	0.12	0.02	0.34
Wet Water Years												
Average	0.03	0.03	0.03	0.04	0.02	0.04	0.05	0.10	0.10	0.09	0.01	0.31
Maximum	0.11	0.09	0.03	0.05	0.03	0.05	0.08	0.11	0.11	0.12	0.02	0.34
Critical Water Years												
Average	0.11	0.12	0.11	0.12	0.11	0.11	0.11	0.09	0.11	0.04	0.01	0.08
Maximum	0.11	0.12	0.12	0.13	0.11	0.11	0.11	0.09	0.11	0.11	0.02	0.12

Key: mg/L = milligrams per liter

Table 3-71. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A under No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	18.44	18.13	19.62	19.44	15.43	25.72	35.10	62.98	56.71	35.68	1.63	24.35
Maximum	61.95	61.95	61.95	41.71	32.29	39.67	48.50	83.33	73.00	63.00	2.20	129.49
Wet Water Years												
Average	12.46	11.78	7.64	6.88	5.34	13.92	20.42	76.82	66.12	49.62	1.83	26.17
Maximum	61.95	51.39	10.68	12.04	7.56	19.63	37.62	83.33	73.00	63.00	2.20	74.05
Critical Water Years												
Average	21.57	21.00	29.15	36.55	31.00	39.28	48.50	42.86	47.00	14.44	0.73	23.92
Maximum	21.57	21.00	29.83	41.71	32.29	39.67	48.50	42.86	47.00	39.71	2.02	40.26

Key: mg/L = milligrams per liter

3.2.2.3 Reach B

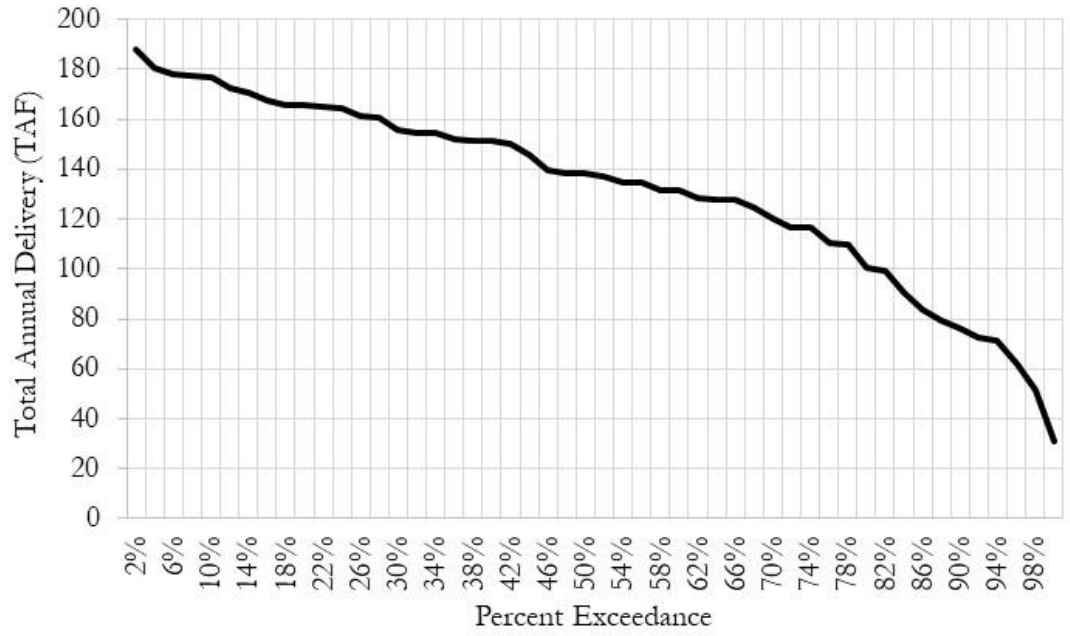
This section summarizes the total water supply delivery and the total water quality to the Friant Contractors in Reach B. The Friant Contractors within Reach B include Shafter-Wasco Irrigation District and South San Joaquin Municipal Utility District.

Water Supply

Under the No Project Alternative, the Reach B Shafter-Wasco check structure capacity is assumed to be 80 cfs. Figure 3-32 shows the probability of exceedance of total annual delivery to the Friant Contractors in Reach B under the No Project Alternative. Figure 3-33 shows the probability of exceedance of total annual delivery via reverse-flow pump-back operations to Friant Contractors in Reach B by San Joaquin Valley Water Year Type under the No Project Alternative. These volumes represent all supply being delivered via reverse-flow pump-back operations at the Intertie and includes the following existing programs: Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach B and not at the Intertie.

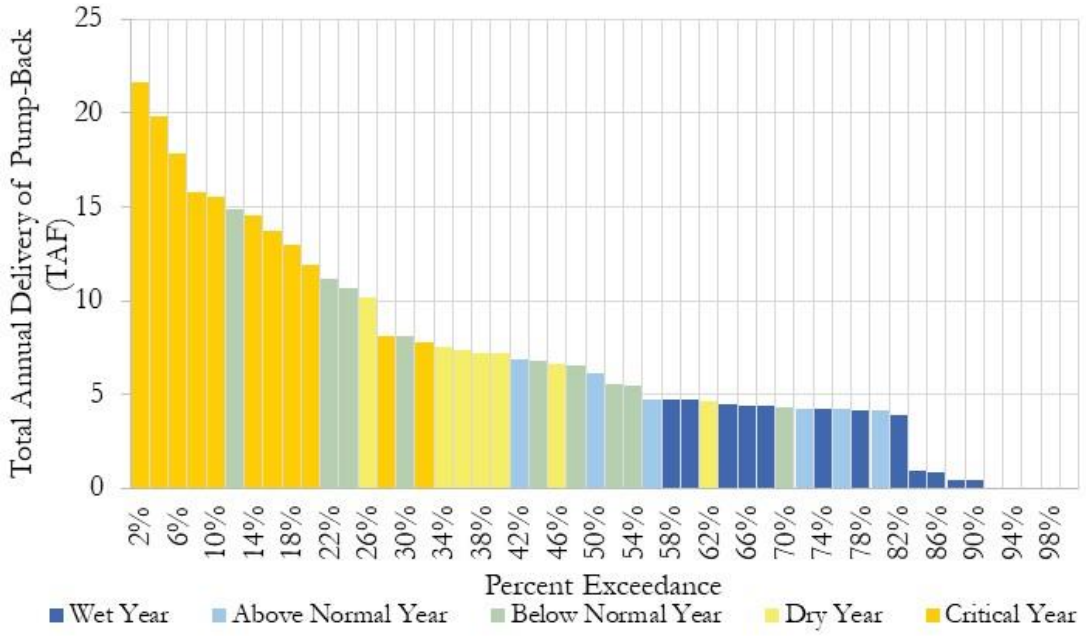
Table 3-72 summarizes the average total delivery to the Friant Contractors in Reach B by source for an average of all years and by San Joaquin Valley Water Year Type under the No Project Alternative. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Ken Banking programs) and from FKC groundwater pump-in programs. Across all years, the total average delivery is 132 TAF with 6 percent from existing programs (total mitigation is less than 1 percent of total delivery). For an average Wet water year, the total delivery is 161 TAF with 2 percent from existing programs (total mitigation is less than 1 percent of total delivery). For an average Critical water year, the total delivery is 78 TAF with 21 percent from existing programs (total mitigation is 2 percent of total delivery).

Table 3-73 to Table 3-75 and Figure 3-34 summarizes the average monthly delivery to the Friant Contractors in Reach B by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-32. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach B under No Project Alternative



Key: TAF = thousand acre-feet

Figure 3-33. Probability of Exceedance for Total Annual Pump-Back Delivery (thousand acre-feet) to the Friant Contractors in Reach B by San Joaquin Valley Water Year Type under No Project Alternative

Table 3-72. Average Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach B by Source for an Average of All Years and by San Joaquin Valley Water Year Type under No Project Alternative

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	124	157	156	123	120	62
Existing Programs	8	4	3	8	7	16
Total Supply	132	161	158	130	127	78

Table 3-73. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source under No Project Alternative for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	4,795	8,005	13,924	24,729	29,229	23,725	10,604	2,459	881	487	1,133	4,445	124,416
Existing Programs	289	381	392	156	283	692	1,727	2,840	422	305	0	0	7,489
Total Supply	5,084	8,386	14,316	24,886	29,512	24,417	12,331	5,300	1,303	793	1,133	4,445	131,904

Table 3-74. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source under No Project Alternative for Wet Water Year Type

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	5,820	9,648	17,146	29,410	35,642	32,201	18,103	1,941	698	250	1,066	4,642	156,568
Existing Programs	26	0	0	0	0	0	0	2,830	470	402	0	0	3,822
Total Supply	5,846	9,648	17,146	29,410	35,642	32,201	18,103	4771	1,168	652	1,066	4,642	160,296

Table 3-75. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source under No Project Alternative for Critical Water Year Type

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	2,027	2,603	5,926	15,182	18,774	10,589	2,042	961	650	89	261	2,771	61,875
Existing Programs	1,035	1,556	1,549	577	1,151	1,938	4,025	3,637	476	189	0	0	16,134
Total Supply	3,063	4,160	7,475	15,758	19,925	12,527	6,067	4,598	1,126	278	261	2,771	78,009

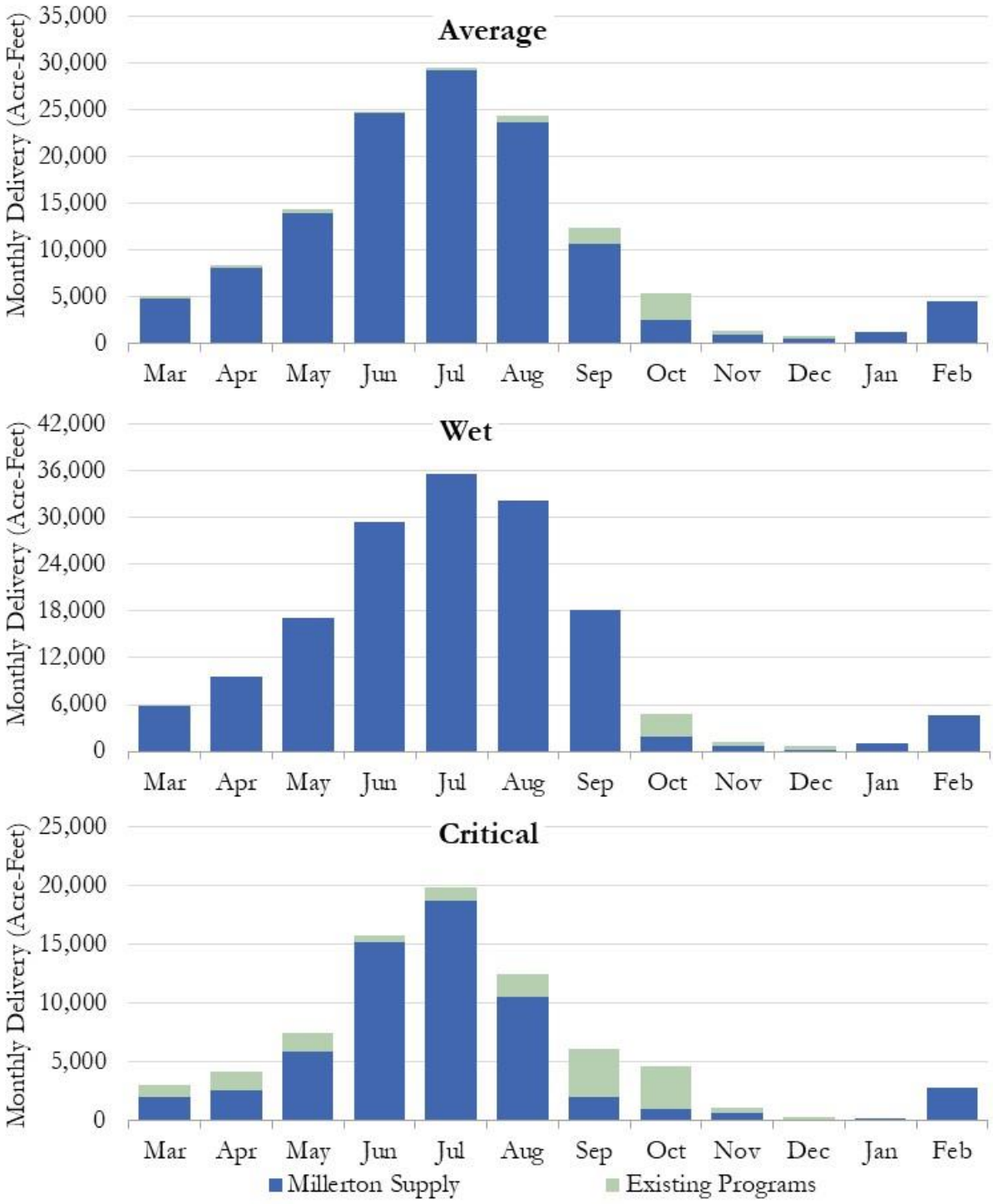


Figure 3-34. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source under No Project Alternative for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach B deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-76 to Table 3-79 show the monthly average and monthly maximum water quality trends for individual constituents under the No Project Alternative. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply being delivered via reverse-flow pump-back operations (i.e., existing programs) and FKC groundwater pump-in programs, water quality concentrations tend to increase. For TDS, nitrate, chloride, and boron, there is a correlation between reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-76. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B under No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	40.29	51.74	34.21	37.96	28.13	28.64	55.25	154.70	133.59	103.13	22.88	24.35
Maximum	200.91	238.33	173.51	121.29	109.65	179.13	192.74	241.65	226.67	210.00	31.60	25.67
Wet Water Years												
Average	34.72	28.00	21.33	21.00	13.00	13.75	13.00	188.56	172.72	143.00	24.58	25.67
Maximum	200.91	28.00	21.33	21.00	13.00	13.75	13.00	241.65	226.67	210.00	29.50	25.67
Critical Water Years												
Average	74.12	130.00	71.68	71.16	58.80	63.97	142.30	143.98	94.95	46.75	11.49	22.00
Maximum	147.14	238.33	173.51	121.29	109.65	179.13	192.74	175.63	178.57	170.00	31.60	22.00

Key: mg/L = milligrams per liter

Table 3-77. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B under No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.87	0.89	0.48	0.92	0.51	0.49	1.08	2.31	2.38	1.67	1.03	0.50
Maximum	6.84	4.73	6.05	3.32	3.08	5.21	4.99	3.83	4.20	4.03	1.80	0.70
Wet Water Years												
Average	0.32	0.16	0.03	0.08	0.04	0.09	0.08	2.66	3.12	2.12	1.50	0.70
Maximum	2.45	0.16	0.03	0.08	0.04	0.09	0.08	3.83	4.20	3.17	1.80	0.70
Critical Water Years												
Average	2.81	2.82	1.89	2.47	1.46	1.57	3.60	2.57	1.68	1.05	0.10	0.17
Maximum	6.84	4.73	6.05	3.32	3.08	5.21	4.99	3.22	3.40	4.03	0.27	0.17

Key: mg/L = milligrams per liter

Table 3-78. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B under No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.03	0.03	0.02	0.03	0.01	0.02	0.03	0.08	0.07	0.06	0.01	0.23
Maximum	0.11	0.12	0.11	0.07	0.07	0.10	0.10	0.11	0.11	0.12	0.02	0.34
Wet Water Years												
Average	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.09	0.08	0.08	0.01	0.34
Maximum	0.11	0.02	0.02	0.02	0.01	0.01	0.02	0.11	0.11	0.12	0.02	0.34
Critical Water Years												
Average	0.05	0.07	0.04	0.04	0.03	0.04	0.08	0.08	0.06	0.03	0.01	0.02
Maximum	0.11	0.12	0.11	0.07	0.07	0.10	0.10	0.09	0.11	0.11	0.02	0.02

Key: mg/L = milligrams per liter

Table 3-79. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B under No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	5.08	4.63	3.69	3.25	2.55	3.57	11.93	48.68	39.32	27.87	1.63	1.79
Maximum	61.95	21.00	29.80	20.92	20.00	39.07	47.53	83.33	73.00	63.00	2.20	1.90
Wet Water Years												
Average	5.62	2.23	1.30	1.08	0.66	0.74	0.72	64.77	54.40	41.90	1.83	1.90
Maximum	61.95	2.23	1.30	1.08	0.66	0.74	0.72	83.33	73.00	63.00	2.20	1.90
Critical Water Years												
Average	9.57	11.85	10.59	7.83	6.86	10.66	34.38	34.74	23.15	10.44	0.73	1.60
Maximum	21.57	21.00	29.80	20.92	20.00	39.07	47.53	42.13	47.00	39.71	2.02	1.60

Key: mg/L = milligrams per liter

3.2.2.4 Reach C

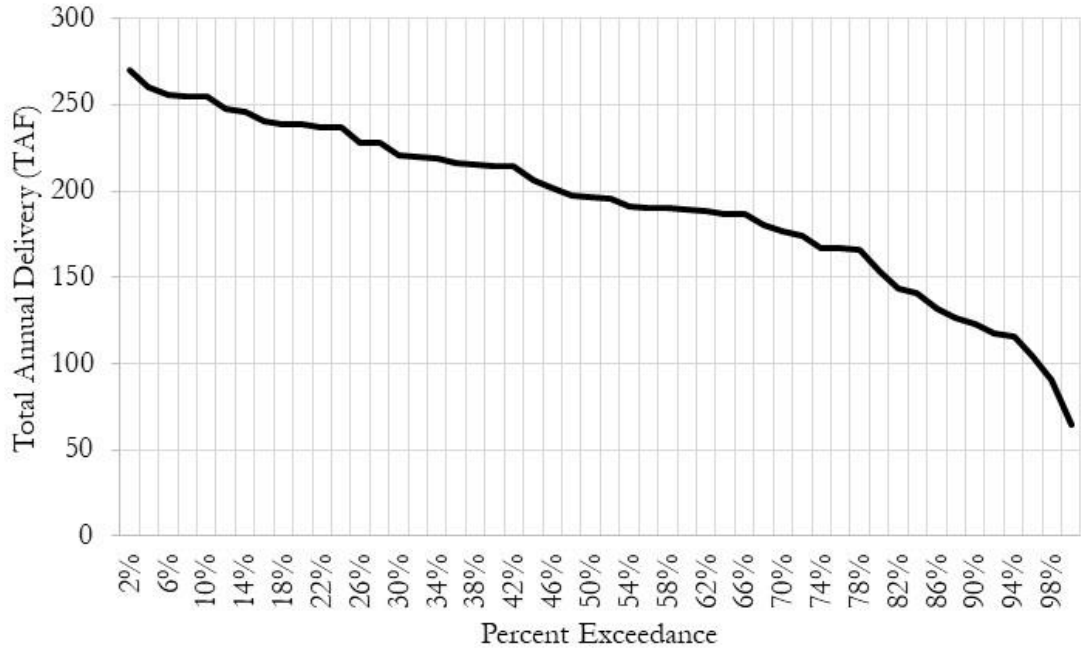
This section summarizes the total water supply delivery and the total water quality to the Friant Contractors in Reach C. The Friant Contractors within Reach C include South San Joaquin Municipal Utility District, Kern-Tulare Water District, Delano-Earlimart Irrigation District, Saucelito Irrigation District, and Terra Bella Irrigation District.

Water Supply

Under the No Project Alternative, the Reach C Lake Woollomes check structure capacity is assumed to be 50 cfs. Figure 3-35 shows the probability of exceedance of total annual delivery to the Friant Contractors in Reach C under the No Project Alternative. Figure 3-36 shows the probability of exceedance of total annual supply delivered to the Friant Contractors in Reach C via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the No Project Alternative. These volumes represent all supply being delivered via reverse-flow pump-back operations at the Intertie and includes the following existing programs: Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach C and not at the Intertie.

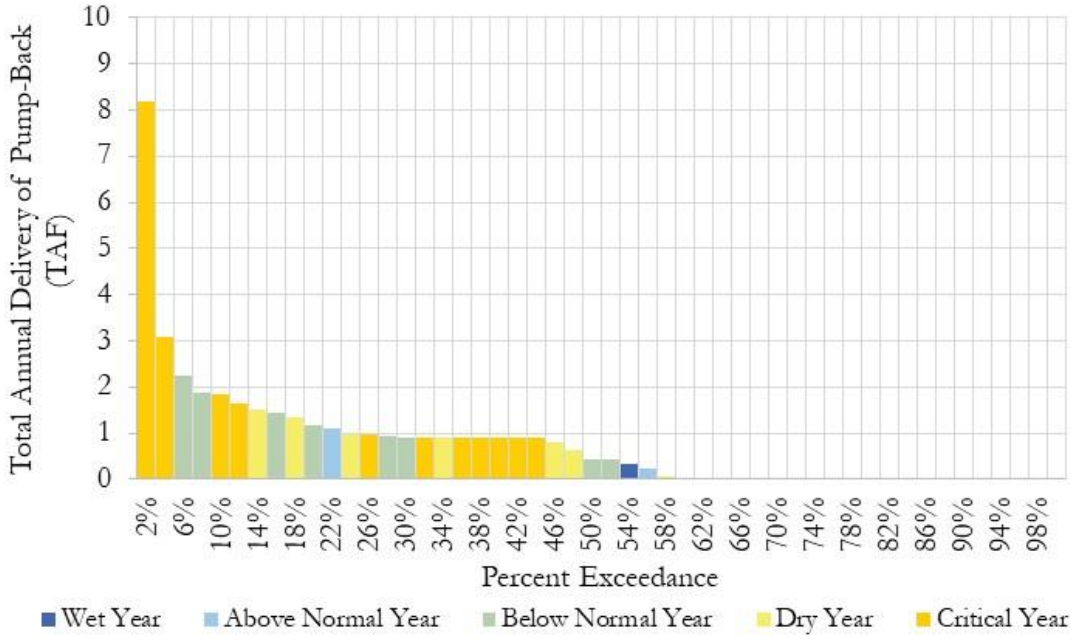
Table 3-80 summarizes the average total annual delivery to the Friant Contractors in Reach C by source for an average of all years and by San Joaquin Valley Water Year Type under the No Project Alternative. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the total average delivery is 192 TAF with 1 percent from existing programs (total mitigation is less than 1 percent of total delivery). For an average Wet water year, the total delivery is 231 TAF with less than 1 percent from existing programs (total mitigation is less than 1 percent of total delivery). For an average Critical water year, the total delivery is 124 TAF with 4 percent from existing programs (total mitigation is less than 1 percent of total delivery).

Table 3-81 to Table 3-83 and Figure 3-37 summarizes the average monthly delivery to the Friant Contractors in Reach C by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-35. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach C under No Project Alternative



Key: TAF = thousand acre-feet

Figure 3-36. Probability of Exceedance for Total Annual Pump-Back Delivery (thousand acre-feet) to the Friant Contractors in Reach C by San Joaquin Valley Water Year Type under No Project Alternative

Table 3-80. Average Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach C by Source for an Average of All Years and by San Joaquin Valley Water Year Type under No Project Alternative

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	190	230	223	184	183	119
Existing Programs	2	<1	<1	<1	4	5
Total Supply	192	231	224	185	187	124

Table 3-81. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source under the No Project Alternative for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	7,855	13,034	21,913	36,437	40,587	33,811	17,219	7,239	2,439	1,598	1,531	6,216	189,880
Existing Programs	15	21	277	275	275	304	312	642	46	253	0	0	2,421
Total Supply	7,870	13,055	22,190	36,712	40,863	34,114	17,531	7,881	2,485	1,852	1,531	6,216	192,300

Table 3-82. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source under the No Project Alternative for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	8,665	14,633	26,188	42,963	49,979	44,362	24,955	6,613	2,246	1,428	1,438	6,513	229,983
Existing Programs	19	0	0	0	0	0	0	476	71	210	0	0	775
Total Supply	8,683	14,633	26,188	42,963	49,979	44,362	24,955	7,089	2,317	1,637	1,438	6,513	230,578

Table 3-83. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source under the No Project Alternative for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	5,730	7,902	12,590	24,181	28,083	17,843	8,769	6,536	2,206	619	334	3,932	118,725
Existing Programs	41	96	772	765	765	894	931	676	15	587	0	0	5,541
Total Supply	5,771	7,999	13,362	24,946	28,848	18,737	9,699	7,211	2,221	1,206	334	3,932	124,266

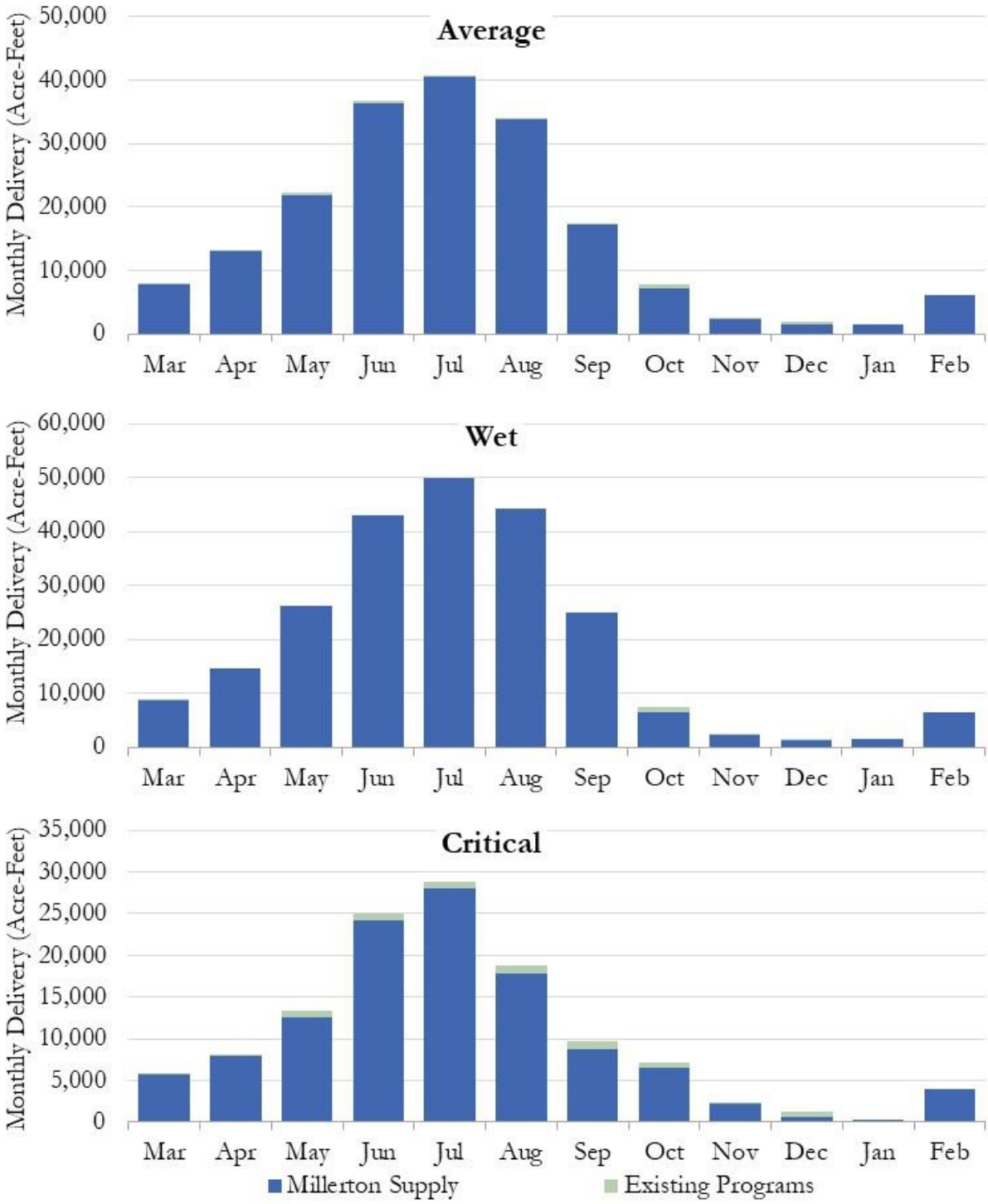


Figure 3-37. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source under No Project Alternative for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach C deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-84 to Table 3-87 show the monthly average and monthly maximum water quality trends for individual constituents under the No Project Alternative. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply being delivered via reverse-flow pump-back operations (i.e., existing programs) and FKC groundwater pump-in programs, water quality concentrations tend to increase. For TDS, nitrate, chloride, and boron, there is a correlation between reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-84. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C under No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	25.70	28.42	28.95	38.11	27.77	23.36	23.80	43.33	25.48	71.07	22.88	24.35
Maximum	64.68	74.51	59.12	76.72	62.53	86.46	79.04	216.80	62.82	210.00	31.60	25.67
Wet Water Years												
Average	26.71	28.00	21.33	21.00	13.00	13.75	13.00	54.12	30.12	66.63	24.58	25.67
Maximum	64.68	28.00	21.33	21.00	13.00	13.75	13.00	216.80	62.82	210.00	29.50	25.67
Critical Water Years												
Average	26.45	30.86	45.63	69.69	55.01	43.91	48.02	41.55	19.59	119.69	11.49	22.00
Maximum	40.93	74.51	59.12	76.72	62.53	86.46	79.04	71.57	35.48	170.00	31.60	22.00

Key: mg/L = milligrams per liter

Table 3-85. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C under No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.18	0.48	0.23	0.94	0.49	0.35	0.37	0.70	0.21	1.10	1.03	0.50
Maximum	0.98	1.84	1.10	2.67	1.54	2.21	1.89	3.73	0.93	4.03	1.80	0.70
Wet Water Years												
Average	0.21	0.16	0.03	0.08	0.04	0.09	0.08	0.89	0.28	0.82	1.50	0.70
Maximum	0.70	0.16	0.03	0.08	0.04	0.09	0.08	3.73	0.93	3.17	1.80	0.70
Critical Water Years												
Average	0.18	1.08	0.68	2.49	1.32	0.91	1.03	0.85	0.12	2.65	0.10	0.17
Maximum	0.98	1.84	1.10	2.67	1.54	2.21	1.89	1.55	0.45	4.03	0.27	0.17

Key: mg/L = milligrams per liter

Table 3-86. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C under No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.03	0.01	0.05	0.01	0.23
Maximum	0.04	0.04	0.02	0.04	0.02	0.04	0.03	0.08	0.03	0.12	0.02	0.34
Wet Water Years												
Average	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.03	0.02	0.04	0.01	0.34
Maximum	0.04	0.02	0.02	0.02	0.01	0.01	0.02	0.08	0.03	0.12	0.02	0.34
Critical Water Years												
Average	0.02	0.02	0.01	0.04	0.02	0.03	0.01	0.01	0.01	0.09	0.01	0.02
Maximum	0.03	0.04	0.02	0.04	0.02	0.04	0.03	0.02	0.02	0.11	0.02	0.02

Key: mg/L = milligrams per liter

Table 3-87. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C under No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	2.21	2.63	2.30	3.00	2.18	1.75	2.11	7.69	3.64	15.38	1.63	1.79
Maximum	15.78	7.16	5.72	7.15	5.65	12.25	12.38	62.12	16.51	63.00	2.20	1.90
Wet Water Years												
Average	2.90	2.23	1.30	1.08	0.66	0.74	0.72	10.61	5.24	15.51	1.83	1.90
Maximum	15.78	2.23	1.30	1.08	0.66	0.74	0.72	62.12	16.51	63.00	2.20	1.90
Critical Water Years												
Average	1.74	3.47	4.37	6.52	4.97	4.05	5.33	4.02	1.66	26.36	0.73	1.60
Maximum	4.12	7.16	5.72	7.15	5.65	12.25	12.38	9.61	6.19	39.71	2.02	1.60

Key: mg/L = milligrams per liter

3.2.2.5 Reach D

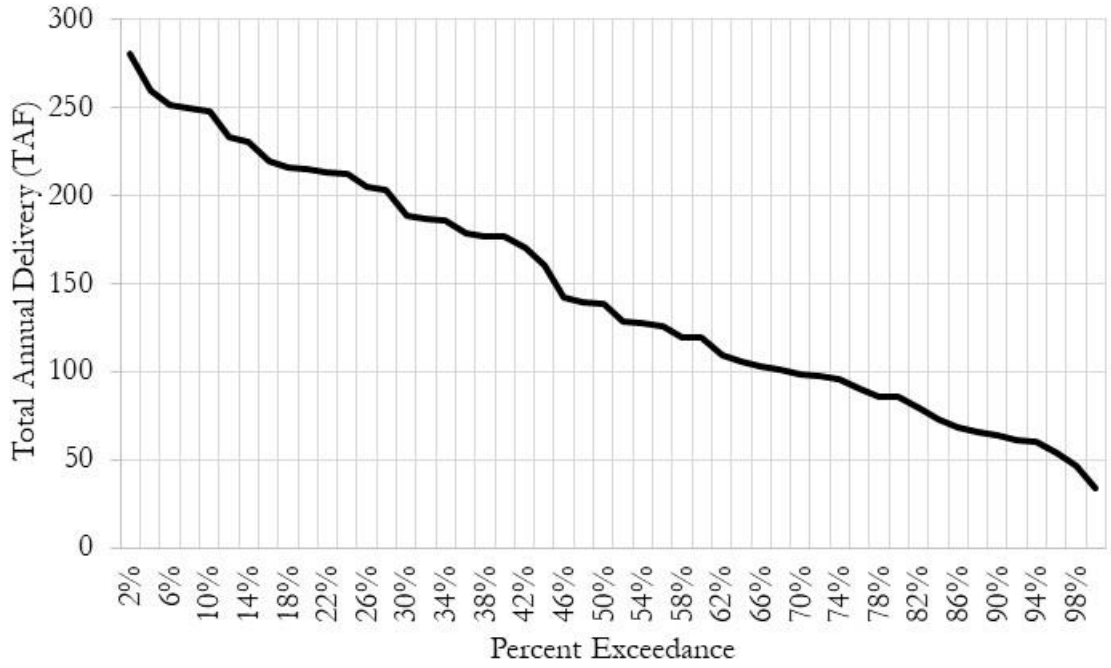
This section summarizes the total water supply delivery and the total water quality to the Friant Contractors in Reach D. The Friant Contractors within Reach D include Saucelito Irrigation District, Terra Bella Irrigation District, Tea Pot Dome Water District, Pixley Irrigation District, Lower Tule River Irrigation District, and Porterville Irrigation District.

Water Supply

Under the No Project Alternative, the Reach D Deer Creek check structure capacity is assumed to be 0 cfs. Since the check structure has zero capacity no supply is delivered via reverse-flow pump-back operations to the Friant Contractors in Reach D. The delivery to the Friant Contractors in Reach D is composed of Millerton Supply and FKC groundwater pump-in program supply. Figure 3-38 shows the percent exceedance of total annual delivery to the Friant Contractors in Reach D under the No Project Alternative. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach D and not at the Intertie.

Table 3-88 summarizes the average total annual delivery to the Friant Contractors in Reach D by source for an average of all years and by San Joaquin Valley Water Year Type under No Project Alternative. In this table, existing programs include the water delivered from FKC groundwater pump-in programs. Across all years, the total average delivery is 146 TAF with less than 1 percent from FKC groundwater pump-in program supply (total mitigation is less than 1 percent of total delivery). For an average Wet water year, the total delivery is 211 TAF all from Millerton supply. For an average Critical water year, the total delivery is 66 TAF with 1 percent from FKC groundwater pump-in program supply (total mitigation is less than 1 percent of total delivery).

Table 3-89 to Table 3-91 and Figure 3-39 summarizes the average monthly delivery to Friant Contractors in Reach D by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-38. Probability of Exceedance for Total Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach D under No Project Alternative

Table 3-88. Average Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach D by Source for an Average of All Years and by San Joaquin Valley Water Year Type under No Project Alternative

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	145	211	186	122	106	65
Existing Programs	<1	0	0	0	<1	<1
Total Supply	146	211	186	122	107	66

Table 3-89. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source under No Project Alternative for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	6,038	9,812	16,775	24,615	27,729	26,472	15,094	8,450	1,329	1,021	2,092	5,833	145,258
Existing Programs	0	0	48	48	48	48	48	48	0	0	0	0	291
Total Supply	6,038	9,812	16,823	24,663	27,778	26,520	15,142	8,498	1,329	1,021	2,092	5,833	145,549

Table 3-90. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source under No Project Alternative for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	10,009	15,897	28,395	38,803	37,343	38,878	23,039	8,165	1,356	621	1,933	6,698	211,138
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Supply	10,009	15,897	28,395	38,803	37,343	38,878	23,039	8,165	1,356	621	1,933	6,698	211,138

Table 3-91. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source under No Project Alternative for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	1,986	2,690	4,769	10,312	16,892	11,315	7,112	6,287	741	191	191	2,486	64,971
Existing Programs	0	0	135	135	135	135	135	98	0	0	0	0	771
Total Supply	1,986	2,690	4,903	10,447	17,027	11,449	7,247	6,385	741	191	191	2,486	65,742

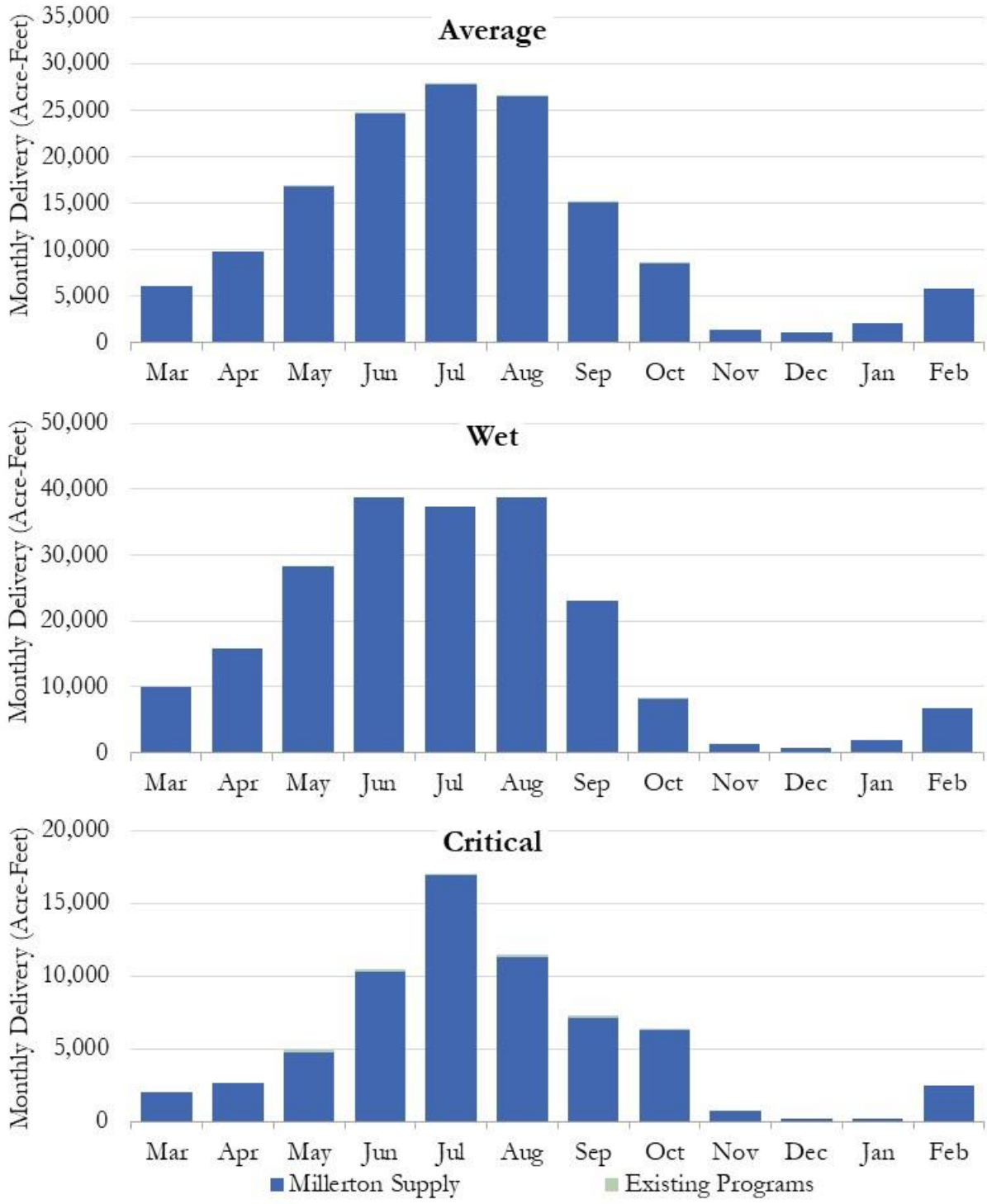


Figure 3-39. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source under No Project Alternative for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach D deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-92 to Table 3-95 show the monthly average and monthly maximum water quality trends for individual constituents under the No Project Alternative. The individual constituents considered are TDS, nitrate, boron, and chloride. For months where there is FKC groundwater pump-in program supply being delivered, water quality concentrations increase slightly. For TDS, nitrate, chloride, and boron, the concentration trends are influenced by seasonal water quality trends of the source water.

Table 3-92. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D under No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	24.57	27.46	26.12	36.55	25.99	19.90	17.02	18.32	19.28	21.82	22.88	24.35
Maximum	25.00	28.00	49.04	69.53	51.10	35.03	26.15	26.71	20.00	29.00	31.60	25.67
Wet Water Years												
Average	24.33	28.00	21.33	21.00	13.00	13.75	13.00	20.10	20.00	24.17	24.58	25.67
Maximum	24.33	28.00	21.33	21.00	13.00	13.75	13.00	26.71	20.00	29.00	29.50	25.67
Critical Water Years												
Average	25.00	26.50	36.75	64.84	49.34	31.46	24.81	19.12	18.00	10.18	11.49	22.00
Maximum	25.00	26.50	49.04	69.53	51.10	35.03	26.15	21.93	18.00	28.00	31.60	22.00

Key: mg/L = milligrams per liter

Table 3-93. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D under No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.15	0.46	0.15	0.90	0.44	0.25	0.17	0.18	0.08	0.14	1.03	0.50
Maximum	0.18	1.00	0.78	2.49	1.21	0.65	0.40	0.40	0.09	0.20	1.80	0.70
Wet Water Years												
Average	0.18	0.16	0.03	0.08	0.04	0.09	0.08	0.21	0.08	0.17	1.50	0.70
Maximum	0.18	0.16	0.03	0.08	0.04	0.09	0.08	0.40	0.08	0.20	1.80	0.70
Critical Water Years												
Average	0.10	1.00	0.42	2.37	1.16	0.54	0.37	0.25	0.09	0.05	0.10	0.17
Maximum	0.10	1.00	0.78	2.49	1.21	0.65	0.40	0.33	0.09	0.13	0.27	0.17

Key: mg/L = milligrams per liter

Table 3-94. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D under No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.23
Maximum	0.02	0.02	0.02	0.04	0.02	0.03	0.02	0.02	0.01	0.05	0.02	0.34
Wet Water Years												
Average	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.34
Maximum	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.02	0.02	0.34
Critical Water Years												
Average	0.02	0.02	0.01	0.04	0.02	0.03	0.01	0.01	0.01	0.02	0.01	0.02
Maximum	0.02	0.02	0.01	0.04	0.02	0.03	0.01	0.01	0.01	0.05	0.02	0.02

Key: mg/L = milligrams per liter

Table 3-95. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D under No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	1.88	2.55	2.05	2.87	2.02	1.34	1.35	1.41	1.55	2.09	1.63	1.79
Maximum	2.10	3.10	4.66	6.51	4.62	2.80	2.64	2.19	1.75	3.05	2.20	1.90
Wet Water Years												
Average	2.10	2.23	1.30	1.08	0.66	0.74	0.72	1.59	1.75	2.54	1.83	1.90
Maximum	2.10	2.23	1.30	1.08	0.66	0.74	0.72	2.19	1.75	3.05	2.20	1.90
Critical Water Years												
Average	1.50	3.10	3.57	6.09	4.46	2.48	2.52	1.44	1.20	0.73	0.73	1.60
Maximum	1.50	3.10	4.66	6.51	4.62	2.80	2.64	1.69	1.20	2.01	2.02	1.60

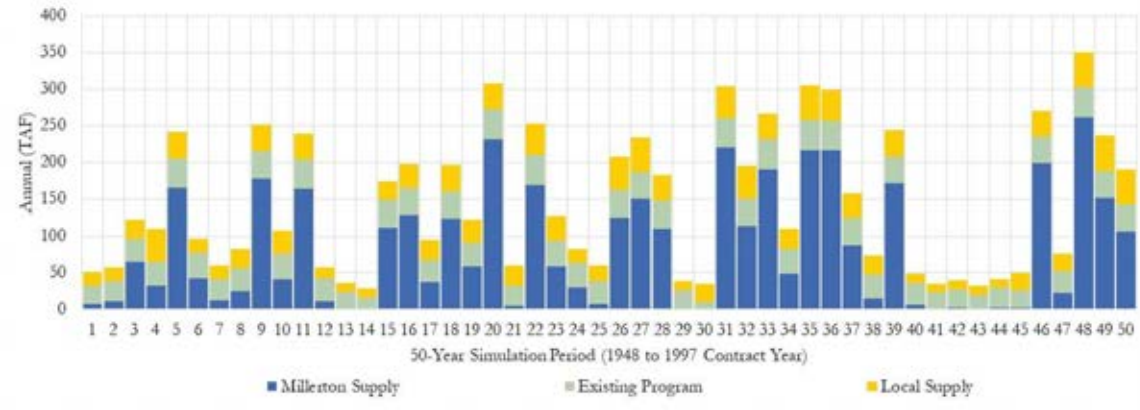
Key: mg/L = milligrams per liter

3.2.2.6 Total Surface Water Delivery to Friant Contractors

This section summarizes the annual total surface water delivery to the Friant Contractors in the study area under the No Project Alternative. The Distribution Module simulates the delivery of Millerton supply and exiting program supply. The local supplies are added to the individual Friant Contractors after the Distribution Module deliveries. Local supplies were considered in this analysis for several Friant Contractors. AEWSD receives deliveries from the Kern River and directly from the California Aqueduct. Porterville ID, LTRID, and TBID all receive deliveries from the Tule River.

Arvin-Edison Water Storage District

Figure 3-40 the total annual surface water delivery to AEWSD in the No Project Alternative. AEWSD receives local sources of water supply directly from the Kern River and directly from the California Aqueduct.

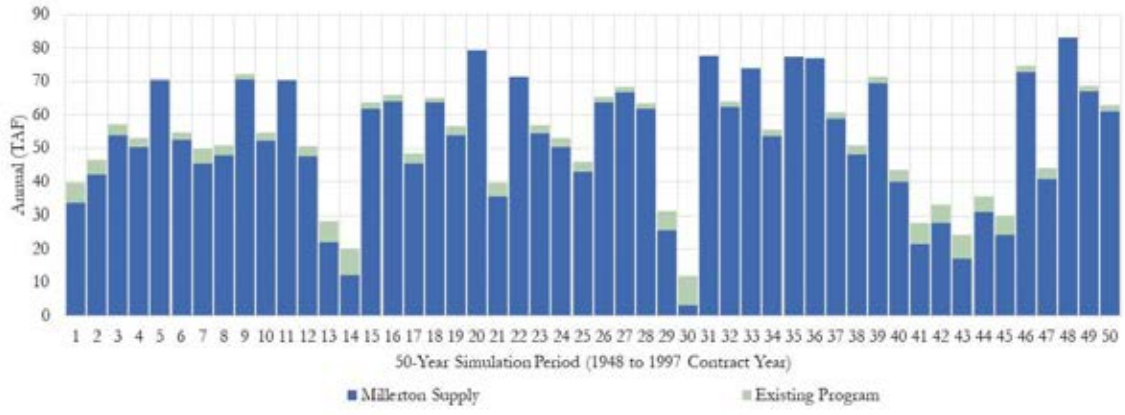


Key: TAF = thousand acre-feet

Figure 3-40. Total Annual Surface Water Delivery (thousand acre-feet) to Arvin-Edison Water Storage District under No Project Alternative

Shafter-Wasco Irrigation District

Figure 3-41 summarizes the total annual surface water delivery to SWID in the No Project Alternative.

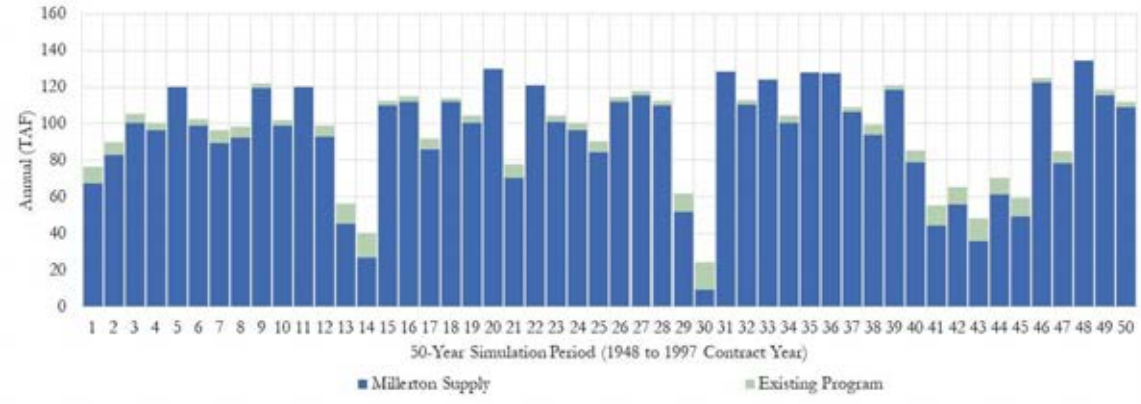


Key: TAF = thousand acre-feet

Figure 3-41. Total Annual Surface Water Delivery (thousand acre-feet) to Shafter-Wasco Irrigation District under No Project Alternative

Southern San Joaquin Municipal Utility District

Figure 3-42 summarizes the total annual surface water delivery to SSJMUD in the No Project Alternative.

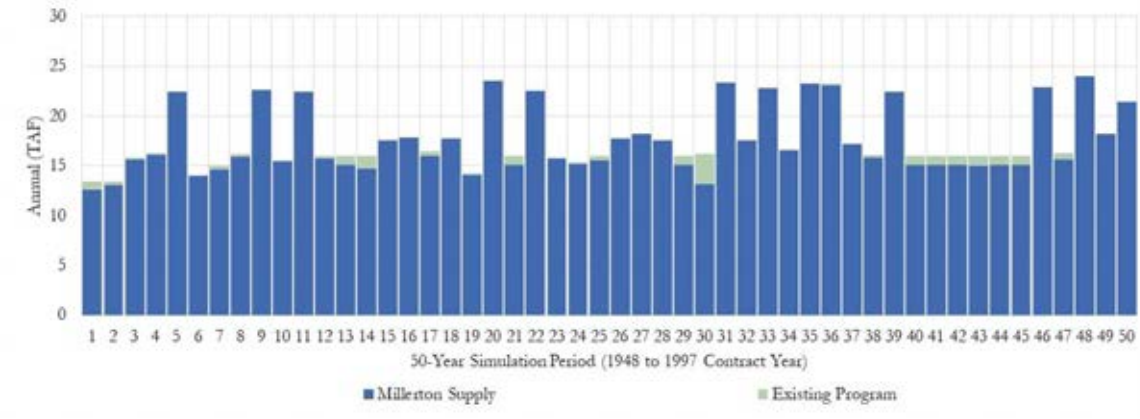


Key: TAF = thousand acre-feet

Figure 3-42. Total Annual Surface Water Delivery (thousand acre-feet) to Southern San Joaquin Municipal Utility District under No Project Alternative

Kern-Tulare Water District

Figure 3-43 summarizes the total annual surface water delivery to KTWD in the No Project Alternative.

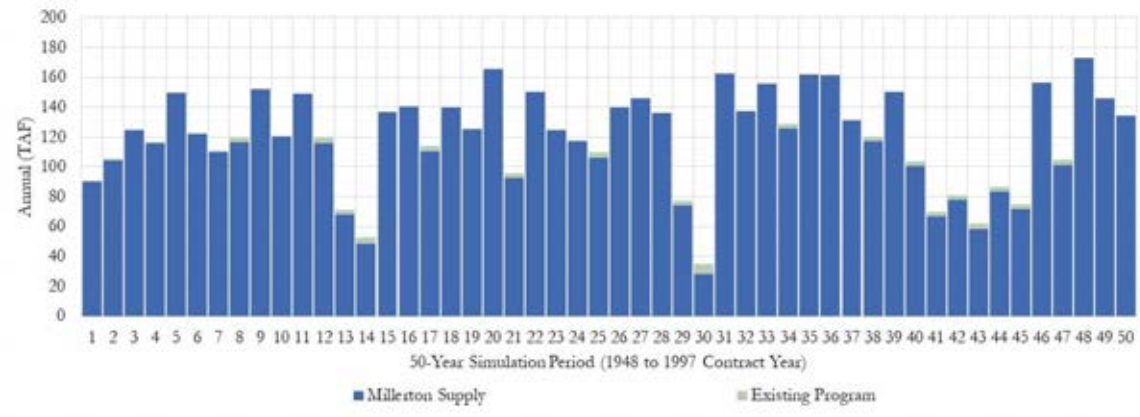


Key: TAF = thousand acre-feet

Figure 3-43. Total Annual Surface Water Delivery (thousand acre-feet) to Kern-Tulare Water District under No Project Alternative

Delano-Earlimart Irrigation District

Figure 3-44 summarizes the total annual surface water delivery to DEID in the No Project Alternative.

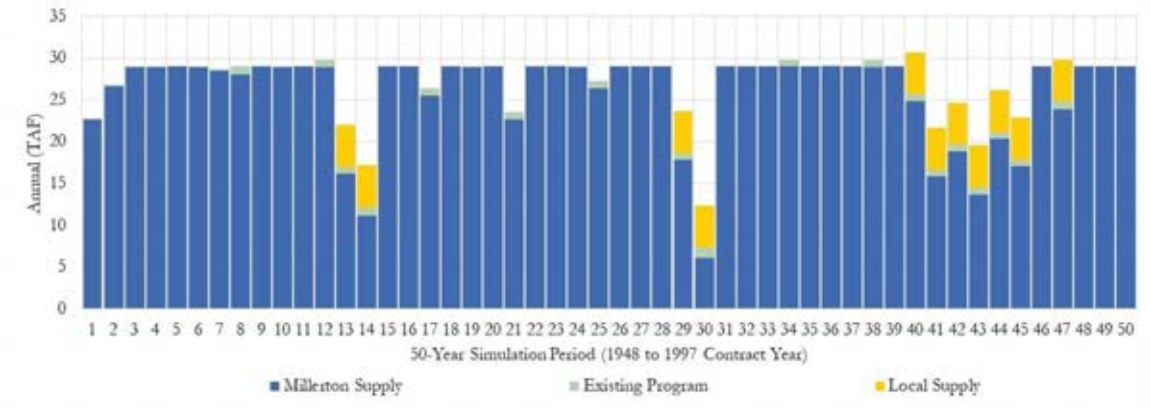


Key: TAF = thousand acre-feet

Figure 3-44. Total Annual Surface Water Delivery (thousand acre-feet) to Delano-Earlimart Irrigation District under No Project Alternative

Terra Bella Irrigation District

Figure 3-45 summarizes the total annual surface water delivery to TBID in the No Project Alternative. TBID receives local sources of water supply directly from the Tule River.

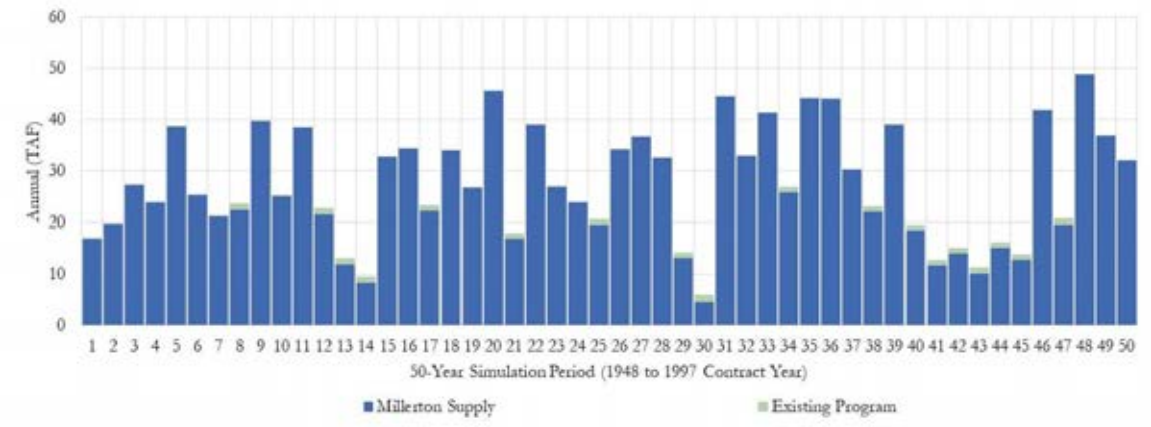


Key: TAF = thousand acre-feet

Figure 3-45. Total Annual Surface Water Delivery (thousand acre-feet) to Terra Bella Irrigation District under No Project Alternative

Saucelito Irrigation District

Figure 3-46 summarizes the total annual surface water delivery to Saucelito ID in the No Project Alternative.

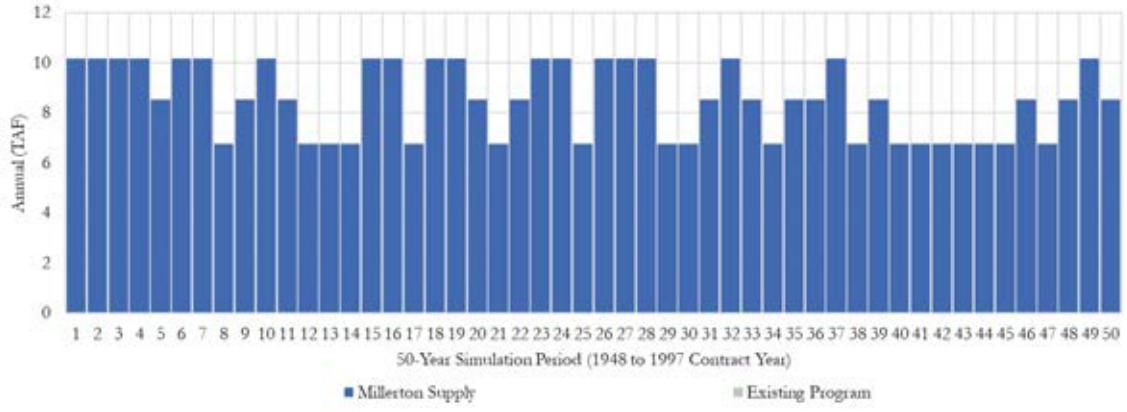


Key: TAF = thousand acre-feet

Figure 3-46. Total Annual Surface Water Delivery (thousand acre-feet) to Saucelito Irrigation District under No Project Alternative

Pixley Irrigation District

Figure 3-47 summarizes the total annual surface water to Pixley Irrigation District in the No Project Alternative.

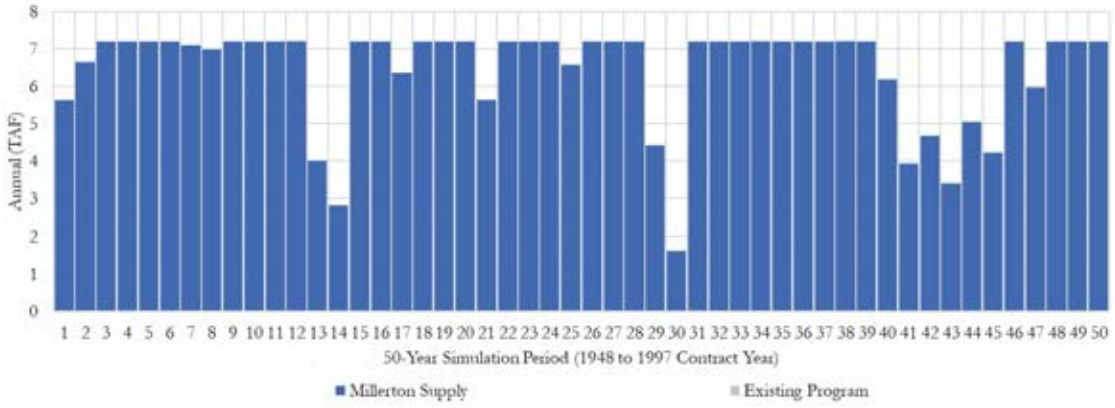


Key: TAF = thousand acre-feet

Figure 3-47. Total Annual Surface Water Delivery (thousand acre-feet) to Pixley Irrigation District under No Project Alternative

Tea Pot Dome Water District

Figure 3-48 summarizes the total annual surface water delivery to TPDWD in the No Project Alternative.

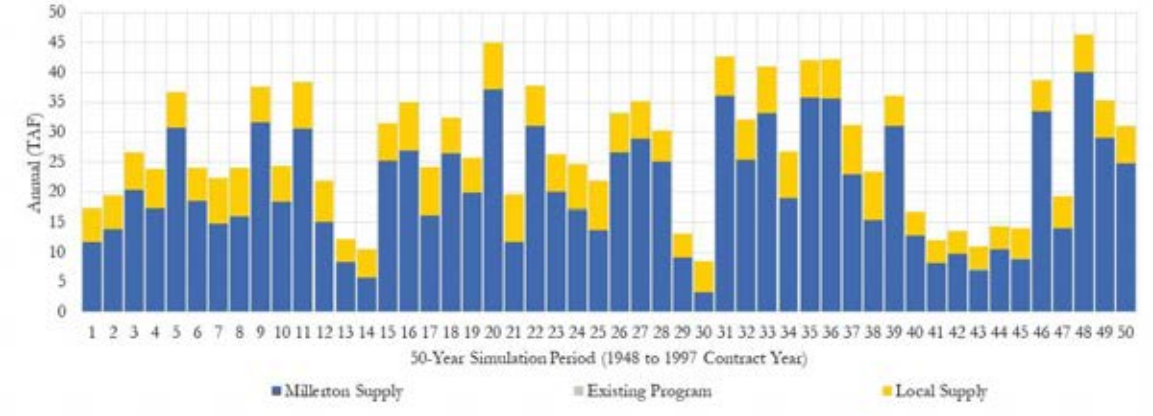


Key: TAF = thousand acre-feet

Figure 3-48. Total Annual Surface Water Delivery (thousand acre-feet) to Tea Pot Dome Water District under No Project Alternative

Porterville Irrigation District

Figure 3-49 summarizes the total annual surface water delivery to Porterville ID in the No Project Alternative. Porterville ID receives local sources of water supply directly from the Tule River.

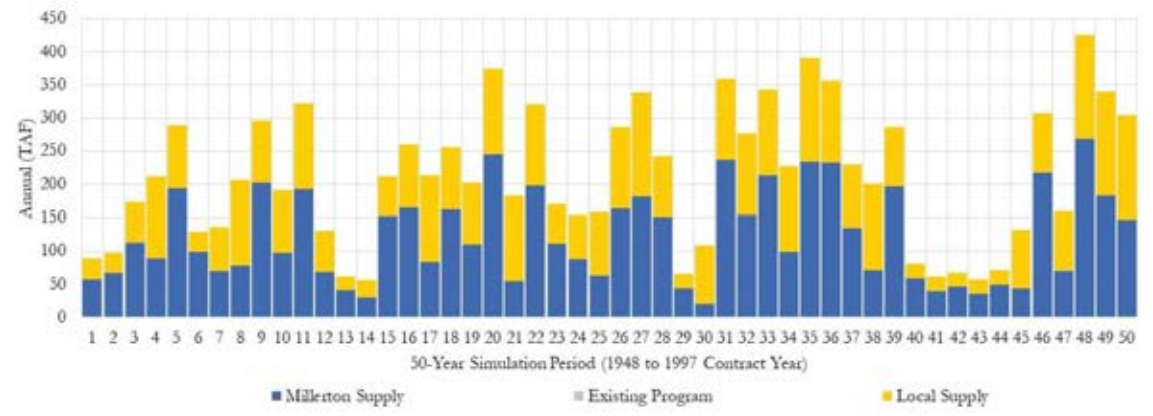


Key: TAF = thousand acre-feet

Figure 3-49. Total Annual Surface Water Delivery (thousand acre-feet) to Porterville Irrigation District under No Project Alternative

Lower Tule River Irrigation District

Figure 3-50 summarizes the total annual surface water delivery to LTRID in the No Project Alternative. LTRID receives local sources of water supply directly from the Tule River.



Key: TAF = thousand acre-feet

Figure 3-50. Total Annual Surface Water Delivery (thousand acre-feet) to Lower Tule River Irrigation District under No Project Alternative

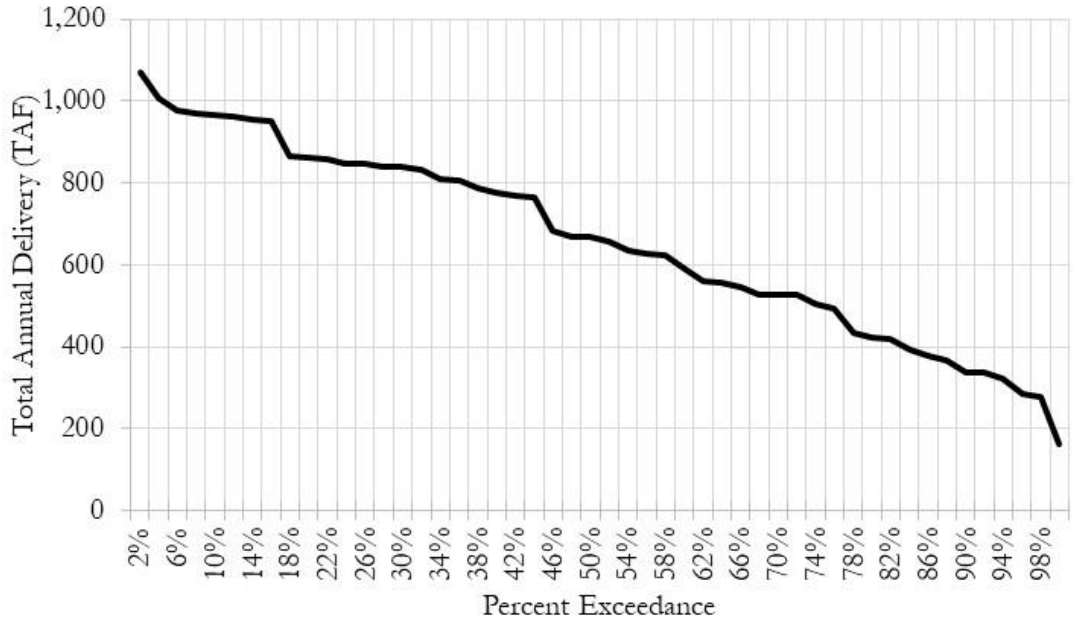
3.2.3 Low Flow Alternative and Seasonal Alternative

Under the Low Flow Alternative, permanent pumps are assumed to be installed and operated at the Shafter-Wasco, Lake Woollomes, and Deer Creek check structures (200 cfs, 75 cfs, and 75 cfs, respectfully). Under the Seasonal Alternative, seasonal pumps are assumed to be installed and operated at the Shafter-Wasco and Lake Woollomes check structures (200 cfs and 75 cfs, respectfully). Operations under the Seasonal Alternative would be nearly identical to those under the Low Flow Alternative (the Deer Creek Check is very rarely utilized in the Low Flow Alternative). As such, the Low Flow Alternative and Seasonal Alternative were modeled concurrently and are presented together in the following sections.

3.2.3.1 Low Flow Alternative and Seasonal Alternative under Existing Conditions

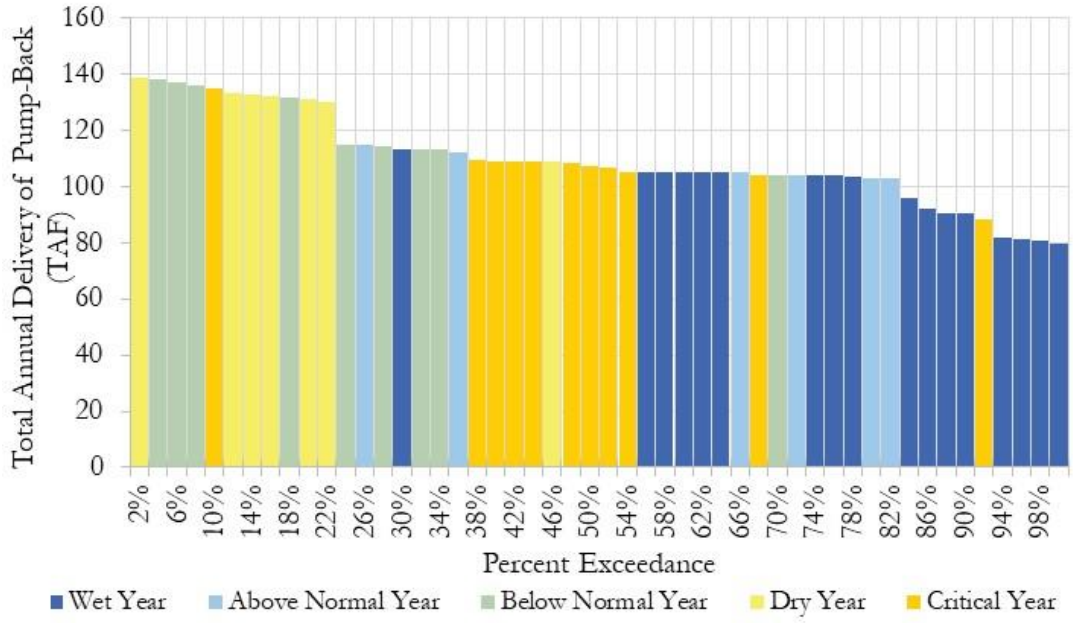
Figure 3-51 shows the probability of exceedance of total annual delivery to Friant Contractors in the study area under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. Figure 3-52 shows the probability of exceedance of total annual supply delivered to Friant Contractors in the study area via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. These pump-back operational volumes represent all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC at different locations along the Project reaches and not at the Intertie.

Table 3-96 summarizes the average total annual delivery to Friant Contractors in the study area by source for an average of all years and by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supply for KTWD, and for Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the average total delivery is 659 TAF with 17 percent from existing programs and additional pump-back supply. For an average Wet water year, the total delivery is 865 TAF with 10 percent from existing programs and additional pump-back supply. For an average Critical water year, the total delivery is 353 TAF with 33 percent from existing programs and additional pump-back supply.



Key: TAF = thousand acre-feet

Figure 3-51. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to Friant Contractors in the Study Area for the Low Flow Alternative and Seasonal Alternative under Existing Conditions



Key: TAF = thousand acre-feet

Figure 3-52. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to Friant Contractors in the Study Area by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Table 3-96. Average Annual Delivery (thousand acre-feet) to Friant Contractors in the Study Area by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	546	779	712	476	413	235
Existing Programs	35	32	33	35	37	38
Additional Pump-Back Supply	77	55	87	88	107	80
Total Supply	659	865	833	599	557	353

Location of Interface

Table 3-97 summarizes the average monthly location of the interface between the reverse-flow pump-back operations and gravity operations (i.e., Millerton supply) for an average of all years and by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Existing Conditions. During peak irrigation season supply available via reverse-flow pump-back is delivered and exchanged to meet irrigation demand in Reach A. As the water year type becomes drier and CVP surface water allocation is reduced, supply delivered via reverse-flow pump-back is delivered further up the canal to meet irrigation demand. In addition, because there is reduced irrigation demand in the shoulder months of the irrigation season (October to March), supply delivered via reverse-flow pump-back is pushed further up the canal as less water is exchanged in the lower Project reaches and the available supply is distributed to more Friant Contractors.

Table 3-97. Average Monthly Project Reach Location of Pump-Back Interface for an Average of All Years and by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Year Type	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Wet	C	A	A	A	A	A	B	C	C	C	C	C
Above Normal	C	A	A	A	A	A	B	C	C	C	C	C
Below Normal	C	B	B	B	B	B	B	C	C	C	C	C
Dry	C	B	B	B	B	B	B	C	C	C	C	C
Critical	C	C	C	C	C	C	C	C	C	C	C	C
Average	C	B	B	B	B	B	B	C	C	C	C	C

Notes:
Year Type is based on San Joaquin Valley Water Year Types
Reach A is the Intertie to Shafter-Wasco Check
Reach B is from Shafter-Wasco Check to Lake Woollomes Check
Reach C is from Lake Woollomes Check to Deer Creek Check

Reach A

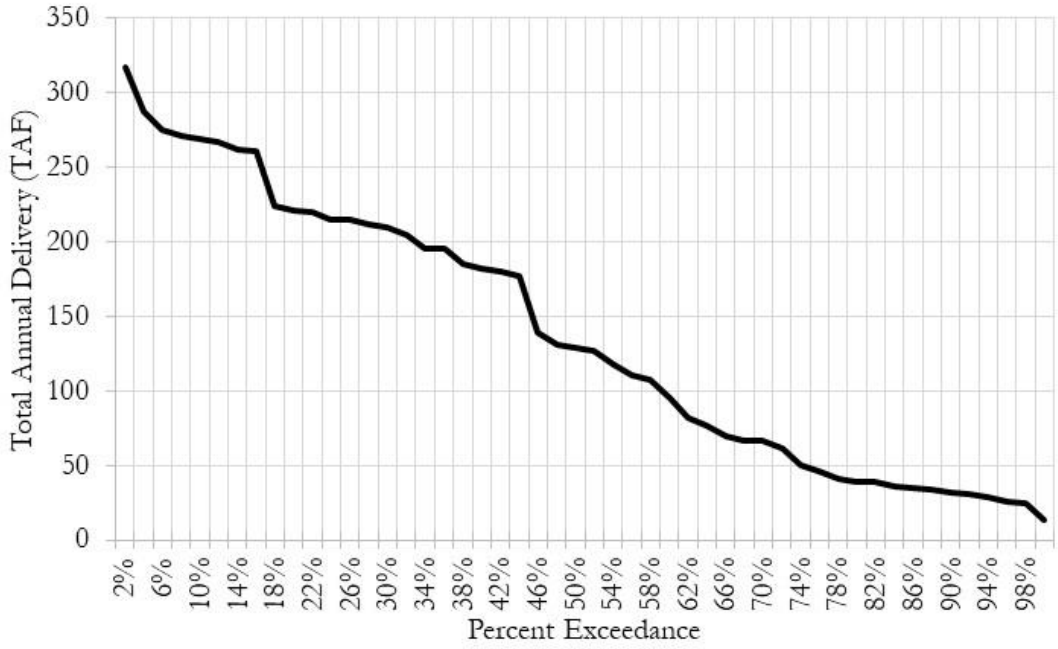
This section summarizes the total water supply delivery and the total water quality to the Friant Contractors in Reach A. The only Friant Contractor within Reach A is AEWSD.

Water Supply

Figure 3-53 shows the probability of exceedance of total annual delivery to the Friant Contractor in Reach A under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. Figure 3-54 shows the probability of exceedance of total annual supply delivered to the Friant Contractor in Reach A via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. These volumes represent all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. There are no FKC groundwater pump-in program deliveries in Reach A.

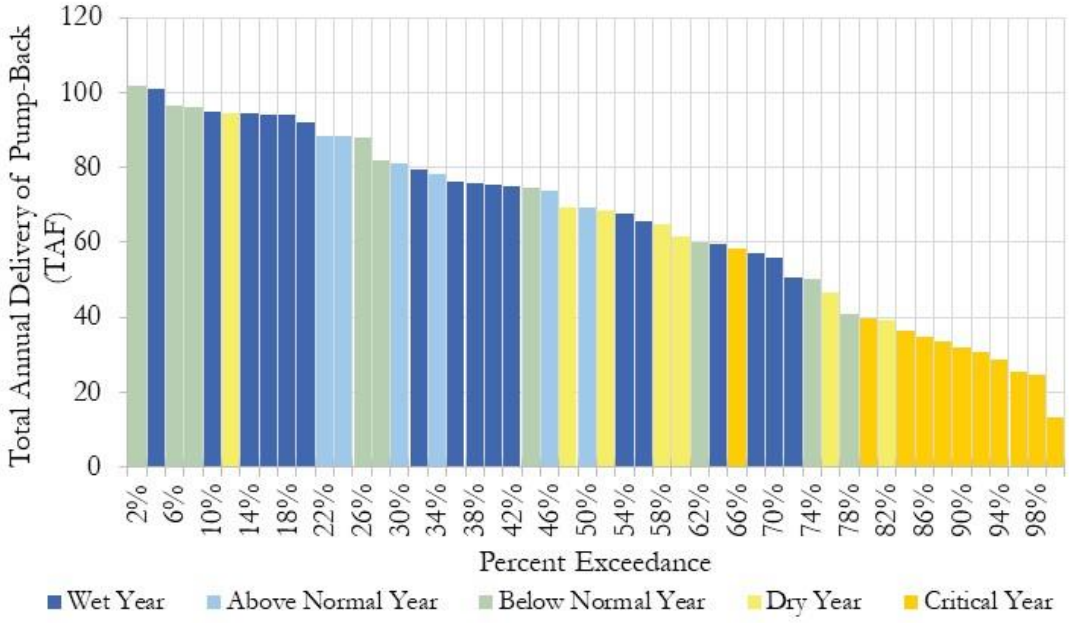
Table 3-98 summarize the average total annual delivery to the Friant Contractor in Reach A by source for an average of all years and by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs). Across all years, the average total delivery is 139 TAF with 47 percent from existing programs and additional pump-back supply (total mitigation is 3 percent of total delivery). For an average Wet water year, the total delivery is 230 TAF with 29 percent from existing programs and additional pump-back supply (total mitigation is 2 percent of total delivery). For an average Critical water year, the total delivery is 34 TAF all from existing programs and additional pump-back supply (total mitigation is 6 percent of total delivery).

Table 3-99 to Table 3-101 and Figure 3-55 summarizes the average monthly delivery to the Friant Contractor in Reach A by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-53. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Existing Conditions



Key: TAF = thousand acre-feet

Figure 3-54. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to the Friant Contractor in Reach A by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Table 3-98. Average Annual Delivery (thousand acre-feet) to the Friant Contractor in Reach A by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	73	164	102	22	3	0
Existing Programs	29	29	32	33	30	23
Additional Pump-Back Supply	37	37	69	44	42	11
Total Supply	139	230	203	98	75	34

Table 3-99. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	4,484	11,520	16,400	17,497	10,795	5,632	1,359	575	277	158	1,018	2,799	72,514
Existing Programs	1,516	2,022	3,381	4,704	5,124	5,129	3,731	2,043	421	358	0	400	28,829
Additional Pump-Back Supply	2,719	832	1,179	2,677	5,212	7,306	4,846	2,016	959	1,115	2,461	5,451	36,772
Total Supply	8,719	14,374	20,960	24,878	21,131	18,067	9,937	4,633	1,656	1,632	3,479	8,650	138,115

Table 3-100. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	11,870	23,581	35,528	40,354	27,700	14,052	3,998	995	455	0	939	4,620	164,091
Existing Programs	1,138	1,840	3,470	4,470	4,922	5,620	4,420	1,981	345	310	0	400	28,915
Additional Pump-Back Supply	2,130	0	0	0	2,486	10,655	9,505	1,829	979	563	2,206	6,240	36,592
Total Supply	15,137	25,421	38,998	44,824	35,108	30,327	17,923	4,804	1,779	872	3,144	11,260	229,598

Table 3-101. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Existing Programs	1,134	1,534	2,510	4,423	4,639	4,026	2,163	1,613	394	139	0	400	22,976
Additional Pump-Back Supply	405	396	610	1,777	2,777	1,044	420	506	185	64	201	2,432	10,816
Total Supply	1,538	1,930	3,120	6,201	7,417	5,069	2,583	2,119	579	203	201	2,832	33,792

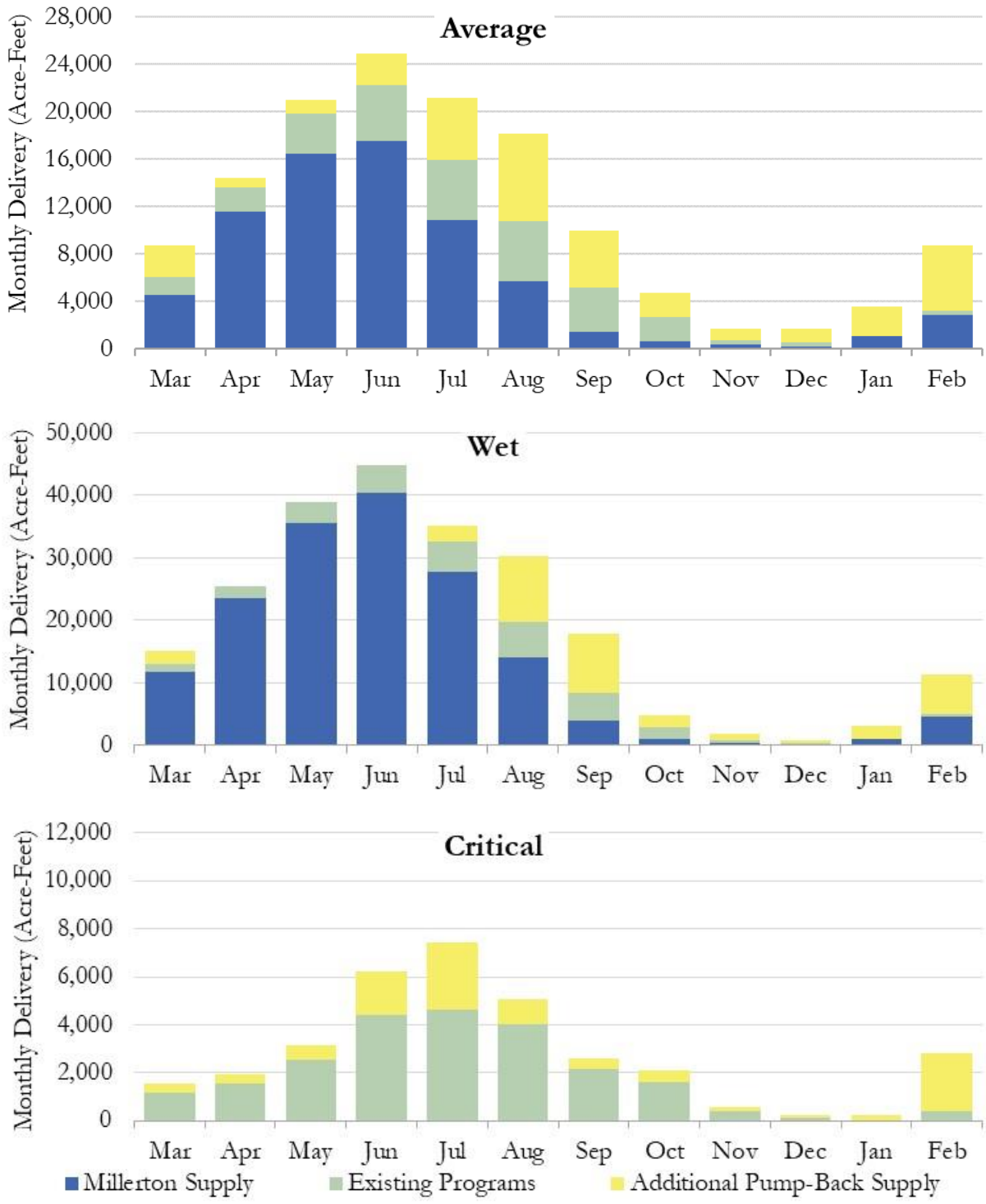


Figure 3-55. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach A deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-102 to Table 3-105 show the monthly average and monthly maximum water quality trends for individual constituents for the Low Flow Alternative and Seasonal Alternative under Existing Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply delivered via reverse-flow pump-back operations (i.e., existing programs and additional pump-back), water quality concentrations also increase. For TDS, nitrate, chloride, and boron, there is a correlation between reverse-flow pump-back supply and higher concentrations, but concentration trends are also influenced by seasonal water quality trends of the source water.

Table 3-102. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	221.87	162.31	158.91	169.81	149.86	191.04	238.08	276.23	277.36	250.94	225.61	275.47
Maximum	333.80	321.20	327.50	304.60	272.00	322.60	368.00	340.50	314.50	335.00	378.50	366.20
Wet Water Years												
Average	92.43	50.57	36.69	32.27	45.33	104.13	146.18	249.87	259.35	273.60	193.39	226.14
Maximum	221.60	157.56	46.62	43.33	103.14	141.41	172.00	260.20	281.00	307.80	228.40	285.80
Critical Water Years												
Average	333.80	321.20	300.80	304.60	272.00	322.60	368.00	300.20	300.00	145.55	150.45	366.20
Maximum	333.80	321.20	300.80	304.60	272.00	322.60	368.00	300.20	300.00	320.20	331.00	366.20

Key: mg/L = milligrams per liter

Table 3-103. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	2.99	1.42	1.29	1.30	1.19	0.78	1.00	1.29	2.30	2.64	3.39	3.69
Maximum	5.90	3.30	3.15	2.80	2.08	1.21	1.53	1.93	3.10	3.55	5.40	4.45
Wet Water Years												
Average	1.41	0.37	0.18	0.27	0.48	0.89	1.30	1.25	2.33	2.96	3.51	3.45
Maximum	3.73	1.37	0.28	0.45	1.26	1.21	1.53	1.30	2.53	3.33	4.08	4.28
Critical Water Years												
Average	3.32	2.24	2.02	1.62	1.68	0.48	0.80	1.04	1.76	1.32	1.42	4.10
Maximum	3.32	2.24	2.02	1.62	1.68	0.48	0.80	1.04	1.76	2.90	3.12	4.10

Key: mg/L = milligrams per liter

Table 3-104. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.18	0.13	0.11	0.11	0.09	0.11	0.14	0.15	0.14	0.15	0.15	0.24
Maximum	0.28	0.26	0.22	0.20	0.18	0.20	0.25	0.20	0.20	0.24	0.25	0.29
Wet Water Years												
Average	0.11	0.04	0.03	0.03	0.03	0.08	0.11	0.10	0.09	0.16	0.13	0.25
Maximum	0.28	0.17	0.04	0.04	0.07	0.10	0.13	0.10	0.10	0.18	0.15	0.29
Critical Water Years												
Average	0.26	0.24	0.22	0.18	0.18	0.20	0.25	0.20	0.18	0.11	0.08	0.24
Maximum	0.26	0.24	0.22	0.18	0.18	0.20	0.25	0.20	0.18	0.24	0.18	0.24

Key: mg/L = milligrams per liter

Table 3-105. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	54.63	37.62	41.00	45.15	35.60	53.04	70.58	84.53	84.90	77.35	63.90	64.01
Maximum	89.00	88.40	87.00	91.20	73.00	96.80	113.80	109.50	100.50	100.80	115.00	100.40
Wet Water Years												
Average	16.22	7.53	5.29	3.66	8.51	23.94	34.46	77.81	85.72	89.60	51.04	33.11
Maximum	43.00	32.66	7.87	6.19	22.55	33.51	41.00	81.20	93.00	100.80	60.60	42.40
Critical Water Years												
Average	89.00	88.40	84.80	91.20	73.00	96.80	113.80	88.40	83.00	43.00	46.18	100.40
Maximum	89.00	88.40	84.80	91.20	73.00	96.80	113.80	88.40	83.00	94.60	101.60	100.40

Key: mg/L = milligrams per liter

Relative Results

Relative changes in both surface water quantity and quality were determined by comparing the Low Flow Alternative and Seasonal Alternative under Existing Conditions outputs to the Existing either the exchange of Millerton supply for existing program supply and/or the net increase of supply due to additional pump-back deliveries. Because reverse-flow pump-back facilities have increased capacity under the Low Flow Alternative and Seasonal Alternative under Existing Conditions as compared to Existing Conditions, there is additional opportunity to increase or maximize direct delivery of existing program supply, and thus volumetric increases are seen in Wet water years and on average for all years for those supply sources.

Table 3-106 to Table 3-108 show the volumetric differences by source between the Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions for an average year of all years and by Wet and Critical water year types. Across all years, the overall average total supply delivered to Reach A increased by 8,628 AF in the Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions. This increase is a result of increased delivery of existing programs supply due to increased pump-back facility capacities and exchanges of Millerton supply for additional pump-back supply.

Table 3-109 to Table 3-112 shows the differences in monthly average and monthly maximum water quality trends for individual constituents between the Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions. For TDS, nitrate, chloride, and boron, there is a correlation between additional reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Water Supply

Table 3-106. Average Monthly Change in Delivery (acre-feet) to the Friant Contractor in Reach A by Source for an Average of All Years, Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-2,308	-625	-954	-2,441	-4,969	-6,175	-3,805	-1,166	-573	-668	-1,738	-4,018	-29,441
Existing Programs	440	90	94	216	456	0	0	0	0	0	0	0	1,296
Additional Pump-Back Supply	2,719	832	1,179	2,677	5,212	7,306	4,846	2,016	959	1,115	2,461	5,451	36,772
Total Supply	851	297	319	452	699	1,130	1,041	850	385	447	723	1,433	8,628

Table 3-107. Average Monthly Change in Delivery (acre-feet) to the Friant Contractor in Reach A by Source for Wet Water Year Types, Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-1,883	0	0	0	-2,424	-9,066	-7,905	-960	-626	-302	-1,542	-4,539	-29,247
Existing Programs	282	0	0	0	282	0	0	0	0	0	0	0	565
Additional Pump-Back Supply	2,130	0	0	0	2,486	10,655	9,505	1,829	979	563	2,206	6,240	36,592
Total Supply	529	0	0	0	345	1,589	1,599	870	353	260	664	1,701	7,909

Table 3-108. Average Monthly Change in Delivery (acre-feet) to the Friant Contractor in Reach A by Source for Critical Water Year Types, Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	0	0	-177	-1,287	-2,292	-591	0	0	0	0	-126	-1,681	-6,154
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	405	396	610	1,777	2,777	1,044	420	506	185	64	201	2,432	10,816
Total Supply	405	396	433	490	486	453	420	506	185	64	75	751	4,662

Water Quality

Table 3-109. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	134.60	46.21	74.92	80.41	85.08	110.11	129.10	92.97	93.15	110.71	200.92	191.10
Maximum	132.89	82.87	165.83	114.60	122.00	152.60	183.00	110.50	87.83	125.00	346.90	75.04
Wet Water Years												
Average	38.61	-2.22	-1.51	-8.75	14.32	65.31	94.76	39.99	65.23	95.62	167.17	141.76
Maximum	20.69	-12.77	-2.49	-17.33	61.92	91.72	104.24	30.20	54.33	97.80	198.90	70.74
Critical Water Years												
Average	186.66	82.87	144.19	139.29	152.70	165.41	183.00	134.49	121.43	68.27	136.09	259.96
Maximum	186.66	82.87	139.13	114.60	122.00	152.60	183.00	134.49	121.43	150.20	299.40	173.37

Key: mg/L = milligrams per liter

Table 3-110. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.31	-0.52	-0.74	-0.45	0.04	-0.81	-0.89	-1.38	-1.11	0.26	2.29	2.35
Maximum	-0.94	-1.43	-2.67	-1.54	-2.32	-3.76	-3.22	-1.18	-1.10	-0.48	3.60	0.25
Wet Water Years												
Average	0.84	-0.12	-0.08	-0.14	0.43	0.66	1.00	-1.58	-1.24	0.28	1.91	2.26
Maximum	1.27	-0.68	-0.13	-0.28	1.21	0.92	1.14	-1.82	-1.68	0.15	2.28	1.97
Critical Water Years												
Average	-3.52	-2.49	-3.58	-2.33	-1.73	-4.09	-3.96	-1.80	-1.64	-0.51	1.29	1.94
Maximum	-3.52	-2.49	-3.80	-2.72	-2.72	-4.50	-3.96	-1.80	-1.64	-1.13	2.85	-0.10

Key: mg/L = milligrams per liter

Table 3-111. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.12	0.07	0.06	0.04	0.05	0.06	0.07	0.05	0.05	0.07	0.13	0.02
Maximum	0.17	0.14	0.10	0.07	0.06	0.09	0.14	0.09	0.09	0.12	0.23	-0.05
Wet Water Years												
Average	0.08	0.01	0.00	-0.01	0.01	0.05	0.08	-0.01	0.00	0.06	0.11	-0.06
Maximum	0.17	0.07	0.01	-0.01	0.04	0.07	0.09	-0.01	-0.01	0.06	0.14	-0.05
Critical Water Years												
Average	0.15	0.12	0.11	0.07	0.09	0.10	0.14	0.11	0.07	0.06	0.07	0.17
Maximum	0.15	0.12	0.10	0.05	0.06	0.09	0.14	0.11	0.07	0.13	0.16	0.11

Key: mg/L = milligrams per liter

Table 3-112. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	38.59	22.38	24.14	27.42	23.18	35.01	42.13	24.33	29.64	38.35	62.14	42.16
Maximum	27.05	37.01	39.01	49.49	40.71	57.13	65.30	26.17	27.50	37.80	112.80	-2.13
Wet Water Years												
Average	4.12	-3.26	-1.71	-2.92	3.26	16.16	21.96	2.21	23.66	36.48	49.08	8.96
Maximum	-18.95	-18.73	-2.81	-5.79	14.71	22.68	23.49	-2.13	20.00	37.80	58.40	-31.29
Critical Water Years												
Average	67.43	67.40	55.99	56.37	49.07	60.51	65.30	45.54	36.00	24.95	45.27	77.51
Maximum	67.43	67.40	54.97	49.49	40.71	57.13	65.30	45.54	36.00	54.89	99.58	55.62

Key: mg/L = milligrams per liter

Reach B

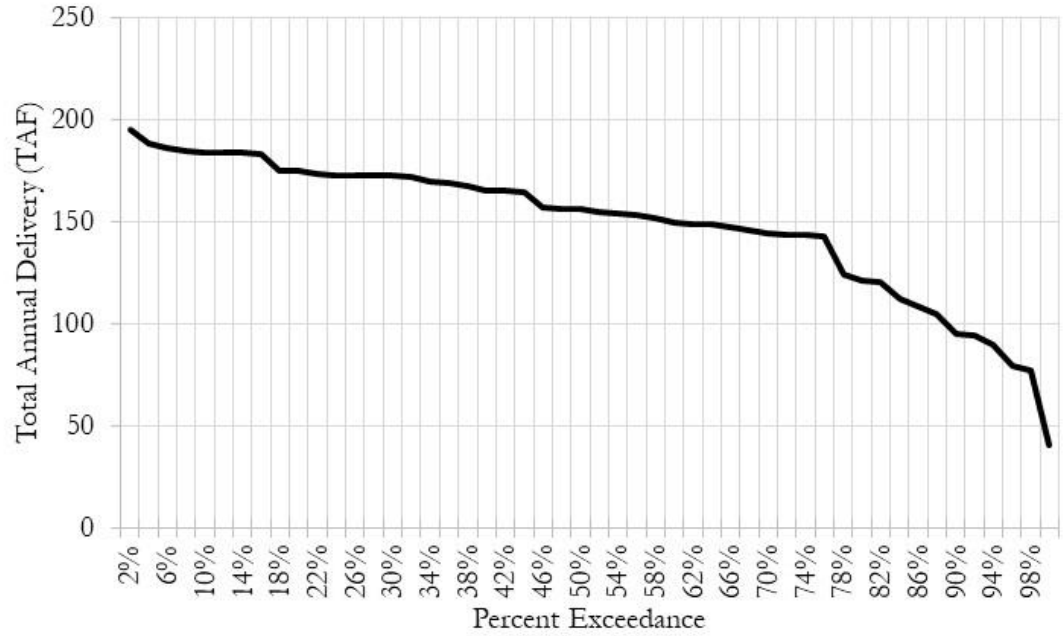
This section summarizes the total water supply delivery and the total water quality to the Friant Contractors in Reach B. The Friant Contractors within Reach B include Shafter-Wasco Irrigation District and South San Joaquin Municipal Utility District.

Water Supply

For the Low Flow Alternative and Seasonal Alternative under Existing Conditions, the Reach B Shafter-Wasco check structure capacity is assumed to be 200 cfs. Figure 3-56 shows the probability of exceedance of total annual delivery to the Friant Contractors in Reach B under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. Figure 3-57 shows the probability of exceedance of total supply delivered to the Friant Contractors in Reach B via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. These volumes represent all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach B and not at the Intertie.

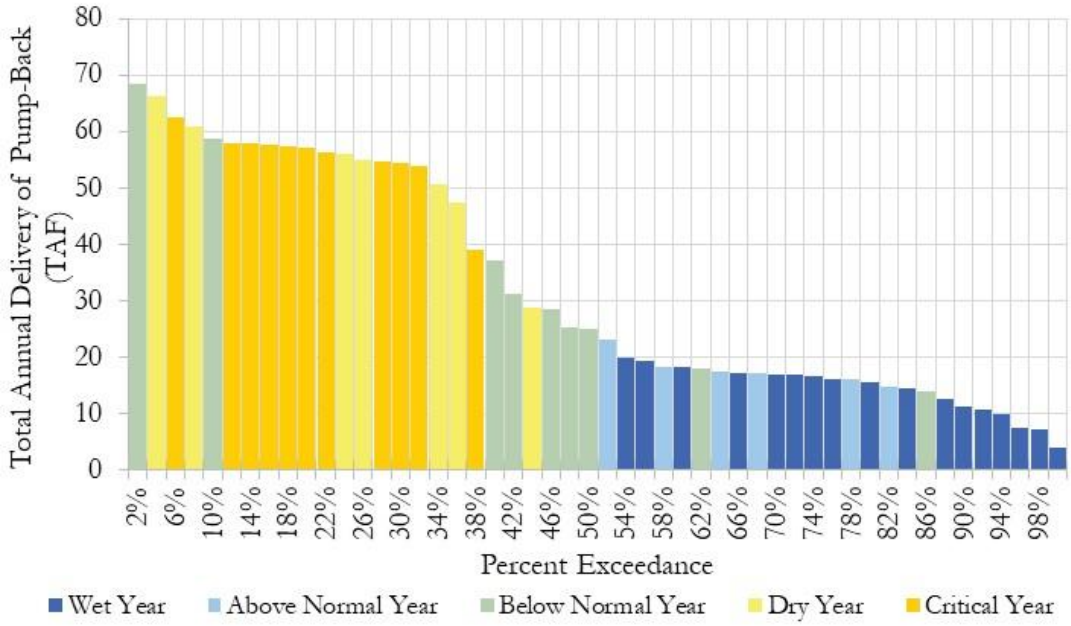
Table 3-113 summarize the average total annual delivery to the Friant Contractors in Reach B by source for an average of all years and by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the total average delivery is 149 TAF with 22 percent from existing programs and additional pump-back supply (total mitigation is 1 percent of total delivery). For an average Wet water year, the total delivery is 171 TAF with 7 percent from existing programs and additional pump-back supply (total mitigation is 1 percent of total delivery). For an average Critical water year, the total delivery is 99 TAF with 59 percent from existing programs and additional pump-back supply (total mitigation is 4 percent of total delivery).

Table 3-114 to Table 3-116 and Figure 3-58 summarizes the average monthly delivery to the Friant Contractors in Reach B by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-56. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Existing Conditions



Key: TAF = thousand acre-feet

Figure 3-57. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to the Friant Contractors in Reach B by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Table 3-113. Average Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach B by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	116	160	161	114	93	41
Existing Programs	4	2	1	2	3	9
Additional Pump-Back Supply	29	9	13	34	55	49
Total Supply	149	171	175	150	151	99

Table 3-114. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	3,117	7,387	12,949	24,129	29,205	23,966	9,252	1,697	278	114	743	3,376	116,212
Existing Programs	257	325	332	130	120	207	405	1,112	417	338	0	0	3,644
Additional Pump-Back Supply	3,209	2,421	2,703	2,301	1,966	2,625	4,732	4,029	1,102	769	841	2,536	29,233
Total Supply	6,583	10,132	15,984	26,560	31,290	26,797	14,389	6,838	1,797	1,222	1,584	5,912	149,089

Table 3-115. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	6,078	10,928	17,848	29,672	36,093	33,683	18,665	1,609	352	28	629	4,083	159,668
Existing Programs	26	0	0	0	0	0	0	1,062	453	433	0	0	1,974
Additional Pump-Back Supply	425	0	0	0	0	0	944	3,546	692	567	874	2,116	9,164
Total Supply	6,528	10,928	17,848	29,672	36,093	33,683	19,610	6,216	1,498	1,027	1,503	6,199	170,806

Table 3-116. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	0	246	1,787	12,217	17,120	8,078	404	0	0	0	0	793	40,645
Existing Programs	928	1,412	1,369	457	411	805	1,468	1,640	465	232	0	0	9,188
Additional Pump-Back Supply	3,892	4,370	6,716	6,187	5,399	6,761	6,366	4,435	1,198	249	478	3,389	49,441
Total Supply	4,820	6,029	9,872	18,861	22,930	15,644	8,238	6,075	1,663	481	478	4,182	99,274

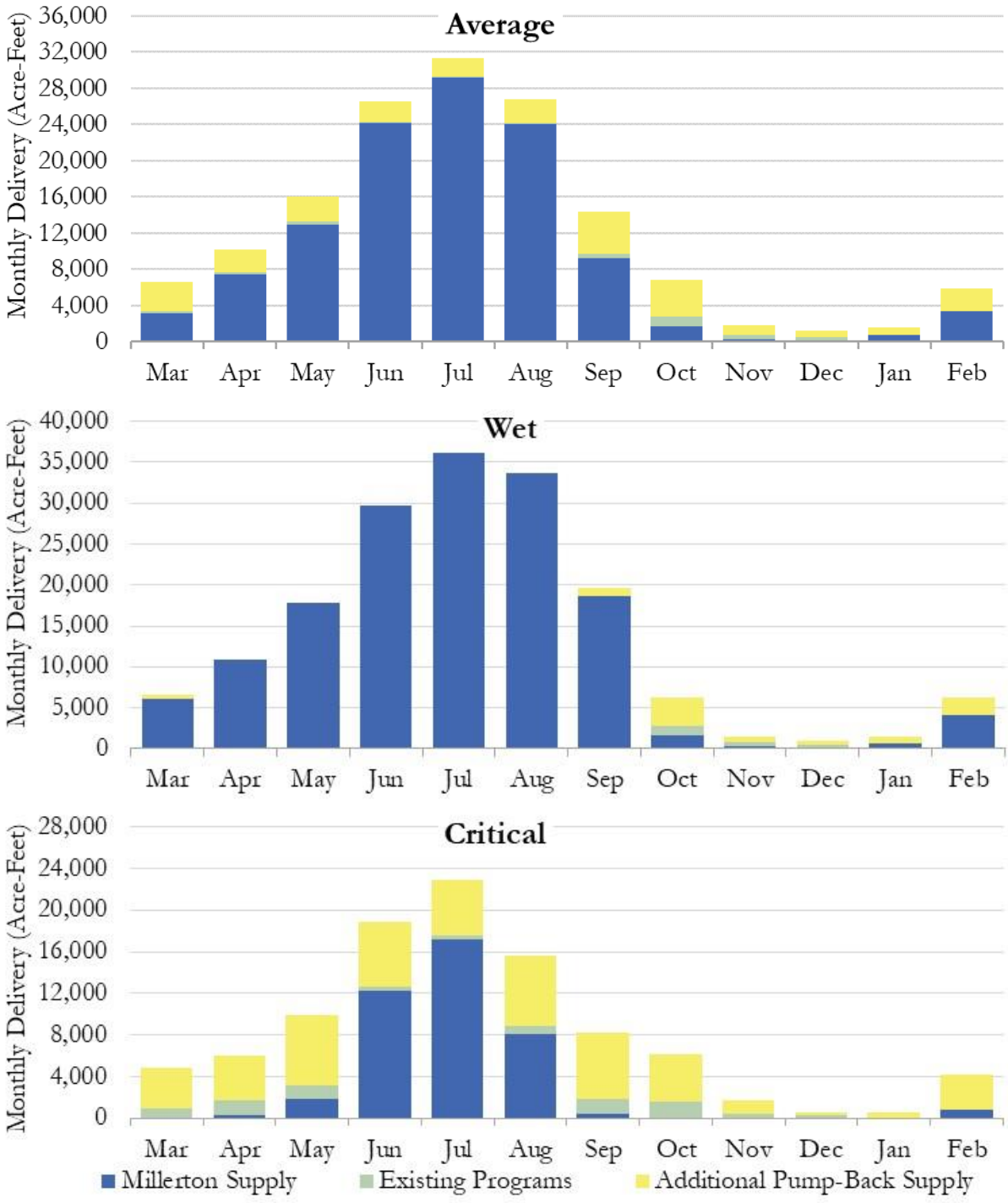


Figure 3-58. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach B deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-117 to Table 3-120 show the monthly average and monthly maximum water quality trends for individual constituents for the Low Flow Alternative and Seasonal Alternative under Existing Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply being delivered via reverse-flow pump-back operations (i.e., existing programs and additional pump-back supply) and FKC groundwater pump-in programs, water quality concentrations tend to increase. For TDS, nitrate, chloride, and boron, there is a correlation between reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-117. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	180.99	124.90	96.26	65.74	45.03	63.55	150.63	253.28	271.64	246.97	200.46	193.15
Maximum	333.80	321.20	302.08	305.18	273.18	322.77	367.01	340.50	314.50	335.00	378.50	366.20
Wet Water Years												
Average	47.61	28.00	21.33	21.00	13.00	13.75	22.36	234.51	250.89	271.44	176.82	147.84
Maximum	221.60	28.00	21.33	21.00	13.00	13.75	44.77	265.80	281.00	307.80	228.40	285.80
Critical Water Years												
Average	333.80	314.03	267.18	159.04	115.63	188.88	354.36	300.93	300.00	145.55	150.45	319.61
Maximum	333.80	321.20	302.08	305.18	273.18	322.77	367.01	301.48	300.00	320.20	331.00	366.20

Key: mg/L = milligrams per liter

Table 3-118. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	2.20	1.05	0.70	0.88	0.50	0.29	0.53	1.29	2.23	2.59	3.16	2.61
Maximum	5.90	3.06	2.36	2.37	1.84	0.83	1.13	1.95	3.10	3.55	5.40	4.45
Wet Water Years												
Average	0.60	0.16	0.03	0.08	0.04	0.09	0.16	1.33	2.25	2.93	3.32	2.38
Maximum	3.73	0.16	0.03	0.08	0.04	0.09	0.37	1.95	2.53	3.33	4.08	4.28
Critical Water Years												
Average	3.32	2.21	1.95	2.10	1.35	0.59	1.00	1.26	1.76	1.32	1.42	3.57
Maximum	3.32	2.24	2.36	2.19	1.84	0.83	1.13	1.42	1.76	2.90	3.12	4.10

Key: mg/L = milligrams per liter

Table 3-119. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.14	0.10	0.07	0.04	0.02	0.04	0.09	0.14	0.14	0.15	0.13	0.25
Maximum	0.28	0.24	0.22	0.18	0.17	0.19	0.24	0.20	0.20	0.24	0.25	0.34
Wet Water Years												
Average	0.05	0.02	0.02	0.02	0.01	0.01	0.02	0.09	0.09	0.16	0.12	0.28
Maximum	0.28	0.02	0.02	0.02	0.01	0.01	0.04	0.10	0.10	0.18	0.15	0.34
Critical Water Years												
Average	0.26	0.23	0.19	0.09	0.06	0.12	0.24	0.20	0.18	0.11	0.08	0.21
Maximum	0.26	0.24	0.22	0.18	0.17	0.19	0.24	0.20	0.18	0.24	0.18	0.24

Key: mg/L = milligrams per liter

Table 3-120. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	44.64	28.87	22.89	12.71	7.60	15.26	44.81	76.41	83.05	76.09	56.61	44.36
Maximum	89.00	88.40	83.52	89.59	72.06	94.00	111.78	109.50	100.50	100.80	115.00	100.40
Wet Water Years												
Average	6.93	2.23	1.30	1.08	0.66	0.74	3.09	71.24	82.76	88.84	46.17	20.92
Maximum	43.00	2.23	1.30	1.08	0.66	0.74	8.77	81.20	93.00	100.80	60.60	42.40
Critical Water Years												
Average	89.00	86.32	73.20	39.29	24.62	52.79	107.51	86.77	83.00	43.00	46.18	87.03
Maximum	89.00	88.40	83.52	89.59	72.06	94.00	111.78	88.40	83.00	94.60	101.60	100.40

Key: mg/L = milligrams per liter

Relative Results

Relative changes in both surface water quantity and quality were determined by comparing the Low Flow Alternative and Seasonal Alternative under Existing Conditions outputs to Existing Conditions outputs. When comparing the scenarios, differences in volumetric deliveries are due to the either the exchange of Millerton supply for existing program supply and/or the net increase of supply due to additional pump-back deliveries. Because reverse-flow pump-back facilities have increased capacity under the Low Flow Alternative and Seasonal Alternative under Existing Conditions as compared to Existing Conditions, there is additional opportunity to increase or maximize direct delivery of existing program supply, and thus volumetric increases are seen in Wet water years and on average for all years for those supply sources.

Table 3-121 to Table 3-123 show the volumetric differences by source between the Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions for an average of all years and by Wet and Critical water year types. Across all years, the overall average total supply delivered to Reach B increased by 11,673 AF in the Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions. This increase is a result of increased delivery of existing programs supply due to increased pump-back facility capacities and exchanges of Millerton supply for additional pump-back supply.

Table 3-124 to Table 3-127 shows the differences in monthly average and monthly maximum water quality trends for individual constituents between the Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to the Existing Conditions. For TDS, nitrate, chloride, and boron, there is a correlation between additional reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Water Supply

Table 3-121. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach B by Source for an Average of All Years, Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-2,121	-1,722	-1,961	-1,454	-897	-1,166	-3,096	-2,409	-567	-389	-444	-1,359	-17,584
Existing Programs	16	6	2	0	0	0	0	0	0	0	0	0	24
Additional Pump-Back Supply	3,209	2,421	2,703	2,301	1,966	2,625	4,732	4,029	1,102	769	841	2,536	29,233
Total Supply	1,104	705	744	847	1,069	1,459	1,636	1,620	535	381	397	1,177	11,673

Table 3-122. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach B by Source for Wet Water Year Types, Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-173	0	0	0	306	1,248	332	-1,981	-293	-237	-478	-1,028	-2,304
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	425	0	0	0	0	0	944	3,546	692	567	874	2,116	9,164
Total Supply	252	0	0	0	306	1,248	1,276	1,565	399	329	397	1,089	6,860

Table 3-123. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach B by Source for Critical Water Year Types, Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-2,450	-2,920	-5,069	-4,612	-3,979	-5,154	-4,616	-2,783	-617	-89	-300	-2,070	-34,660
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	3,892	4,370	6,716	6,187	5,399	6,761	6,366	4,436	1,198	249	478	3,389	49,441
Total Supply	1,442	1,450	1,647	1,575	1,419	1,607	1,750	1,652	581	160	178	1,320	14,781

Water Quality

Table 3-124. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	143.07	77.86	63.98	28.20	18.28	39.80	122.97	175.17	139.41	135.17	175.77	168.80
Maximum	132.89	82.87	128.76	185.55	191.66	147.13	232.52	99.02	87.83	125.00	346.90	340.53
Wet Water Years												
Average	12.89	0.00	0.00	0.00	0.00	0.00	9.36	138.97	86.28	120.61	150.60	122.18
Maximum	20.69	0.00	0.00	0.00	0.00	0.00	31.77	24.33	54.33	97.80	198.90	260.13
Critical Water Years												
Average	267.57	199.60	202.29	89.72	63.09	140.24	286.09	219.03	198.90	83.36	136.09	297.61
Maximum	186.66	82.87	128.76	185.55	191.66	147.13	232.52	154.39	121.43	150.20	299.40	344.20

Key: mg/L = milligrams per liter

Table 3-125. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	1.46	0.24	0.29	-0.03	0.04	-0.08	0.08	0.14	-0.13	0.78	2.05	2.11
Maximum	-0.94	-1.66	-3.68	-0.92	-0.34	-4.27	-2.26	-1.87	-1.10	-0.48	3.60	3.76
Wet Water Years												
Average	0.28	0.00	0.00	0.00	0.00	0.00	0.09	-0.03	-0.73	0.70	1.72	1.68
Maximum	1.27	0.00	0.00	0.00	0.00	0.00	0.29	-1.87	-1.68	0.15	2.28	3.58
Critical Water Years												
Average	0.94	-0.34	0.34	-0.34	0.08	-0.49	-0.57	-0.19	-0.04	-0.10	1.29	3.40
Maximum	-3.52	-2.49	-3.68	-1.10	-0.34	-4.27	-2.26	-1.31	-1.64	-1.13	2.85	3.94

Key: mg/L = milligrams per liter

Table 3-126. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.11	0.07	0.05	0.02	0.01	0.02	0.07	0.09	0.07	0.08	0.11	0.02
Maximum	0.17	0.12	0.11	0.10	0.13	0.09	0.18	0.10	0.09	0.12	0.23	0.00
Wet Water Years												
Average	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.01	0.07	0.10	-0.06
Maximum	0.17	0.00	0.00	0.00	0.00	0.00	0.02	0.00	-0.01	0.06	0.14	0.00
Critical Water Years												
Average	0.21	0.17	0.15	0.05	0.04	0.08	0.20	0.15	0.11	0.07	0.07	0.19
Maximum	0.15	0.12	0.11	0.10	0.13	0.09	0.18	0.13	0.07	0.13	0.16	0.22

Key: mg/L = milligrams per liter

Table 3-127. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	39.95	24.67	19.58	9.56	5.41	12.99	40.73	54.88	44.15	45.93	54.85	42.57
Maximum	27.05	67.40	53.71	69.11	59.70	55.72	80.71	32.57	27.50	37.80	112.80	98.50
Wet Water Years												
Average	1.31	0.00	0.00	0.00	0.00	0.00	2.37	42.35	30.87	44.71	44.22	19.02
Maximum	-18.95	0.00	0.00	0.00	0.00	0.00	8.05	4.27	20.00	37.80	58.40	40.50
Critical Water Years												
Average	80.72	75.79	63.88	31.91	19.41	46.09	93.75	69.24	58.10	28.95	45.27	85.43
Maximum	67.43	67.40	53.71	69.11	59.70	55.72	80.71	54.74	36.00	54.89	99.58	98.80

Key: mg/L = milligrams per liter

Reach C

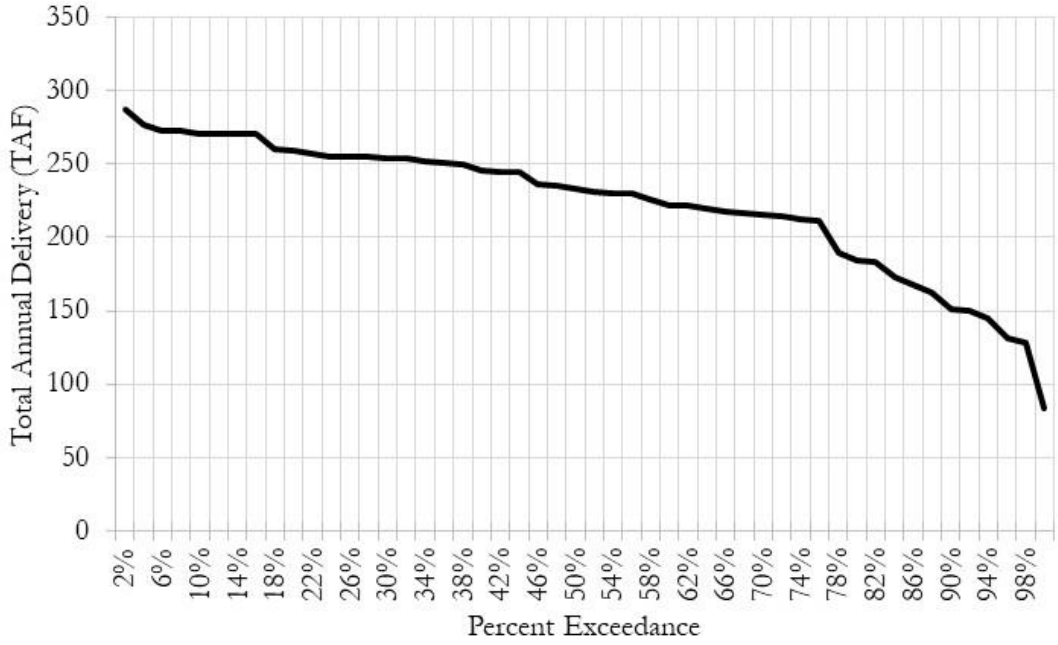
This section summarizes the total water supply delivery and the total water quality to the Friant Contractors in Reach C. The Friant Contractors within Reach C include South San Joaquin Municipal Utility District, Kern-Tulare Water District, Delano-Earlimart Irrigation District, Saucelito Irrigation District, and Terra Bella Irrigation District.

Water Supply

For the Low Flow Alternative and Seasonal Alternative under Existing Conditions, the Reach C Lake Woollomes check structure capacity is modeled as 75 cfs. Figure 3-59 shows the probability of exceedance of total annual delivery to the Friant Contractors in Reach C under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. Figure 3-60 shows the probability of exceedance of total annual supply delivered via reverse-flow pump-back operations to the Friant Contractors in Reach C by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. These volumes represent all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach C and not at the Intertie.

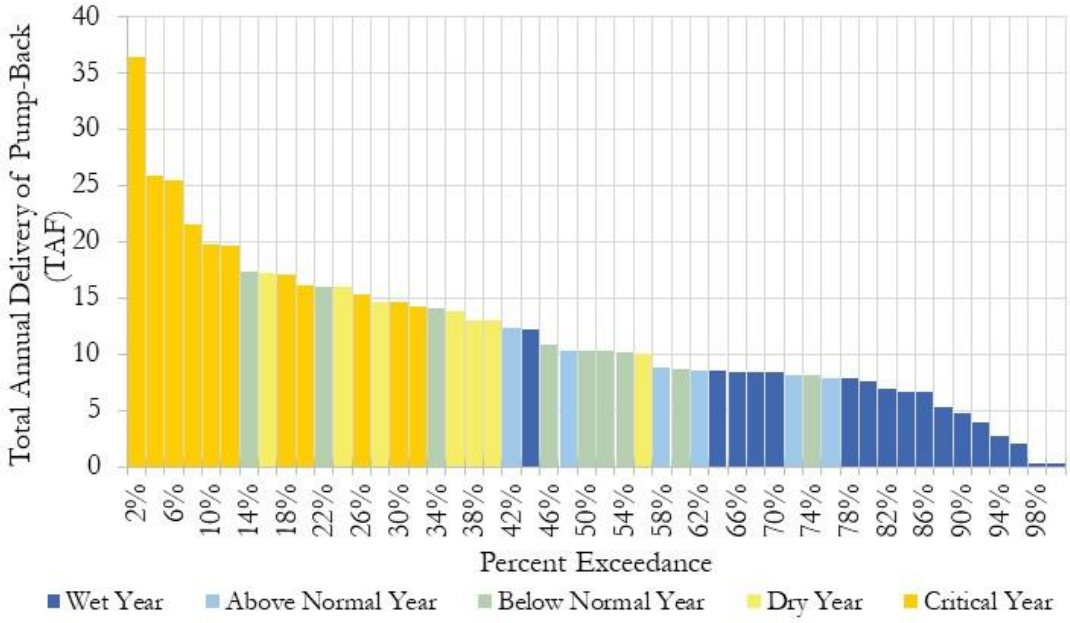
Table 3-128 summarize the average total annual delivery to the Friant Contractors in Reach C by source for an average of all years and by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the total average delivery is 223 TAF with 6 percent from existing programs and additional pump-back supply (total mitigation is less than 1 percent of total delivery). For an average Wet water year, the total delivery is 253 TAF with 4 percent from existing programs and additional pump-back supply (total mitigation is less than 1 percent of total delivery). For an average Critical water year, the total delivery is 156 TAF with 16 percent from existing programs and additional pump-back supply (total mitigation is 1 percent of total delivery).

Table 3-129 to Table 3-131 and Figure 3-61 summarizes the average monthly delivery to the Friant Contractors in Reach C by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-59. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Existing Conditions



Key: TAF = thousand acre-feet

Figure 3-60. Probability of Exceedance for Total Annual Pump-Back Delivery (thousand acre-feet) to the Friant Contractors in Reach C by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Table 3-128. Average Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach C by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	210	244	252	214	207	131
Existing Programs	2	<1	<1	<1	4	5
Additional Pump-Back Supply	11	9	6	10	10	20
Total Supply	223	253	259	225	221	156

Table 3-129. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	8,692	14,641	23,804	38,634	45,098	39,101	21,395	7,305	1,421	1,003	1,592	6,858	209,545
Existing Programs	15	21	276	275	275	275	275	296	62	203	0	0	1,974
Additional Pump-Back Supply	1,390	693	245	45	5	128	355	4,062	1,659	1,212	487	1,105	11,387
Total Supply	10,097	15,354	24,325	38,955	45,378	39,504	22,025	11,664	3,142	2,419	2,079	7,964	222,905

Table 3-130. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	9,842	16,459	27,209	43,355	51,617	49,000	29,479	6,014	1,359	731	1,426	7,422	243,914
Existing Programs	19	0	0	0	0	0	0	58	102	157	0	0	336
Additional Pump-Back Supply	0	0	0	0	0	0	0	4,722	1,320	1,269	539	1,030	8,880
Total Supply	9,861	16,459	27,209	43,355	51,617	49,000	29,479	10,794	2,780	2,158	1,965	8,452	253,130

Table 3-131. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	4,113	6,993	14,111	27,487	33,414	22,998	11,024	5,848	853	252	249	3,568	130,911
Existing Programs	38	93	766	765	765	765	765	556	40	529	0	0	5,083
Additional Pump-Back Supply	3,794	3,150	1,114	205	24	581	1,613	4,294	2,054	706	342	1,954	19,832
Total Supply	7,945	10,236	15,991	28,456	34,204	24,344	13,402	10,699	2,948	1,488	591	5,522	155,826

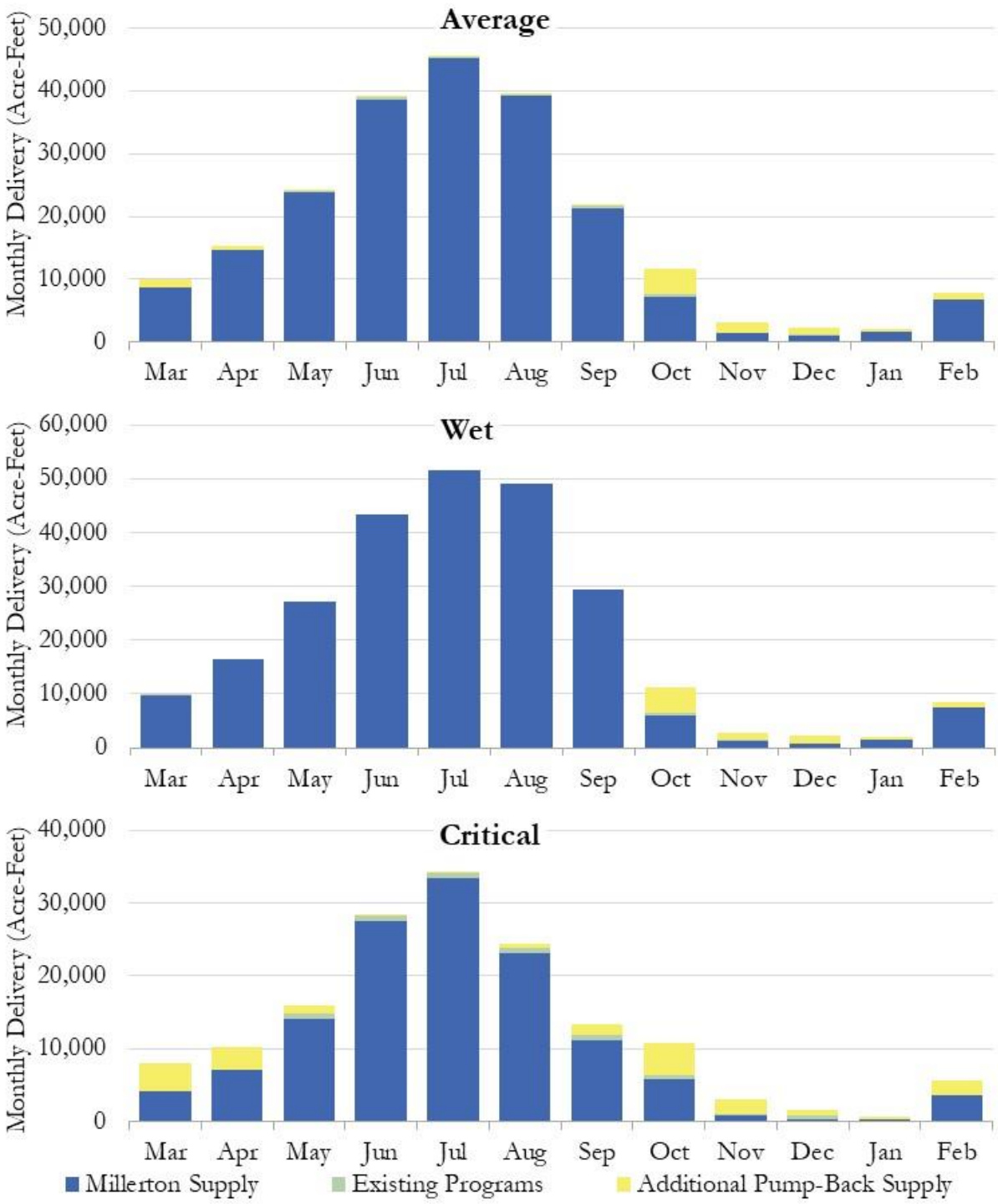


Figure 3-61. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach C deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-132 to Table 3-135 show the monthly average and monthly maximum water quality trends for individual constituents for the Low Flow Alternative and Seasonal Alternative under Existing Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply being delivered via reverse-flow pump-back operations (i.e., existing programs and additional pump-back supply) and FKC groundwater pump-in programs, water quality concentrations tend to increase. For TDS, nitrate, chloride, and boron, there is a correlation between reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-132. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	73.68	51.71	34.10	38.55	27.47	25.21	31.73	135.03	201.24	233.24	118.17	89.92
Maximum	267.63	263.61	239.99	112.14	62.95	214.42	216.53	251.92	281.00	335.00	232.56	230.04
Wet Water Years												
Average	26.98	28.00	21.33	21.00	13.00	13.75	13.00	148.65	200.62	235.68	109.04	75.76
Maximum	69.41	28.00	21.33	21.00	13.00	13.75	13.00	224.28	281.00	307.80	145.23	186.64
Critical Water Years												
Average	181.89	136.72	70.09	71.97	53.95	53.02	86.19	149.23	221.00	287.09	93.03	166.17
Maximum	267.63	263.61	239.99	112.14	62.95	214.42	216.53	233.13	243.01	320.20	205.66	230.04

Key: mg/L = milligrams per liter

Table 3-133. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.73	0.56	0.24	0.93	0.48	0.30	0.30	0.85	1.62	2.36	2.19	1.31
Maximum	2.63	2.00	2.15	2.52	1.46	1.04	1.17	1.97	2.53	3.55	3.89	2.91
Wet Water Years												
Average	0.23	0.16	0.03	0.08	0.04	0.09	0.08	1.03	1.77	2.52	2.55	1.38
Maximum	0.99	0.16	0.03	0.08	0.04	0.09	0.08	1.97	2.53	3.33	3.12	2.91
Critical Water Years												
Average	1.74	1.46	0.77	2.45	1.29	0.73	0.80	0.97	1.29	2.59	0.87	1.81
Maximum	2.63	2.00	2.15	2.52	1.46	1.04	1.17	1.49	1.42	2.90	1.93	2.54

Key: mg/L = milligrams per liter

Table 3-134. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.05	0.04	0.02	0.02	0.01	0.02	0.02	0.07	0.10	0.15	0.07	0.23
Maximum	0.21	0.20	0.16	0.06	0.02	0.12	0.13	0.15	0.16	0.24	0.15	0.34
Wet Water Years												
Average	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.06	0.07	0.14	0.07	0.32
Maximum	0.08	0.02	0.02	0.02	0.01	0.01	0.02	0.08	0.10	0.18	0.09	0.34
Critical Water Years												
Average	0.14	0.10	0.03	0.04	0.02	0.03	0.04	0.09	0.13	0.22	0.05	0.11
Maximum	0.21	0.20	0.16	0.06	0.02	0.12	0.13	0.14	0.14	0.24	0.11	0.15

Key: mg/L = milligrams per liter

Table 3-135. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	15.54	9.56	4.05	3.24	2.16	2.59	5.16	37.50	60.50	70.05	30.89	18.18
Maximum	70.25	71.73	61.45	20.07	6.44	57.43	59.88	79.91	93.00	100.80	67.83	61.32
Wet Water Years												
Average	2.65	2.23	1.30	1.08	0.66	0.74	0.72	41.91	64.90	75.51	26.27	9.70
Maximum	11.45	2.23	1.30	1.08	0.66	0.74	0.72	60.95	93.00	100.80	36.18	26.96
Critical Water Years												
Average	45.96	35.00	12.41	7.61	4.94	7.92	19.36	38.68	60.09	84.11	27.08	42.98
Maximum	70.25	71.73	61.45	20.07	6.44	57.43	59.88	62.18	66.47	94.60	59.91	61.32

Key: mg/L = milligrams per liter

Relative Results

Relative changes in both surface water quantity and quality were determined by comparing the Low Flow Alternative and Seasonal Alternative under Existing Conditions outputs to Existing Conditions outputs. When comparing the scenarios, differences in volumetric deliveries are due to the either the exchange of Millerton supply for existing program supply and/or the net increase of supply due to additional pump-back deliveries. Because reverse-flow pump-back facilities have increased capacity under the Low Flow Alternative and Seasonal Alternative under Existing Conditions as compared to Existing Conditions, there is additional opportunity to increase or maximize direct delivery of existing program supply, and thus volumetric increases are seen in Wet water years and on average for all years for those supply sources.

Table 3-136 to Table 3-138 show the volumetric differences by source between the Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions for an average of all years and by Wet and Critical water year types. Across all years, the overall average total supply delivered to Reach C increased by 14,640 AF in the Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions. This increase is a result of increased delivery of existing programs supply due to increased pump-back facility capacities and exchanges of Millerton supply for additional pump-back supply.

Table 3-139 to Table 3-142 shows the differences in monthly average and monthly maximum water quality trends for individual constituents between the Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to the Existing Conditions. For TDS, nitrate, chloride, and boron, there is a correlation between additional reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-136. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach C by Source for an Average of All Years, Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	278	143	602	1,072	1,719	1,578	1,327	-2,055	-952	-698	-10	249	3,253
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	1,390	693	245	45	5	128	355	4,062	1,659	1,212	487	1,105	11,387
Total Supply	1,668	836	847	1,117	1,724	1,706	1,682	2,008	707	514	477	1,354	14,640

Table 3-137. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach C by Source for Wet Water Year Types, Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	559	0	0	0	666	1,617	1,579	-2,689	-772	-799	-64	253	350
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	0	0	0	0	0	0	0	4,722	1,320	1,269	539	1,030	8,880
Total Supply	559	0	0	0	666	1,617	1,579	2,034	547	470	476	1,283	9,230

Table 3-138. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach C by Source for Critical Water Year Types, Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-2,031	-1,460	543	1,347	1,567	1,041	64	-2,280	-1,275	-469	-136	-482	-3,570
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	3,794	3,150	1,114	205	25	581	1,613	4,294	2,054	706	342	1,954	19,832
Total Supply	1,764	1,690	1,657	1,552	1,592	1,622	1,677	2,014	779	237	206	1,473	16,262

Water Quality

Table 3-139. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	48.00	23.33	5.56	0.60	-0.04	3.07	10.01	107.58	171.92	171.78	93.47	65.58
Maximum	202.95	190.97	182.24	35.59	2.28	162.49	168.67	151.98	54.33	125.00	200.96	204.37
Wet Water Years												
Average	0.28	0.00	0.00	0.00	0.00	0.00	0.00	115.31	161.75	179.42	82.82	50.09
Maximum	4.73	0.00	0.00	0.00	0.00	0.00	0.00	124.34	54.33	97.80	115.73	160.97
Critical Water Years												
Average	155.54	106.02	25.72	2.88	-0.05	14.19	46.41	114.47	198.52	177.81	78.67	144.17
Maximum	227.84	190.97	182.24	35.59	2.28	162.49	168.67	184.76	192.75	150.20	174.06	208.04

Key: mg/L = milligrams per liter

Table 3-140. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.55	0.09	0.03	-0.01	0.00	-0.01	0.00	0.42	1.33	1.44	1.08	0.80
Maximum	1.71	0.19	1.11	-0.14	-0.03	-0.09	0.14	0.06	-1.68	-0.48	2.09	2.22
Wet Water Years												
Average	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.47	1.32	1.87	0.95	0.69
Maximum	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.06	-1.68	0.15	1.32	2.22
Critical Water Years												
Average	1.56	0.39	0.13	-0.02	-0.01	-0.03	0.01	0.28	1.11	0.22	0.75	1.65
Maximum	1.71	0.19	1.11	-0.14	-0.03	-0.09	0.14	0.41	0.67	-1.13	1.66	2.38

Key: mg/L = milligrams per liter

Table 3-141. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.04	0.02	0.00	0.00	0.00	0.00	0.01	0.05	0.09	0.10	0.06	0.01
Maximum	0.17	0.16	0.14	0.02	0.00	0.10	0.12	0.11	0.05	0.12	0.13	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.05	0.10	0.06	-0.02
Maximum	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.04	-0.01	0.06	0.08	0.00
Critical Water Years												
Average	0.12	0.08	0.02	0.00	0.00	0.01	0.03	0.08	0.11	0.13	0.04	0.09
Maximum	0.18	0.16	0.14	0.02	0.00	0.10	0.12	0.13	0.11	0.13	0.09	0.13

Key: mg/L = milligrams per liter

Table 3-142. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	13.33	6.94	1.79	0.25	0.01	1.05	3.39	35.03	55.55	57.69	29.13	16.39
Maximum	54.47	64.73	55.98	12.94	0.96	53.09	55.31	59.23	20.00	37.80	65.63	59.42
Wet Water Years												
Average	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	38.46	56.64	63.43	24.32	7.80
Maximum	-4.33	0.00	0.00	0.00	0.00	0.00	0.00	40.27	20.00	37.80	33.98	25.06
Critical Water Years												
Average	44.23	31.55	8.16	1.14	0.06	4.77	15.51	35.82	57.60	60.52	26.17	41.38
Maximum	66.32	64.73	55.98	12.94	0.96	53.09	55.31	58.09	56.06	54.89	57.89	59.72

Key: mg/L = milligrams per liter

Reach D

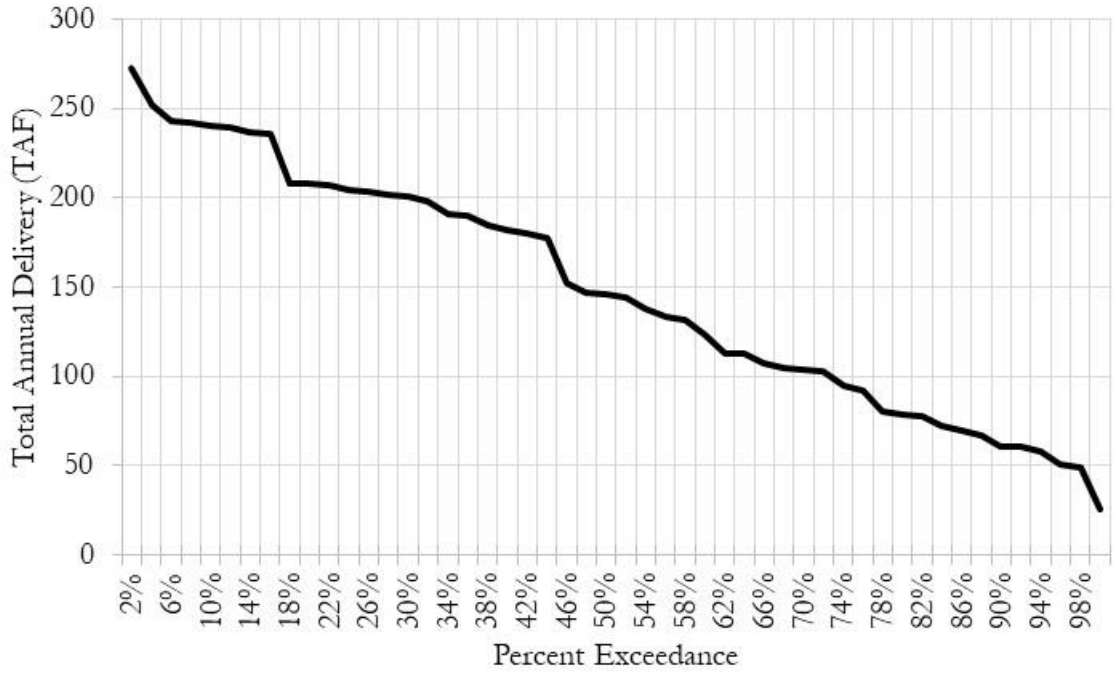
This section summarizes the total water supply delivery and the total water quality to the Friant Contractors in Reach D. The Friant Contractors within Reach D include Saucelito Irrigation District, Terra Bella Irrigation District, Tea Pot Dome Water District, Pixley Irrigation District, Lower Tule River Irrigation District, and Porterville Irrigation District.

Water Supply

For the Low Flow Alternative under Existing Conditions, the Reach D Deer Creek check structure capacity is modeled as 75 cfs. The delivery to the Friant Contractors in Reach D is composed of Millerton supply and FKC groundwater pump-in program supply. Similarly, under the Seasonal Alternative under Existing Conditions, the Reach D Deer Creek check structure capacity is assumed to be 0 cfs. As such, no supply delivered via reverse-flow pump-back was simulated for the Low Flow Alternative and Seasonal Alternative under Existing Conditions. The delivery to the Friant Contractors in Reach D is composed of Millerton Supply and FKC groundwater pump-in program supply. Figure 3-62 shows the percent exceedance of total annual delivery to the Friant Contractors in Reach D under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach D and not at the Intertie.

Table 3-143 summarizes the average total annual delivery to the Friant Contractors in Reach D for an average of all years and by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. In this table, existing programs include the water delivered from FKC groundwater pump-in programs. Across all years, the total average delivery is 148 TAF with less than 1 percent from FKC groundwater pump-in program supply (total mitigation is less than 1 percent of total delivery). For an average Wet water year, the total delivery is 211 TAF, all from Millerton supply. For an average Critical water year, the total delivery is 64 TAF with 1 percent from FKC groundwater pump-in program supply (total mitigation is less than 1 percent of total delivery).

Table 3-144 to Table 3-146 and Figure 3-63 summarizes the average monthly delivery to the Friant Contractors in Reach D by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-62. Probability of Exceedance for Total Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Table 3-143. Average Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach D by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	148	211	197	125	110	64
Existing Programs	<1	0	0	0	<1	<1
Additional Pump-Back Supply	0	0	0	0	0	0
Total Supply	148	211	197	125	111	64

Table 3-144. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	7,905	12,940	19,442	26,728	26,908	22,817	12,090	5,563	1,704	1,410	2,622	7,439	147,569
Existing Programs	0	0	48	48	48	48	48	48	0	0	0	0	291
Additional Pump-Back Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Supply	7,905	12,940	19,490	26,777	26,956	22,865	12,139	5,611	1,704	1,410	2,622	7,439	147,859

Table 3-145. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	11,698	19,796	30,858	39,888	37,369	33,184	19,218	5,421	1,646	912	2,398	9,030	211,419
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Supply	11,698	19,796	30,858	39,888	37,369	33,184	19,218	5,421	1,646	912	2,398	9,030	211,419

Table 3-146. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	2,989	3,747	6,103	12,134	14,973	9,990	4,893	3,745	1,049	318	319	3,340	63,599
Existing Programs	0	0	135	135	135	135	135	98	0	0	0	0	771
Additional Pump-Back Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Supply	2,989	3,747	6,238	12,268	15,107	10,125	5,028	3,843	1,049	318	319	3,340	64,370

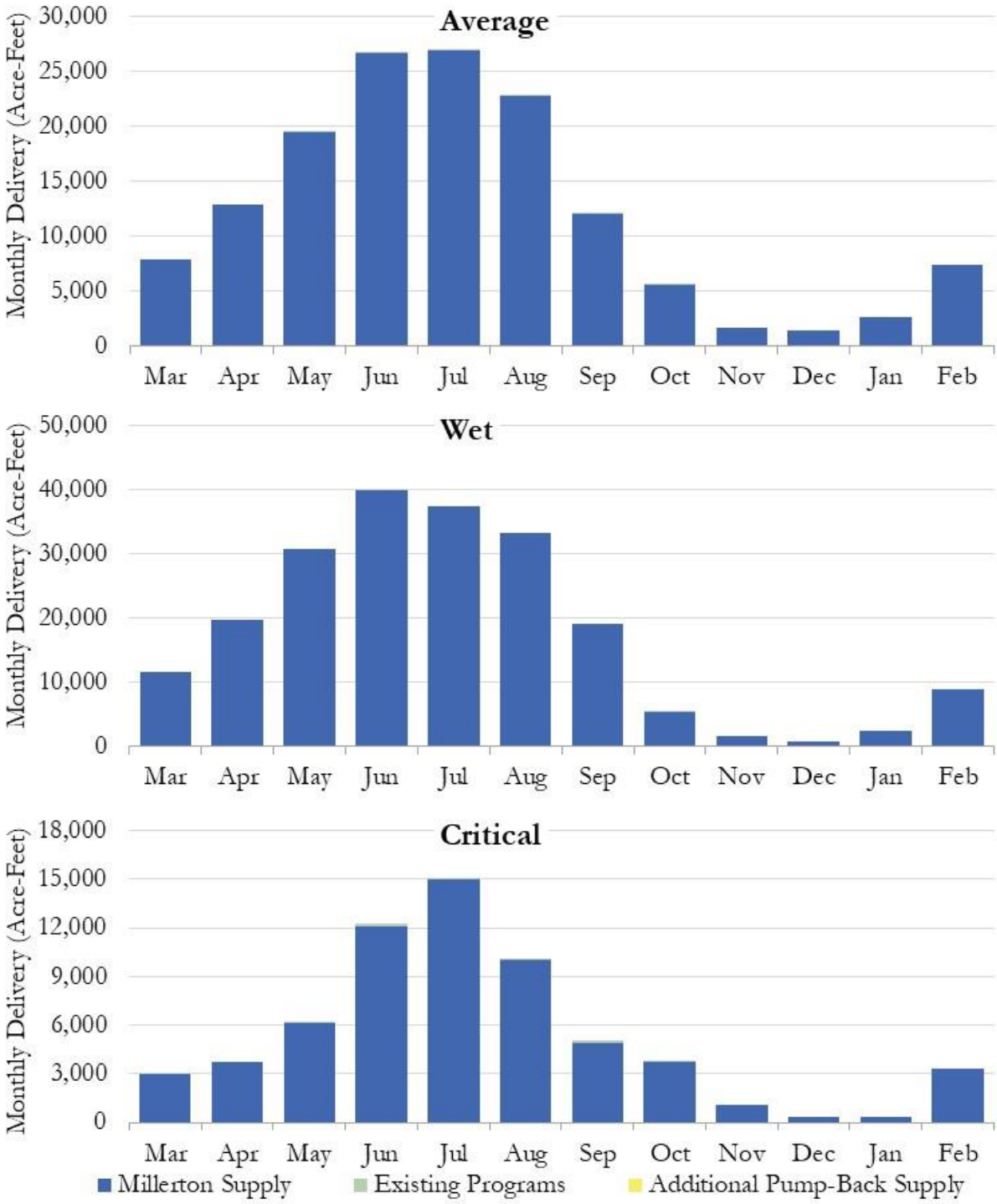


Figure 3-63. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach D deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-147 to Table 3-150 show the monthly average and monthly maximum water quality trends for individual constituents for the Low Flow Alternative and Seasonal Alternative under Existing Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is from FKC groundwater pump-in programs supply being delivered, water quality concentrations tend to increase. For TDS, nitrate, chloride, and boron, the concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-147. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	24.57	27.46	25.45	36.38	26.10	20.12	17.80	20.39	18.88	23.54	24.69	24.35
Maximum	25.00	28.00	42.14	68.09	53.01	40.32	32.15	43.89	20.00	29.00	31.60	25.67
Wet Water Years												
Average	24.33	28.00	21.33	21.00	13.00	13.75	13.00	23.07	18.89	25.78	26.22	25.67
Maximum	24.33	28.00	21.33	21.00	13.00	13.75	13.00	43.89	20.00	29.00	29.50	25.67
Critical Water Years												
Average	25.00	26.50	34.34	64.22	49.73	32.37	27.70	22.73	18.00	12.73	14.36	22.00
Maximum	25.00	26.50	42.14	68.09	53.01	40.32	32.15	29.50	18.00	28.00	31.60	22.00

Key: mg/L = milligrams per liter

Table 3-148. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.15	0.46	0.13	0.89	0.45	0.25	0.20	0.24	0.08	0.15	1.11	0.50
Maximum	0.18	1.00	0.58	2.45	1.27	0.80	0.58	0.90	0.09	0.20	1.80	0.70
Wet Water Years												
Average	0.18	0.16	0.03	0.08	0.04	0.09	0.08	0.30	0.07	0.18	1.60	0.70
Maximum	0.18	0.16	0.03	0.08	0.04	0.09	0.08	0.90	0.08	0.20	1.80	0.70
Critical Water Years												
Average	0.10	1.00	0.35	2.35	1.18	0.57	0.45	0.35	0.09	0.06	0.12	0.17
Maximum	0.10	1.00	0.58	2.45	1.27	0.80	0.58	0.54	0.09	0.13	0.27	0.17

Key: mg/L = milligrams per liter

Table 3-149. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.23
Maximum	0.02	0.02	0.02	0.04	0.02	0.03	0.02	0.02	0.01	0.05	0.02	0.34
Wet Water Years												
Average	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.34
Maximum	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.02	0.02	0.34
Critical Water Years												
Average	0.02	0.02	0.01	0.04	0.02	0.03	0.01	0.01	0.01	0.02	0.01	0.02
Maximum	0.02	0.02	0.01	0.04	0.02	0.03	0.01	0.01	0.01	0.05	0.02	0.02

Key: mg/L = milligrams per liter

Table 3-150. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	1.88	2.55	1.99	2.85	2.03	1.36	1.42	1.59	1.52	2.25	1.76	1.79
Maximum	2.10	3.10	4.05	6.38	4.79	3.29	3.17	3.75	1.75	3.05	2.20	1.90
Wet Water Years												
Average	2.10	2.23	1.30	1.08	0.66	0.74	0.72	1.86	1.65	2.71	1.96	1.90
Maximum	2.10	2.23	1.30	1.08	0.66	0.74	0.72	3.75	1.75	3.05	2.20	1.90
Critical Water Years												
Average	1.50	3.10	3.35	6.04	4.50	2.56	2.77	1.76	1.20	0.91	0.92	1.60
Maximum	1.50	3.10	4.05	6.38	4.79	3.29	3.17	2.38	1.20	2.01	2.02	1.60

Key: mg/L = milligrams per liter

Relative changes in both surface water quantity and quality were determined by comparing the Low Flow Alternative and Seasonal Alternative under Existing Conditions outputs to Existing Conditions outputs. When comparing the scenarios, differences in volumetric deliveries are due to increased delivery of Millerton supply in exchange of existing program supply. Because reverse-flow pump-back facilities have increased capacity under the Low Flow Alternative and Seasonal Alternative under Existing Conditions as compared to Existing Conditions, there is additional opportunity to increase or maximize direct delivery of existing program supply, and thus volumetric increases are seen in Wet water years and on average for all years for those supply sources.

Table 3-151 to Table 3-153 show the volumetric differences by source between the Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions for an average of all years and by Wet and Critical water year types. Across all years, the overall average total supply delivered to Reach D increased by 8,324 AF in the Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions. This increase is a result of increased pump-back facility capacities which results in increased exchanges of existing program supply for Millerton supply.

Table 3-154 to Table 3-157 shows the differences in monthly average and monthly maximum water quality trends for individual constituents between the Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to the Existing Conditions. For TDS, nitrate, chloride, and boron, there are minor differences in water quality due to the source of supply being mainly Millerton Supply.

Table 3-151. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach D by Source for an Average of All Years, Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	799	400	418	509	762	1,083	1,045	1,046	401	358	468	1,036	8,324
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Supply	799	400	418	509	762	1,083	1,045	1,046	401	358	468	1,036	8,324

Table 3-152. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach D by Source for Wet Water Year Types, Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	321	0	0	0	282	1,222	1,178	1,053	331	259	441	1,101	6,188
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Supply	321	0	0	0	282	1,222	1,178	1,053	331	259	441	1,101	6,188

Table 3-153. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach D by Source for Critical Water Year Types, Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	789	771	828	802	828	828	802	901	336	101	102	792	7,880
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Supply	789	771	828	802	828	828	802	901	336	101	102	792	7,880

Water Quality

Table 3-154. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.00	0.00	-0.39	-0.08	-0.06	-0.18	-0.51	-1.87	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-6.55	-1.30	-0.89	-4.30	-4.34	-11.20	0.00	0.00	0.00	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-2.73	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-11.20	0.00	0.00	0.00	0.00
Critical Water Years												
Average	0.00	0.00	-1.57	-0.30	-0.20	-0.71	-1.86	-3.06	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-6.55	-1.30	-0.89	-4.30	-4.34	-6.85	0.00	0.00	0.00	0.00

Key: mg/L = milligrams per liter

Table 3-155. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.00	0.00	-0.01	0.00	0.00	-0.01	-0.01	-0.05	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-0.19	-0.03	-0.03	-0.12	-0.12	-0.32	0.00	0.00	0.00	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.08	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.32	0.00	0.00	0.00	0.00
Critical Water Years												
Average	0.00	0.00	-0.05	-0.01	-0.01	-0.02	-0.05	-0.09	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-0.19	-0.03	-0.03	-0.12	-0.12	-0.20	0.00	0.00	0.00	0.00

Key: mg/L = milligrams per liter

Table 3-156. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Critical Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key: mg/L = milligrams per liter

Table 3-157. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.00	0.00	-0.03	-0.01	-0.01	-0.02	-0.05	-0.17	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-0.58	-0.12	-0.08	-0.39	-0.39	-1.02	0.00	0.00	0.00	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.25	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.02	0.00	0.00	0.00	0.00
Critical Water Years												
Average	0.00	0.00	-0.14	-0.03	-0.02	-0.07	-0.17	-0.28	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-0.58	-0.12	-0.08	-0.39	-0.39	-0.62	0.00	0.00	0.00	0.00

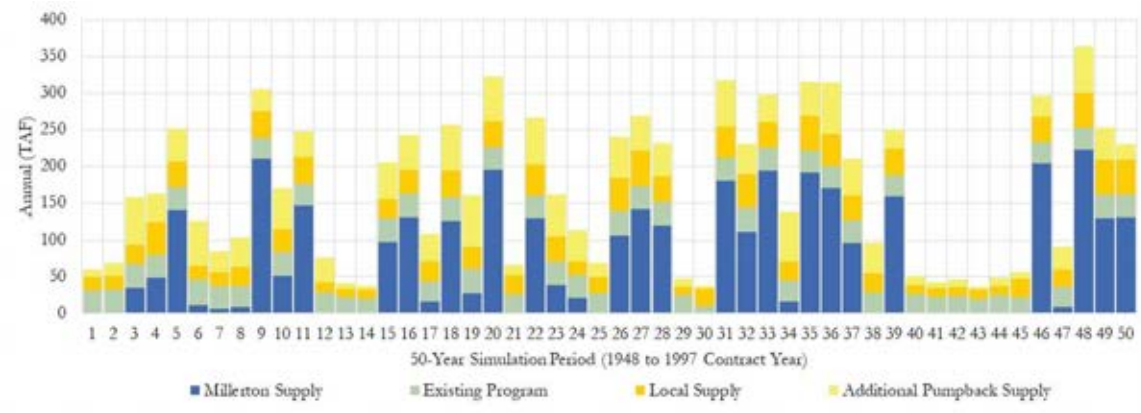
Key: mg/L = milligrams per liter

Total Surface Water Delivery to Friant Contractors

This section summarizes the annual total surface water delivery to the Friant Contractors in the study area under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. The Distribution Module simulates the delivery of Millerton supply and exiting program supply. The local supplies are added to the individual Friant Contractors after the Distribution Module deliveries. Local supplies were considered in this analysis for several Friant Contractors. AEWSD receives deliveries from the Kern River and directly from the California Aqueduct. Porterville ID, LTRID, and TBID all receive deliveries from the Tule River.

Arvin-Edison Water Storage District

Figure 3-64 the total annual surface water delivery to AEWSD in the Low Flow Alternative and Seasonal Alternative under Existing Conditions. AEWSD receives local sources of water supply directly from the Kern River and directly from the California Aqueduct.

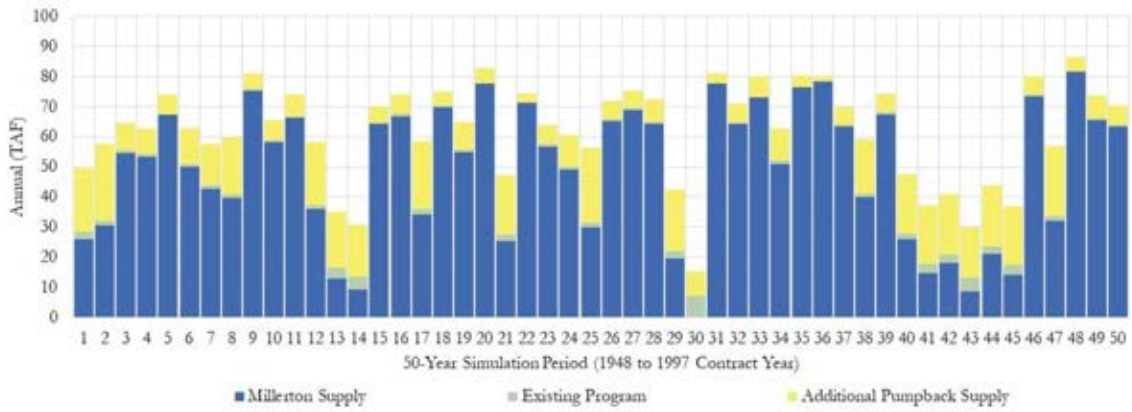


Key: TAF = thousand acre-feet

Figure 3-64. Total Annual Surface Water Delivery (thousand acre-feet) to Arvin-Edison Water Storage District for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Shafter-Wasco Irrigation District

Figure 3-65 summarizes the total annual surface water delivery to SWID in the Low Flow Alternative and Seasonal Alternative under Existing Conditions.

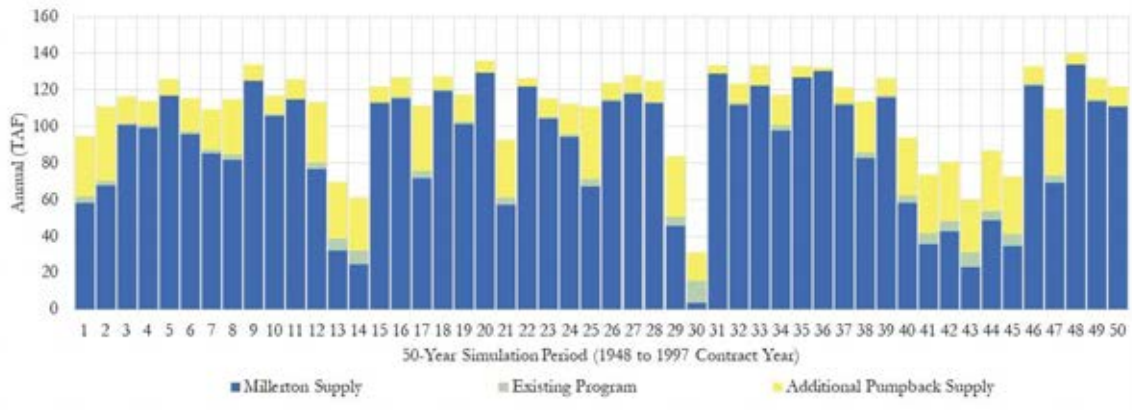


Key: TAF = thousand acre-feet

Figure 3-65. Total Annual Surface Water Delivery (thousand acre-feet) to Shafter-Wasco Irrigation District for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Southern San Joaquin Municipal Utility District

Figure 3-66 summarizes the total annual surface water delivery to SSJMUD in the Low Flow Alternative and Seasonal Alternative under Existing Conditions.

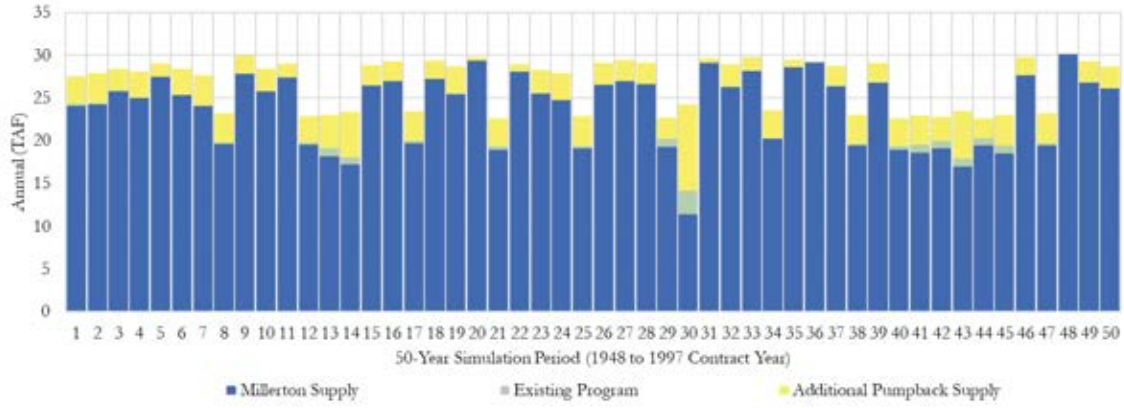


Key: TAF = thousand acre-feet

Figure 3-66. Total Annual Surface Water Delivery (thousand acre-feet) to Southern San Joaquin Municipal Utility District for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Kern-Tulare Water District

Figure 3-67 summarizes the total annual surface water delivery to KTWD in the Low Flow Alternative and Seasonal Alternative under Existing Conditions.

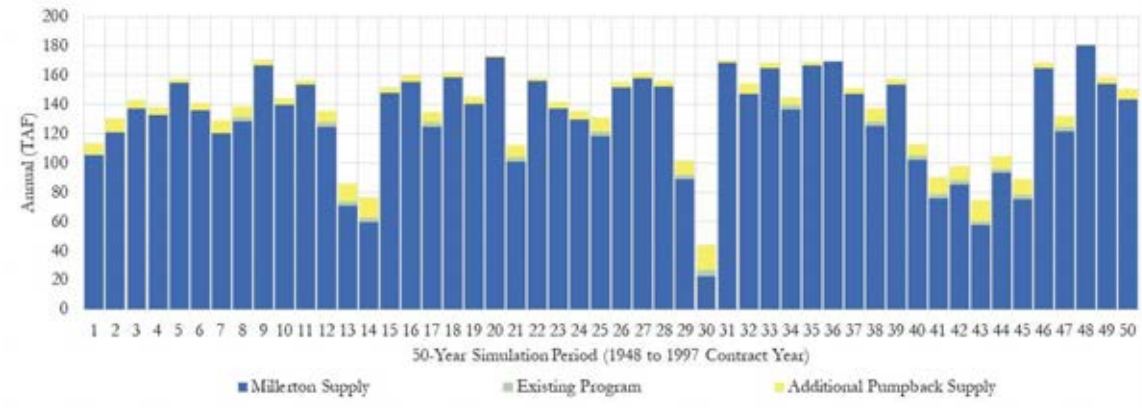


Key: TAF = thousand acre-feet

Figure 3-67. Total Annual Surface Water Delivery (thousand acre-feet) to Kern-Tulare Water District for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Delano-Earlimart Irrigation District

Figure 3-68 summarizes the total annual surface water delivery to DEID in the Low Flow Alternative and Seasonal Alternative under Existing Conditions.

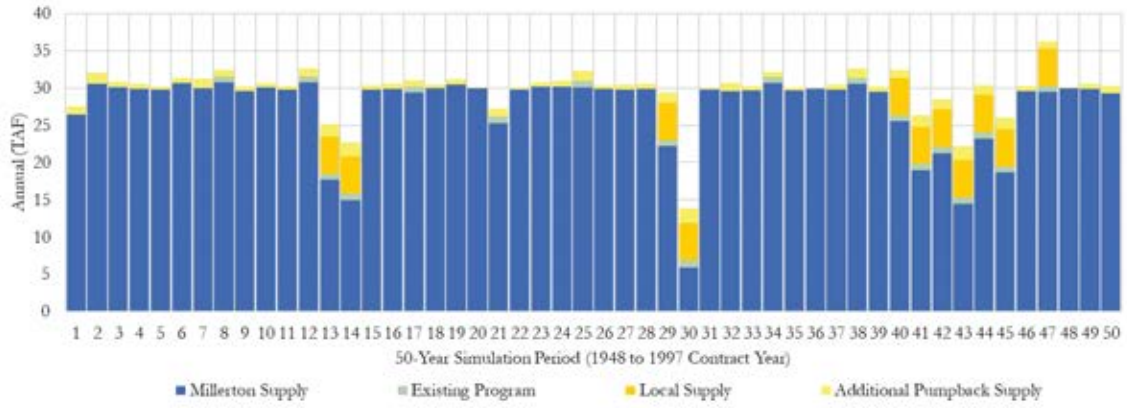


Key: TAF = thousand acre-feet

Figure 3-68. Total Annual Surface Water Delivery (thousand acre-feet) to Delano-Earlimart Irrigation District for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Terra Bella Irrigation District

Figure 3-69 summarizes the total annual surface water delivery to TBID in the Low Flow Alternative and Seasonal Alternative under Existing Conditions. TBID receives local sources of water supply directly from the Tule River.

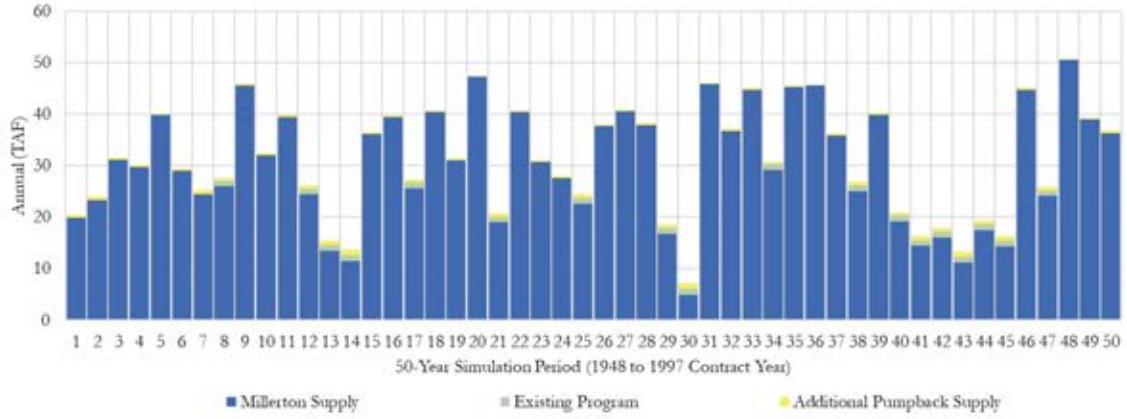


Key: TAF = thousand acre-feet

Figure 3-69. Total Annual Surface Water Delivery (thousand acre-feet) to Terra Bella Irrigation District for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Saucelito Irrigation District

Figure 3-70 summarizes the total annual surface water delivery to Saucelito ID in the Low Flow Alternative and Seasonal Alternative under Existing Conditions.



Key: TAF = thousand acre-feet

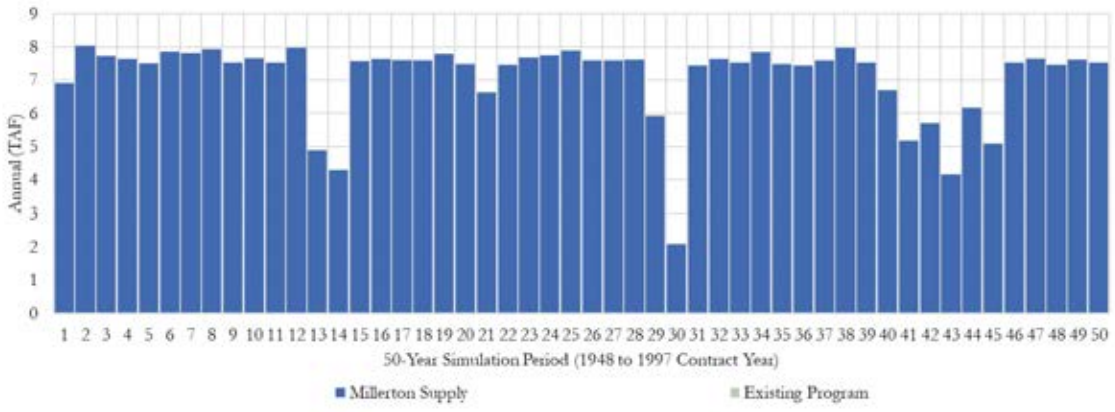
Figure 3-70. Total Annual Surface Water Delivery (thousand acre-feet) to Saucelito Irrigation District for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Pixley Irrigation District

In the Low Flow Alternative and Seasonal Alternative under Existing Conditions, Pixley ID does receive mitigation supply from existing programs supply. However, this supply is very small (ess than 100 AF) and only occurs in Dry and Critical water year types.

Tea Pot Dome Water District

Figure 3-71 summarizes the total annual surface water delivery to TPDWD in the Low Flow Alternative and Seasonal Alternative under Existing Conditions.

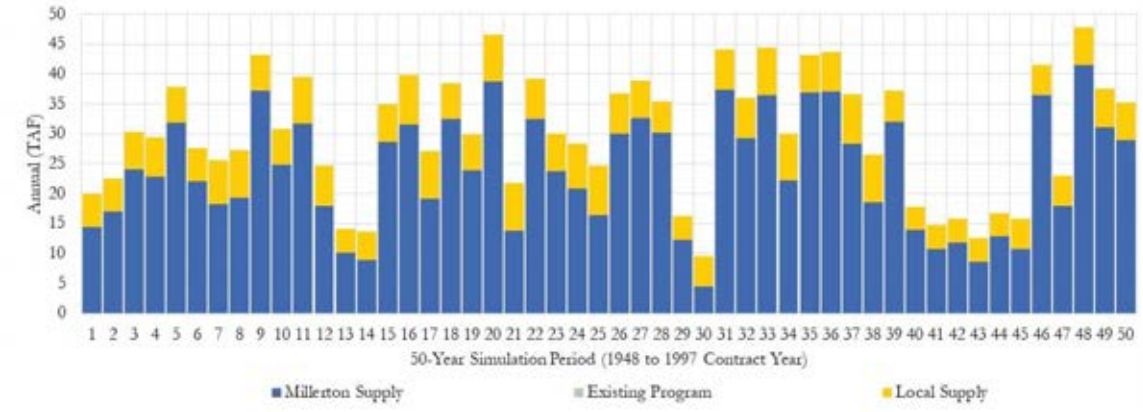


Key: TAF = thousand acre-feet

Figure 3-71. Total Annual Surface Water Delivery (thousand acre-feet) to Tea Pot Dome Water District for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Porterville Irrigation District

Figure 3-72 summarizes the total annual surface water delivery to Porterville ID in the Low Flow Alternative and Seasonal Alternative under Existing Conditions. Porterville ID receives local sources of water supply directly from the Tule River.

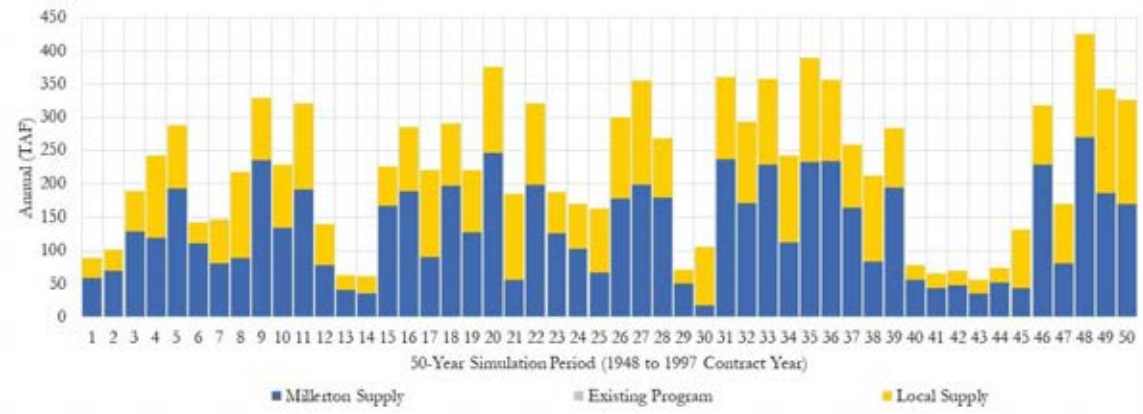


Key: TAF = thousand acre-feet

Figure 3-72. Total Annual Surface Water Delivery (thousand acre-feet) to Porterville Irrigation District for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Lower Tule River Irrigation District

Figure 3-73 summarizes the total annual surface water delivery to LTRID in the Low Flow Alternative and Seasonal Alternative under Existing Conditions. LTRID receives local sources of water supply directly from the Tule River.



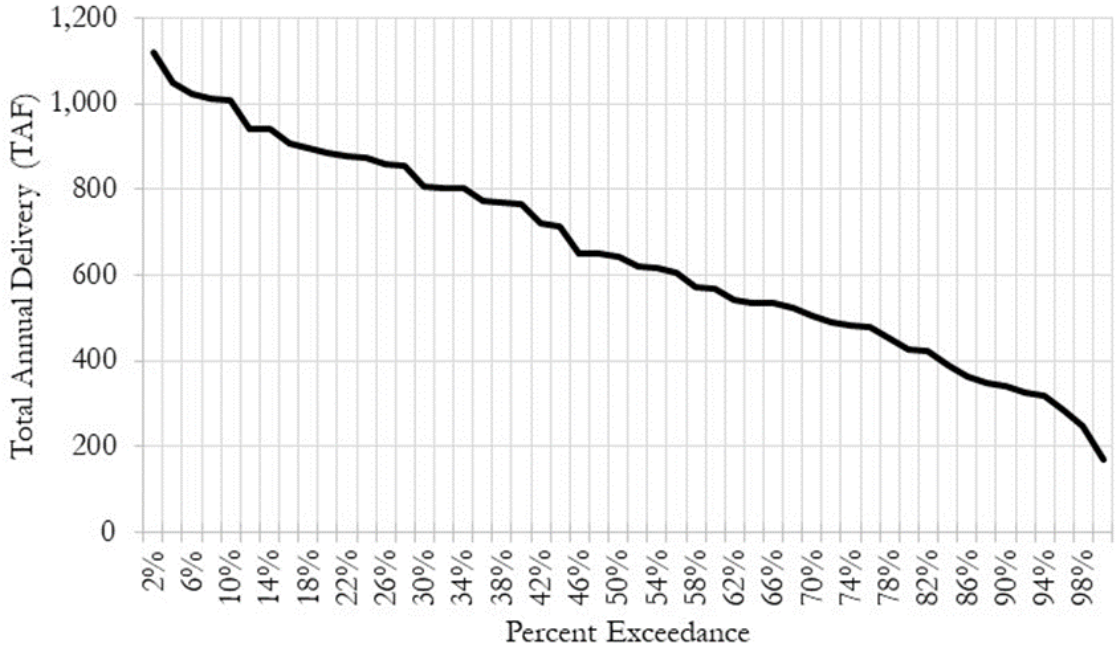
Key: TAF = thousand acre-feet

Figure 3-73. Total Annual Surface Water Delivery (thousand acre-feet) to Lower Tule River Irrigation District for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

3.2.3.2 Low Flow Alternative and Seasonal Alternative under Future Conditions

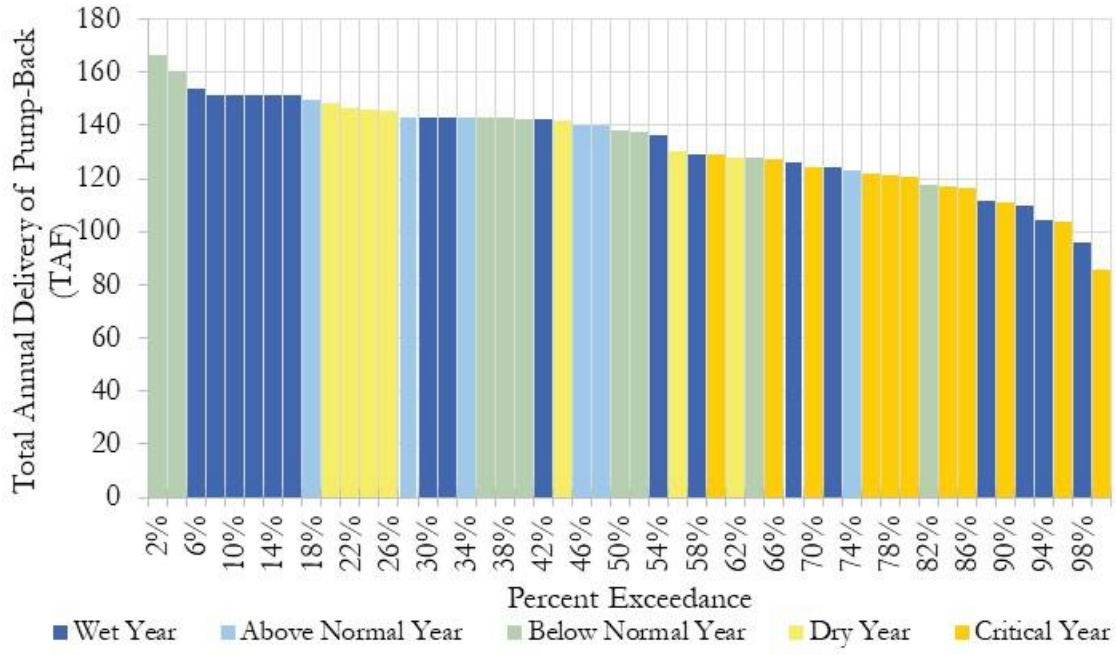
Figure 3-74 shows the probability of exceedance of total annual delivery to Friant Contractors in the study area under the Low Flow Alternative and Seasonal Alternative under Future Conditions. Figure 3-75 shows the probability of exceedance of total annual supply delivered to Friant Contractors in the study area via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Future Conditions. These pump-back operational volumes represent all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supplies for KTWD, LTRID and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC at different locations along the Project reaches and not at the Intertie.

Table 3-158 summarizes the average total annual delivery to Friant Contractors in the study area by source for an average of all years and by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Future Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the average total delivery is 650 TAF with 21 percent from existing programs and additional pump-back supply. For an average Wet water year, the total delivery is 865 TAF with 14 percent from existing programs and additional pump-back supply. For an average Critical water year, the total delivery is 347 TAF with 37 percent from existing programs and additional pump-back supply.



Key: TAF = thousand acre-feet

Figure 3-74. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to Friant Contractors in the Study Area for the Low Flow Alternative and Seasonal Alternative under Future Conditions



Key: TAF = thousand acre-feet

Figure 3-75. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to Friant Contractors in the Study Area by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Table 3-158. Average Annual Delivery (thousand acre-feet) to Friant Contractors in the Study Area by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	515	748	652	440	387	220
Existing Programs	75	74	90	87	67	64
Additional Pump-Back Supply	61	43	72	58	94	63
Total Supply	650	865	815	584	547	347

Location of Interface

Table 3-159 summarizes the average monthly location of the interface between the reverse-flow pump-back operations and gravity operations (i.e., Millerton supply) for an average of all years and by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Future Conditions. During peak irrigation season supply is delivered via reverse-flow pump-back operations and exchanged to meet irrigation demand in Reach A. As the water year type becomes drier and CVP surface water allocation is reduced, supply delivered via reverse-flow pump-back operations is delivered further up the canal to meet irrigation demand. In addition, because

there is reduced irrigation demand in the shoulder months of the irrigation season (October to March), supply delivered via reverse flow pump-back is pushed further up the canal as less water is exchanged in the lower Project reaches and the available supply is distributed to more Friant Contractors.

Table 3-159. Average Monthly Reach Location of Pump-Back Interface for an Average of All Years and by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Year Type	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Wet	C	A	A	A	B	B	B	C	C	C	C	C
Above Normal	C	A	A	A	B	B	C	C	C	C	C	C
Below Normal	C	C	B	B	B	B	C	C	C	C	C	C
Dry	C	C	B	B	B	B	C	C	C	C	C	C
Critical	C	C	C	C	C	C	C	D	C	C	C	C
Average	C	C	B	B	B	B	C	C	C	C	C	C

Notes:
Year Type is based on San Joaquin Valley Water Year Types
Reach A is the Intertie to Shafter-Wasco Check
Reach B is from Shafter-Wasco Check to Lake Woollomes Check
Reach C is from Lake Woollomes Check to Deer Creek Check

Reach A

This section summarizes the total water supply delivery and the total water quality to the Friant Contractors in Reach A. The only Friant Contractor within Reach A is AEWSD.

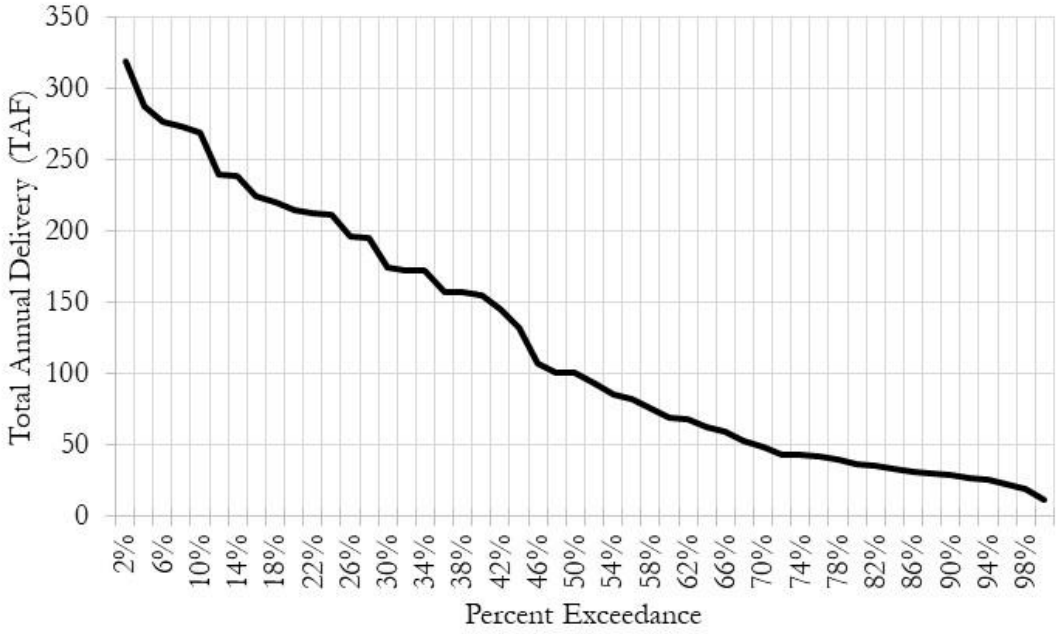
Water Supply

Figure 3-76 shows the probability of exceedance of total annual delivery to the Friant Contractor in Reach A under the Low Flow Alternative and Seasonal Alternative under Future Conditions. Figure 3-77 shows the probability of exceedance of total annual supply delivered to the Friant Contractor in Reach A via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Future Conditions. These volumes represent all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. There are no FKC groundwater pump-in program deliveries in Reach A.

Table 3-160 summarize the average total annual delivery to the Friant Contractor in Reach A by source for an average of all years and by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Future Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs). Across all years, the average total delivery is 123 TAF with 56 percent from existing programs and additional pump-back supply (total mitigation is 3 percent of total delivery). For an average Wet water year, the total delivery is 213 TAF with 39 percent from existing programs and additional

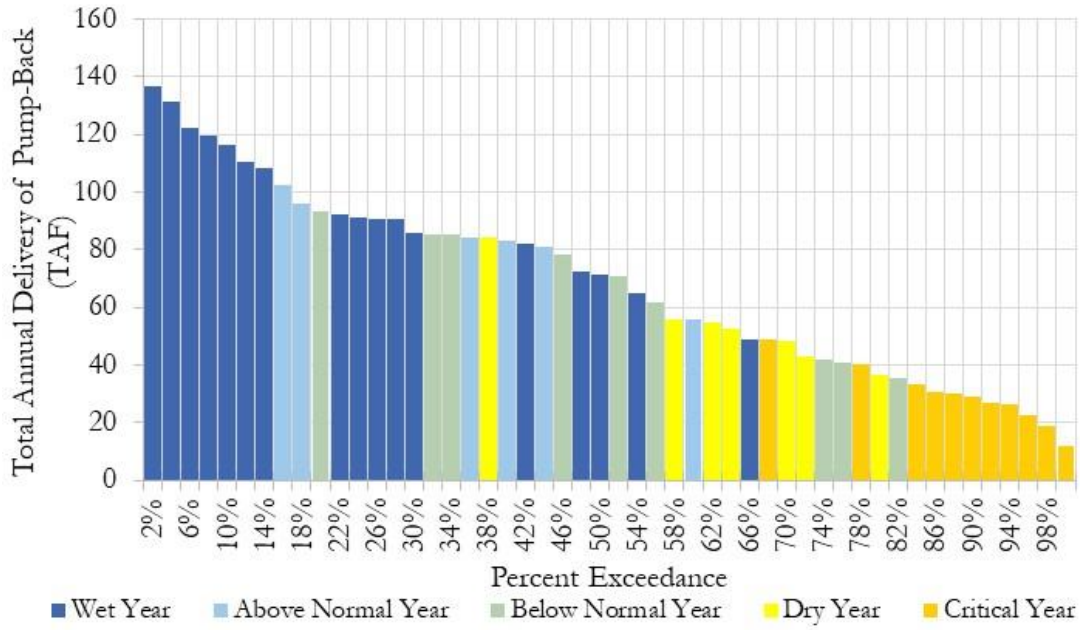
pump-back supply (total mitigation is 2 percent of total delivery). For an average Critical water year, the total delivery is 31 TAF all from existing programs and additional pump-back supply (total mitigation is 6 percent of total delivery).

Table 3-161 to Table 3-163 and Figure 3-78 summarizes the average monthly delivery to the Friant Contractor in Reach A by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-76. Probability of Exceedance for Total Annual Delivery (thousand acre-feet) to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Future Conditions



Key: TAF = thousand acre-feet

Figure 3-77. Probability of Exceedance for Total Annual Pump-Back Delivery (thousand acre-feet) to the Friant Contractor in Reach A by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Table 3-160. Average Annual Delivery (thousand acre-feet) to the Friant Contractor in Reach A by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	54	130	65	10	1	0
Existing Programs	48	61	68	48	40	24
Additional Pump-Back Supply	20	23	39	19	22	6
Total Supply	123	213	172	77	63	31

Table 3-161. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source for the Low Flow Alternative and Seasonal Alternative under Future Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	3,547	8,033	13,676	15,859	8,424	649	35	0	277	156	1,028	2,379	54,063
Existing Programs	1,446	1,939	3,296	4,677	10,469	13,421	8,134	3,711	432	341	0	400	48,268
Additional Pump-Back Supply	2,054	463	797	2,188	1,024	2,991	981	335	964	1,107	2,365	5,023	20,292
Total Supply	7,047	10,435	17,769	22,724	19,917	17,061	9,150	4,046	1,673	1,605	3,393	7,803	122,623

Table 3-162. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source for the Low Flow Alternative and Seasonal Alternative under Future Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	9,975	17,867	31,829	38,685	24,755	1,909	102	0	455	0	1,029	3,453	130,057
Existing Programs	1,138	1,840	3,470	4,470	8,581	21,082	15,250	3,592	359	288	0	400	60,470
Additional Pump-Back Supply	1,970	0	0	0	1,082	7,453	2,414	584	986	553	2,067	5,474	22,582
Total Supply	13,082	19,707	35,299	43,155	34,418	30,443	17,766	4,176	1,801	841	3,096	9,326	213,109

Table 3-163. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source for the Low Flow Alternative and Seasonal Alternative under Future Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Existing Programs	1,024	1,387	2,325	4,304	6,480	4,121	1,931	1,614	409	124	0	400	24,119
Additional Pump-Back Supply	383	384	525	1,366	374	305	194	53	192	57	180	2,382	6,396
Total Supply	1,407	1,771	2,850	5,670	6,854	4,426	2,125	1,667	600	182	180	2,782	30,515

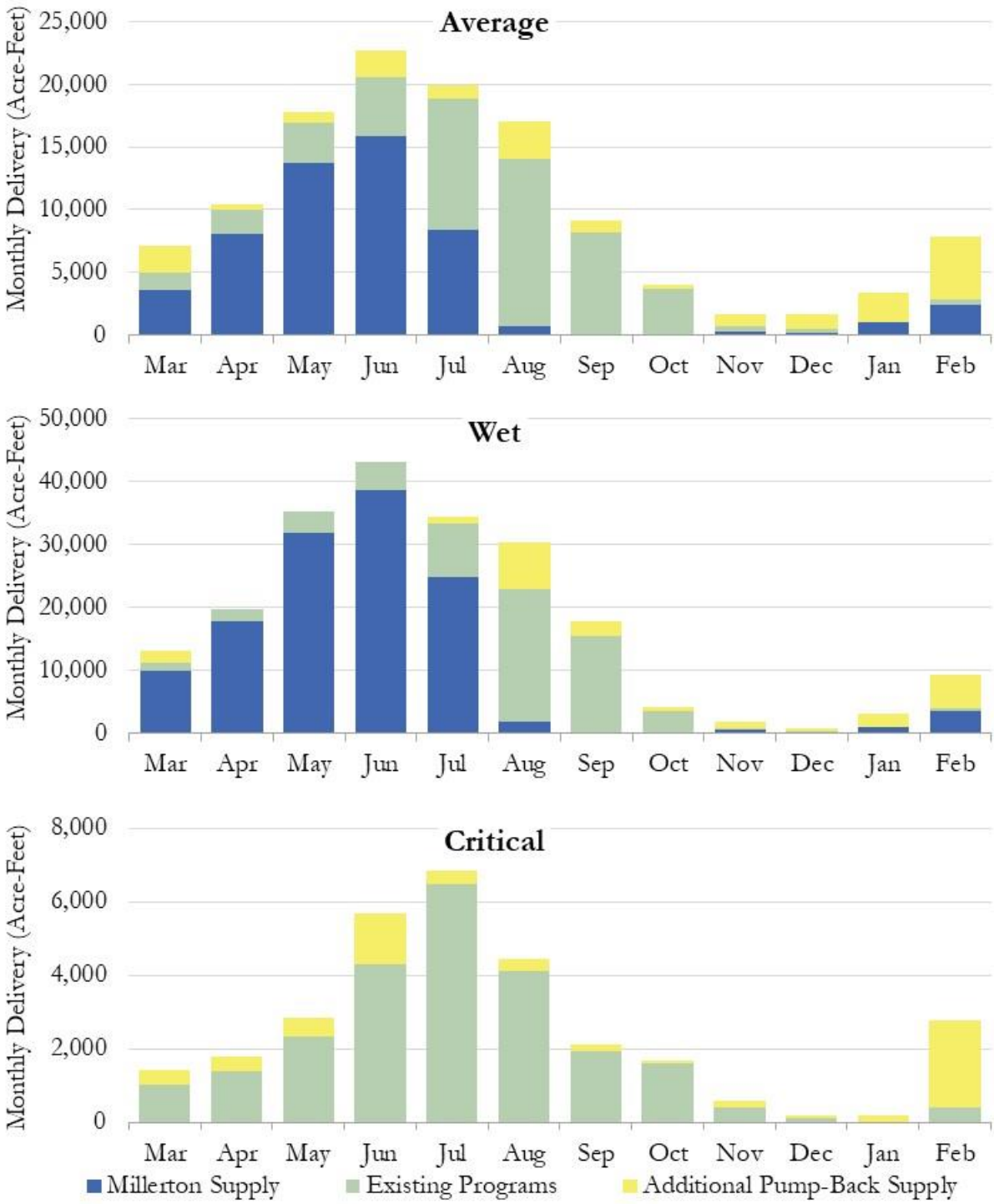


Figure 3-78. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source for the Low Flow Alternative and Seasonal Alternative under Future Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach A deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-164 to Table 3-167 show the monthly average and monthly maximum water quality trends for individual constituents for the Low Flow Alternative and Seasonal Alternative under Future Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply delivered via reverse-flow pump-back operations (i.e., existing programs and additional pump-back supply), water quality concentrations generally increase. For TDS, nitrate, chloride, and boron, there is a correlation between additional reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-164. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	225.52	171.02	167.38	174.44	163.88	219.24	246.69	282.88	282.98	231.69	207.04	279.84
Maximum	333.80	321.20	327.50	304.60	272.00	322.60	368.00	340.50	314.50	335.00	378.50	366.20
Wet Water Years												
Average	95.55	53.15	38.41	32.88	57.89	168.01	171.49	260.20	274.96	256.50	179.50	238.79
Maximum	221.60	157.56	46.62	43.47	147.00	176.80	172.00	260.20	281.00	307.80	228.40	285.80
Critical Water Years												
Average	333.80	321.20	300.80	304.60	272.00	322.60	368.00	300.20	300.00	116.44	120.36	366.20
Maximum	333.80	321.20	300.80	304.60	272.00	322.60	368.00	300.20	300.00	320.20	331.00	366.20

Key: mg/L = milligrams per liter

Table 3-165. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	3.07	1.52	1.37	1.35	1.36	0.99	1.08	1.32	2.35	2.45	3.14	3.75
Maximum	5.90	3.30	3.15	2.80	2.40	1.53	1.53	1.93	3.10	3.55	5.40	4.45
Wet Water Years												
Average	1.46	0.39	0.20	0.28	0.65	1.45	1.53	1.30	2.47	2.77	3.27	3.63
Maximum	3.73	1.37	0.28	0.45	1.85	1.53	1.53	1.30	2.53	3.33	4.08	4.28
Critical Water Years												
Average	3.32	2.24	2.02	1.62	1.68	0.48	0.80	1.04	1.76	1.05	1.13	4.10
Maximum	3.32	2.24	2.02	1.62	1.68	0.48	0.80	1.04	1.76	2.90	3.12	4.10

Key: mg/L = milligrams per liter

Table 3-166. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.18	0.14	0.12	0.11	0.10	0.13	0.14	0.15	0.15	0.14	0.14	0.24
Maximum	0.28	0.26	0.22	0.20	0.18	0.20	0.25	0.20	0.20	0.24	0.25	0.29
Wet Water Years												
Average	0.11	0.05	0.03	0.03	0.04	0.12	0.13	0.10	0.10	0.15	0.12	0.24
Maximum	0.28	0.17	0.04	0.04	0.10	0.13	0.13	0.10	0.10	0.18	0.15	0.29
Critical Water Years												
Average	0.26	0.24	0.22	0.18	0.18	0.20	0.25	0.20	0.18	0.09	0.07	0.24
Maximum	0.26	0.24	0.22	0.18	0.18	0.20	0.25	0.20	0.18	0.24	0.18	0.24

Key: mg/L = milligrams per liter

Table 3-167. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	55.49	39.59	43.36	46.46	38.97	60.34	72.76	86.63	86.76	71.47	58.43	64.67
Maximum	89.00	88.40	87.00	91.20	73.00	96.80	113.80	109.50	100.50	100.80	115.00	100.40
Wet Water Years												
Average	16.87	8.14	5.74	3.80	11.56	40.34	40.87	81.20	90.89	84.00	47.32	35.08
Maximum	43.00	32.66	7.87	6.22	33.20	42.60	41.00	81.20	93.00	100.80	60.60	42.40
Critical Water Years												
Average	89.00	88.40	84.80	91.20	73.00	96.80	113.80	88.40	83.00	34.40	36.95	100.40
Maximum	89.00	88.40	84.80	91.20	73.00	96.80	113.80	88.40	83.00	94.60	101.60	100.40

Key: mg/L = milligrams per liter

Relative Results

Relative changes in both surface water quantity and quality were determined by comparing the Low Flow Alternative and Seasonal Alternative under Future Conditions outputs to the No Project Alternative outputs. When comparing the scenarios, differences in volumetric deliveries are due to the either the exchange of Millerton supply for existing program supply and/or the net increase of supply due to additional pump-back deliveries. Because reverse-flow pump-back facilities have increased capacity under the Low Flow Alternative and Seasonal Alternative under Future Conditions as compared to the No Project Alternative, there is additional opportunity to increase or maximize direct delivery of existing program supply, and thus volumetric increases are seen in Wet water years and on average for all years for those supply sources.

Table 3-168 to Table 3-170 show the volumetric differences by source between the Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative for an average of all years and by Wet and Critical water year types. Across all years, the overall average total supply delivered to Reach A increased by 7,161 AF in the Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative. This increase is a result of increased delivery of existing programs supply due to increased pump-back facility capacities and exchanges of Millerton supply for additional pump-back supply.

Table 3-171 to Table 3-174 shows the differences in monthly average and monthly maximum water quality trends for individual constituents between the Low Flow Alternative and Seasonal Alternative under Future Conditions compared to No Project Alternative. For TDS, nitrate, chloride, and boron, there is a correlation between additional reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-168. Average Monthly Change in Delivery (acre-feet) to the Friant Contractor in Reach A by Source for an Average of All Years, Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-1,765	-298	-600	-2,005	-5,564	-7,209	-3,366	-1,317	-573	-668	-1,665	-3,687	-28,717
Existing Programs	419	70	72	216	5,179	5,264	3,082	1,285	0	0	0	0	15,586
Additional Pump-Back Supply	2,054	463	797	2,188	1,024	2,991	981	335	964	1,107	2,365	5,023	20,292
Total Supply	707	235	269	399	640	1,045	697	303	391	439	700	1,336	7,161

Table 3-169. Average Monthly Change in Delivery (acre-feet) to the Friant Contractor in Reach A by Source for Wet Water Year Types, Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-1,755	0	0	0	-4,611	-16,203	-8,944	-1,667	-626	-302	-1,443	-3,956	-39,507
Existing Programs	282	0	0	0	3,942	10,651	8,043	1,418	0	0	0	0	24,336
Additional Pump-Back Supply	1,970	0	0	0	1,082	7,453	2,414	584	986	553	2,068	5,474	22,582
Total Supply	497	0	0	0	412	1,901	1,513	335	360	250	625	1,517	7,410

Table 3-170. Average Monthly Change in Delivery (acre-feet) to the Friant Contractor in Reach A by Source for Critical Water Year Types, Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	0	0	-108	-910	-388	-68	0	0	0	0	-113	-1,650	-3,238
Existing Programs	0	0	0	0	402	72	0	0	0	0	0	0	474
Additional Pump-Back Supply	383	384	525	1,366	374	305	194	53	192	58	180	2,382	6,396
Total Supply	383	384	417	455	387	309	194	53	192	58	67	733	3,632

Water Quality

Table 3-171. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	129.46	43.78	74.06	78.85	87.91	110.51	115.76	91.59	94.24	103.26	184.15	188.22
Maximum	132.89	82.87	126.59	114.60	122.00	152.60	183.00	110.50	87.83	125.00	346.90	3.93
Wet Water Years												
Average	40.65	-2.48	-1.68	-9.22	26.49	107.33	94.24	47.14	68.25	90.19	154.91	149.08
Maximum	20.69	-12.77	-2.49	-17.44	106.90	95.81	38.67	30.20	54.33	97.80	198.90	69.78
Critical Water Years												
Average	186.66	82.87	142.54	133.12	126.73	154.06	183.00	134.49	121.43	54.62	108.87	255.91
Maximum	186.66	82.87	139.13	114.60	122.00	152.60	183.00	134.49	121.43	150.20	299.40	191.26

Key: mg/L = milligrams per liter

Table 3-172. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.14	-0.58	-0.86	-0.50	-0.10	-0.94	-1.01	-1.47	-1.14	0.27	2.11	2.32
Maximum	-0.94	-1.43	-2.67	-1.54	-2.00	-3.45	-3.22	-1.18	-1.10	-0.48	3.60	0.67
Wet Water Years												
Average	0.89	-0.13	-0.09	-0.15	0.60	1.10	1.08	-1.58	-1.33	0.27	1.77	2.39
Maximum	1.27	-0.68	-0.13	-0.29	1.81	1.06	0.76	-1.82	-1.68	0.15	2.28	1.96
Critical Water Years												
Average	-3.52	-2.49	-3.65	-2.43	-2.57	-4.45	-3.96	-1.80	-1.64	-0.41	1.04	1.85
Maximum	-3.52	-2.49	-3.80	-2.72	-2.72	-4.50	-3.96	-1.80	-1.64	-1.13	2.85	0.32

Key: mg/L = milligrams per liter

Table 3-173. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.12	0.07	0.06	0.04	0.05	0.06	0.07	0.05	0.05	0.07	0.12	0.02
Maximum	0.17	0.14	0.10	0.07	0.06	0.09	0.14	0.09	0.09	0.12	0.23	-0.05
Wet Water Years												
Average	0.08	0.01	0.00	-0.01	0.01	0.08	0.08	0.00	0.00	0.06	0.11	-0.07
Maximum	0.17	0.07	0.01	-0.01	0.07	0.07	0.06	-0.01	-0.01	0.06	0.14	-0.05
Critical Water Years												
Average	0.15	0.12	0.11	0.06	0.07	0.09	0.14	0.11	0.07	0.05	0.06	0.16
Maximum	0.15	0.12	0.10	0.05	0.06	0.09	0.14	0.11	0.07	0.13	0.16	0.12

Key: mg/L = milligrams per liter

Table 3-174. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the Low Flow Alternative and Seasonal Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	37.06	21.47	23.74	27.02	23.53	34.62	37.67	23.65	30.04	35.79	56.80	40.32
Maximum	27.05	26.45	25.05	49.49	40.71	57.13	65.30	26.17	27.50	37.80	112.80	-29.09
Wet Water Years												
Average	4.41	-3.64	-1.90	-3.08	6.22	26.42	20.45	4.38	24.77	34.38	45.49	8.91
Maximum	-18.95	-18.73	-2.81	-5.83	25.64	22.97	3.38	-2.13	20.00	37.80	58.40	-31.65
Critical Water Years												
Average	67.43	67.40	55.65	54.65	42.00	57.52	65.30	45.54	36.00	19.96	36.21	76.48
Maximum	67.43	67.40	54.97	49.49	40.71	57.13	65.30	45.54	36.00	54.89	99.58	60.14

Key: mg/L = milligrams per liter

Reach B

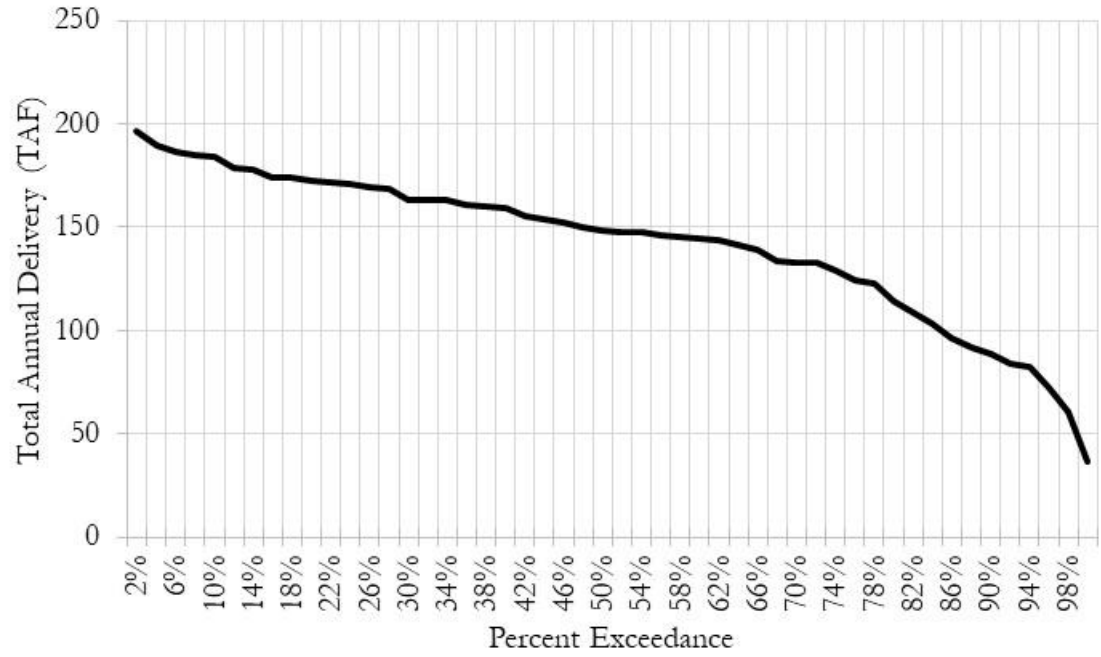
This section summarizes the total water supply delivery and the total water quality to Friant Contractors in Reach B. The Friant Contractors within Reach B include Shafter-Wasco Irrigation District and South San Joaquin Municipal Utility District.

Water Supply

For the Low Flow Alternative and Seasonal Alternative under Future Conditions, the Reach B Shafter-Wasco check structure capacity is assumed to be 200 cfs. Figure 3-79 shows the probability of exceedance of total annual delivery to Friant Contractors in Reach B under the Low Flow Alternative and Seasonal Alternative under Future Conditions. Figure 3-80 shows the probability of exceedance of total annual supply delivered to Friant Contractors in Reach B via reverse-flow pump-back by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Future Conditions. These volumes represent all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach B and not at the Intertie.

Table 3-175 summarizes the average total annual delivery to Friant Contractors in Reach B by source for an average of all years and by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Future Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the total average delivery is 142 TAF with 36 percent from existing programs and additional pump-back supply (total mitigation is 2 percent of total delivery). For an average Wet water year, the total delivery is 166 TAF with 15 percent from existing programs and additional pump-back supply (total mitigation is 1 percent of total delivery). For an average Critical water year, the total delivery is 90 TAF with 72 percent from existing programs and additional pump-back supply (total mitigation is 5 percent of total delivery).

Table 3-176 to Table 3-178 and Figure 3-81 summarize the average monthly delivery to Friant Contractors in Reach B by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-79. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Future Conditions

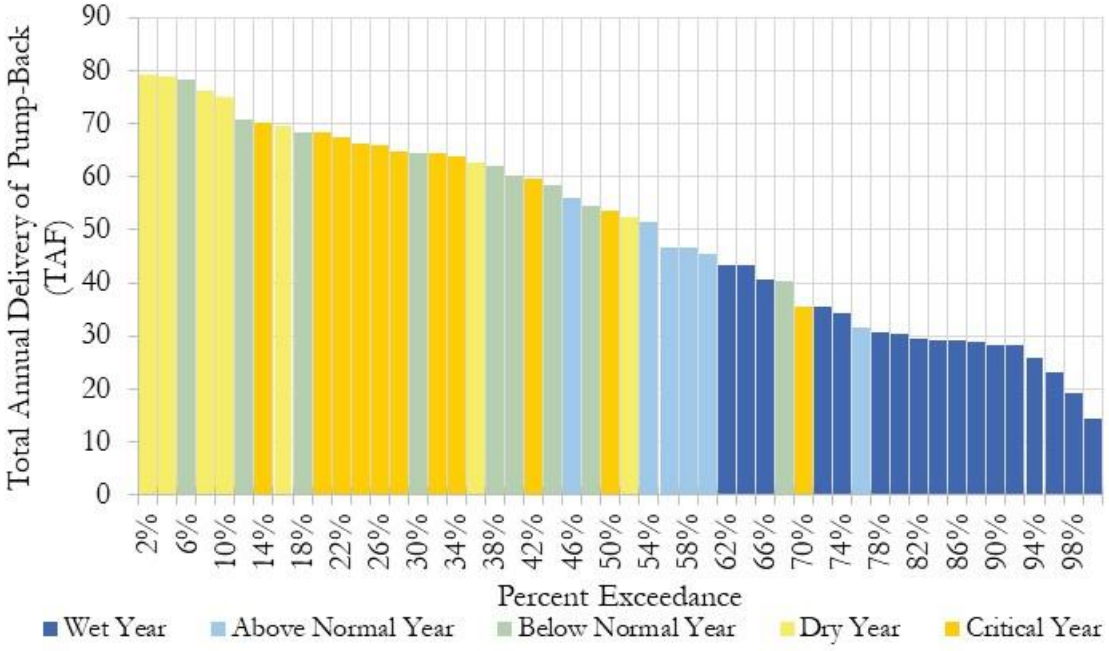


Figure 3-80. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to Friant Contractors in Reach B by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Table 3-175. Average Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach B by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	91	142	119	77	66	25
Existing Programs	20	9	20	33	18	27
Additional Pump-Back Supply	31	16	29	31	60	38
Total Supply	142	166	168	141	144	90

Table 3-176. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source for the Low Flow Alternative and Seasonal Alternative under Future Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	2,585	6,202	11,777	22,912	22,828	16,994	3,226	541	278	114	698	3,030	91,184
Existing Programs	326	408	416	156	2,909	3,863	6,861	4,111	422	305	0	0	19,779
Additional Pump-Back Supply	3,318	2,489	2,875	2,682	4,893	5,043	3,538	998	1,161	730	809	2,597	31,133
Total Supply	6,229	9,099	15,068	25,750	30,630	25,900	13,626	5,650	1,861	1,149	1,507	5,627	142,096

Table 3-177. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source for the Low Flow Alternative and Seasonal Alternative under Future Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	5,510	9,648	17,146	29,410	34,767	30,823	8,994	1,004	352	28	618	3,324	141,626
Existing Programs	26	0	0	0	0	89	4,694	3,310	470	402	0	0	8,991
Additional Pump-Back Supply	584	0	0	0	1,210	2,598	6,055	715	784	529	815	2,458	15,748
Total Supply	6,121	9,648	17,146	29,410	35,977	33,510	19,744	5,029	470	402	0	0	166,365

Table 3-178. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source for the Low Flow Alternative and Seasonal Alternative under Future Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	0	233	1,386	10,364	9,843	2,261	0	0	0	0	0	792	24,880
Existing Programs	1,035	1,556	1,549	577	4,761	6,352	5,934	4,682	476	189	0	0	27,112
Additional Pump-Back Supply	3,374	3,743	6,117	6,372	6,796	5,353	951	166	1,254	229	415	3,245	38,016
Total Supply	4,409	5,533	9,051	17,313	21,400	13,967	6,885	4,849	1,731	418	415	4,037	90,007

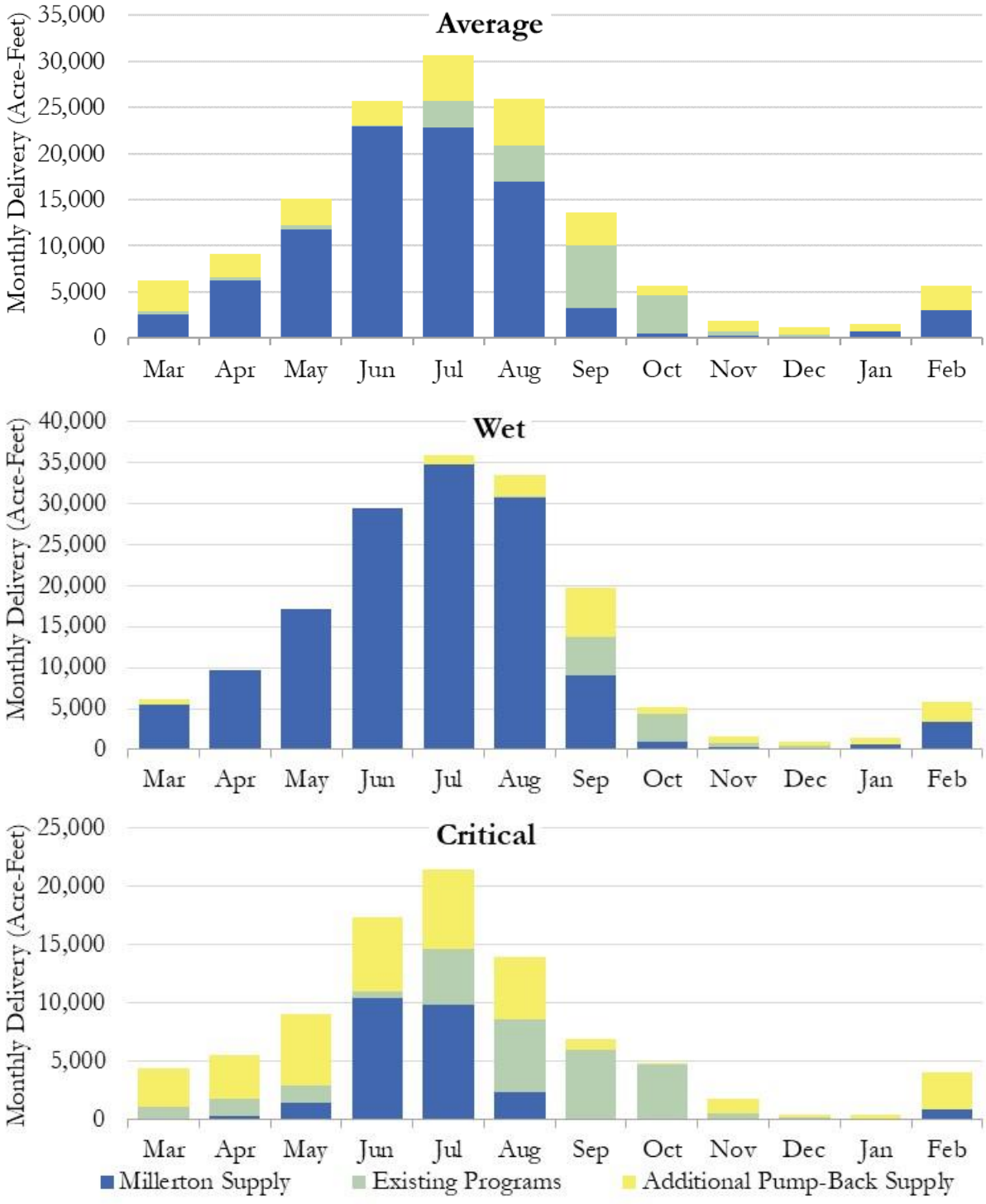


Figure 3-81. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source for the Low Flow Alternative and Seasonal Alternative under Future Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach B deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-179 to Table 3-182 show the monthly average and monthly maximum water quality trends for individual constituents for the Low Flow Alternative and Seasonal Alternative under Future Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply delivered via reverse-flow pump-back operations (i.e., existing programs and additional pump-back supply) and FKC groundwater pump-in programs, water quality concentrations generally increase. For TDS, nitrate, chloride, and boron, there is a correlation between additional reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-179. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	192.91	134.41	106.68	72.07	82.59	121.84	223.04	274.90	277.26	227.71	185.13	201.70
Maximum	333.80	321.20	302.10	305.18	273.28	322.84	367.17	340.50	314.50	335.00	378.50	366.20
Wet Water Years												
Average	51.96	28.00	21.33	21.00	17.66	28.29	108.57	245.00	266.50	254.34	164.13	166.19
Maximum	221.60	28.00	21.33	21.00	37.99	74.28	159.41	267.43	281.00	307.80	228.40	285.80
Critical Water Years												
Average	333.80	313.83	274.52	172.10	180.00	286.54	366.62	301.13	300.00	116.44	120.36	319.66
Maximum	333.80	321.20	302.10	305.18	273.28	322.84	367.17	301.83	300.00	320.20	331.00	366.20

Key: mg/L = milligrams per liter

Table 3-180. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	2.38	1.14	0.81	0.90	0.75	0.46	0.96	1.43	2.29	2.40	2.94	2.73
Maximum	5.90	3.30	2.78	2.37	1.85	0.98	1.42	2.14	3.10	3.55	5.40	4.45
Wet Water Years												
Average	0.68	0.16	0.03	0.08	0.10	0.22	0.95	1.43	2.39	2.75	3.10	2.63
Maximum	3.73	0.16	0.03	0.08	0.38	0.62	1.42	2.14	2.53	3.33	4.08	4.28
Critical Water Years												
Average	3.32	2.21	2.02	2.07	1.52	0.63	1.07	1.32	1.76	1.05	1.13	3.57
Maximum	3.32	2.24	2.37	2.20	1.85	0.98	1.25	1.53	1.76	2.90	3.12	4.10

Key: mg/L = milligrams per liter

Table 3-181. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Future Conditions for All Years, Wet Years and Critical Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.15	0.10	0.08	0.05	0.05	0.07	0.13	0.14	0.14	0.14	0.12	0.25
Maximum	0.28	0.26	0.22	0.18	0.17	0.20	0.25	0.20	0.20	0.24	0.25	0.34
Wet Water Years												
Average	0.05	0.02	0.02	0.02	0.01	0.02	0.09	0.09	0.10	0.15	0.11	0.28
Maximum	0.28	0.02	0.02	0.02	0.02	0.05	0.12	0.10	0.10	0.18	0.15	0.34
Critical Water Years												
Average	0.26	0.23	0.19	0.10	0.11	0.18	0.24	0.19	0.18	0.09	0.07	0.21
Maximum	0.26	0.24	0.22	0.18	0.17	0.20	0.25	0.20	0.18	0.24	0.18	0.24

Key: mg/L = milligrams per liter

Table 3-182. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Future Conditions for All Years, Wet Years and Critical Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	47.85	31.07	25.82	14.72	17.56	32.85	65.95	82.64	84.91	70.21	52.17	45.95
Maximum	89.00	88.40	83.49	89.57	71.98	95.57	112.10	109.50	100.50	100.80	115.00	100.40
Wet Water Years												
Average	7.83	2.23	1.30	1.08	1.79	4.47	24.93	74.18	87.93	83.24	42.81	23.78
Maximum	43.00	2.23	1.30	1.08	6.72	16.28	37.81	81.20	93.00	100.80	60.60	42.40
Critical Water Years												
Average	89.00	86.27	75.28	43.80	44.23	83.94	110.98	86.33	83.00	34.40	36.95	87.04
Maximum	89.00	88.40	83.49	89.57	71.98	95.57	112.10	88.40	83.00	94.60	101.60	100.40

Key: mg/L = milligrams per liter

Relative Results

Relative changes in both surface water quantity and quality were determined by comparing the Low Flow Alternative and Seasonal Alternative under Future Conditions outputs to No Project Alternative outputs. When comparing the scenarios, differences in volumetric deliveries are due to the either the exchange of Millerton supply for existing program supply and/or the net increase of supply due to additional pump-back deliveries. Because reverse-flow pump-back facilities have increased capacity under the Low Flow Alternative and Seasonal Alternative under Future Conditions as compared to No Project Alternative, there is additional opportunity to increase or maximize direct delivery of existing program supply, and thus volumetric increases are seen in Wet water years and on average for all years for those supply sources.

Table 3-183 to Table 3-185 show the volumetric differences by source between the Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative for an average of all years and by Wet and Critical water year types. Across all years, the overall average total supply delivered to Reach B increased by 10,192 AF in the Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative. This increase is a result of increased delivery of existing programs due to increased pump-back facility capacities and exchanges of Millerton supply for additional pump-back supply.

Table 3-186 to Table 3-189 shows the differences in monthly average and monthly maximum water quality trends for individual constituents between the Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative. For TDS, nitrate, chloride, and boron, there is a correlation between additional reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Water Supply

Table 3-183. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach B by Source for an Average of All Years, Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-2,210	-1,802	-2,147	-1,817	-6,401	-6,731	-7,378	-1,918	-603	-373	-435	-1,415	-33,232
Existing Programs	37	27	24	0	2,627	3,172	5,134	1,271	0	0	0	0	12,291
Additional Pump-Back Supply	3,318	2,489	2,875	2,682	4,893	5,043	3,538	998	1,161	730	809	2,597	31,133
Total Supply	1,145	713	752	865	1,118	1,483	1,295	350	558	357	374	1,182	10,192

Table 3-184. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach B by Source for Wet Water Year Types, Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-309	0	0	0	-874	-1,378	-9,109	-937	-346	-222	-448	-1,318	-14,943
Existing Programs	0	0	0	0	0	89	4,694	480	0	0	0	0	5,263
Additional Pump-Back Supply	584	0	0	0	1,210	2,598	6,055	715	784	529	815	2,458	15,748
Total Supply	275	0	0	0	336	1,309	1,640	258	438	306	367	1,140	6,069

Table 3-185. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach B by Source for Critical Water Year Types, Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-2,027	-2,370	-4,540	-4,817	-8,932	-8,328	-2,042	-961	-650	-89	-261	-1,979	-36,996
Existing Programs	0	0	0	0	3,610	4,414	1,908	1,045	0	0	0	0	10,978
Additional Pump-Back Supply	3,374	3,743	6,117	6,372	6,796	5,353	951	166	1,255	229	415	3,245	38,016
Total Supply	1,346	1,373	1,577	1,555	1,474	1,440	818	250	605	140	154	1,266	11,998

Water Quality

Table 3-186. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	152.61	82.67	72.47	34.12	54.45	93.20	167.79	120.20	143.67	124.58	162.25	177.36
Maximum	132.89	82.87	128.59	183.89	163.63	143.71	174.43	98.85	87.83	125.00	346.90	340.53
Wet Water Years												
Average	17.24	0.00	0.00	0.00	4.66	14.54	95.57	56.44	93.78	111.34	139.55	140.53
Maximum	20.69	0.00	0.00	0.00	24.99	60.53	146.41	25.78	54.33	97.80	198.90	260.13
Critical Water Years												
Average	259.68	183.84	202.84	100.94	121.20	222.57	224.32	157.15	205.05	69.69	108.87	297.66
Maximum	186.66	82.87	128.59	183.89	163.63	143.71	174.43	126.20	121.43	150.20	299.40	344.20

Key: mg/L = milligrams per liter

Table 3-187. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	1.51	0.25	0.32	-0.02	0.25	-0.02	-0.13	-0.87	-0.10	0.73	1.91	2.22
Maximum	-0.94	-1.43	-3.26	-0.94	-1.23	-4.24	-3.57	-1.69	-1.10	-0.48	3.60	3.76
Wet Water Years												
Average	0.36	0.00	0.00	0.00	0.06	0.13	0.88	-1.23	-0.73	0.63	1.60	1.93
Maximum	1.27	0.00	0.00	0.00	0.34	0.53	1.34	-1.69	-1.68	0.15	2.28	3.58
Critical Water Years												
Average	0.51	-0.61	0.12	-0.40	0.06	-0.94	-2.52	-1.25	0.08	0.00	1.04	3.40
Maximum	-3.52	-2.49	-3.68	-1.12	-1.23	-4.24	-3.74	-1.69	-1.64	-1.13	2.85	3.94

Key: mg/L = milligrams per liter

Table 3-188. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.12	0.07	0.05	0.02	0.04	0.05	0.09	0.07	0.08	0.08	0.11	0.02
Maximum	0.17	0.14	0.11	0.10	0.10	0.09	0.14	0.09	0.09	0.12	0.23	0.00
Wet Water Years												
Average	0.03	0.00	0.00	0.00	0.00	0.01	0.07	0.00	0.01	0.07	0.09	-0.07
Maximum	0.17	0.00	0.00	0.00	0.02	0.04	0.11	-0.01	-0.01	0.06	0.14	0.00
Critical Water Years												
Average	0.21	0.17	0.15	0.06	0.08	0.13	0.17	0.12	0.12	0.05	0.06	0.19
Maximum	0.15	0.12	0.11	0.10	0.10	0.09	0.14	0.11	0.07	0.13	0.16	0.22

Key: mg/L = milligrams per liter

Table 3-189. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the Low Flow Alternative and Seasonal Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	42.76	26.44	22.13	11.47	15.00	29.29	54.02	33.96	45.59	42.35	50.54	44.15
Maximum	27.05	67.40	53.69	68.65	51.99	56.50	64.57	26.17	27.50	37.80	112.80	98.50
Wet Water Years												
Average	2.21	0.00	0.00	0.00	1.13	3.73	24.21	9.41	33.53	41.34	40.97	21.88
Maximum	-18.95	0.00	0.00	0.00	6.07	15.54	37.09	-2.13	20.00	37.80	58.40	40.50
Critical Water Years												
Average	79.43	74.42	64.69	35.97	37.37	73.28	76.61	51.59	59.85	23.96	36.21	85.44
Maximum	67.43	67.40	53.69	68.65	51.99	56.50	64.57	46.27	36.00	54.89	99.58	98.80

Key: mg/L = milligrams per liter

Reach C

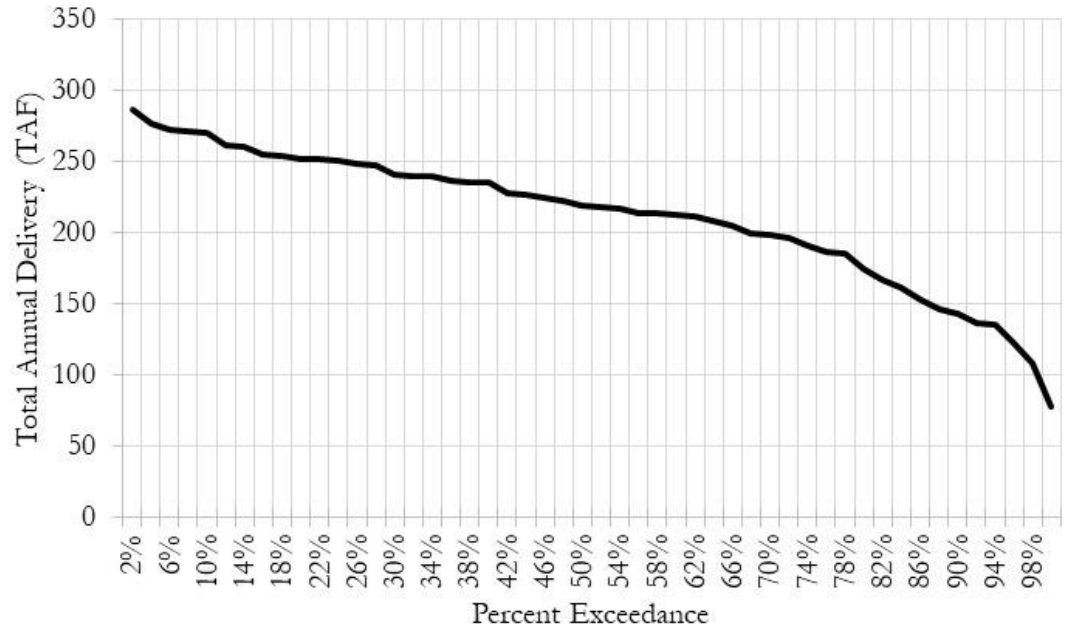
This section summarizes the total water supply delivery and the total water quality to Friant Contractors in Reach C. The Friant Contractors within Reach C include South San Joaquin Municipal Utility District, Kern-Tulare Water District, Delano-Earlimart Irrigation District, Saucelito Irrigation District, and Terra Bella Irrigation District.

Water Supply

For the Low Flow Alternative and Seasonal Alternative under Future Conditions, the Reach C Lake Woollomes check structure capacity is modeled as 75 cfs. Figure 3-82 shows the probability of exceedance of total annual delivery to the Friant Contractors in Reach C under the Low Flow Alternative and Seasonal Alternative under Future Conditions. Figure 3-83 shows the probability of exceedance of total annual supply delivered to the Friant Contractors in Reach C via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Future Conditions. These volumes represent all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach C and not at the Intertie.

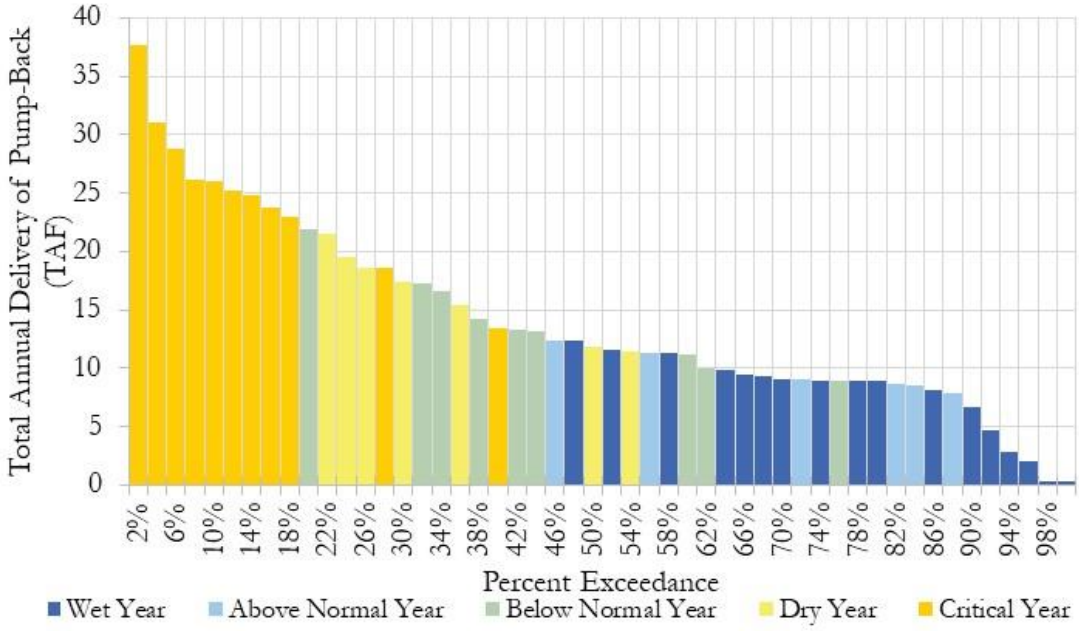
Table 3-190 summarize the average total annual delivery to the Friant Contractors in Reach C by source for an average of all years and by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Future Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the total average delivery is 212 TAF with 7 percent from existing programs and additional pump-back supply (total mitigation is less than 1 percent of total delivery). For an average Wet water year, the total delivery is 246 TAF with 4 percent from existing programs and additional pump-back supply (total delivery is less than 1 percent of total delivery). For an average Critical water year, the total delivery is 144 TAF with 21 percent from existing programs and additional pump-back supply (total mitigation is 2 percent of total delivery).

Table 3-191 to Table 3-193 and Figure 3-84 summarizes the average monthly delivery to Friant Contractors in Reach C by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-82. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Future Conditions



Key: TAF = thousand acre-feet

Figure 3-83. Probability of Exceedance for Total Annual Pump-Back Delivery (thousand acre-feet) to the Friant Contractors in Reach C by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Table 3-190. Average Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach C by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	196	237	240	195	191	114
Existing Programs	7	5	3	6	8	12
Additional Pump-Back Supply	9	5	4	8	12	19
Total Supply	212	246	246	208	211	144

Table 3-191. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source for the Low Flow Alternative and Seasonal Alternative under Future Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	7,794	13,003	22,416	37,501	43,877	37,431	18,618	5,096	1,454	965	1,535	6,316	196,005
Existing Programs	15	21	277	275	282	367	916	4,119	46	253	0	0	6,573
Additional Pump-Back Supply	1,792	882	345	48	69	96	1,015	346	1,721	1,112	443	1,266	9,135
Total Supply	9,602	13,906	23,037	37,825	44,228	37,895	20,549	9,561	3,220	2,331	1,978	7,582	211,713

Table 3-192. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source for the Low Flow Alternative and Seasonal Alternative under Future Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	9,239	14,633	26,188	42,963	51,382	48,600	28,859	4,500	1,414	695	1,380	6,649	236,503
Existing Programs	19	0	0	0	0	0	0	3,870	71	210	0	0	4,170
Additional Pump-Back Supply	0	0	0	0	0	0	0	294	1,428	1,169	498	1,188	4,577
Total Supply	9,258	14,633	26,188	42,963	51,382	48,600	28,859	8,664	2,913	2,074	1,878	7,837	245,250

Table 3-193. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source for the Low Flow Alternative and Seasonal Alternative under Future Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	3,511	6,025	12,664	25,475	30,912	20,234	6,543	3,606	888	219	216	3,473	113,764
Existing Programs	41	96	772	765	796	1,183	2,716	4,580	15	587	0	0	11,551
Additional Pump-Back Supply	3,911	3,548	1,567	218	314	437	2,741	840	2,128	605	298	1,875	18,483
Total Supply	7,463	9,670	15,003	26,458	32,021	21,854	12,000	9,026	3,031	1,411	513	5,348	143,799

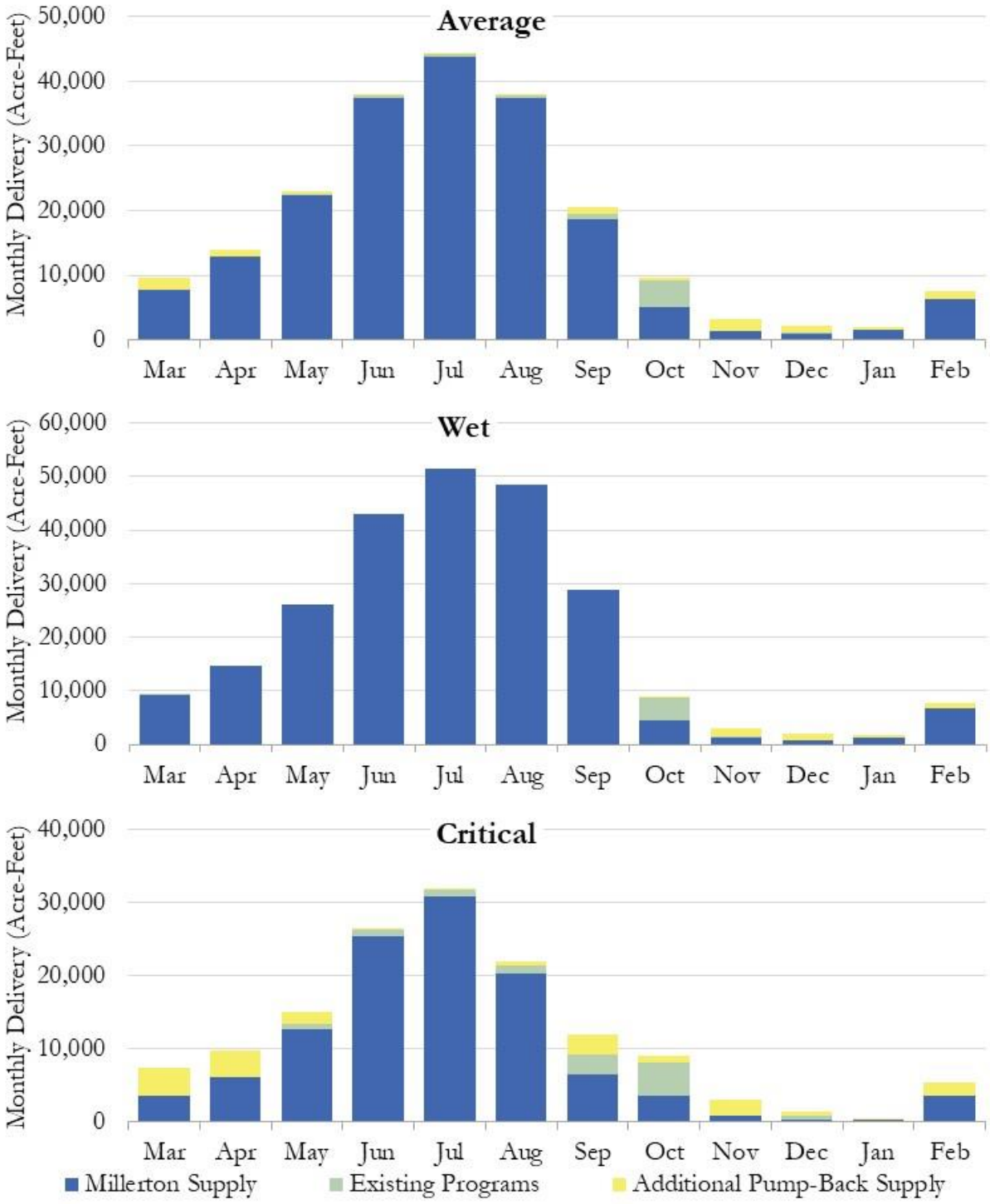


Figure 3-84. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source for the Low Flow Alternative and Seasonal Alternative under Future Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach C deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-194 to Table 3-197 show the monthly average and monthly maximum water quality trends for individual constituents for the Low Flow Alternative and Seasonal Alternative under Future Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply delivered via reverse-flow pump-back operations (i.e., existing programs and additional pump-back supply) and FKC groundwater pump-in programs, water quality concentrations also increase. For TDS, nitrate, chloride, and boron, there is a correlation between additional reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-194. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	86.84	58.12	36.74	38.75	28.55	26.97	62.70	172.17	199.43	237.82	106.57	99.52
Maximum	268.19	264.14	241.04	115.09	111.87	208.35	232.79	296.87	252.25	335.00	232.56	227.89
Wet Water Years												
Average	26.98	28.00	21.33	21.00	13.00	13.75	13.00	171.41	196.86	239.96	101.03	82.70
Maximum	69.41	28.00	21.33	21.00	13.00	13.75	13.00	270.47	228.59	307.80	145.23	186.87
Critical Water Years												
Average	196.33	154.92	81.58	72.77	58.83	60.83	182.46	188.67	219.02	292.63	74.55	167.63
Maximum	268.19	264.14	241.04	115.09	111.87	208.35	232.79	219.24	237.85	320.20	205.66	227.89

Key: mg/L = milligrams per liter

Table 3-195. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.90	0.60	0.27	0.93	0.49	0.31	0.39	1.07	1.60	2.40	2.01	1.43
Maximum	2.64	2.00	2.16	2.53	1.60	1.20	1.32	2.49	2.46	3.55	3.89	2.91
Wet Water Years												
Average	0.23	0.16	0.03	0.08	0.04	0.09	0.08	1.20	1.74	2.56	2.37	1.48
Maximum	0.99	0.16	0.03	0.08	0.04	0.09	0.08	2.49	2.03	3.33	3.12	2.91
Critical Water Years												
Average	1.89	1.54	0.87	2.47	1.31	0.77	1.03	1.16	1.28	2.64	0.70	1.83
Maximum	2.64	2.00	2.16	2.53	1.60	1.20	1.32	1.57	1.39	2.90	1.93	2.52

Key: mg/L = milligrams per liter

Table 3-196. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.06	0.04	0.02	0.02	0.01	0.02	0.04	0.09	0.10	0.15	0.07	0.24
Maximum	0.21	0.20	0.16	0.06	0.06	0.12	0.14	0.18	0.16	0.24	0.15	0.34
Wet Water Years												
Average	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.07	0.07	0.14	0.06	0.32
Maximum	0.08	0.02	0.02	0.02	0.01	0.01	0.02	0.09	0.08	0.18	0.09	0.34
Critical Water Years												
Average	0.15	0.12	0.04	0.04	0.02	0.04	0.11	0.11	0.13	0.22	0.04	0.11
Maximum	0.21	0.20	0.16	0.06	0.06	0.12	0.14	0.13	0.14	0.24	0.11	0.15

Key: mg/L = milligrams per liter

Table 3-197. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	19.19	11.28	4.78	3.27	2.47	3.08	15.19	49.04	59.88	71.55	27.63	20.61
Maximum	70.41	71.88	61.72	21.07	21.27	54.14	63.99	94.93	79.63	100.80	67.83	60.70
Wet Water Years												
Average	2.65	2.23	1.30	1.08	0.66	0.74	0.72	48.75	63.58	77.01	24.28	10.78
Maximum	11.45	2.23	1.30	1.08	0.66	0.74	0.72	73.20	74.68	100.80	36.18	27.00
Critical Water Years												
Average	50.05	40.27	15.66	7.75	6.33	10.10	49.66	50.17	59.51	85.86	21.71	43.40
Maximum	70.41	71.88	61.72	21.07	21.27	54.14	63.99	56.92	64.97	94.60	59.91	60.70

Key: mg/L = milligrams per liter

Relative Results

Relative changes in both surface water quantity and quality were determined by comparing the Low Flow Alternative and Seasonal Alternative under Future Conditions outputs to the No Project Alternative outputs. When comparing the scenarios, differences in volumetric deliveries are due to the either the exchange of Millerton supply for existing program supply and/or the net increase of supply due to additional pump-back deliveries. Because reverse-flow pump-back facilities have increased capacity under the Low Flow Alternative and Seasonal Alternative under Future Conditions as compared to the No Project Alternative, there is additional opportunity to increase or maximize direct delivery of existing program supply, and thus volumetric increases are seen in Wet water years and on average for all years for those supply sources.

Table 3-198 to Table 3-200 show the volumetric differences by source between the Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative for an average of all years and by Wet and Critical water year types. For an average year, the overall total supply delivered to Reach C increased by 19,412 AF in the Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative. This increase is a result of increased delivery of existing programs due to increased pump-back facility capacities and exchanges of Millerton supply for additional pump-back supply.

Table 3-201 to Table 3-204 shows the differences in monthly average and monthly maximum water quality trends for individual constituents between the Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative. For TDS, nitrate, chloride, and boron, there is a correlation between additional reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-198. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach C by Source for an Average of All Years, Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-60	-31	503	1,064	3,289	3,620	1,398	-2,144	-985	-633	4	100	6,125
Existing Programs	0	0	0	0	7	64	604	3,477	0	0	0	0	4,152
Additional Pump-Back Supply	1,792	882	345	48	69	96	1,015	346	1,721	1,113	443	1,266	9,135
Total Supply	1,731	851	847	1,112	3,365	3,780	3,018	1,680	736	479	447	1,366	19,412

Table 3-199. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach C by Source for Wet Water Year Types, Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	575	0	0	0	1,403	4,239	3,904	-2,114	-832	-733	-58	136	6,520
Existing Programs	0	0	0	0	0	0	0	3,394	0	0	0	0	3,395
Additional Pump-Back Supply	0	0	0	0	0	0	0	294	1,428	1,169	498	1,188	4,577
Total Supply	575	0	0	0	1,403	4,239	3,904	1,575	596	436	440	1,324	14,492

Table 3-200. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach C by Source for Critical Water Year Types, Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-2,219	-1,878	74	1,294	2,829	2,390	-2,226	-2,930	-1,318	-400	-118	-460	-4,961
Existing Programs	0	0	0	0	31	290	1,786	3,905	0	0	0	0	6,010
Additional Pump-Back Supply	3,911	3,548	1,567	218	314	437	2,741	840	2,128	605	298	1,875	18,483
Total Supply	1,692	1,671	1,640	1,512	3,173	3,117	2,301	1,815	810	205	179	1,416	19,532

Water Quality

Table 3-201. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	61.14	29.70	7.79	0.64	0.78	3.61	38.90	128.84	173.95	166.76	83.68	75.18
Maximum	203.51	189.62	181.92	38.37	49.34	121.89	153.75	80.07	189.43	125.00	200.96	202.23
Wet Water Years												
Average	0.28	0.00	0.00	0.00	0.00	0.00	0.00	117.29	166.74	173.32	76.44	57.04
Maximum	4.73	0.00	0.00	0.00	0.00	0.00	0.00	53.67	165.77	97.80	115.73	161.20
Critical Water Years												
Average	169.89	124.06	35.95	3.07	3.82	16.92	134.43	147.12	199.43	172.94	63.06	145.63
Maximum	227.26	189.62	181.92	38.37	49.34	121.89	153.75	147.68	202.37	150.20	174.06	205.89

Key: mg/L = milligrams per liter

Table 3-202. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.72	0.13	0.04	-0.01	0.00	-0.03	0.02	0.37	1.39	1.31	0.98	0.93
Maximum	1.66	0.16	1.07	-0.14	0.06	-1.00	-0.56	-1.24	1.53	-0.48	2.09	2.22
Wet Water Years												
Average	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.31	1.46	1.75	0.87	0.78
Maximum	0.29	0.00	0.00	0.00	0.00	0.00	0.00	-1.24	1.10	0.15	1.32	2.22
Critical Water Years												
Average	1.71	0.46	0.19	-0.02	-0.01	-0.14	0.00	0.31	1.16	-0.01	0.60	1.66
Maximum	1.66	0.16	1.07	-0.14	0.06	-1.00	-0.56	0.02	0.94	-1.13	1.66	2.35

Key: mg/L = milligrams per liter

Table 3-203. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.05	0.02	0.01	0.00	0.00	0.00	0.02	0.06	0.09	0.10	0.05	0.01
Maximum	0.17	0.16	0.14	0.02	0.04	0.08	0.11	0.09	0.13	0.12	0.13	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.06	0.10	0.05	-0.03
Maximum	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.06	0.08	0.00
Critical Water Years												
Average	0.13	0.09	0.03	0.00	0.00	0.01	0.10	0.10	0.12	0.13	0.03	0.09
Maximum	0.18	0.16	0.14	0.02	0.04	0.08	0.11	0.10	0.12	0.13	0.09	0.13

Key: mg/L = milligrams per liter

Table 3-204. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the Low Flow Alternative and Seasonal Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	16.98	8.65	2.47	0.27	0.29	1.32	13.08	41.35	56.24	56.17	26.00	18.81
Maximum	54.63	64.73	56.00	13.92	15.62	41.90	51.61	32.81	63.11	37.80	65.63	58.80
Wet Water Years												
Average	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	38.14	58.34	61.50	22.44	8.88
Maximum	-4.33	0.00	0.00	0.00	0.00	0.00	0.00	11.08	58.16	37.80	33.98	25.10
Critical Water Years												
Average	48.31	36.80	11.29	1.23	1.36	6.06	44.34	46.15	57.85	59.51	20.97	41.80
Maximum	66.29	64.73	56.00	13.92	15.62	41.90	51.61	47.31	58.79	54.89	57.89	59.10

Key: mg/L = milligrams per liter

Reach D

This section summarizes the total water supply delivery and the total water quality to Friant Contractors in Reach D. The Friant Contractors within Reach D include Saucelito Irrigation District, Terra Bella Irrigation District, Tea Pot Dome Water District, Pixley Irrigation District, Lower Tule River Irrigation District, and Porterville Irrigation District.

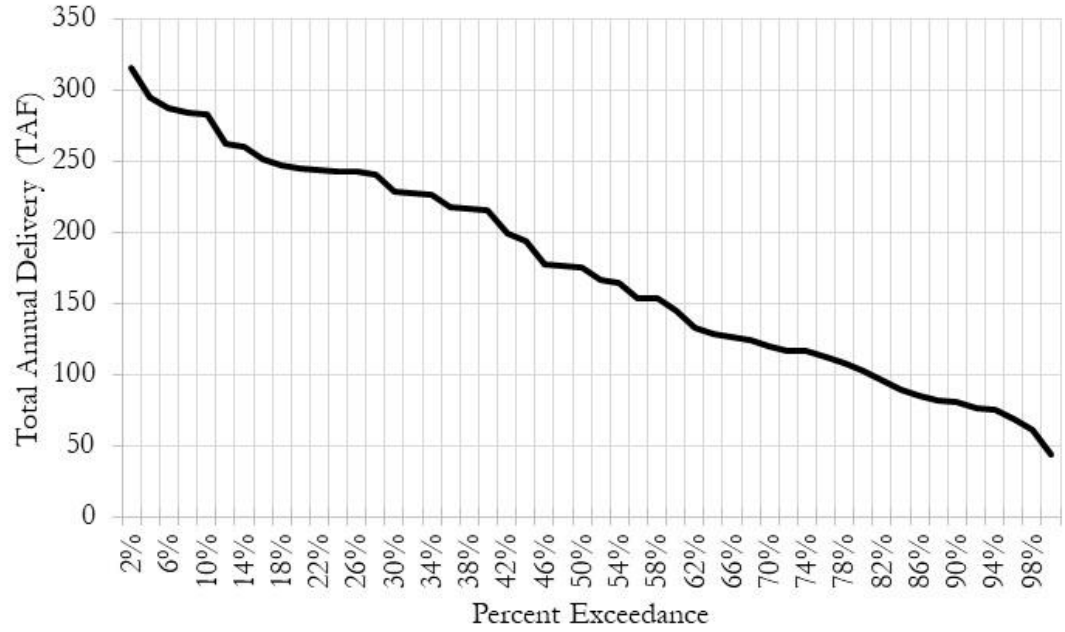
Water Supply

For the Low Flow Alternative under Future Conditions, the Reach D Deer Creek check structure capacity is modeled as 75 cfs. For most months, except for one (October 1977), the delivery to Friant Contractors in Reach D is composed of Millerton supply and FKC groundwater pump-in program supply. Similarly, under the Seasonal Alternative under Future Conditions, the Reach D Deer Creek check structure capacity is assumed to be 0 cfs. Since the check structure has zero capacity, no supply is delivered via reverse-flow pump-back operations to the Friant Contractors in Reach D. The delivery to the Friant Contractors in Reach D is composed of Millerton Supply and FKC groundwater pump-in program supply. Figure 3-85 shows the probability of exceedance of total annual supply to the Friant Contractors in Reach D under the Low Flow Alternative and Seasonal Alternative under Future Conditions. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach D and not at the Intertie.

Figure 3-86 shows the probability of exceedance of total annual supply delivered to Friant Contractors via reverse-flow pump-back operations in Reach D by San Joaquin Valley Water Year Type under the Low Flow Alternative under Future Conditions. For the Low Flow Alternative under Future Conditions, this supply is only delivered to Friant Contractors in Reach D in one month (October 1977, in a Wet water year) and represents additional pump-back supply. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach D and not at the Intertie.

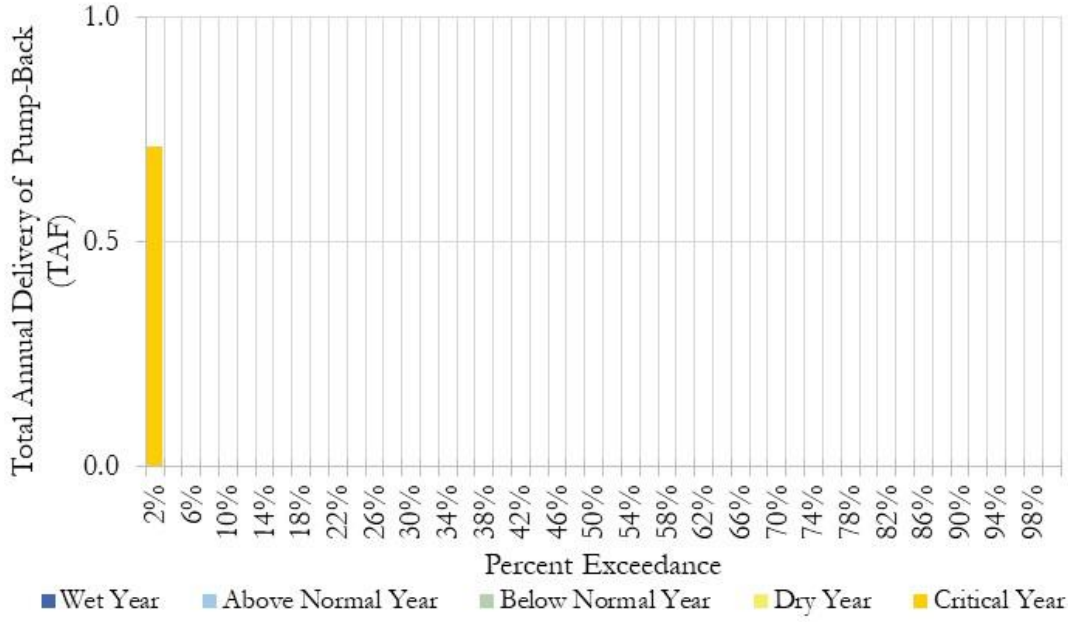
Table 3-205 summarize the average total annual delivery to Friant Contractors in Reach D for an average of all years and by San Joaquin Valley Water Year Type under the Low Flow Alternative and Seasonal Alternative under Future Conditions. In this table, existing programs include the water delivered from FKC groundwater pump-in programs. Across all years, the average total delivery is 174 TAF with less than 1 percent from existing programs and additional pump-back supply (total mitigation is less than 1 percent of total delivery). For an average Wet water year, the total delivery is 239 TAF with 1 percent from existing programs and additional pump-back supply (total mitigation is less than 1 percent of total delivery). For an average Critical water year, the total delivery is 82 TAF with 1 percent from existing programs (total mitigation is less than 1 percent of total delivery).

Table 3-206 to Table 3-208 and Figure 3-87 shows the average monthly delivery to the Friant Contractors in Reach D by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-85. Probability of Exceedance for Total Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Future Conditions



Note: This supply is only delivered to Friant Contractors in Reach D in one month (October 1977, in a Wet water year).
Key: TAF = thousand acre-feet

Figure 3-86. Probability of Exceedance for Total Annual Pump-Back Delivery (thousand acre-feet) to the Friant Contractors in Reach D by San Joaquin Valley Water Year Type under the Low Flow Alternative under Future Conditions

Table 3-205. Average Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach D by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	173	239	229	158	129	81
Existing Programs	<1	<1	0	0	<1	<1
Additional Pump-Back Supply	<1*	<1*	0	0	0	0
Total Supply	173	239	229	158	129	82

Notes:

*In the Seasonal Alternative under Future Conditions, the Deer Creek check structure has zero capacity. No additional pump-back supply is delivered via reverse flow pump-back operations to the Friant Contractors in Reach D.

Table 3-206. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source for the Low Flow Alternative and Seasonal Alternative under Future Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	6,797	10,192	17,176	25,107	33,583	33,008	21,919	13,057	1,742	1,364	2,542	6,834	173,321
Existing Programs	0	0	48	48	48	48	48	48	0	0	0	0	291
Additional Pump-Back Supply	0	0	0	0	0	0	0	14*	0	0	0	0	14*
Total Supply	6,797	10,192	17,225	25,156	33,631	33,057	21,967	13,119	1,742	1,364	2,542	6,834	173,625

Table Notes:
*In the Seasonal Alternative under Future Conditions, the Deer Creek check structure has zero capacity. No additional pump-back supply is delivered via reverse flow pump-back operations to the Friant Contractors in Reach D.

Table 3-207. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source for the Low Flow Alternative and Seasonal Alternative under Future Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	10,323	15,897	28,395	38,803	40,347	47,525	33,283	12,138	1,706	866	2,346	7,744	239,373
Existing Programs	0	0	0	0	0	0	0	60	0	0	0	0	60
Additional Pump-Back Supply	0	0	0	0	0	0	0	40*	0	0	0	0	40*
Total Supply	10,323	15,897	28,395	38,803	40,347	47,525	33,283	12,238	1,706	866	2,346	7,744	239,473

Table Notes:
*In the Seasonal Alternative under Future Conditions, the Deer Creek check structure has zero capacity. No additional pump-back supply is delivered via reverse flow pump-back operations to the Friant Contractors in Reach D.

Table 3-208. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source for the Low Flow Alternative and Seasonal Alternative under Future Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	2,734	3,438	5,574	11,093	19,846	14,503	9,644	9,703	1,090	279	280	3,252	81,437
Existing Programs	0	0	135	135	135	135	135	98	0	0	0	0	771
Additional Pump-Back Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Supply	2,734	3,438	5,709	11,227	19,981	14,638	9,779	9,801	1,090	279	280	3,252	82,208

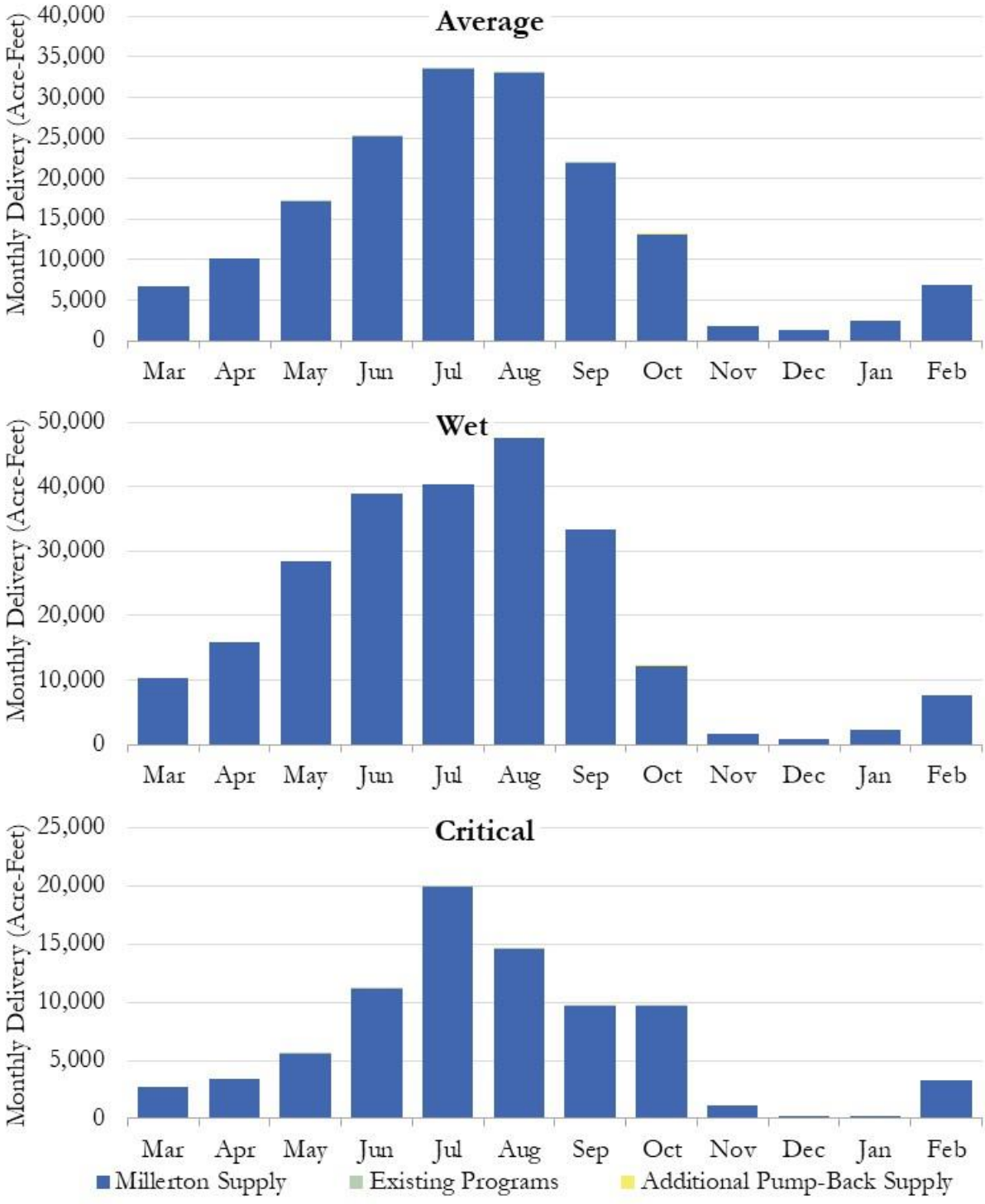


Figure 3-87. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source for the Low Flow Alternative and Seasonal Alternative under Future Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach D deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-209 to Table 3-212 show the monthly average and monthly maximum water quality trends for individual constituents for the Low Flow Alternative and Seasonal Alternative under Future Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is reverse-flow pump-back and/or FKC groundwater pump-in program supply being delivered, water quality concentrations also increase. For TDS, nitrate, chloride, and boron, the concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-209. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	24.57	27.46	25.67	36.46	25.88	19.66	16.55	18.15	19.28	21.82	22.88	24.35
Maximum	25.00	28.00	42.37	68.19	50.19	33.26	24.34	60.64	20.00	29.00	31.60	25.67
Wet Water Years												
Average	24.33	28.00	21.33	21.00	13.00	13.75	13.00	21.02	20.00	24.17	24.58	25.67
Maximum	24.33	28.00	21.33	21.00	13.00	13.75	13.00	60.64	20.00	29.00	29.50	25.67
Critical Water Years												
Average	25.00	26.50	34.95	64.50	48.96	30.60	23.30	17.34	18.00	10.18	11.49	22.00
Maximum	25.00	26.50	42.37	68.19	50.19	33.26	24.34	19.32	18.00	28.00	31.60	22.00

Key: mg/L = milligrams per liter

Table 3-210. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.15	0.46	0.13	0.90	0.44	0.24	0.16	0.16	0.08	0.14	1.03	0.50
Maximum	0.18	1.00	0.58	2.45	1.19	0.60	0.35	0.53	0.09	0.20	1.80	0.70
Wet Water Years												
Average	0.18	0.16	0.03	0.08	0.04	0.09	0.08	0.19	0.08	0.17	1.50	0.70
Maximum	0.18	0.16	0.03	0.08	0.04	0.09	0.08	0.53	0.08	0.20	1.80	0.70
Critical Water Years												
Average	0.10	1.00	0.36	2.36	1.15	0.52	0.32	0.19	0.09	0.05	0.10	0.17
Maximum	0.10	1.00	0.58	2.45	1.19	0.60	0.35	0.25	0.09	0.13	0.27	0.17

Key: mg/L = milligrams per liter

Table 3-211. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.23
Maximum	0.02	0.02	0.02	0.04	0.02	0.03	0.02	0.04	0.01	0.05	0.02	0.34
Wet Water Years												
Average	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.03	0.01	0.02	0.01	0.34
Maximum	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.04	0.01	0.02	0.02	0.34
Critical Water Years												
Average	0.02	0.02	0.01	0.04	0.02	0.03	0.01	0.01	0.01	0.02	0.01	0.02
Maximum	0.02	0.02	0.01	0.04	0.02	0.03	0.01	0.01	0.01	0.05	0.02	0.02

Key: mg/L = milligrams per liter

Table 3-212. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	1.88	2.55	2.01	2.86	2.01	1.32	1.30	1.56	1.55	2.09	1.63	1.79
Maximum	2.10	3.10	4.07	6.39	4.54	2.64	2.48	13.71	1.75	3.05	2.20	1.90
Wet Water Years												
Average	2.10	2.23	1.30	1.08	0.66	0.74	0.72	2.14	1.75	2.54	1.83	1.90
Maximum	2.10	2.23	1.30	1.08	0.66	0.74	0.72	13.71	1.75	3.05	2.20	1.90
Critical Water Years												
Average	1.50	3.10	3.41	6.06	4.43	2.40	2.38	1.27	1.20	0.73	0.73	1.60
Maximum	1.50	3.10	4.07	6.39	4.54	2.64	2.48	1.45	1.20	2.01	2.02	1.60

Key: mg/L = milligrams per liter

Relative Results

Relative changes in both surface water quantity and quality were determined by comparing for the Low Flow Alternative and Seasonal Alternative under Future Conditions outputs to the No Project outputs. When comparing the scenarios, differences in volumetric deliveries are due to increased delivery of Millerton supply in exchange of existing program supply. Because reverse-flow pump-back facilities have increased capacity under the Low Flow Alternative and Seasonal Alternative under Existing Conditions as compared to Existing Conditions, there is additional opportunity to increase or maximize direct delivery of existing program supply, and thus volumetric increases are seen in Wet water years and on average for all years for those supply sources.

Table 3-213 to Table 3-215 show the volumetric differences by source between the Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative for an average of all years and by Wet and Critical water year types. Across all years, the overall total supply delivered to Reach D increased by 28,077 AF in the Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative. This increase is a result of increased pump-back facility capacities which results in increased exchanges of existing program supply for Millerton supply.

Table 3-216 to Table 3-219 shows the differences in monthly average and monthly maximum water quality trends for individual constituents between the Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative. For TDS, nitrate, chloride, and boron, there are minor differences in water quality due to the source of supply being mainly Millerton Supply in both scenarios.

Table 3-213. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach D by Source for an Average of All Years, Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	758	380	401	493	5,854	6,537	6,825	4,607	413	343	449	1,001	28,063
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	0	0	0	0	0	0	0	14*	0	0	0	0	14*
Total Supply	758	380	401	493	5,854	6,537	6,825	4,621	413	343	449	1,001	28,077

Notes:
*Under Seasonal Alternative under Future Conditions, the Deer Creek check structure has zero capacity. No additional pump-back supply is delivered via reverse flow pump-back operations to the Friant Contractors in Reach D.

Table 3-214. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach D by Source for Wet Water Year Types, Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	314	0	0	0	3,004	8,647	10,244	3,973	350	245	413	1,046	28,236
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	0	0	0	0	0	0	0	40*	0	0	0	0	40*
Total Supply	314	0	0	0	3,004	8,647	10,244	4,013	350	245	413	1,046	28,276

Notes:
*Under Seasonal Alternative under Future Conditions, the Deer Creek check structure has zero capacity. No additional pump-back supply is delivered via reverse flow pump-back operations to the Friant Contractors in Reach D.

Table 3-215. Average Monthly Change in Delivery (acre-feet) to Friant Contractors in Reach D by Source for Critical Water Year Types, Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	748	748	806	781	2,954	3,189	2,532	3,416	349	89	89	766	16,466
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Supply	748	748	805	781	2,954	3,189	2,532	3,416	349	89	89	766	16,466

Water Quality

Table 3-216. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.00	0.00	-0.45	-0.09	-0.11	-0.24	-0.47	-0.16*	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-6.66	-1.34	-0.92	-1.77	-1.81	33.93*	0.00	0.00	0.00	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.92*	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.93*	0.00	0.00	0.00	0.00
Critical Water Years												
Average	0.00	0.00	-1.80	-0.34	-0.38	-0.86	-1.52	-1.78	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-6.66	-1.34	-0.92	-1.77	-1.81	-2.61	0.00	0.00	0.00	0.00

Key: mg/L = milligrams per liter

Notes: *Under Seasonal Alternative under Future Conditions, the Deer Creek check structure has zero capacity. No additional pump-back supply is delivered via reverse flow pump-back operations to the Friant Contractors in Reach D.

Table 3-217. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.00	0.00	-0.01	0.00	0.00	-0.01	-0.01	-0.02*	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-0.20	-0.03	-0.03	-0.05	-0.05	0.13*	0.00	0.00	0.00	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02*	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13*	0.00	0.00	0.00	0.00
Critical Water Years												
Average	0.00	0.00	-0.05	-0.01	-0.01	-0.02	-0.04	-0.05	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-0.20	-0.03	-0.03	-0.05	-0.05	-0.07	0.00	0.00	0.00	0.00

Key: mg/L = milligrams per liter

Notes: *Under Seasonal Alternative under Future Conditions, the Deer Creek check structure has zero capacity. No additional pump-back supply is delivered via reverse flow pump-back operations to the Friant Contractors in Reach D.

Table 3-218. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00*	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01*	0.00	0.00	0.00	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00*	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01*	0.00	0.00	0.00	0.00
Critical Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key: mg/L = milligrams per liter

Notes: *Under Seasonal Alternative under Future Conditions, the Deer Creek check structure has zero capacity. No additional pump-back supply is delivered via reverse flow pump-back operations to the Friant Contractors in Reach D.

Table 3-219. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the Low Flow Alternative and Seasonal Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.00	0.00	-0.04	-0.01	-0.01	-0.02	-0.04	0.15*	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-0.59	-0.12	-0.08	-0.16	-0.16	11.52*	0.00	0.00	0.00	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.55*	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.52*	0.00	0.00	0.00	0.00
Critical Water Years												
Average	0.00	0.00	-0.16	-0.03	-0.03	-0.08	-0.14	-0.16	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-0.59	-0.12	-0.08	-0.16	-0.16	-0.24	0.00	0.00	0.00	0.00

Key: mg/L = milligrams per liter

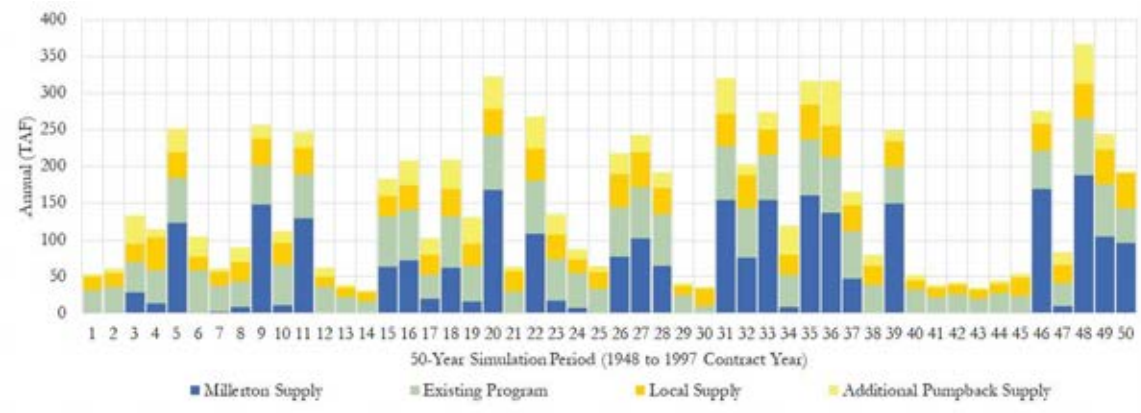
Notes: *Under Seasonal Alternative under Future Conditions, the Deer Creek check structure has zero capacity. No additional pump-back supply is delivered via reverse flow pump-back operations to the Friant Contractors in Reach D

Total Surface Water Delivery to Friant Contractors

This section summarizes the annual total surface water delivery to the Friant Contractors in the study area under the Low Flow Alternative and Seasonal Alternative under Future Conditions. The Distribution Module simulates the delivery of Millerton supply and exiting program supply. The local supplies are added to the individual Friant Contractors after the Distribution Module deliveries. Local supplies were considered in this analysis for several Friant Contractors. AEWSD receives deliveries from the Kern River and directly from the California Aqueduct. Porterville ID, LTRID, and TBID all receive deliveries from the Tule River.

Arvin-Edison Water Storage District

Figure 3-88 the total annual surface water delivery to AEWSD in the Low Flow Alternative and Seasonal Alternative under Future Conditions. AEWSD receives local sources of water supply directly from the Kern River and directly from the California Aqueduct.

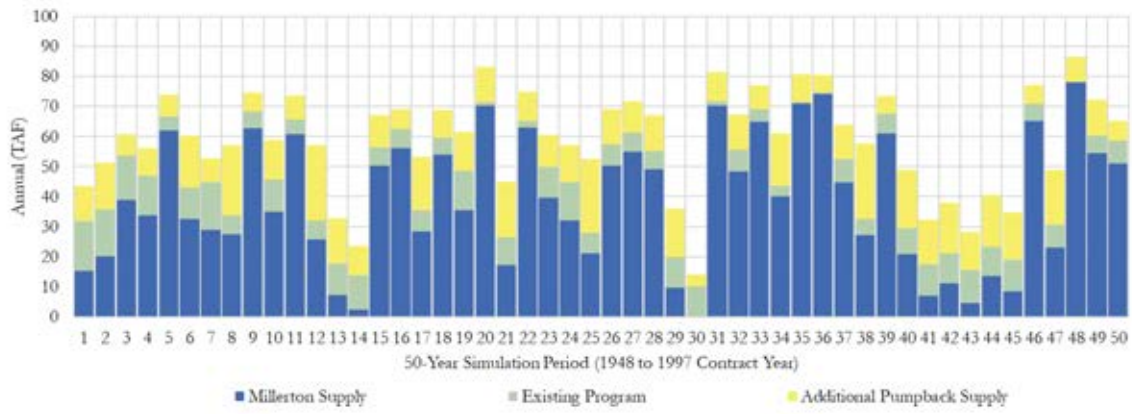


Key: TAF = thousand acre-feet

Figure 3-88. Total Annual Surface Water Delivery (thousand acre-feet) to Arvin-Edison Water Storage District for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Shafter-Wasco Irrigation District

Figure 3-89 summarizes the total annual surface water delivery to SWID in the Low Flow Alternative and Seasonal Alternative under Future Conditions.

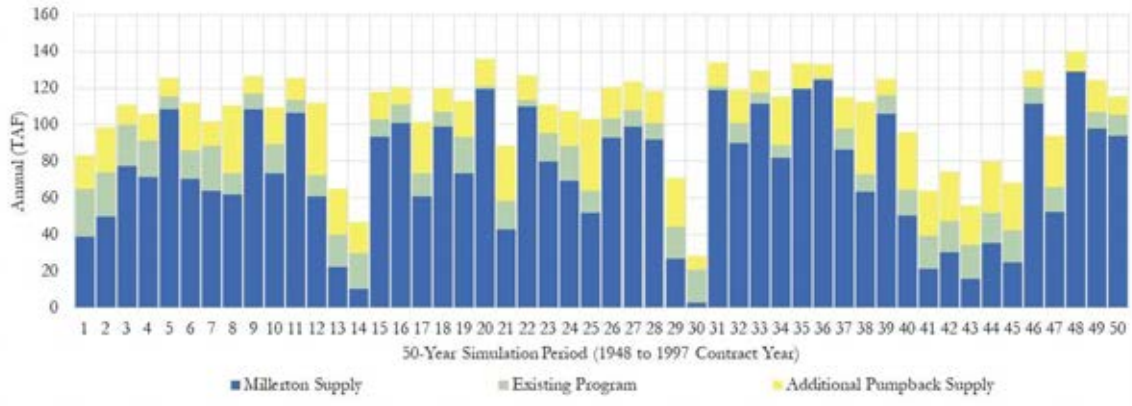


Key: TAF = thousand acre-feet

Figure 3-89. Total Annual Surface Water Delivery (thousand acre-feet) to Shafter-Wasco Irrigation District for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Southern San Joaquin Municipal Utility District

Figure 3-90 summarizes the total annual surface water delivery to SSJMUD in the Low Flow Alternative and Seasonal Alternative under Future Conditions.

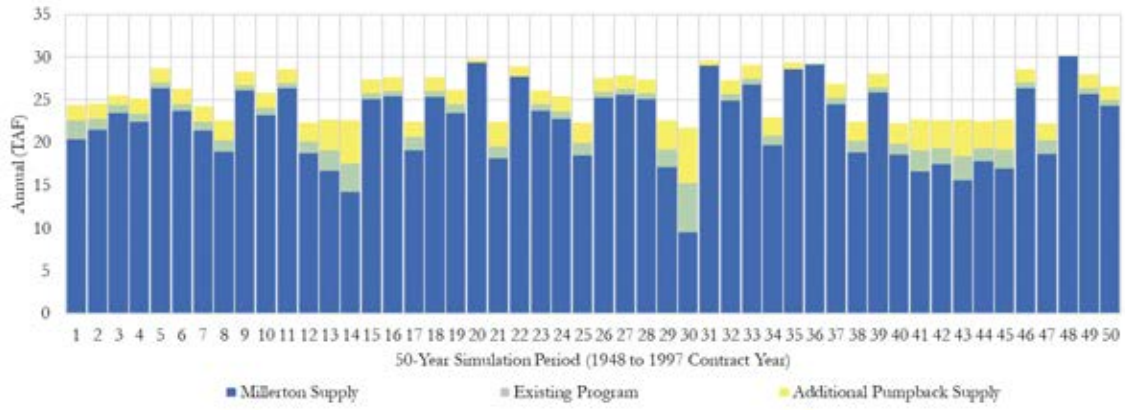


Key: TAF = thousand acre-feet

Figure 3-90. Total Annual Surface Water Delivery (thousand acre-feet) to Southern San Joaquin Municipal Utility District for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Kern-Tulare Water District

Figure 3-91 summarizes the total annual surface water delivery to KTWD in the Low Flow Alternative and Seasonal Alternative under Future Conditions.

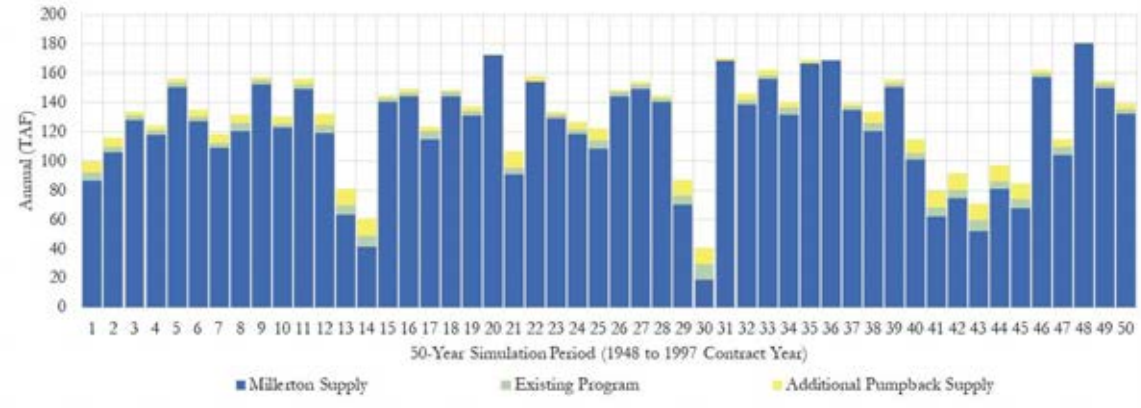


Key: TAF = thousand acre-feet

Figure 3-91. Total Annual Surface Water Delivery (thousand acre-feet) to Kern-Tulare Water District for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Delano-Earlimart Irrigation District

Figure 3-92 summarizes the total annual surface water delivery to DEID in the Low Flow Alternative and Seasonal Alternative under Future Conditions.



Key: TAF = thousand acre-feet

Figure 3-92. Total Annual Surface Water Delivery (thousand acre-feet) to Delano-Earlimart Irrigation District for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Terra Bella Irrigation District

Figure 3-93 summarizes the total annual surface water delivery to TBID in the Low Flow Alternative and Seasonal Alternative under Future Conditions. TBID receives local sources of water supply directly from the Tule River.

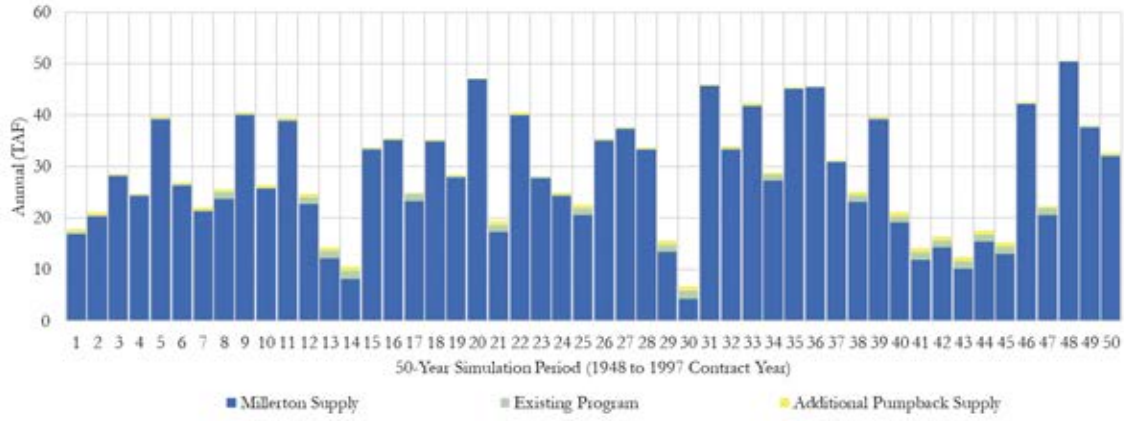


Key: TAF = thousand acre-feet

Figure 3-93. Total Annual Surface Water Delivery (thousand acre-feet) to Terra Bella Irrigation District for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Saucelito Irrigation District

Figure 3-94 summarizes the total annual surface water delivery to Saucelito ID in the Low Flow Alternative and Seasonal Alternative under Future Conditions.

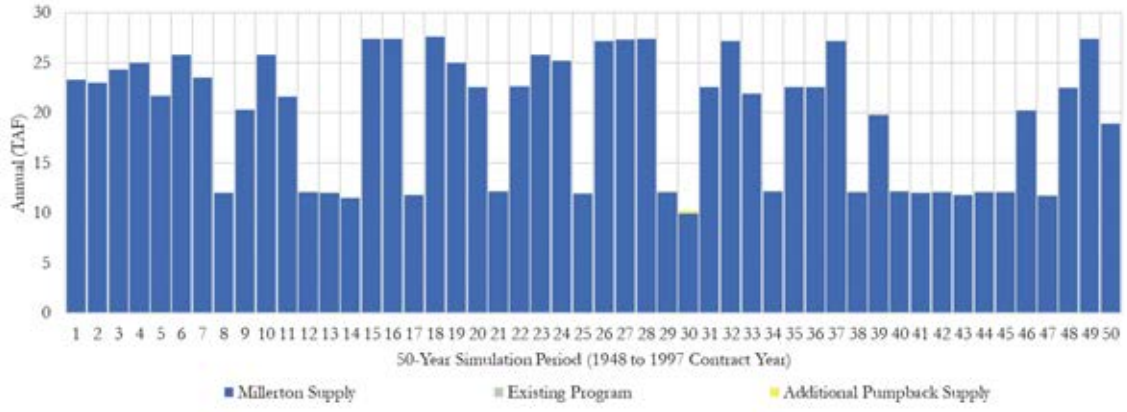


Key: TAF = thousand acre-feet

Figure 3-94. Total Annual Surface Water Delivery (thousand acre-feet) to Saucelito Irrigation District for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Pixley Irrigation District

Figure 3-95 summarizes the total annual surface water delivery to Pixley ID in the Low Flow Alternative and Seasonal Alternative under Future Conditions.

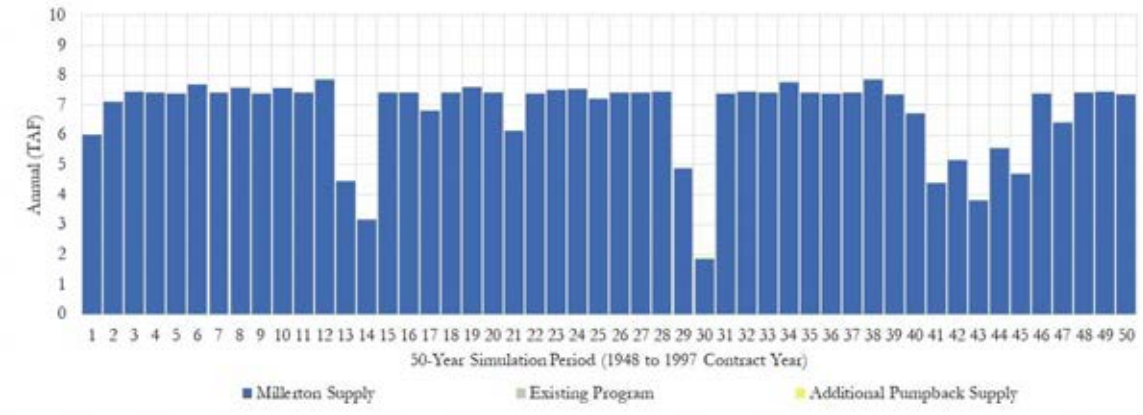


Key: TAF = thousand acre-feet

Figure 3-95. Total Annual Surface Water Delivery (thousand acre-feet) to Pixley Irrigation District for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Tea Pot Dome Water District

Figure 3-96 summarizes the total annual surface water delivery to TPDWD in the Low Flow Alternative and Seasonal Alternative under Future Conditions.

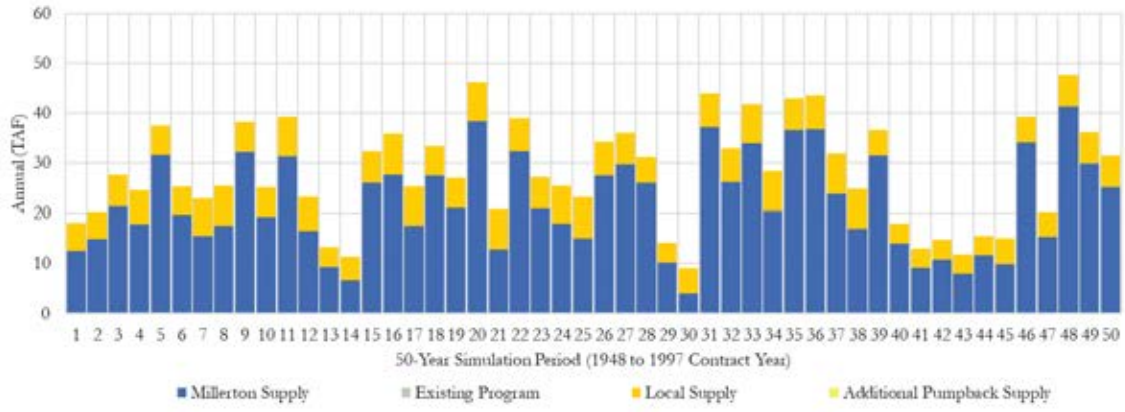


Key: TAF = thousand acre-feet

Figure 3-96. Total Annual Surface Water Delivery (thousand acre-feet) to Tea Pot Dome Water District for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Porterville Irrigation District

Figure 3-97 summarizes the total annual surface water delivery to Porterville ID in the Low Flow Alternative and Seasonal Alternative under Future Conditions. Porterville ID receives local sources of water supply directly from the Tule River.

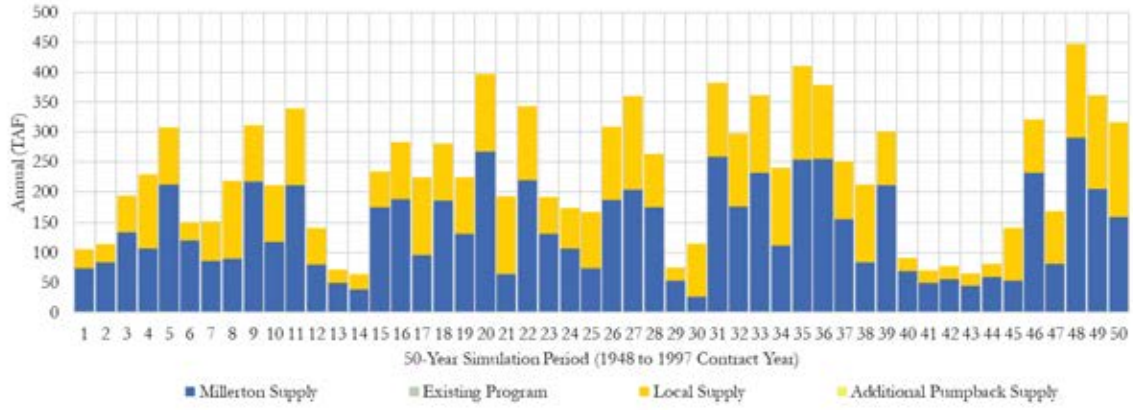


Key: TAF = thousand acre-feet

Figure 3-97. Total Annual Surface Water Delivery (thousand acre-feet) to Porterville Irrigation District for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Lower Tule River Irrigation District

Figure 3-98 summarizes the total annual surface water delivery to LTRID in the Low Flow Alternative and Seasonal Alternative under Future Conditions. LTRID receives local sources of water supply directly from the Tule River.



Key: TAF = thousand acre-feet

Figure 3-98. Total Annual Surface Water Delivery (thousand acre-feet) to Lower Tule River Irrigation District for the Low Flow Alternative and Seasonal Alternative under Future Conditions

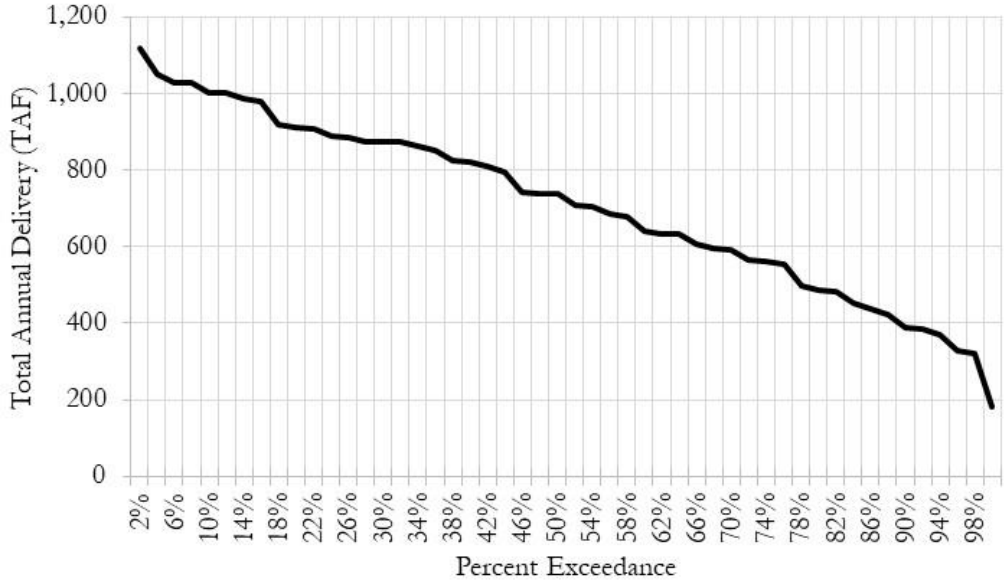
3.2.4 High Flow Alternative

Under High Flow Alternative, permanent pumps are assumed to be installed and operated at the Shafter-Wasco, Lake Woollomes, and Deer Creek check structures (500 cfs, 250 cfs and 250 cfs, respectfully).

3.2.4.1 High Flow Alternative under Existing Conditions

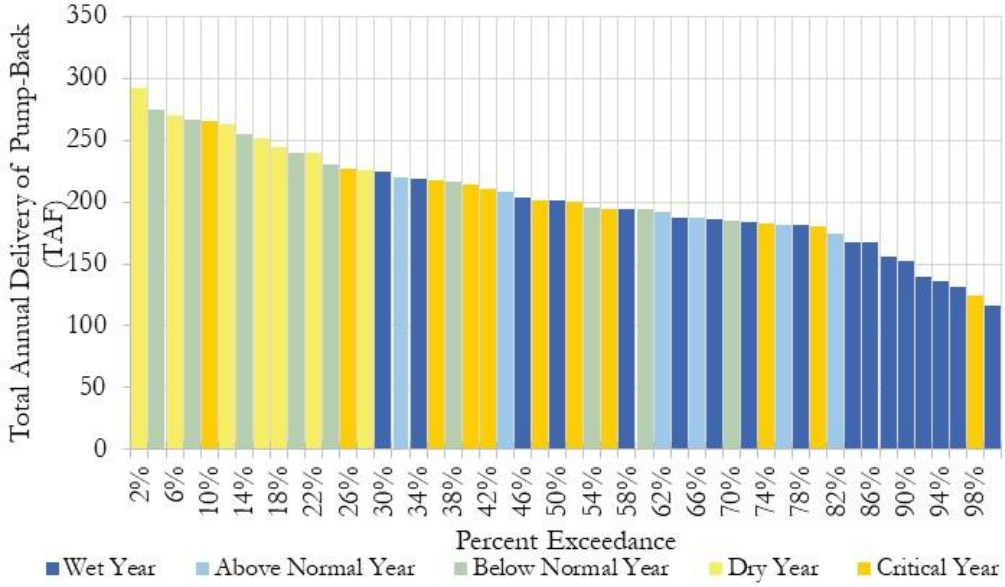
Figure 3-99 shows the probability of exceedance of total annual delivery to Friant Contractors in the study area under the High Flow Alternative under Existing Conditions. Figure 3-100 shows the probability of exceedance of total annual supply delivered to Friant Contractors in the study area via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the High Flow Alternative under Existing Conditions. These pump-back operational volumes represents all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC at different locations along the Project reaches and not at the Intertie.

Table 3-220 summarizes the average total annual delivery to Friant Contractors in the study area by source for an average of all years and by San Joaquin Valley Water Year Type under the High Flow Alternative under Existing Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the average total delivery is 709 TAF with 29 percent from existing programs and additional pump-back supply. For an average Wet water year, the total delivery is 898 TAF with 16 percent from existing programs and additional pump-back supply. For an average Critical water year, the total delivery is 405 TAF with 53 percent from existing programs and additional pump-back supply.



Key: TAF = thousand acre-feet

Figure 3-99. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to Friant Contractors in the Study Area for the High Flow Alternative under Existing Conditions



Key: TAF = thousand acre-feet

Figure 3-100. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to Friant Contractors in the Study Area by San Joaquin Valley Water Year Type for the High Flow Alternative under Existing Conditions

Table 3-220. Average Annual Delivery (thousand acre-feet) to Friant Contractors in the Study Area by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the High Flow Alternative under Existing Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	503	752	657	428	351	191
Existing Programs	35	32	33	35	37	38
Additional Pump-Back Supply	171	115	206	193	242	176
Total Supply	709	898	896	656	630	405

Location of Interface

Table 3-221 summarizes the average monthly location of the interface between the reverse-flow pump-back operations and gravity operations (i.e., Millerton supply) for an average of all years and by San Joaquin Valley Water Year Type for the High Flow Alternative under Existing Conditions. During peak irrigation season available supply is delivered via reverse-flow pump-back operations and exchanged to meet irrigation demand in Reach A. As the water year type becomes drier and thus CVP surface water allocation is reduced, supply delivered via reverse-flow pump-back operations is delivered further up the canal to meet irrigation demand. In addition, because there is reduced irrigation demand in the shoulder months of the irrigation season (October to March), this supply delivered via reverse-flow pump-back is pushed further up the canal as less water is exchanged in the lower Project reaches and the available supply is distributed to more Friant Contractors.

Table 3-221. Average Monthly Project Reach Location of Pump-Back Interface for an Average of All Years and by San Joaquin Valley Water Year Type for the High Flow Alternative under Existing Conditions

Year Type	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Wet	C	A	A	A	B	B	C	C	C	C	C	C
Above Normal	C	A	A	B	B	B	C	C	C	C	C	C
Below Normal	C	C	C	B	B	B	C	C	C	C	C	C
Dry	C	C	C	B	B	B	C	C	C	C	C	C
Critical	C	C	C	C	C	C	C	C	C	C	C	C
Average	C	C	C	B	B	B	C	C	C	C	C	C

Notes:
Year Type is based on San Joaquin Valley Water Year Types
Reach A is the Intertie to Shafter-Wasco Check
Reach B is from Shafter-Wasco Check to Lake Woollomes Check
Reach C is from Lake Woollomes Check to Deer Creek Check

Reach A

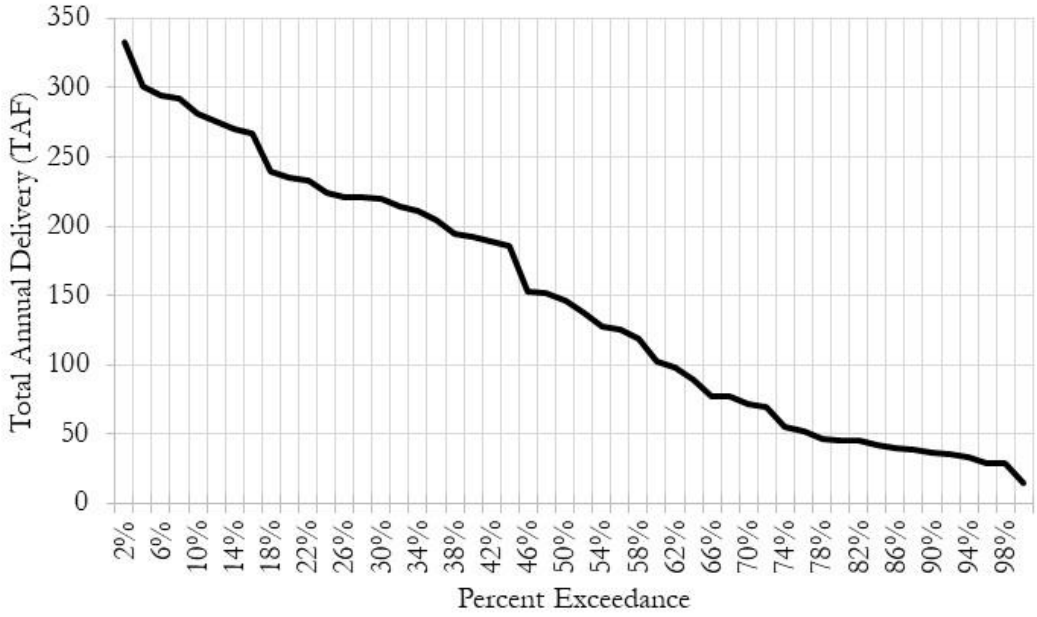
This section summarizes the total water supply delivery and the total water quality to the Friant Contractors in Reach A. The only Friant Contractor within Reach A is AEWSD.

Water Supply

Figure 3-101 shows the probability of exceedance of total annual delivery to the Friant Contractor in Reach A under the High Flow Alternative under Existing Conditions. Figure 3-102 shows the probability of exceedance of total annual supply delivered to the Friant Contractor in Reach A via reverse-flow pump-back by San Joaquin Valley Water Year Type under the High Flow Alternative under Existing Conditions. This volume represents all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. There are no FKC groundwater pump-in program deliveries in Reach A.

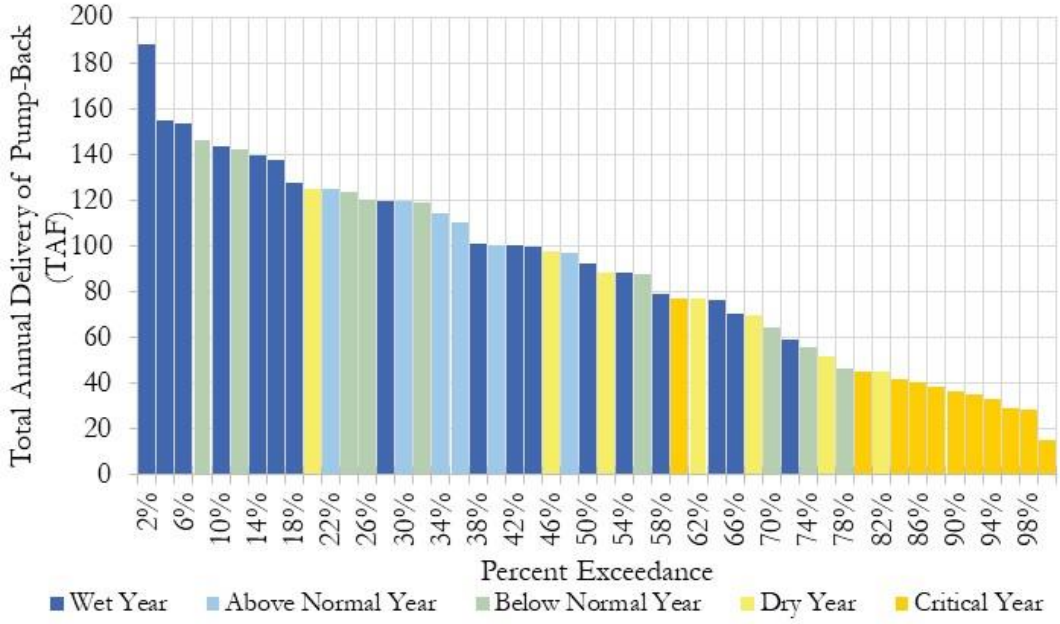
Table 3-222 summarizes the average total annual delivery to the Friant Contractor in Reach A by source for an average of all years and by San Joaquin Valley Water Year Type under the High Flow Alternative under Existing Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs). Across all years, the average total delivery is 148 TAF with 61 percent from existing programs and additional pump-back supply (total mitigation is 4 percent of total delivery). For an average Wet water year, the total delivery is 239 TAF with 42 percent from existing programs and additional pump-back supply (total mitigation is 3 percent of total delivery. For an average Critical water year, the total delivery is 39 TAF all from existing programs and additional pump-back supply (total mitigation is 6 percent of the total delivery).

Table 3-223 to Table 3-225 and Figure 3-103 summarize the average monthly delivery to the Friant Contractors in Reach A by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-101. Probability of Exceedance for Total Annual Delivery (thousand acre-feet) to the Friant Contractor in Reach A for the High Flow Alternative under Existing Conditions



Key: TAF = thousand acre-feet

Figure 3-102. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to the Friant Contractor in Reach A for the High Flow Alternative under Existing Conditions

Table 3-222. Average Annual Delivery (thousand acre-feet) to the Friant Contractor in Reach A by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the High Flow Alternative under Existing Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	58	139	69	15	0	0
Existing Programs	29	29	32	33	30	23
Additional Pump-Back Supply	61	71	120	60	54	16
Total Supply	148	239	221	108	84	39

Table 3-223. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source for the High Flow Alternative under Existing Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	3,717	11,315	16,162	17,165	8,714	907	71	0	0	0	0	0	58,052
Existing Programs	1,516	2,022	3,381	4,704	5,124	5,129	3,731	2,043	421	358	0	400	28,829
Additional Pump-Back Supply	4,429	1,420	1,867	3,560	8,202	13,548	7,470	3,195	1,457	1,451	4,212	10,038	60,850
Total Supply	9,661	14,757	21,410	25,429	22,040	19,585	11,273	5,238	1,878	1,810	4,212	10,438	147,731

Table 3-224. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source for the High Flow Alternative under Existing Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	10,933	23,581	35,528	40,354	25,401	2,668	210	0	0	0	0	0	138,676
Existing Programs	1,138	1,840	3,470	4,470	4,922	5,620	4,420	1,981	345	310	0	400	28,915
Additional Pump-Back Supply	3,810	0	0	0	5,235	24,284	15,263	3,356	1,743	624	3,820	13,287	71,422
Total Supply	15,881	25,421	38,998	44,824	35,558	32,572	19,893	5,337	2,088	933	3,820	13,687	239,013

Table 3-225. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source for the High Flow Alternative under Existing Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Existing Programs	1,134	1,534	2,510	4,423	4,639	4,026	2,163	1,613	394	139	0	400	22,976
Additional Pump-Back Supply	537	725	1,321	2,666	3,697	1,913	982	752	185	64	201	2,852	15,894
Total Supply	1,671	2,260	3,830	7,090	8,336	5,939	3,144	2,365	579	203	201	3,252	38,870

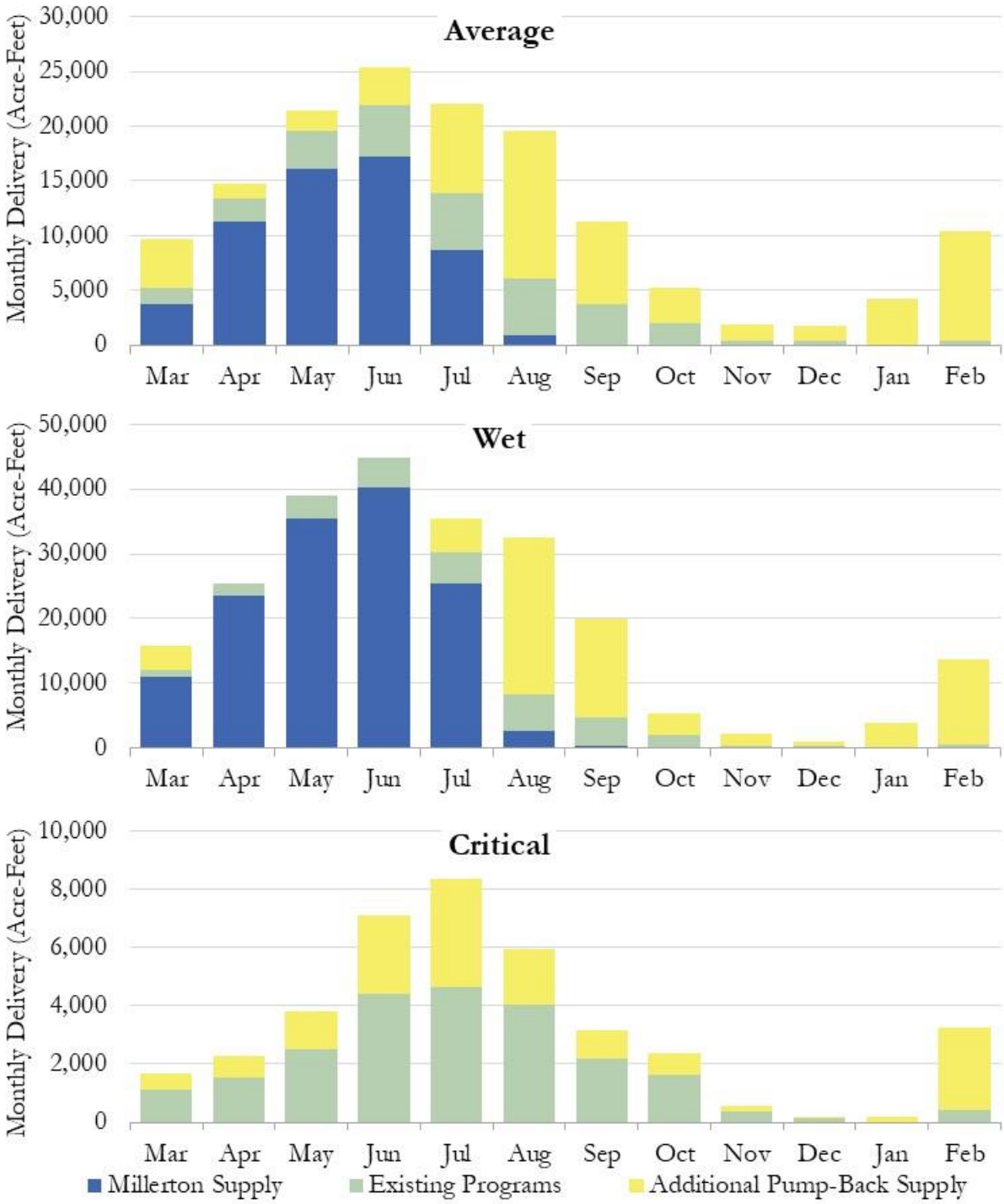


Figure 3-103. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source for the High Flow Alternative under Existing Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach A deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-226 to Table 3-229 show the monthly average and monthly maximum water quality trends for individual constituents for the High Flow Alternative under Existing Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply being delivered via reverse-flow pump-back operations (i.e., existing programs and additional pump-back), water quality concentrations tend to increase. For TDS, nitrate, chloride, and boron, there is a correlation between reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-226. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the High Flow Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	228.76	164.45	162.05	173.96	163.02	218.20	246.52	282.88	280.84	252.90	237.64	310.21
Maximum	333.80	321.20	327.50	304.60	272.00	322.60	368.00	340.50	314.50	335.00	378.50	366.20
Wet Water Years												
Average	99.29	50.57	36.69	32.27	56.40	164.94	171.01	260.20	265.39	273.60	203.02	285.80
Maximum	221.60	157.56	46.62	43.33	147.00	176.80	172.00	260.20	281.00	307.80	228.40	285.80
Critical Water Years												
Average	333.80	321.20	300.80	304.60	272.00	322.60	368.00	300.20	300.00	145.55	150.45	366.20
Maximum	333.80	321.20	300.80	304.60	272.00	322.60	368.00	300.20	300.00	320.20	331.00	366.20

Key: mg/L = milligrams per liter

Table 3-227. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the High Flow Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	3.15	1.44	1.32	1.34	1.35	0.98	1.08	1.32	2.34	2.67	3.50	4.16
Maximum	5.90	3.30	3.15	2.80	2.40	1.53	1.53	1.93	3.10	3.55	5.40	4.45
Wet Water Years												
Average	1.53	0.37	0.18	0.27	0.63	1.42	1.52	1.30	2.38	2.96	3.62	4.28
Maximum	3.73	1.37	0.28	0.45	1.85	1.53	1.53	1.30	2.53	3.33	4.08	4.28
Critical Water Years												
Average	3.32	2.24	2.02	1.62	1.68	0.48	0.80	1.04	1.76	1.32	1.42	4.10
Maximum	3.32	2.24	2.02	1.62	1.68	0.48	0.80	1.04	1.76	2.90	3.12	4.10

Key: mg/L = milligrams per liter

Table 3-228. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the High Flow Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.19	0.13	0.12	0.11	0.10	0.13	0.14	0.15	0.15	0.15	0.16	0.22
Maximum	0.28	0.26	0.22	0.20	0.18	0.20	0.25	0.20	0.20	0.24	0.25	0.25
Wet Water Years												
Average	0.12	0.04	0.03	0.03	0.04	0.12	0.13	0.10	0.09	0.16	0.13	0.22
Maximum	0.28	0.17	0.04	0.04	0.10	0.13	0.13	0.10	0.10	0.18	0.15	0.22
Critical Water Years												
Average	0.26	0.24	0.22	0.18	0.18	0.20	0.25	0.20	0.18	0.11	0.08	0.24
Maximum	0.26	0.24	0.22	0.18	0.18	0.20	0.25	0.20	0.18	0.24	0.18	0.24

Key: mg/L = milligrams per liter

Table 3-229. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the High Flow Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	56.25	38.11	41.88	46.34	38.76	60.07	72.72	86.63	86.04	77.95	67.24	70.92
Maximum	89.00	88.40	87.00	91.20	73.00	96.80	113.80	109.50	100.50	100.80	115.00	100.40
Wet Water Years												
Average	17.64	7.53	5.29	3.66	11.20	39.56	40.75	81.20	87.83	89.60	53.87	42.40
Maximum	43.00	32.66	7.87	6.19	33.20	42.60	41.00	81.20	93.00	100.80	60.60	42.40
Critical Water Years												
Average	89.00	88.40	84.80	91.20	73.00	96.80	113.80	88.40	83.00	43.00	46.18	100.40
Maximum	89.00	88.40	84.80	91.20	73.00	96.80	113.80	88.40	83.00	94.60	101.60	100.40

Key: mg/L = milligrams per liter

Relative Results

Relative changes in both surface water quantity and quality were determined by comparing the High Flow Alternative under Existing Conditions outputs to the Existing Conditions outputs. When comparing the scenarios, differences in volumetric deliveries are due to the either the exchange of Millerton supply for existing program supply and/or the net increase of supply due to additional pump-back deliveries. Because reverse-flow pump-back facilities have increased capacity under the High Flow Alternative under Existing Conditions as compared to Existing Conditions, there is additional opportunity to increase or maximize direct delivery of existing program supply, and thus volumetric increases are seen in Wet water years and on average for all years for those supply sources.

Table 3-230 to Table 3-232 show the volumetric differences by source between the High Flow Alternative under Existing Conditions compared to Existing Conditions for an average of all years and by Wet and Critical water year types. Across all years, the overall total supply delivered to Reach A increased by 18,244 AF in the High Flow Alternative under Existing Conditions compared to Existing Conditions. This increase is a result of increased delivery of existing programs supply due to increased pump-back facility capacities and exchanges of Millerton supply for additional pump-back supply.

Table 3-233 to Table 3-236 shows the differences in monthly average and monthly maximum water quality trends for individual constituents between the High Flow Alternative under Existing Conditions compared to Existing Conditions. For TDS, nitrate, chloride, and boron, there is a correlation between additional reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-230. Average Monthly Change in Delivery (acre-feet) to the Friant Contractor in Reach A by Source for an Average of All Years, High Flow Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-3,075	-830	-1,193	-2,772	-7,050	-10,900	-5,093	-1,741	-850	-826	-2,756	-6,818	-43,903
Existing Programs	440	90	94	216	456	0	0	0	0	0	0	0	1,296
Additional Pump-Back Supply	4,429	1,420	1,867	3,560	8,202	13,548	7,470	3,195	1,457	1,451	4,212	10,038	60,850
Total Supply	1,794	680	769	1,004	1,608	2,648	2,377	1,454	607	626	1,457	3,221	18,244

Table 3-231. Average Monthly Change in Delivery (acre-feet) to the Friant Contractor in Reach A by Source for Wet Water Year Types, High Flow Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-2,820	0	0	0	-4,722	-20,450	-11,693	-1,954	-1,081	-302	-2,481	-9,159	-54,662
Existing Programs	282	0	0	0	282	0	0	0	0	0	0	0	565
Additional Pump-Back Supply	3,811	0	0	0	5,235	24,284	15,263	3,356	1,743	624	3,820	13,288	71,422
Total Supply	1,273	0	0	0	795	3,834	3,570	1,402	662	321	1,340	4,128	17,325

Table 3-232. Average Monthly Change in Delivery (acre-feet) to the Friant Contractor in Reach A by Source for Critical Water Year Types, High Flow Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	0	0	-177	-1,287	-2,292	-591	0	0	0	0	-126	-1,681	-6,154
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	537	725	1,321	2,667	3,697	1,913	982	752	185	64	201	2,852	15,894
Total Supply	537	725	1,144	1,379	1,405	1,322	982	752	185	64	75	1,171	9,740

Water Quality

Table 3-233. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the High Flow Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	141.49	48.35	78.06	84.56	98.23	137.27	137.54	99.61	96.64	112.68	212.94	225.84
Maximum	132.89	82.87	165.83	114.60	122.00	152.60	183.00	110.50	87.83	125.00	346.90	75.04
Wet Water Years												
Average	45.47	-2.22	-1.51	-8.75	25.38	126.13	119.59	50.32	71.27	95.62	176.80	201.42
Maximum	20.69	-12.77	-2.49	-17.33	105.78	127.11	104.24	30.20	54.33	97.80	198.90	70.74
Critical Water Years												
Average	186.66	82.87	144.19	139.29	152.70	165.41	183.00	134.49	121.43	68.27	136.09	259.96
Maximum	186.66	82.87	139.13	114.60	122.00	152.60	183.00	134.49	121.43	150.20	299.40	173.37

Key: mg/L = milligrams per liter

Table 3-234. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the High Flow Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.47	-0.49	-0.71	-0.40	0.20	-0.61	-0.81	-1.35	-1.07	0.28	2.39	2.82
Maximum	-0.94	-1.43	-2.67	-1.54	-2.00	-3.45	-3.22	-1.18	-1.10	-0.48	3.60	0.25
Wet Water Years												
Average	0.97	-0.12	-0.08	-0.14	0.58	1.19	1.22	-1.53	-1.18	0.28	2.02	3.08
Maximum	1.27	-0.68	-0.13	-0.28	1.81	1.23	1.14	-1.82	-1.68	0.15	2.28	1.97
Critical Water Years												
Average	-3.52	-2.49	-3.58	-2.33	-1.73	-4.09	-3.96	-1.80	-1.64	-0.51	1.29	1.94
Maximum	-3.52	-2.49	-3.80	-2.72	-2.72	-4.50	-3.96	-1.80	-1.64	-1.13	2.85	-0.10

Key: mg/L = milligrams per liter

Table 3-235. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the High Flow Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.13	0.07	0.06	0.04	0.06	0.07	0.08	0.06	0.05	0.07	0.14	0.00
Maximum	0.17	0.14	0.10	0.07	0.06	0.09	0.14	0.09	0.09	0.12	0.23	-0.09
Wet Water Years												
Average	0.08	0.01	0.00	-0.01	0.01	0.09	0.10	0.00	0.00	0.06	0.12	-0.09
Maximum	0.17	0.07	0.01	-0.01	0.07	0.09	0.09	-0.01	-0.01	0.06	0.14	-0.12
Critical Water Years												
Average	0.15	0.12	0.11	0.07	0.09	0.10	0.14	0.11	0.07	0.06	0.07	0.17
Maximum	0.15	0.12	0.10	0.05	0.06	0.09	0.14	0.11	0.07	0.13	0.16	0.11

Key: mg/L = milligrams per liter

Table 3-236. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the High Flow Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	40.21	22.87	25.02	28.61	26.34	42.04	44.27	26.42	30.79	38.95	65.48	49.07
Maximum	27.05	37.01	39.01	49.49	40.71	57.13	65.30	26.17	27.50	37.80	112.80	-2.13
Wet Water Years												
Average	5.55	-3.26	-1.71	-2.92	5.95	31.78	28.25	5.60	25.77	36.48	51.91	18.24
Maximum	-18.95	-18.73	-2.81	-5.79	25.36	31.77	23.49	-2.13	20.00	37.80	58.40	-31.29
Critical Water Years												
Average	67.43	67.40	55.99	56.37	49.07	60.51	65.30	45.54	36.00	24.95	45.27	77.51
Maximum	67.43	67.40	54.97	49.49	40.71	57.13	65.30	45.54	36.00	54.89	99.58	55.62

Key: mg/L = milligrams per liter

Reach B

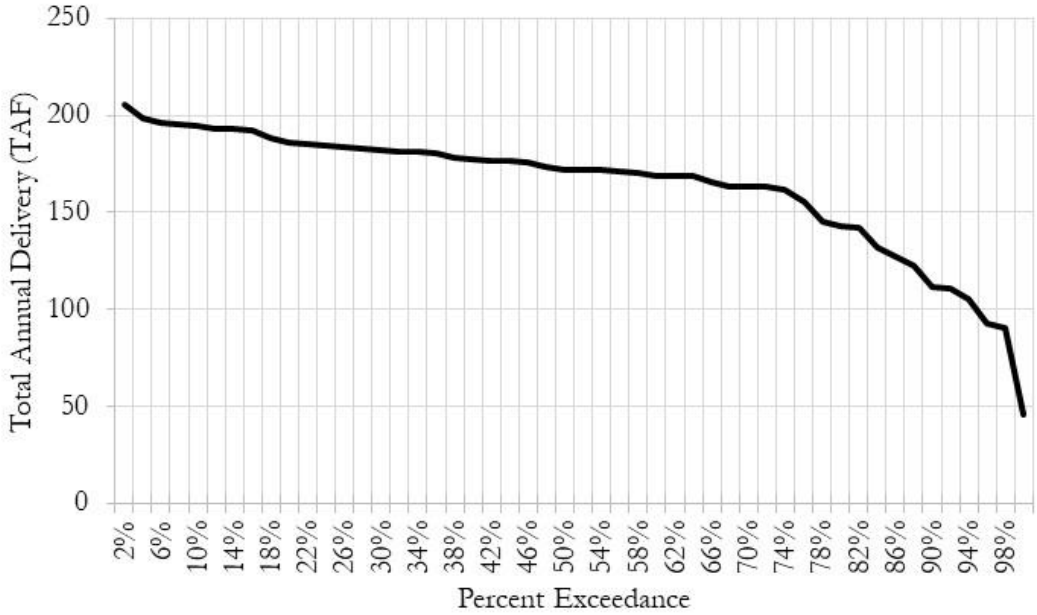
This section summarizes the total water supply delivery and the total water quality to the Friant Contractors in Reach B. The Friant Contractors within Reach B include Shafter-Wasco Irrigation District and South San Joaquin Municipal Utility District.

Water Supply

For the High Flow Alternative under Existing Conditions, the Reach B Shafter-Wasco check structure capacity is assumed to be 500 cfs. Figure 3-104 shows the probability of exceedance of total annual delivery to the Friant Contractors in Reach B under the High Flow Alternative under Existing Conditions. Figure 3-105 shows the probability of exceedance of total annual delivery of supply to the Friant Contractors in Reach B via reverse-flow pump-back by San Joaquin Valley Water Year Type under the High Flow Alternative under Existing Conditions. These volumes represent all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach B and not at the Intertie.

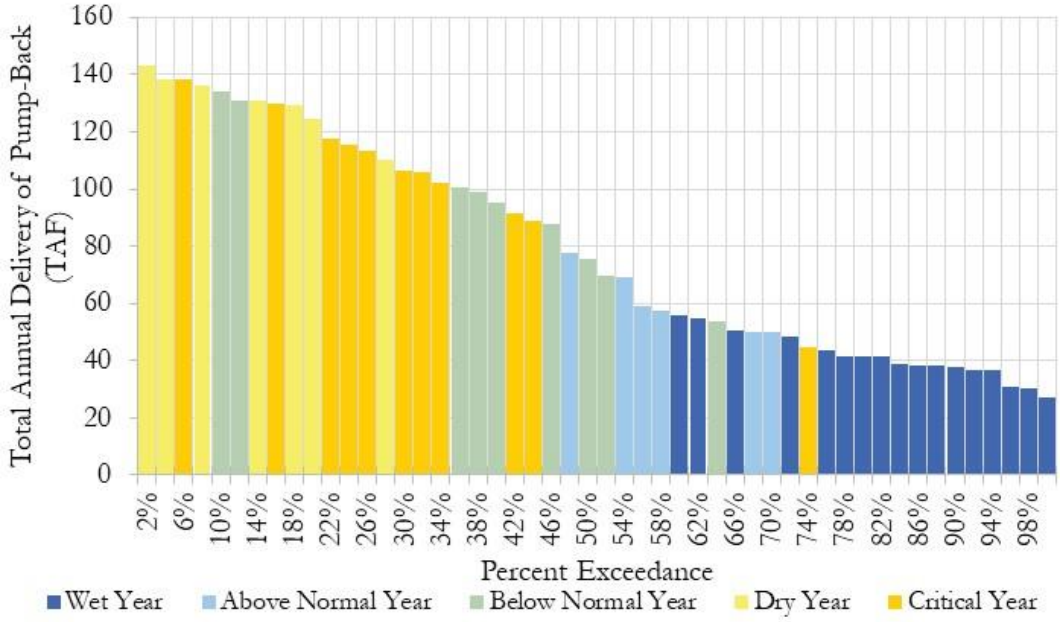
Table 3-237 summarize the average total annual delivery to the Friant Contractors in Reach B by source for an average of all years and by San Joaquin Valley Water Year Type under the High Flow Alternative under Existing Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the total average delivery is 163 TAF with 49 percent from existing programs and additional pump-back supply (total mitigation is 3 percent of the total delivery). For an average Wet water year, the total delivery is 178 TAF with 18 percent from existing programs and additional pump-back supply (total mitigation is 1 percent of the total delivery). For an average Critical water year, the total delivery is 116 TAF with 94 percent from existing programs and additional pump-back supply (total mitigation is 6 percent of the total delivery).

Table 3-238 to Table 3-240 and Figure 3-106 summarizes the average monthly delivery to the Friant Contractors in Reach B by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-104. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach B for the High Flow Alternative under Existing Conditions



Key: TAF = thousand acre-feet

Figure 3-105. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to the Friant Contractors in Reach B by San Joaquin Valley Water Year Type for the High Flow Alternative under Existing Conditions

Table 3-237. Average Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach B by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the High Flow Alternative under Existing Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	83	147	121	71	34	7
Existing Programs	4	2	1	2	3	9
Additional Pump-Back Supply	76	30	68	94	137	100
Total Supply	163	178	190	167	174	116

Table 3-238. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source for the High Flow Alternative under Existing Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	2,020	6,514	10,602	18,344	22,353	17,779	3,717	654	11	0	138	1,317	83,449
Existing Programs	257	325	332	130	120	207	405	1,112	417	338	0	0	3,644
Additional Pump-Back Supply	5,225	4,143	6,265	9,804	10,863	11,431	12,807	5,892	1,489	950	1,691	5,674	76,232
Total Supply	7,503	10,982	17,200	28,278	33,335	29,416	16,929	7,658	1,917	1,288	1,829	6,991	163,326

Table 3-239. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source for the High Flow Alternative under Existing Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	5,337	10,928	17,848	29,672	35,705	33,531	10,512	1,139	32	0	0	2,018	146,721
Existing Programs	26	0	0	0	0	0	0	1,155	453	433	0	0	2,068
Additional Pump-Back Supply	1,618	0	0	0	867	2,094	11,668	4,518	1,156	622	1,727	5,327	29,597
Total Supply	6,981	10,928	17,848	29,672	36,572	35,625	22,180	6,812	1,641	1,055	1,727	7,345	178,386

Table 3-240. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source for the High Flow Alternative under Existing Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	0	0	0	1,570	4,664	622	0	0	0	0	0	0	6,855
Existing Programs	928	1,412	1,369	457	411	805	1,468	1,640	465	232	0	0	9,188
Additional Pump-Back Supply	4,308	5,669	10,848	20,303	21,154	17,368	8,572	5,115	1,198	249	478	4,600	99,862
Total Supply	5,236	7,082	12,217	22,329	26,229	18,795	10,040	6,755	1,663	481	478	4,600	115,905

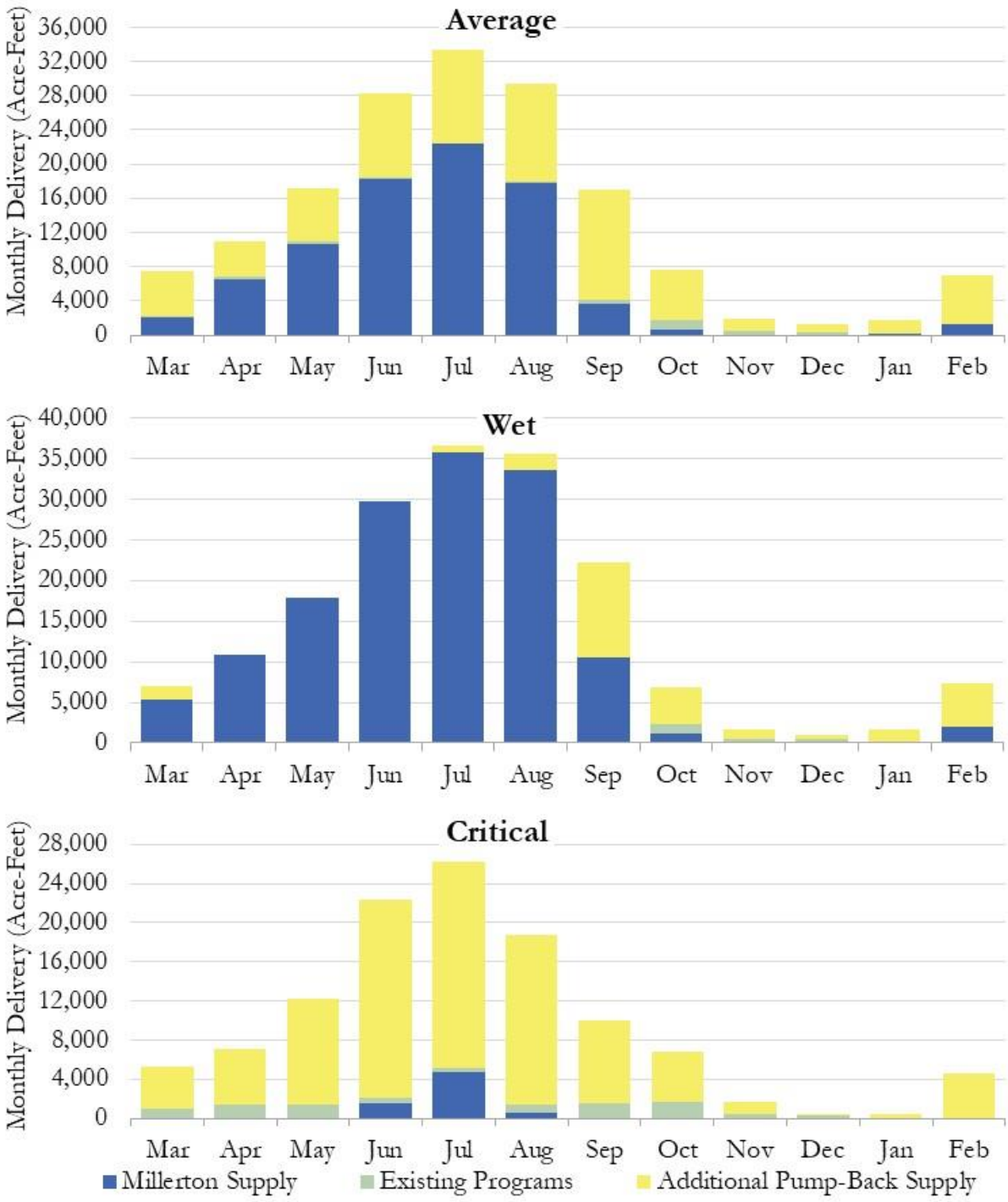


Figure 3-106. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach B by Source for the High Flow Alternative under Existing Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach B deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-241 to Table 3-244 show the monthly average and monthly maximum water quality trends for individual constituents for the High Flow Alternative under Existing Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply being delivered via reverse-flow pump-back operations (i.e., existing programs and additional pump-back supply) and FKC groundwater pump-in programs, water quality concentrations tend to increase. For TDS, nitrate, chloride, and boron, there is a correlation between reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-241. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the High Flow Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	215.16	144.66	133.14	127.81	96.98	130.55	219.87	269.15	280.47	252.90	233.72	279.65
Maximum	333.80	321.20	327.50	301.74	269.47	319.42	362.96	340.50	314.50	335.00	378.50	366.20
Wet Water Years												
Average	70.75	28.00	21.33	21.00	16.16	24.35	103.81	237.53	264.37	273.60	203.02	234.33
Maximum	221.60	28.00	21.33	21.00	33.66	63.39	172.00	260.20	281.00	307.80	228.40	285.80
Critical Water Years												
Average	333.80	321.20	294.75	287.62	234.48	311.68	359.69	292.49	300.00	145.55	150.45	366.20
Maximum	333.80	321.20	297.70	301.74	269.47	319.42	362.96	300.20	300.00	320.20	331.00	366.20

Key: mg/L = milligrams per liter

Table 3-242. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the High Flow Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	2.87	1.23	1.07	1.00	0.75	0.45	0.91	1.37	2.34	2.67	3.47	3.74
Maximum	5.90	3.30	3.15	2.47	1.78	1.05	1.53	1.93	3.10	3.55	5.40	4.45
Wet Water Years												
Average	1.02	0.16	0.03	0.08	0.08	0.18	0.91	1.34	2.38	2.96	3.62	3.57
Maximum	3.73	0.16	0.03	0.08	0.32	0.53	1.53	1.83	2.53	3.33	4.08	4.28
Critical Water Years												
Average	3.32	2.24	2.13	1.72	1.64	0.57	0.95	1.21	1.76	1.32	1.42	4.10
Maximum	3.32	2.24	2.29	1.83	1.78	0.75	1.05	1.36	1.76	2.90	3.12	4.10

Key: mg/L = milligrams per liter

Table 3-243. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the High Flow Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.17	0.11	0.10	0.08	0.06	0.08	0.13	0.15	0.15	0.15	0.15	0.24
Maximum	0.28	0.26	0.22	0.18	0.17	0.20	0.25	0.20	0.20	0.24	0.25	0.31
Wet Water Years												
Average	0.08	0.02	0.02	0.02	0.01	0.02	0.08	0.09	0.09	0.16	0.13	0.24
Maximum	0.28	0.02	0.02	0.02	0.02	0.05	0.13	0.10	0.10	0.18	0.15	0.31
Critical Water Years												
Average	0.26	0.24	0.22	0.17	0.15	0.19	0.25	0.20	0.18	0.11	0.08	0.24
Maximum	0.26	0.24	0.22	0.18	0.17	0.20	0.25	0.20	0.18	0.24	0.18	0.24

Key: mg/L = milligrams per liter

Table 3-244. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the High Flow Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	53.26	33.57	33.88	32.95	22.22	36.29	65.76	82.32	85.91	77.95	66.20	64.80
Maximum	89.00	88.40	87.00	90.34	72.32	95.85	112.24	109.50	100.50	100.80	115.00	100.40
Wet Water Years												
Average	11.72	2.23	1.30	1.08	1.42	3.46	23.72	73.85	87.48	89.60	53.87	34.39
Maximum	43.00	2.23	1.30	1.08	5.67	13.48	41.00	81.20	93.00	100.80	60.60	42.40
Critical Water Years												
Average	89.00	88.40	83.09	85.40	61.62	93.38	111.23	86.13	83.00	43.00	46.18	100.40
Maximum	89.00	88.40	83.93	90.34	72.32	95.85	112.24	88.40	83.00	94.60	101.60	100.40

Key: mg/L = milligrams per liter

Relative Results

Relative changes in both surface water quantity and quality were determined by comparing the High Flow Alternative under Existing Conditions outputs to Existing Conditions outputs. When comparing the scenarios, differences in volumetric deliveries are due to the either the exchange of Millerton supply for existing program supply and/or the net increase of supply due to additional pump-back deliveries. Because reverse-flow pump-back facilities have increased capacity under the High Flow Alternative under Existing Conditions as compared to Existing Conditions, there is additional opportunity to increase or maximize direct delivery of existing program supply, and thus volumetric increases are seen in wet years and on average for all years for those supply sources. Table 3-247 show the volumetric differences by source between the High Flow Alternative under Existing Conditions compared to Existing Conditions for an average of all years and by Wet and Critical water year types. Across all years, the overall total supply delivered to Reach B increased by 25,910 AF in the High Flow Alternative under Existing Conditions compared to Existing Conditions. This increase is a result of increased delivery of existing programs due to increased pump-back facility capacities and exchanges of Millerton supply for additional pump-back supply.

Table 3-248 to Table 3-251 shows the differences in monthly average and monthly maximum water quality trends for individual constituents between the High Flow Alternative under Existing Conditions compared to Existing Conditions. For TDS, nitrate, chloride, and boron, there is a correlation between additional reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-245. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach B by Source for an Average of All Years, High Flow Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-3,217	-2,594	-4,307	-7,239	-7,749	-7,353	-8,631	-3,452	-834	-503	-1,050	-3,417	-50,346
Existing Programs	16	6	2	0	0	0	0	0	0	0	0	0	24
Additional Pump-Back Supply	5,225	4,143	6,265	9,804	10,863	11,431	12,807	5,892	1,489	950	1,691	5,674	76,233
Total Supply	2,024	1,554	1,960	2,565	3,114	4,078	4,176	2,440	655	447	641	2,257	25,910

Table 3-246. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach B by Source for Wet Water Year Types, High Flow Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-914	0	0	0	-82	1,095	-7,821	-2,452	-614	-265	-1,107	-3,092	-15,252
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	1,618	0	0	0	867	2,094	11,668	4,518	1,156	622	1,727	5,327	29,597
Total Supply	704	0	0	0	785	3,189	3,846	2,067	543	357	620	2,235	14,345

Table 3-247. Average Monthly Change in Delivery (acre-feet) to the Friant Contractors in Reach B by Source for Critical Water Year Types, High Flow Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-2,450	-3,167	-6,856	-15,259	-16,436	-12,610	-5,020	-2,783	-617	-89	-300	-2,863	-68,451
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	4,308	5,669	10,848	20,303	21,154	17,368	8,572	5,116	1,198	249	478	4,600	99,862
Total Supply	1,859	2,503	3,992	5,043	4,718	4,758	3,552	2,332	581	160	178	1,737	31,412

Table 3-248. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the High Flow Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	177.24	97.62	100.86	90.26	70.23	106.80	192.22	191.05	148.25	141.10	209.03	255.31
Maximum	132.89	82.87	154.19	182.12	187.94	143.78	228.47	99.02	87.83	125.00	346.90	340.53
Wet Water Years												
Average	36.03	0.00	0.00	0.00	3.16	10.60	90.81	141.99	99.77	122.76	176.80	208.66
Maximum	20.69	0.00	0.00	0.00	20.66	49.64	159.00	18.72	54.33	97.80	198.90	260.13
Critical Water Years												
Average	267.57	206.77	229.86	218.30	181.94	263.04	291.42	210.58	198.90	83.36	136.09	344.20
Maximum	186.66	82.87	124.38	182.12	187.94	143.78	228.47	153.11	121.43	150.20	299.40	344.20

Key: mg/L = milligrams per liter

Table 3-249. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the High Flow Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	2.13	0.42	0.67	0.09	0.28	0.08	0.45	0.22	-0.02	0.85	2.36	3.24
Maximum	-0.94	-1.43	-2.89	-0.82	-0.40	-4.06	-1.86	-1.88	-1.10	-0.48	3.60	3.76
Wet Water Years												
Average	0.70	0.00	0.00	0.00	0.04	0.09	0.83	-0.02	-0.60	0.72	2.02	2.87
Maximum	1.27	0.00	0.00	0.00	0.28	0.44	1.46	-1.99	-1.68	0.15	2.28	3.58
Critical Water Years												
Average	0.94	-0.31	0.52	-0.72	0.38	-0.51	-0.61	-0.24	-0.04	-0.10	1.29	3.94
Maximum	-3.52	-2.49	-3.75	-1.46	-0.40	-4.35	-2.34	-1.38	-1.64	-1.13	2.85	3.94

Key: mg/L = milligrams per liter

Table 3-250. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the High Flow Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.15	0.08	0.07	0.06	0.05	0.06	0.11	0.10	0.08	0.09	0.14	0.01
Maximum	0.17	0.14	0.11	0.11	0.13	0.10	0.18	0.10	0.09	0.12	0.23	-0.03
Wet Water Years												
Average	0.06	0.00	0.00	0.00	0.00	0.01	0.07	0.04	0.02	0.08	0.12	-0.10
Maximum	0.17	0.00	0.00	0.00	0.01	0.03	0.12	0.00	-0.01	0.06	0.14	-0.03
Critical Water Years												
Average	0.21	0.18	0.18	0.13	0.13	0.16	0.21	0.16	0.11	0.07	0.07	0.22
Maximum	0.15	0.12	0.11	0.11	0.13	0.10	0.18	0.13	0.07	0.13	0.16	0.22

Key: mg/L = milligrams per liter

Table 3-251. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the High Flow Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	48.57	29.37	30.57	29.80	20.03	34.01	61.68	60.79	47.02	47.79	64.44	63.01
Maximum	27.05	67.40	57.20	69.86	59.97	57.57	81.16	32.57	27.50	37.80	112.80	98.50
Wet Water Years												
Average	6.10	0.00	0.00	0.00	0.77	2.72	23.00	44.96	35.59	45.47	51.91	32.49
Maximum	-18.95	0.00	0.00	0.00	5.02	12.75	40.28	4.27	20.00	37.80	58.40	40.50
Critical Water Years												
Average	80.72	77.87	73.78	78.02	56.42	86.68	97.47	68.60	58.10	28.95	45.27	98.80
Maximum	67.43	67.40	54.12	69.86	59.97	57.57	81.16	54.74	36.00	54.89	99.58	98.80

Key: mg/L = milligrams per liter

Reach C

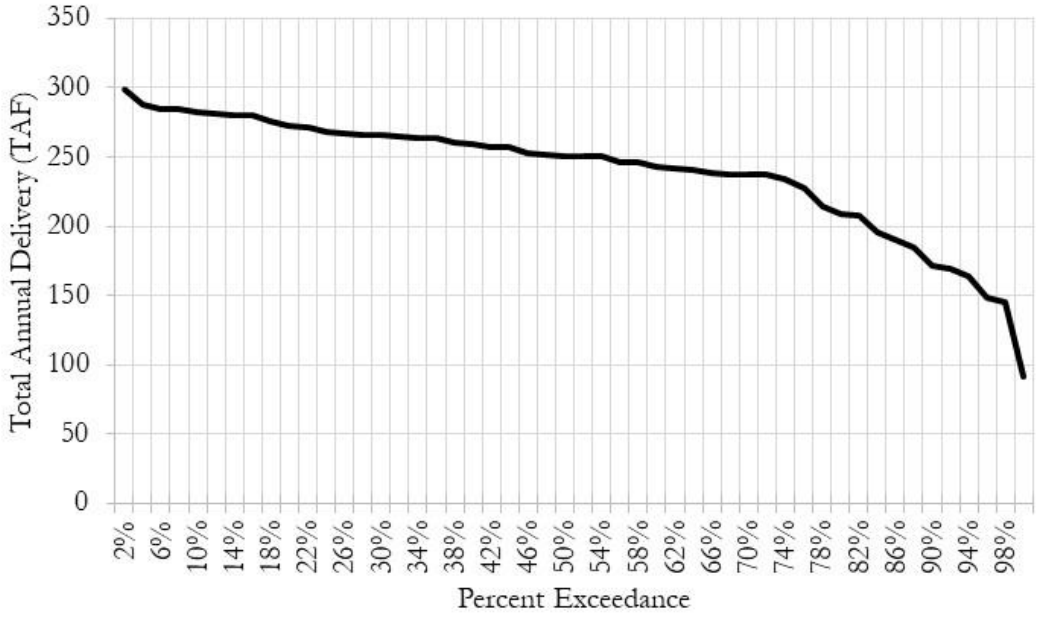
This section summarizes the total water supply delivery and the total water quality to the Friant Contractors in Reach C. The Friant Contractors within Reach C include South San Joaquin Municipal Utility District, Kern-Tulare Water District, Delano-Earlimart Irrigation District, Saucelito Irrigation District, and Terra Bella Irrigation District.

Water Supply

Under the High Flow Alternative under Existing Conditions, the Reach C Lake Woollomes check structure capacity is modeled as 250 cfs. Figure 3-107 shows the probability of exceedance of total annual delivery to Friant Contractors in Reach C under the High Flow Alternative under Existing Conditions. Figure 3-108 shows the probability of exceedance of total annual supply delivered to the Friant Contractors in Reach C via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the High Flow Alternative under Existing Conditions. These volumes represent all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach C and not at the Intertie.

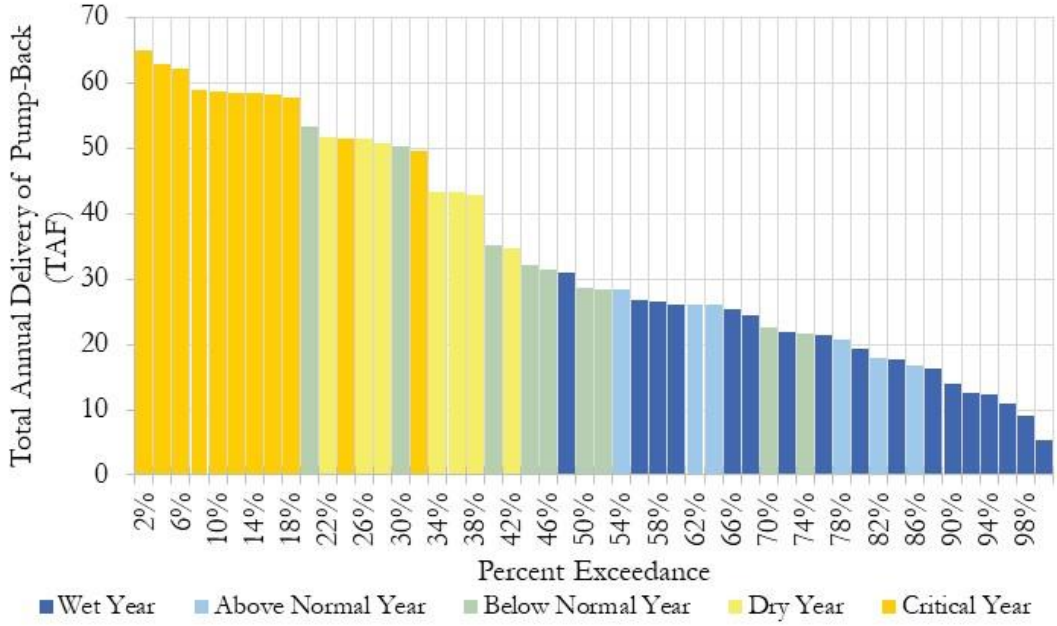
Table 3-252 summarizes the average total annual delivery to the Friant Contractors in Reach C by source for an average of all years and by San Joaquin Valley Water Year Type under the High Flow Alternative under Existing Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supply for KTWD, and the Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the average total delivery is 239 TAF with 15 percent from existing programs and additional pump-back supply (total mitigation is 1 percent of total delivery). For an average Wet water year, the total delivery is 262 TAF with 6 percent from existing programs and additional pump-back supply (total mitigation is less than 1 percent of total delivery). For an average Critical water year, the total delivery is 177 TAF with 37 percent from existing programs and additional pump-back supply (total mitigation is 3 percent of total delivery).

Table 3-253 to Table 3-255 and Figure 3-109 summarizes the average monthly delivery to the Friant Contractors in Reach C by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-107. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach C for the High Flow Alternative under Existing Conditions



Key: TAF = thousand acre-feet

Figure 3-108. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to the Friant Contractors in Reach C by San Joaquin Valley Water Year Type for the High Flow Alternative under Existing Conditions

Table 3-252. Average Annual Delivery (thousand acre-feet) to the Friant Contractors in Reach C by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the High Flow Alternative under Existing Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	203	247	257	205	192	111
Existing Programs	2	<1	<1	<1	4	5
Additional Pump-Back Supply	34	14	18	38	52	60
Total Supply	239	262	275	244	248	177

Table 3-253. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source for the High Flow Alternative under Existing Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	6,316	12,692	22,423	39,701	46,957	40,662	19,446	5,661	1,274	789	1,354	6,065	203,340
Existing Programs	15	21	276	275	275	275	275	296	62	203	0	0	1,974
Additional Pump-Back Supply	5,031	3,789	3,075	657	381	1,429	5,282	6,793	1,950	1,522	1,013	3,152	34,075
Total Supply	11,362	16,502	25,773	40,634	47,614	42,366	25,003	12,750	3,287	2,515	2,368	9,217	239,390

Table 3-254. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source for the High Flow Alternative under Existing Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	8,984	16,459	27,209	43,355	52,192	51,386	31,952	5,212	1,241	566	1,315	7,519	247,391
Existing Programs	19	0	0	0	0	0	0	58	102	157	0	0	336
Additional Pump-Back Supply	1,450	0	0	0	0	0	22	6,194	1,606	1,483	896	2,170	13,820
Total Supply	10,452	16,459	27,209	43,355	52,192	51,386	31,974	11,463	2,950	2,207	2,211	9,688	261,547

Table 3-255. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source for the High Flow Alternative under Existing Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	2,645	3,591	7,981	28,222	35,327	20,699	5,341	3,418	853	252	249	2,495	111,075
Existing Programs	38	93	766	765	765	765	765	556	40	529	0	0	5,083
Additional Pump-Back Supply	5,895	8,113	10,480	2,987	1,732	6,494	10,077	7,793	2,054	706	342	3,577	60,251
Total Supply	8,579	11,798	19,227	31,974	37,824	27,958	16,183	11,767	2,948	1,488	591	6,072	176,409

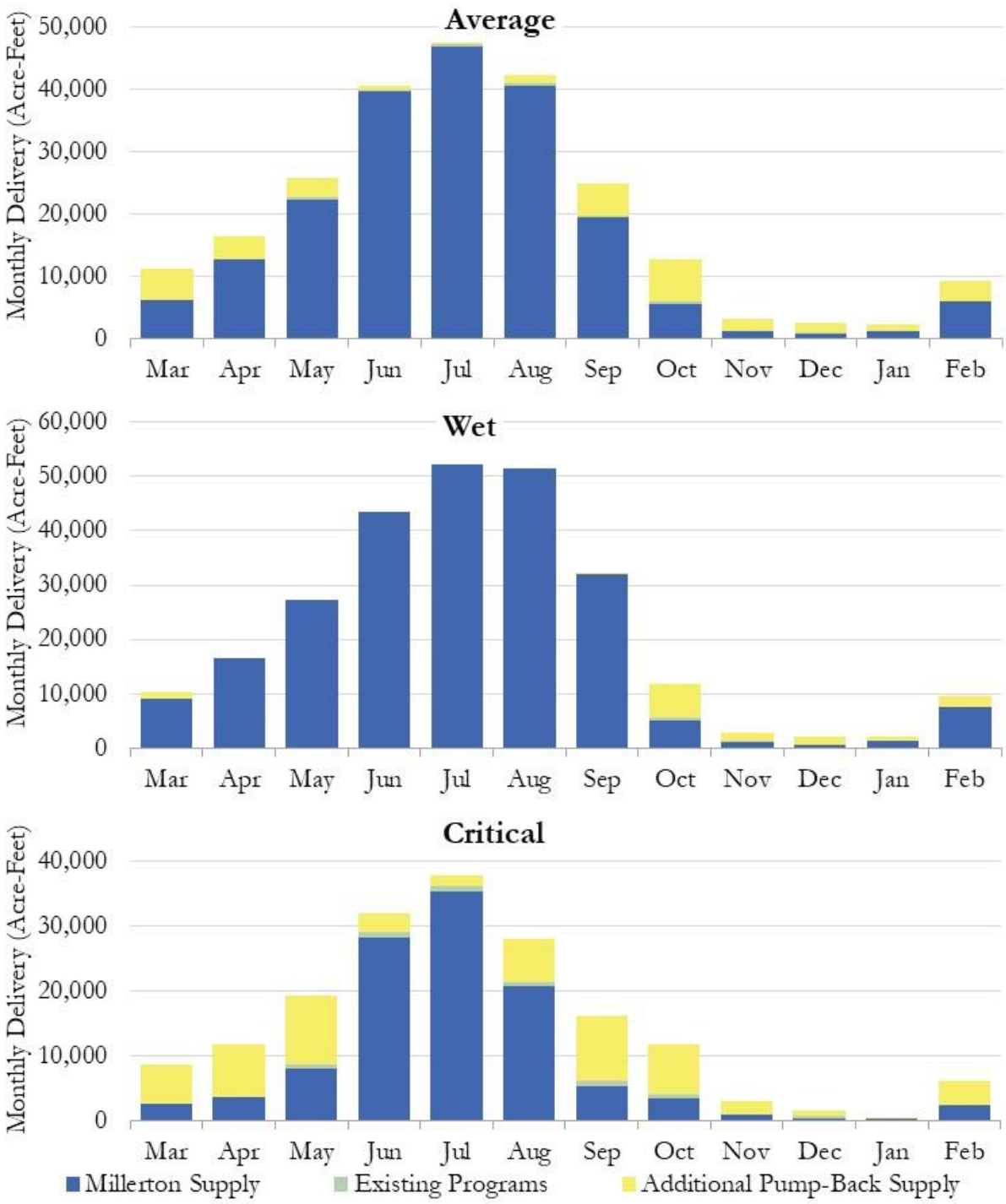


Figure 3-109. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach C by Source for the High Flow Alternative under Existing Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach C deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-256 to Table 3-259 show the monthly average and monthly maximum water quality trends for individual constituents for the High Flow Alternative under Existing Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply being delivered via reverse-flow pump-back operations (i.e., existing programs and additional pump-back supply) and FKC groundwater pump-in programs, water quality concentrations tend to increase. For TDS, nitrate, chloride, and boron, there is a correlation between reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-256. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the High Flow Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	144.19	98.69	65.38	41.74	28.63	36.71	96.35	178.50	209.98	246.15	139.59	151.57
Maximum	267.63	263.61	217.80	223.69	200.34	237.80	249.81	256.30	281.00	335.00	232.56	230.04
Wet Water Years												
Average	47.71	28.00	21.33	21.00	13.00	13.75	13.14	164.55	209.23	245.27	119.66	108.63
Maximum	153.61	28.00	21.33	21.00	13.00	13.75	15.32	192.68	281.00	307.80	145.23	186.64
Critical Water Years												
Average	240.55	234.98	185.01	90.53	62.88	109.61	237.34	202.73	221.00	287.09	93.03	224.25
Maximum	267.63	263.61	217.80	223.69	200.34	237.80	249.81	212.59	243.01	320.20	205.66	230.04

Key: mg/L = milligrams per liter

Table 3-257. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the High Flow Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	1.77	0.89	0.49	0.89	0.48	0.28	0.42	1.05	1.71	2.51	2.42	2.10
Maximum	3.94	2.52	2.06	2.39	1.73	0.92	1.12	1.81	2.53	3.55	3.89	2.91
Wet Water Years												
Average	0.60	0.16	0.03	0.08	0.04	0.09	0.08	1.11	1.85	2.62	2.67	1.84
Maximum	2.50	0.16	0.03	0.08	0.04	0.09	0.10	1.81	2.53	3.33	3.12	2.91
Critical Water Years												
Average	2.35	1.88	1.55	2.32	1.28	0.66	0.94	1.10	1.29	2.59	0.87	2.48
Maximum	2.63	2.00	2.06	2.39	1.73	0.92	1.12	1.37	1.42	2.90	1.93	2.54

Key: mg/L = milligrams per liter

Table 3-258. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the High Flow Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.11	0.07	0.05	0.03	0.01	0.03	0.06	0.10	0.11	0.16	0.09	0.24
Maximum	0.21	0.20	0.17	0.14	0.13	0.16	0.18	0.15	0.16	0.24	0.15	0.34
Wet Water Years												
Average	0.05	0.02	0.02	0.02	0.01	0.01	0.02	0.07	0.08	0.14	0.08	0.30
Maximum	0.19	0.02	0.02	0.02	0.01	0.01	0.02	0.09	0.10	0.18	0.09	0.34
Critical Water Years												
Average	0.19	0.18	0.14	0.06	0.03	0.08	0.16	0.14	0.13	0.22	0.05	0.15
Maximum	0.21	0.20	0.17	0.14	0.13	0.16	0.18	0.14	0.14	0.24	0.11	0.15

Key: mg/L = milligrams per liter

Table 3-259. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the High Flow Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	34.42	21.76	14.35	5.11	3.05	7.06	27.98	53.61	63.29	74.23	37.34	34.32
Maximum	70.25	71.73	60.35	63.50	51.47	70.01	76.23	81.37	93.00	100.80	67.83	61.32
Wet Water Years												
Average	6.95	2.23	1.30	1.08	0.66	0.74	0.75	49.98	67.91	78.88	29.39	14.82
Maximum	28.90	2.23	1.30	1.08	0.66	0.74	1.31	59.05	93.00	100.80	36.18	26.96
Critical Water Years												
Average	62.58	63.44	50.31	16.50	9.32	28.64	72.15	58.81	60.09	84.11	27.08	59.65
Maximum	70.25	71.73	60.35	63.50	51.47	70.01	76.23	61.66	66.47	94.60	59.91	61.32

Key: mg/L = milligrams per liter

Relative Results

Relative changes in both surface water quantity and quality were determined by comparing the High Flow Alternative under Existing Conditions outputs to Existing Conditions outputs. When comparing the scenarios, differences in volumetric deliveries are due to the either the exchange of Millerton supply for existing program supply and/or the net increase of supply due to additional pump-back deliveries. Because reverse-flow pump-back facilities have increased capacity under the High Flow Alternative under Existing Conditions as compared to Existing Conditions, there is additional opportunity to increase or maximize direct delivery of existing program supply, and thus volumetric increases are seen in Wet water years and on average for all years for those supply sources.

Table 3-262 show the volumetric differences by source between the High Flow Alternative under Existing Conditions compared to Existing Conditions for an average of all years and by Wet and Critical water year types. Across all years, the overall average total supply delivered to Reach C increased by 31,124 AF in the High Flow Alternative under Existing Conditions compared to Existing Conditions. This increase is a result of increased delivery of existing programs supply due to increased pump-back facility capacities and exchanges of Millerton supply for additional pump-back supply.

Table 3-263 to Table 3-266 shows the differences in monthly average and monthly maximum water quality trends for individual constituents between the High Flow Alternative under Existing Conditions compared to the Existing Conditions. For TDS, nitrate, chloride, and boron, there is a correlation between additional reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-260. Average Monthly Change in Delivery (acre-feet) to Friant Contractors in Reach C by Source for an Average of All Years, High Flow Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-2,099	-1,806	-779	2,139	3,578	3,140	-622	-3,699	-1,099	-912	-247	-545	-2,951
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	5,031	3,789	3,075	657	381	1,429	5,282	6,793	1,950	1,522	1,013	3,152	34,075
Total Supply	2,933	1,983	2,296	2,796	3,960	4,568	4,660	3,094	852	610	766	2,607	31,124

Table 3-261. Average Monthly Change in Delivery (acre-feet) to Friant Contractors in Reach C by Source for Wet Water Year Types, High Flow Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-299	0	0	0	1,240	4,004	4,052	-3,491	-890	-964	-175	350	3,827
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	1,450	0	0	0	0	0	22	6,194	1,606	1,483	896	2,170	13,820
Total Supply	1,150	0	0	0	1,240	4,004	4,074	2,703	717	519	721	2,520	17,647

Table 3-262. Average Monthly Change in Delivery (acre-feet) to Friant Contractors in Reach C by Source for Critical Water Year Types, High Flow Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-3,498	-4,862	-5,587	2,083	3,480	-1,258	-5,619	-4,710	-1,275	-469	-136	-1,554	-23,405
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	5,895	8,113	10,480	2,987	1,732	6,495	10,077	7,793	2,054	706	342	3,577	60,251
Total Supply	2,397	3,251	4,892	5,070	5,212	5,236	4,459	3,082	779	237	206	2,023	36,845

Water Quality

Table 3-263. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the High Flow Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	118.51	70.30	36.84	3.79	1.12	14.58	74.63	151.05	180.66	184.69	114.89	127.23
Maximum	202.95	190.97	160.04	147.13	139.67	185.87	201.95	156.36	54.33	125.00	200.96	204.37
Wet Water Years												
Average	21.00	0.00	0.00	0.00	0.00	0.00	0.14	131.20	170.36	189.01	93.43	82.96
Maximum	88.92	0.00	0.00	0.00	0.00	0.00	2.32	92.74	54.33	97.80	115.73	160.97
Critical Water Years												
Average	214.21	204.28	140.65	21.44	8.88	70.77	197.56	167.97	198.52	177.81	78.67	202.25
Maximum	227.84	190.97	160.04	147.13	139.67	185.87	201.95	164.22	192.75	150.20	174.06	208.04

Key: mg/L = milligrams per liter

Table 3-264. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the High Flow Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	1.59	0.42	0.27	-0.04	-0.01	-0.03	0.11	0.61	1.43	1.59	1.31	1.59
Maximum	3.02	0.71	1.02	-0.28	0.25	-0.21	0.10	-0.10	-1.68	-0.48	2.09	2.22
Wet Water Years												
Average	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.55	1.40	1.98	1.07	1.14
Maximum	1.80	0.00	0.00	0.00	0.00	0.00	0.02	-0.10	-1.68	0.15	1.32	2.22
Critical Water Years												
Average	2.17	0.80	0.91	-0.15	-0.02	-0.09	0.15	0.41	1.11	0.22	0.75	2.31
Maximum	1.71	0.19	1.02	-0.28	0.25	-0.21	0.10	0.29	0.67	-1.13	1.66	2.38

Key: mg/L = milligrams per liter

Table 3-265. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the High Flow Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.09	0.06	0.03	0.00	0.00	0.01	0.05	0.08	0.09	0.11	0.08	0.02
Maximum	0.17	0.16	0.14	0.10	0.11	0.13	0.16	0.11	0.05	0.12	0.13	0.00
Wet Water Years												
Average	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.06	0.11	0.06	-0.04
Maximum	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.04	-0.01	0.06	0.08	0.00
Critical Water Years												
Average	0.17	0.15	0.12	0.02	0.01	0.05	0.15	0.13	0.11	0.13	0.04	0.13
Maximum	0.18	0.16	0.15	0.10	0.11	0.13	0.16	0.13	0.11	0.13	0.09	0.13

Key: mg/L = milligrams per liter

Table 3-266. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the High Flow Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	32.21	19.14	12.08	2.12	0.90	5.52	26.22	51.14	58.34	61.86	35.58	32.53
Maximum	54.47	64.73	54.88	56.36	45.99	65.67	71.66	60.70	20.00	37.80	65.63	59.42
Wet Water Years												
Average	4.04	0.00	0.00	0.00	0.00	0.00	0.03	46.53	59.65	66.80	27.43	12.92
Maximum	13.13	0.00	0.00	0.00	0.00	0.00	0.59	38.38	20.00	37.80	33.98	25.06
Critical Water Years												
Average	60.86	59.99	46.06	10.03	4.44	25.48	68.30	55.95	57.60	60.52	26.17	58.05
Maximum	66.32	64.73	54.88	56.36	45.99	65.67	71.66	57.56	56.06	54.89	57.89	59.72

Key: mg/L = milligrams per liter

Reach D

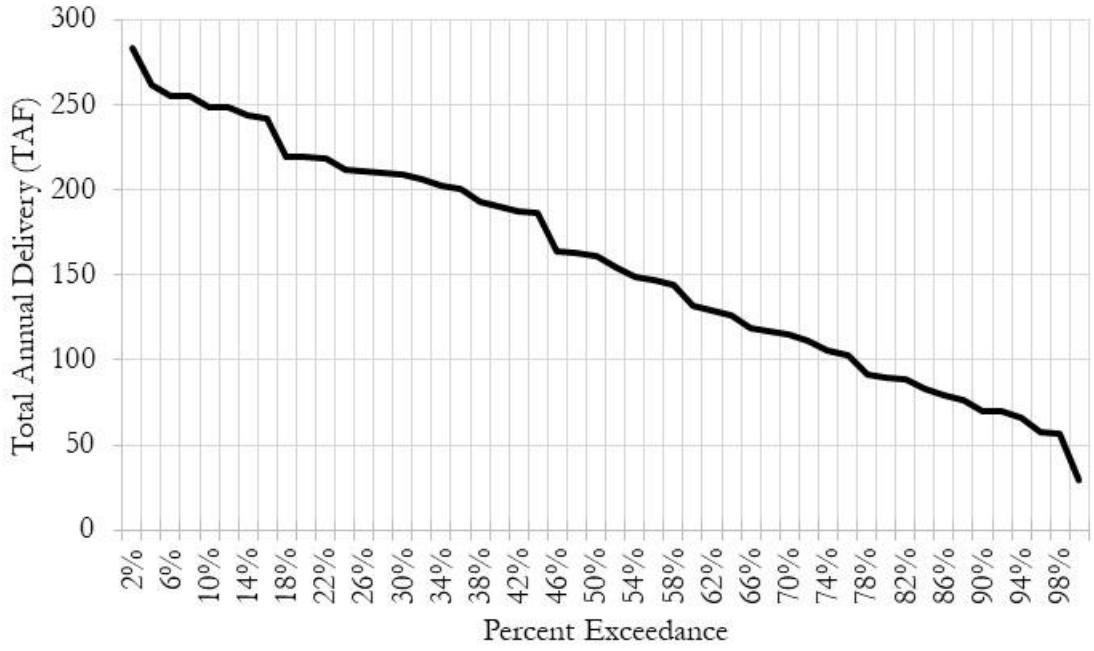
This section summarizes the total water supply delivery and the total water quality to the Friant Contractors in Reach D. The Friant Contractors within Reach D include Saucelito Irrigation District, Terra Bella Irrigation District, Tea Pot Dome Water District, Pixley Irrigation District, Lower Tule River Irrigation District, and Porterville Irrigation District.

Water Supply

Under the High Flow Alternative under Existing Conditions, the Reach D Deer Creek check structure capacity is modeled as 250 cfs. The delivery to Friant Contractors in Reach D is composed of Millerton supply and FKC groundwater pump-in program supply. Figure 3-110 shows the percent exceedance of total annual delivery to the Friant Contractors in Reach D under the High Flow Alternative under Existing Conditions. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach D and not at the Intertie.

Table 3-267 summarizes the average total annual delivery to the Friant Contractors in Reach D for an average of all years and by San Joaquin Valley Water Year Type under the High Flow Alternative under Existing Conditions. In this table, existing programs include the water delivered from FKC groundwater pump-in programs. Across all years, the total average delivery is 158 TAF with less than 1 percent from FKC groundwater pump-in supply (total mitigation is less than 1 percent of total delivery). For an average Wet water year, the total delivery is 219 TAF all from Millerton supply. For an average Critical water year, the total delivery is 74 TAF with 1 percent from FKC groundwater pump-in supply (total mitigation is less than 1 percent of total delivery).

Table 3-268 to Table 3-270 and Figure 3-111 summarizes the average monthly delivery to Friant Contractors in Reach D by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-110. Probability of Exceedance for Total Annual Delivery (thousand acre-feet) to Friant Contractors in Reach D for the High Flow Alternative under Existing Conditions

Table 3-267. Average Annual Delivery (thousand acre-feet) to Friant Contractors in Reach D by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the High Flow Alternative under Existing Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	158	219	211	137	124	73
Existing Programs	<1	0	0	0	<1	<1
Additional Pump-Back Supply	0	0	0	0	0	0
Total Supply	158	219	211	137	125	74

Table 3-268. Average Monthly Delivery (acre-feet) to Friant Contractors in Reach D by Source for the High Flow Alternative under Existing Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	8,762	13,494	20,157	27,635	28,199	24,564	13,736	6,195	1,856	1,521	3,053	8,654	157,827
Existing Programs	0	0	48	48	48	48	48	48	0	0	0	0	291
Additional Pump-Back Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Supply	8,762	13,494	20,205	27,684	28,248	24,612	13,784	6,243	1,856	1,521	3,053	8,654	158,118

Table 3-269. Average Monthly Delivery (acre-feet) to Friant Contractors in Reach D by Source for the High Flow Alternative under Existing Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	12,243	19,796	30,858	39,888	37,779	34,988	21,078	5,875	1,845	955	2,789	10,483	218,578
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Supply	12,243	19,796	30,858	39,888	37,779	34,988	21,078	5,875	1,845	955	2,789	10,483	218,578

Table 3-270. Average Monthly Delivery (acre-feet) to Friant Contractors in Reach D by Source for the High Flow Alternative under Existing Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	3,248	4,389	7,497	13,879	16,829	11,708	5,965	4,178	1,049	318	319	3,723	73,102
Existing Programs	0	0	135	135	135	135	135	98	0	0	0	0	771
Additional Pump-Back Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Supply	3,248	4,389	7,632	14,013	16,964	11,843	6,100	4,276	1,049	318	319	3,723	73,872

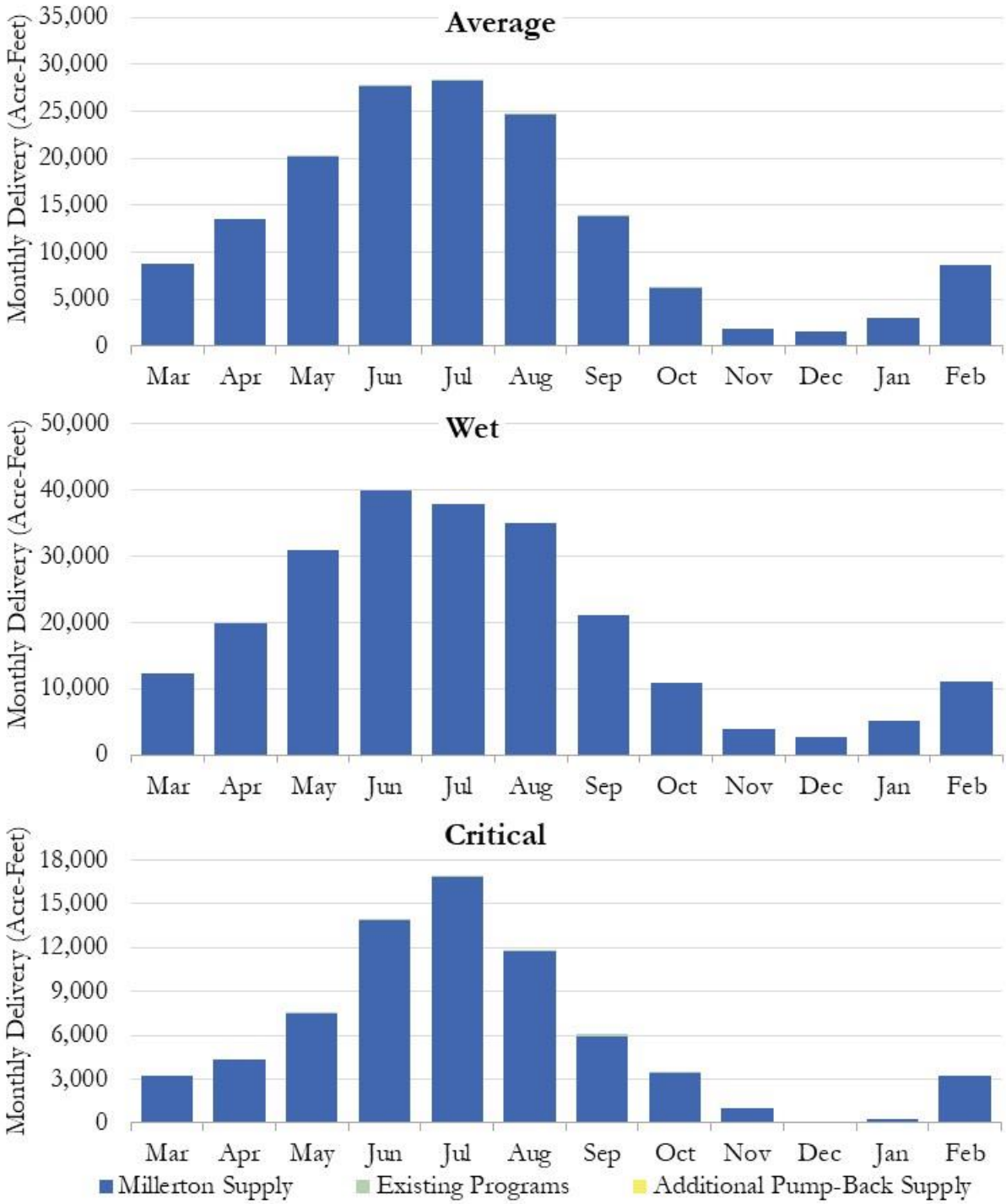


Figure 3-111. Average Monthly Delivery (acre-feet) to Friant Contractors in Reach D by Source for the High Flow Alternative under Existing Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach D deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-271 to Table 3-274 show the monthly average and monthly maximum water quality trends for individual constituents for the High Flow Alternative under Existing Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is FKC groundwater pump-in program supply being delivered, water quality concentrations tend to increase. For TDS, nitrate, chloride, and boron, the concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-271. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the High Flow Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	24.57	27.46	23.22	35.20	25.11	18.65	15.02	15.25	18.88	23.54	24.69	24.35
Maximum	25.00	28.00	26.83	60.66	46.77	27.50	18.78	16.50	20.00	29.00	31.60	25.67
Wet Water Years												
Average	24.33	28.00	21.33	21.00	13.00	13.75	13.00	16.15	18.89	25.78	26.22	25.67
Maximum	24.33	28.00	21.33	21.00	13.00	13.75	13.00	16.50	20.00	29.00	29.50	25.67
Critical Water Years												
Average	25.00	26.50	26.44	60.36	46.60	27.29	18.55	13.30	18.00	12.73	14.36	22.00
Maximum	25.00	26.50	26.72	60.57	46.70	27.46	18.73	13.67	18.00	28.00	31.60	22.00

Key: mg/L = milligrams per liter

Table 3-272. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the High Flow Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.15	0.46	0.11	0.89	0.44	0.24	0.17	0.22	0.08	0.15	1.11	0.50
Maximum	0.18	1.00	0.50	2.38	1.21	0.71	0.49	0.77	0.09	0.20	1.80	0.70
Wet Water Years												
Average	0.18	0.16	0.03	0.08	0.04	0.09	0.08	0.27	0.07	0.18	1.60	0.70
Maximum	0.18	0.16	0.03	0.08	0.04	0.09	0.08	0.77	0.08	0.20	1.80	0.70
Critical Water Years												
Average	0.10	1.00	0.28	2.33	1.15	0.53	0.38	0.29	0.09	0.06	0.12	0.17
Maximum	0.10	1.00	0.50	2.38	1.21	0.71	0.49	0.47	0.09	0.13	0.27	0.17

Key: mg/L = milligrams per liter

Table 3-273. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the High Flow Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.23
Maximum	0.02	0.02	0.02	0.04	0.02	0.03	0.02	0.03	0.01	0.05	0.02	0.34
Wet Water Years												
Average	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.03	0.01	0.02	0.01	0.34
Maximum	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.03	0.01	0.02	0.02	0.34
Critical Water Years												
Average	0.02	0.02	0.01	0.04	0.02	0.03	0.01	0.01	0.01	0.02	0.01	0.02
Maximum	0.02	0.02	0.02	0.04	0.02	0.03	0.01	0.01	0.01	0.05	0.02	0.02

Key: mg/L = milligrams per liter

Table 3-274. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the High Flow Alternative under Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	1.88	2.55	1.79	2.74	1.94	1.23	1.17	1.13	1.52	2.25	1.76	1.79
Maximum	2.10	3.10	2.68	5.72	4.23	2.12	1.98	1.27	1.75	3.05	2.20	1.90
Wet Water Years												
Average	2.10	2.23	1.30	1.08	0.66	0.74	0.72	1.24	1.65	2.71	1.96	1.90
Maximum	2.10	2.23	1.30	1.08	0.66	0.74	0.72	1.27	1.75	3.05	2.20	1.90
Critical Water Years												
Average	1.50	3.10	2.64	5.69	4.21	2.10	1.95	0.91	1.20	0.91	0.92	1.60
Maximum	1.50	3.10	2.67	5.71	4.22	2.12	1.97	0.94	1.20	2.01	2.02	1.60

Key: mg/L = milligrams per liter

Relative Results

Relative changes in both surface water quantity and quality were determined by comparing the High Flow Alternative under Existing Conditions outputs to Existing Conditions outputs. When comparing the scenarios, differences in volumetric deliveries are due to increased delivery of Millerton supply in exchange of existing program supply. Because reverse-flow pump-back facilities have increased capacity under the High Flow Alternative under Existing Conditions as compared to Existing Conditions, there is additional opportunity to increase or maximize direct delivery of existing program supply, and thus volumetric increases are seen in Wet water years and on average for all years for those supply sources.

Table 3-277 show the volumetric differences by source between the High Flow Alternative under Existing Conditions compared to Existing Conditions for an average of all years and by Wet and Critical water year types. Across all years, the overall average total supply delivered to Reach D increased by 18,583 AF in the High Flow Alternative under Existing Conditions compared to Existing Conditions. This increase is a result of increased pump-back facility capacities which results in increased exchanges of existing program supply for Millerton supply.

Table 3-278 to Table 3-281 shows the differences in monthly average and monthly maximum water quality trends for individual constituents between the High Flow Alternative under Existing Conditions compared to the Existing Conditions. For TDS, nitrate, chloride, and boron, there are minor differences in water quality due to the source of supply being mainly Millerton Supply in both scenarios.

Water Supply

Table 3-275. Average Monthly Change in Delivery (acre-feet) to Friant Contractors in Reach D by Source for an Average of All Years, High Flow Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	1,657	954	1,133	1,416	2,053	2,830	2,691	1,678	553	469	899	2,250	18,583
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Supply	1,657	954	1,133	1,416	2,053	2,830	2,691	1,678	553	469	899	2,250	18,583

Table 3-276. Average Monthly Change in Delivery (acre-feet) to Friant Contractors in Reach D by Source for Wet Water Year Types, High Flow Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	866	0	0	0	692	3,027	3,038	1,507	530	303	832	2,554	13,346
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Supply	866	0	0	0	692	3,027	3,038	1,507	530	303	832	2,554	13,346

Table 3-277. Average Monthly Change in Delivery (acre-feet) to Friant Contractors in Reach D by Source for Critical Water Year Types, High Flow Alternative under Existing Conditions compared to Existing Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	1,047	1,414	2,222	2,547	2,685	2,546	1,873	1,334	336	101	102	1,174	17,382
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Supply	1,047	1,414	2,222	2,547	2,685	2,546	1,873	1,334	336	101	102	1,174	17,382

Water Quality

Table 3-278. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the High Flow Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.00	0.00	-2.62	-1.26	-1.04	-1.65	-3.29	-7.01	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-21.85	-8.73	-7.14	-17.12	-17.71	-38.59	0.00	0.00	0.00	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-9.64	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-38.59	0.00	0.00	0.00	0.00
Critical Water Years												
Average	0.00	0.00	-9.46	-4.15	-3.33	-5.79	-11.01	-12.49	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-21.97	-8.82	-7.21	-17.16	-17.76	-22.69	0.00	0.00	0.00	0.00

Key: mg/L = milligrams per liter

Table 3-279. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the High Flow Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.00	0.00	-0.03	-0.01	-0.01	-0.02	-0.04	-0.08	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-0.27	-0.10	-0.09	-0.21	-0.21	-0.45	0.00	0.00	0.00	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.11	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.45	0.00	0.00	0.00	0.00
Critical Water Years												
Average	0.00	0.00	-0.11	-0.03	-0.03	-0.06	-0.13	-0.14	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-0.27	-0.10	-0.09	-0.21	-0.21	-0.27	0.00	0.00	0.00	0.00

Key: mg/L = milligrams per liter

Table 3-280. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the High Flow Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Critical Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key: mg/L = milligrams per liter

Table 3-281. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the High Flow Alternative under Existing Conditions Relative to Existing Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.00	0.00	-0.24	-0.11	-0.09	-0.15	-0.29	-0.63	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-1.95	-0.78	-0.64	-1.56	-1.58	-3.50	0.00	0.00	0.00	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.87	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-3.50	0.00	0.00	0.00	0.00
Critical Water Years												
Average	0.00	0.00	-0.85	-0.37	-0.30	-0.52	-0.99	-1.13	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-1.96	-0.79	-0.65	-1.56	-1.59	-2.06	0.00	0.00	0.00	0.00

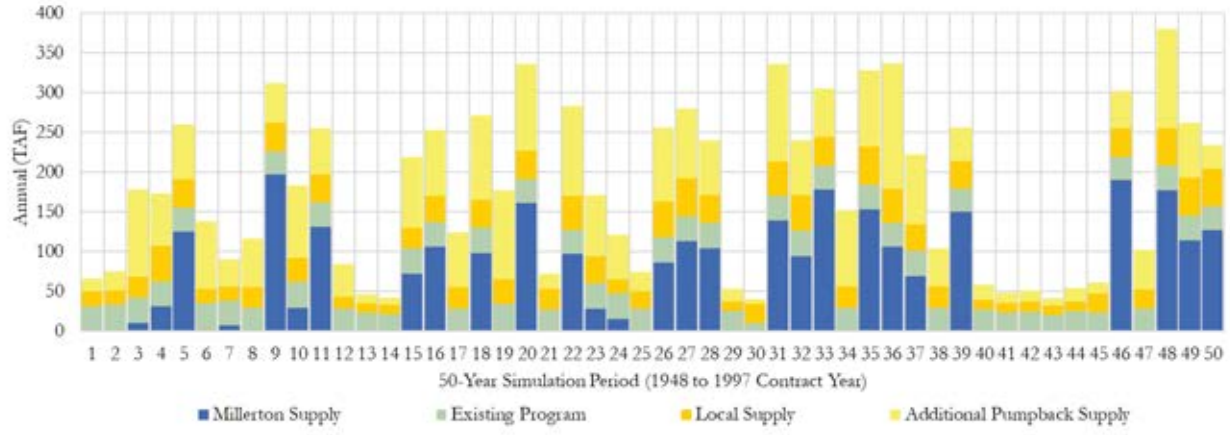
Key: mg/L = milligrams per liter

Total Surface Water Delivery to Friant Contractors

This section summarizes the annual total surface water delivery to the Friant Contractors in the study area under the High Flow Alternative under Existing Conditions. The Distribution Module simulates the delivery of Millerton supply and exiting program supply. The local supplies are added to the individual Friant Contractors after the Distribution Module deliveries. Local supplies were considered in this analysis for several Friant Contractors. AEWSD receives deliveries from the Kern River and directly from the California Aqueduct. Porterville ID, LTRID, and TBID all receive deliveries from the Tule River.

Arvin-Edison Water Storage District

Figure 3-112 the total annual surface water delivery to AEWSD in the High Flow Alternative under Existing Conditions. AEWSD receives local sources of water supply directly from the Kern River and directly from the California Aqueduct.

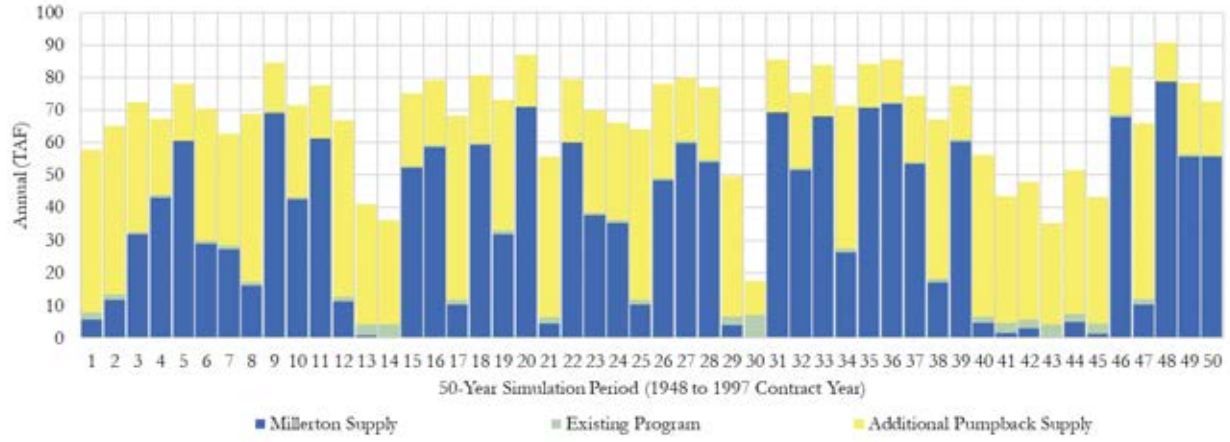


Key: TAF = thousand acre-feet

Figure 3-112. Total Annual Surface Water Delivery (thousand acre-feet) to Arvin-Edison Water Storage District for the High Flow Alternative under Existing Conditions

Shafter-Wasco Irrigation District

Figure 3-113 summarizes the total annual surface water delivery to SWID in the High Flow Alternative under Existing Conditions.

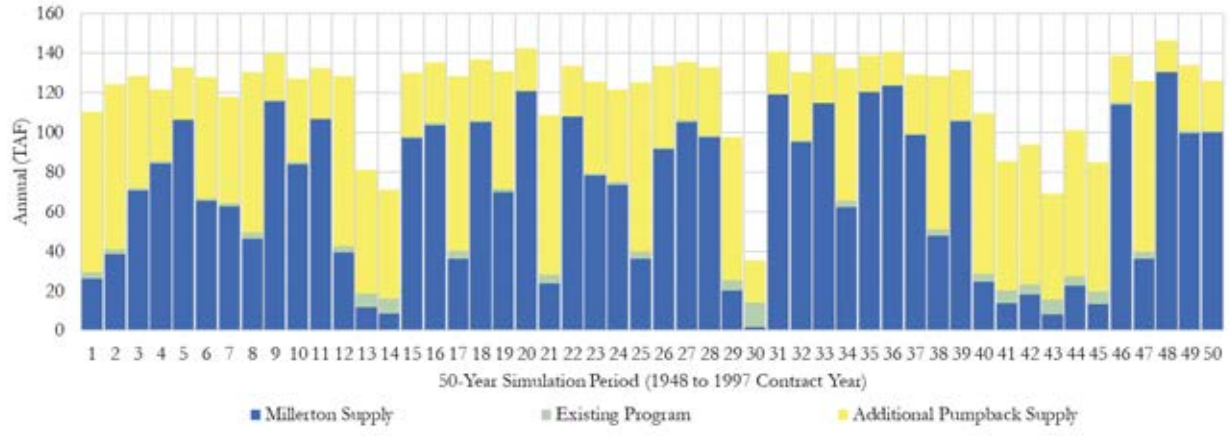


Key: TAF = thousand acre-feet

Figure 3-113. Total Annual Surface Water Delivery (thousand acre-feet) to Shafter-Wasco Irrigation District for the High Flow Alternative under Existing Conditions

Southern San Joaquin Municipal Utility District

Figure 3-114 summarizes the total annual surface water delivery to SSJMUD in the High Flow Alternative under Existing Conditions.

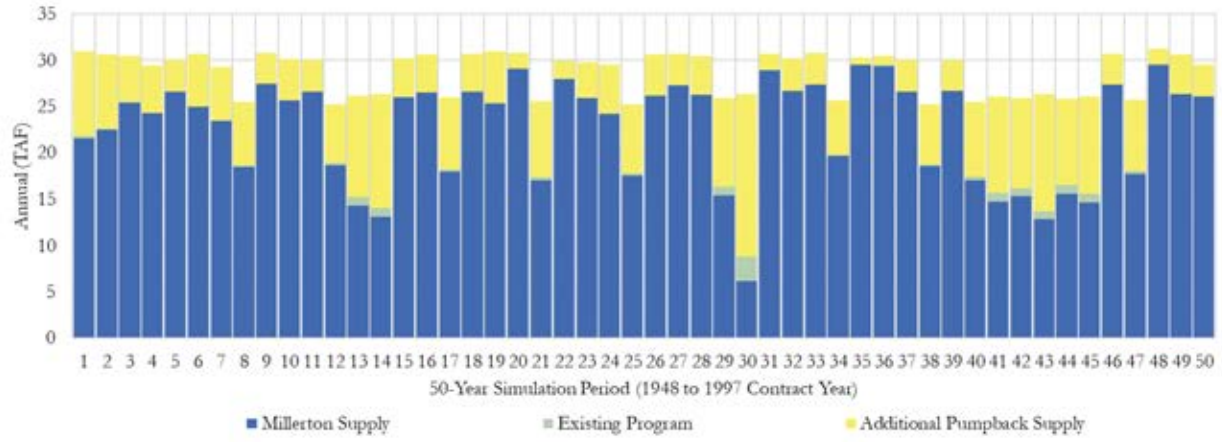


Key: TAF = thousand acre-feet

Figure 3-114. Total Annual Surface Water Delivery (thousand acre-feet) to Southern San Joaquin Municipal Utility District for the High Flow Alternative under Existing Conditions

Kern-Tulare Water District

Figure 3-115 summarizes the total annual surface water delivery to KTWD in the High Flow Alternative under Existing Conditions.

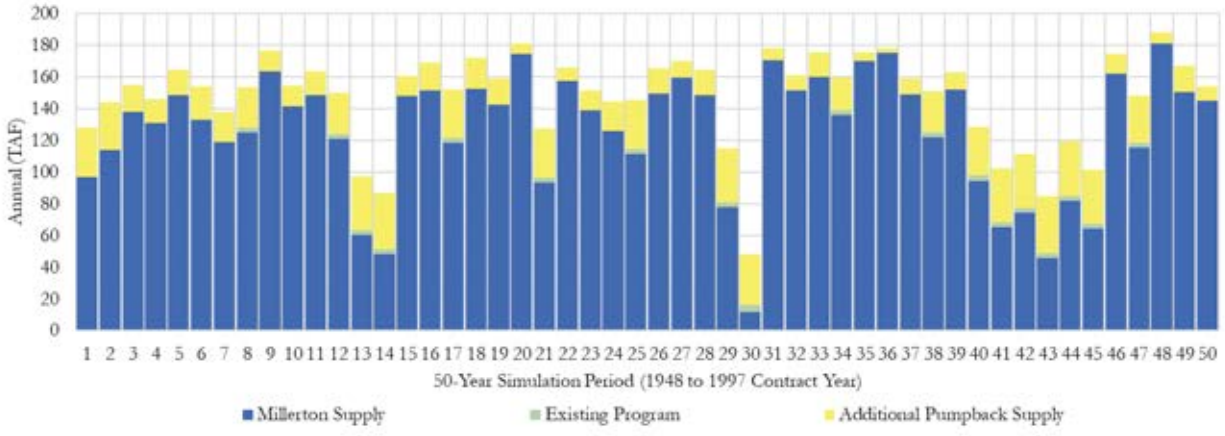


Key: TAF = thousand acre-feet

Figure 3-115. Total Annual Surface Water Delivery (thousand acre-feet) to Kern-Tulare Water District for the High Flow Alternative under Existing Conditions

Delano-Earlimart Irrigation District

Figure 3-116 summarizes the total annual surface water delivery to DEID in the High Flow Alternative under Existing Conditions.

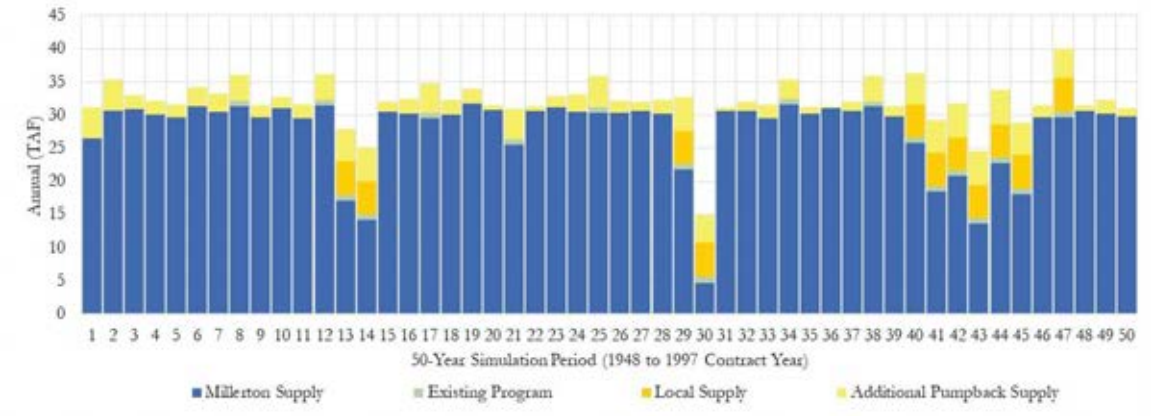


Key: TAF = thousand acre-feet

Figure 3-116. Total Annual Surface Water Delivery (thousand acre-feet) to Delano-Earlimart Irrigation District for the High Flow Alternative under Existing Conditions

Terra Bella Irrigation District

Figure 3-117 summarizes the total annual surface water delivery to TBID in the High Flow Alternative under Existing Conditions. TBID receives local sources of water supply directly from the Tule River.

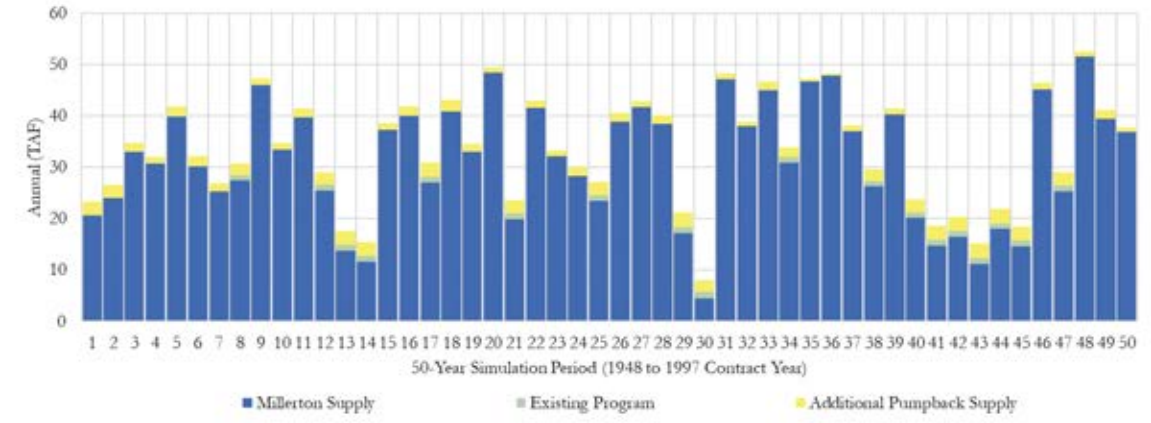


Key: TAF = thousand acre-feet

Figure 3-117. Total Annual Surface Water Delivery (thousand acre-feet) to Terra Bella Irrigation District for the High Flow Alternative under Existing Conditions

Saucelito Irrigation District

Figure 3-118 summarizes the total annual surface water delivery to Saucelito ID in the High Flow Alternative under Existing Conditions.



Key: TAF = thousand acre-feet

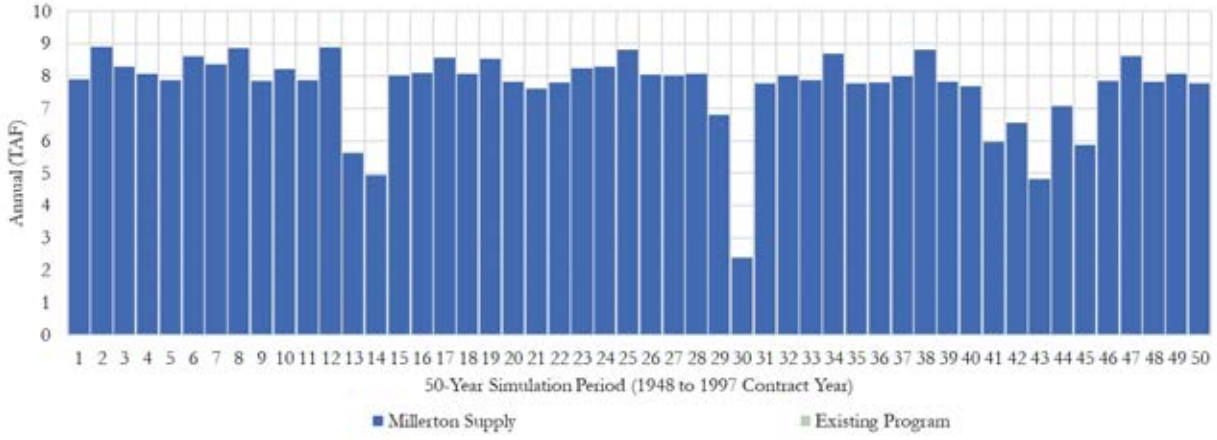
Figure 3-118. Total Annual Surface Water Delivery (thousand acre-feet) to Saucelito Irrigation District for the High Flow Alternative under Existing Conditions

Pixley Irrigation District

In the High Flow Alternative under Existing Conditions, Pixley ID does receive mitigation supply from existing programs supply. However, this supply is very small (less than 100 AF) and only occurs in Dry and Critical water year types.

Tea Pot Dome Water District

Figure 3-119 summarizes the total annual surface water delivery to TPDWD in the High Flow Alternative under Existing Conditions.

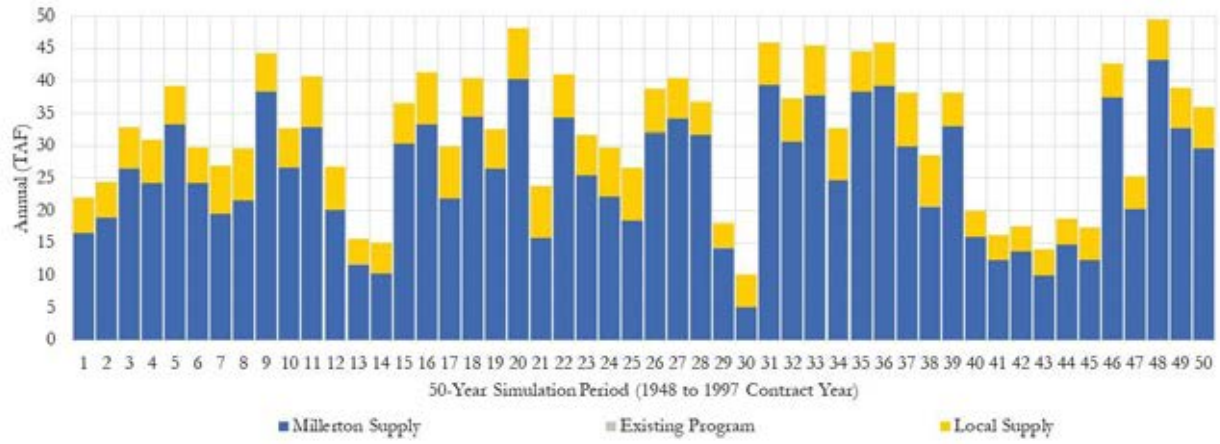


Key: TAF = thousand acre-feet

Figure 3-119. Total Annual Surface Water Delivery (thousand acre-feet) to Tea Pot Dome Water District for the High Flow Alternative under Existing Conditions

Porterville Irrigation District

Figure 3-120 summarizes the total annual surface water delivery to Porterville ID in the High Flow Alternative under Existing Conditions. Porterville ID receives local sources of water supply directly from the Tule River.

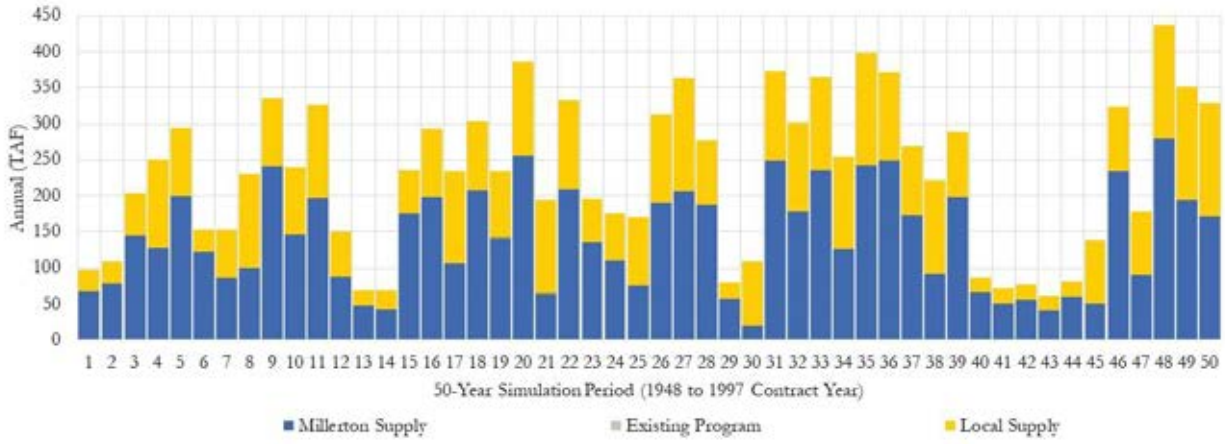


Key: TAF = thousand acre-feet

Figure 3-120. Total Annual Surface Water Delivery (thousand acre-feet) to Porterville Irrigation District for the High Flow Alternative under Existing Conditions

Lower Tule River Irrigation District

Figure 3-121 summarizes the total annual surface water delivery to LTRID in the High Flow Alternative under Existing Conditions. LTRID receives local sources of water supply directly from the Tule River.



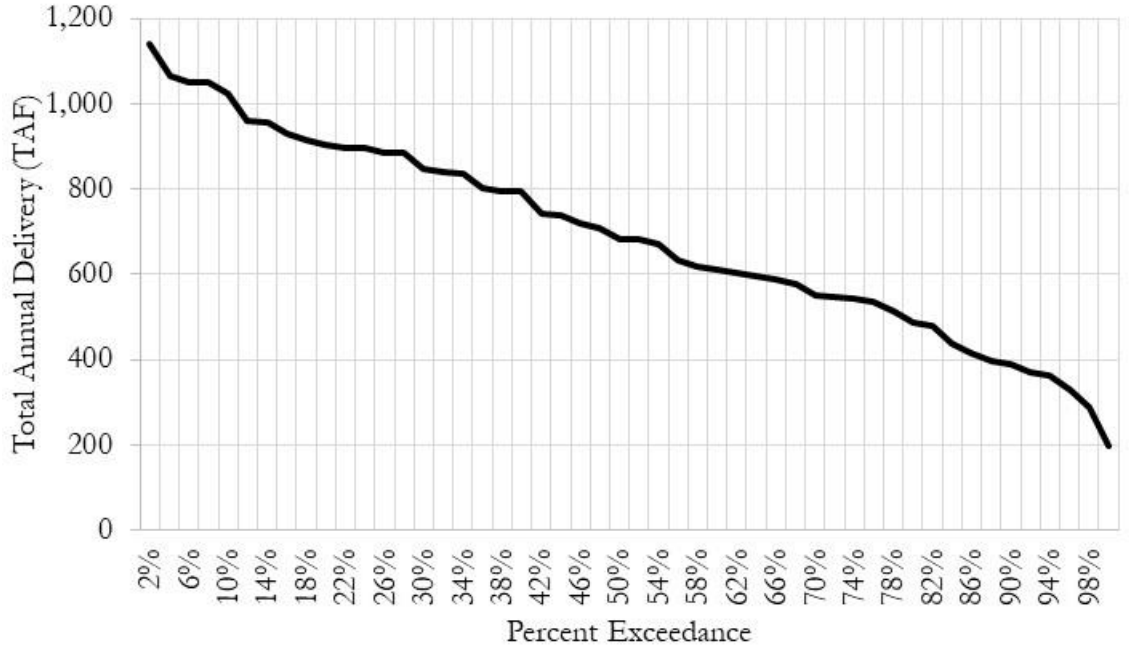
Key: TAF = thousand acre-feet

Figure 3-121. Total Annual Surface Water Delivery (thousand acre-feet) to Lower Tule River Irrigation District for the High Flow Alternative under Existing Conditions

3.2.4.2 High Flow Alternative under Future Conditions

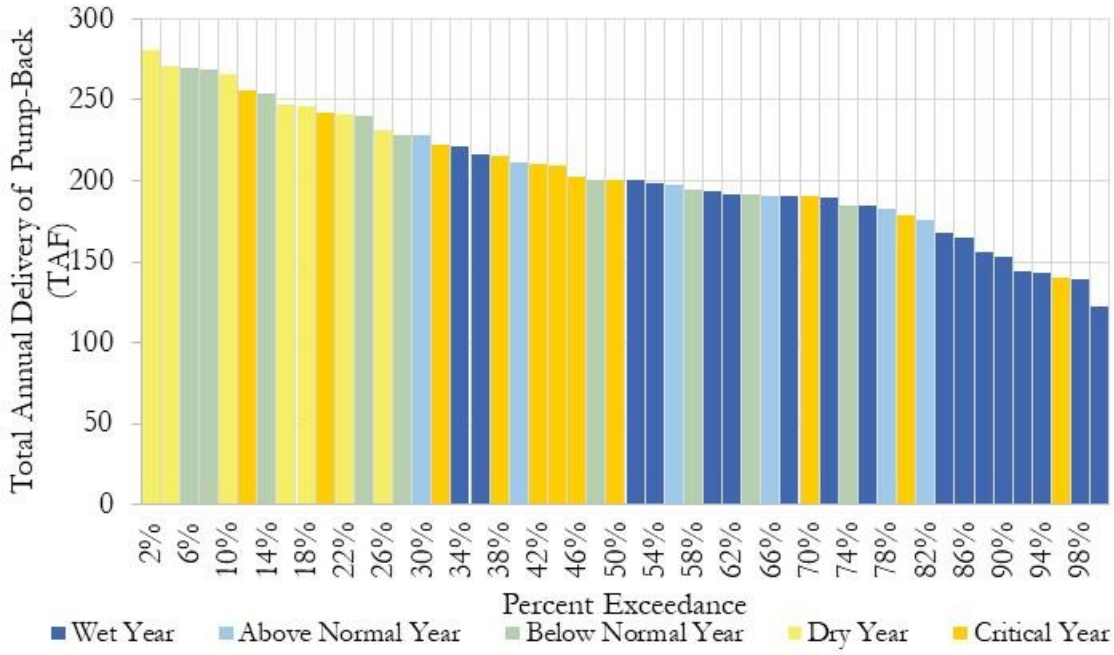
Figure 3-122 shows the probability of exceedance of total annual delivery to Friant Contractors in the Project reach under the High Flow Alternative under Future Conditions. Figure 3-123 shows the probability of exceedance of total annual supply delivered to Friant Contractors in the Project Reach via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the High Flow Alternative under Future Conditions. These pump-back operational volumes represents all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supplies for KTWD, LTRID and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC at different locations along the Project reaches and not at the Intertie.

Table 3-282 summarizes the average total annual delivery to Friant Contractors in the study area by source for an average of all years and by San Joaquin Valley Water Year Type under the High Flow Alternative under Future Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the average total delivery is 691 TAF with 30 percent from existing programs and additional pump-back supply. For an average Wet water year, the total delivery is 883 TAF with 17 percent from existing programs and additional pump-back supply. For an average Critical water year, the total delivery is 398 TAF with 55 percent from existing programs and additional pump-back supply.



Key: TAF = thousand acre-feet

Figure 3-122. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to Friant Contractors in the Study Area for the High Flow Alternative under Future Conditions



Key: TAF = thousand acre-feet

Figure 3-123. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to Friant Contractors in the Study Area by San Joaquin Valley Water Year Type for the High Flow Alternative under Future Conditions

Table 3-282. Average Annual Delivery (thousand acre-feet) to Friant Contractors in the Study Area by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the High Flow Alternative under Future Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	483	734	618	406	335	178
Existing Programs	78	76	92	93	69	65
Additional Pump-Back Supply	130	73	147	133	208	155
Total Supply	691	883	856	631	612	398

Location of Interface

Table 3-283 summarizes the average monthly location of the interface between the reverse-flow pump-back operations and gravity operations (i.e., Millerton supply) for an average of all years and by San Joaquin Valley Water Year Type for the High Flow Alternative under Future Conditions. During peak irrigation season supply is delivered via reverse-flow pump-back operations and exchanged to meet irrigation demand in Reach A. As the water year type becomes drier and thus CVP surface water allocation is less, supply delivered via reverse-flow pump-back is delivered further up the canal to meet irrigation demand. In addition, because there is reduced irrigation demand in the shoulder months of the irrigation season (October to March), supply delivered via reverse-flow pump-back is pushed further up the canal as less water is exchanged in the lower Project reaches and the available supply is distributed to more Friant Contractors.

Table 3-283. Average Monthly Reach Location of Pump-Back Interface for an Average of All Years and by San Joaquin Valley Water Year Type for the High Flow Alternative under Future Conditions

Year Type	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Wet	C	A	A	A	B	B	C	D	C	C	C	C
Above Normal	C	A	A	B	B	B	C	D	C	C	C	C
Below Normal	C	C	C	B	B	C	D	D	C	C	C	C
Dry	C	C	C	B	B	C	C	D	C	C	C	C
Critical	C	C	C	C	C	D	D	D	C	C	C	C
Average	C	C	C	B	B	C	D	D	C	C	C	C

Notes:
Year Type is based on San Joaquin Valley Water Year Types
Reach A is the Intertie to Shafter-Wasco Check
Reach B is from Shafter-Wasco Check to Lake Woollomes Check
Reach C is from Lake Woollomes Check to Deer Creek Check

Reach A

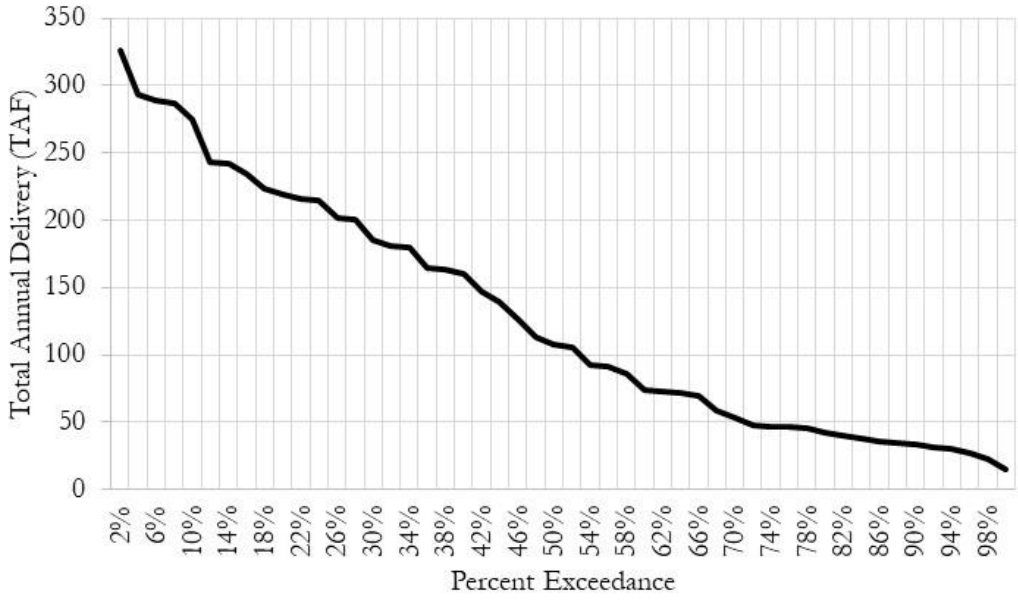
This section summarizes the total water supply delivery and the total water quality to the Reach A contractor. The only Friant Contractor within Reach A is AEWSD.

Water Supply

Figure 3-124 shows the probability of exceedance of total annual delivery to the Friant Contractor in Reach A under the High Flow Alternative under Future Conditions. Figure 3-125 shows the probability of exceedance of total annual supply delivered to the Friant Contractor in Reach A via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the High Flow Alternative under Future Conditions. This volume represents all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. There are no FKC groundwater pump-in program deliveries in Reach A.

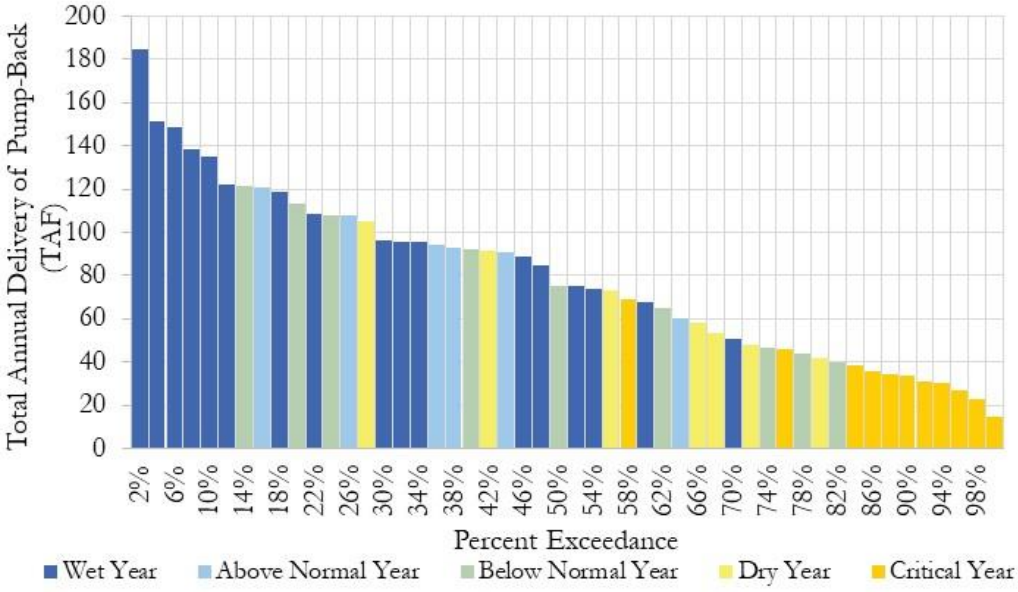
Table 3-284 summarizes the average total annual delivery to the Friant Contractor in Reach A by source for an average of all years and by San Joaquin Valley Water Year Type under the High Flow Alternative under Future Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs). Across all years, the average total delivery is 129 TAF with 61 percent from existing programs and additional pump-back supply (total mitigation is 4 percent of total delivery). For an average Wet water year, the total delivery is 218 TAF with 43 percent from existing programs and additional pump-back supply (total mitigation is 3 percent of total delivery). For an average Critical water year, the total delivery is 35 TAF all from existing programs and additional pump-back supply (total mitigation is 6 percent of total delivery).

Table 3-285 to Table 3-287 and Figure 3-126 summarize the average monthly delivery to the Friant Contractors in Reach A by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-124. Probability of Exceedance for Total Annual Delivery (thousand acre-feet) to the Friant Contractor in Reach A for the High Flow Alternative under Future Conditions



Key: TAF = thousand acre-feet

Figure 3-125. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to the Friant Contractor in Reach A by San Joaquin Valley Water Year Type for the High Flow Alternative under Future Conditions

Table 3-284. Average Annual Delivery (thousand acre-feet) to the Friant Contractor in Reach A by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the High Flow Alternative under Future Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	50	125	47	9	0	0
Existing Programs	48	61	68	48	40	24
Additional Pump-Back Supply	31	33	69	26	31	11
Total Supply	129	218	184	82	71	35

Table 3-285. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source for the High Flow Alternative under Future Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	3,215	8,033	13,525	15,773	8,424	649	35	0	0	0	0	0	49,654
Existing Programs	1,446	1,939	3,296	4,677	10,469	13,421	8,134	3,711	432	341	0	400	48,268
Additional Pump-Back Supply	3,084	740	1,340	2,784	1,283	3,284	1,461	1,007	1,463	1,442	4,092	9,002	30,982
Total Supply	7,746	10,712	18,162	23,234	20,175	17,355	9,630	4,719	1,895	1,783	4,092	9,402	128,903

Table 3-286. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source for the High Flow Alternative under Future Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	9,455	17,867	31,829	38,685	24,755	1,909	102	0	0	0	0	0	124,601
Existing Programs	1,138	1,840	3,470	4,470	8,581	21,082	15,250	3,592	359	288	0	400	60,470
Additional Pump-Back Supply	3,153	0	0	0	1,082	7,453	2,588	1,257	1,750	614	3,746	10,933	32,574
Total Supply	13,746	19,707	35,299	43,155	34,418	30,443	17,940	4,849	2,109	902	3,746	11,333	217,646

Table 3-287. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source for the High Flow Alternative under Future Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	0	0	0	0	0	0	0	0	0	0	0	0	0
Existing Programs	1,024	1,387	2,325	4,304	6,480	4,121	1,931	1,614	409	124	0	400	24,119
Additional Pump-Back Supply	485	656	1,155	2,264	1,017	1,003	855	661	192	57	180	2,801	11,327
Total Supply	1,508	2,044	3,480	6,568	7,496	5,124	2,786	2,275	600	182	180	3,201	35,445

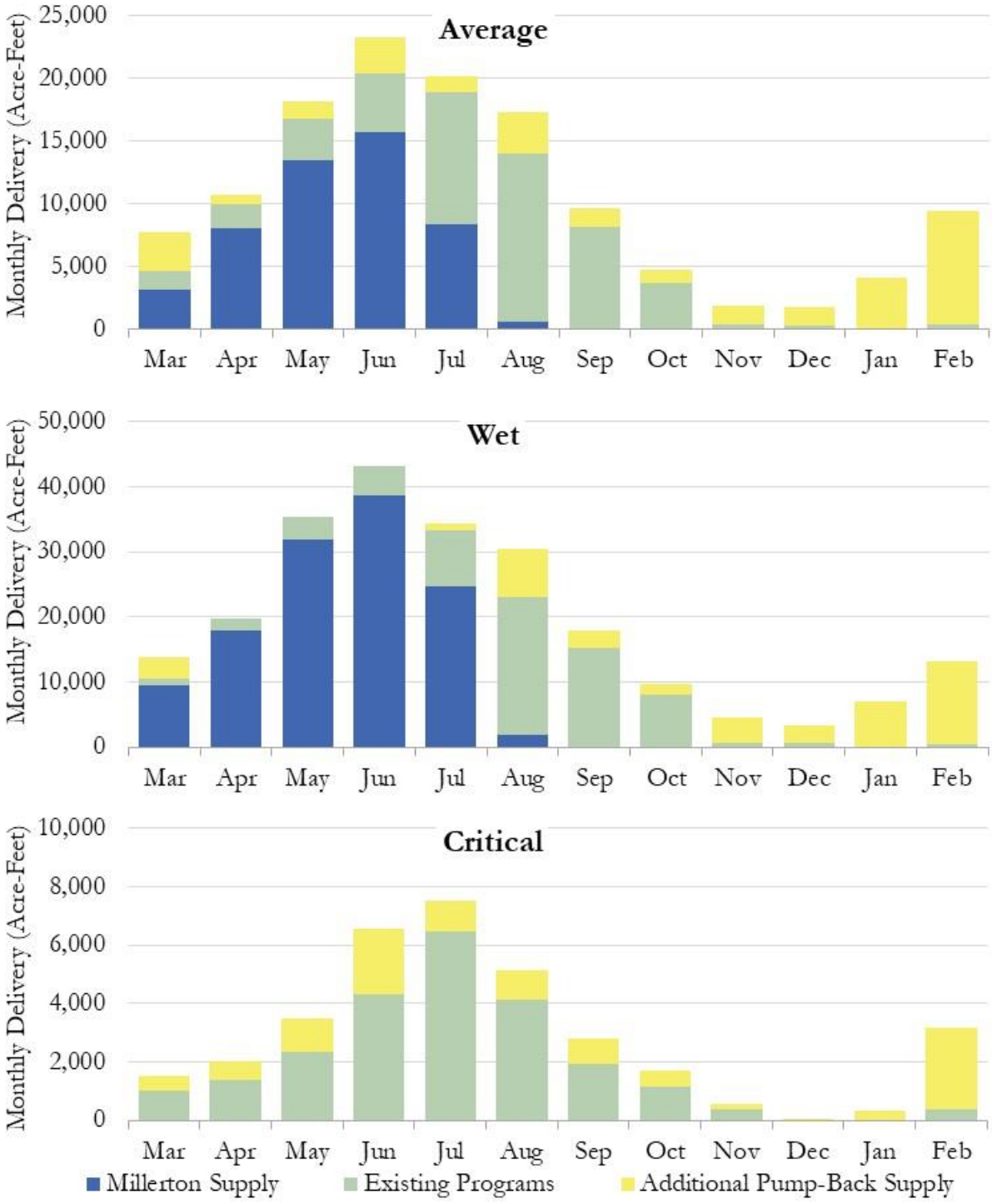


Figure 3-126. Average Monthly Delivery (acre-feet) to the Friant Contractor in Reach A by Source for the High Flow Alternative under Future Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach A deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-288 to Table 3-291 show the monthly average and monthly maximum water quality trends for individual constituents for the High Flow Alternative under Future Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply being delivered via reverse-flow pump-back operations (i.e., existing programs and additional pump-back supply), water quality concentrations tend to increase. For TDS, nitrate, chloride, and boron, there is a correlation between reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-288. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the High Flow Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	229.08	171.02	169.38	175.57	163.88	219.24	246.69	282.88	286.46	233.64	218.88	310.21
Maximum	333.80	321.20	327.50	304.60	272.00	322.60	368.00	340.50	314.50	335.00	378.50	366.20
Wet Water Years												
Average	100.26	53.15	38.41	32.88	57.89	168.01	171.49	260.20	281.00	256.50	190.33	285.80
Maximum	221.60	157.56	46.62	43.47	147.00	176.80	172.00	260.20	281.00	307.80	228.40	285.80
Critical Water Years												
Average	333.80	321.20	300.80	304.60	272.00	322.60	368.00	300.20	300.00	116.44	120.36	366.20
Maximum	333.80	321.20	300.80	304.60	272.00	322.60	368.00	300.20	300.00	320.20	331.00	366.20

Key: mg/L = milligrams per liter

Table 3-289. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the High Flow Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	3.15	1.52	1.40	1.36	1.36	0.99	1.08	1.32	2.39	2.47	3.25	4.16
Maximum	5.90	3.30	3.15	2.80	2.40	1.53	1.53	1.93	3.10	3.55	5.40	4.45
Wet Water Years												
Average	1.55	0.39	0.20	0.28	0.65	1.45	1.53	1.30	2.53	2.77	3.40	4.28
Maximum	3.73	1.37	0.28	0.45	1.85	1.53	1.53	1.30	2.53	3.33	4.08	4.28
Critical Water Years												
Average	3.32	2.24	2.02	1.62	1.68	0.48	0.80	1.04	1.76	1.05	1.13	4.10
Maximum	3.32	2.24	2.02	1.62	1.68	0.48	0.80	1.04	1.76	2.90	3.12	4.10

Key: mg/L = milligrams per liter

Table 3-290. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the High Flow Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.19	0.14	0.12	0.11	0.10	0.13	0.14	0.15	0.15	0.14	0.15	0.22
Maximum	0.28	0.26	0.22	0.20	0.18	0.20	0.25	0.20	0.20	0.24	0.25	0.25
Wet Water Years												
Average	0.12	0.05	0.03	0.03	0.04	0.12	0.13	0.10	0.10	0.15	0.13	0.22
Maximum	0.28	0.17	0.04	0.04	0.10	0.13	0.13	0.10	0.10	0.18	0.15	0.22
Critical Water Years												
Average	0.26	0.24	0.22	0.18	0.18	0.20	0.25	0.20	0.18	0.09	0.07	0.24
Maximum	0.26	0.24	0.22	0.18	0.18	0.20	0.25	0.20	0.18	0.24	0.18	0.24

Key: mg/L = milligrams per liter

Table 3-291. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the High Flow Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	56.32	39.59	43.92	46.78	38.97	60.34	72.76	86.63	87.90	72.07	61.70	70.92
Maximum	89.00	88.40	87.00	91.20	73.00	96.80	113.80	109.50	100.50	100.80	115.00	100.40
Wet Water Years												
Average	17.84	8.14	5.74	3.80	11.56	40.34	40.87	81.20	93.00	84.00	50.50	42.40
Maximum	43.00	32.66	7.87	6.22	33.20	42.60	41.00	81.20	93.00	100.80	60.60	42.40
Critical Water Years												
Average	89.00	88.40	84.80	91.20	73.00	96.80	113.80	88.40	83.00	34.40	36.95	100.40
Maximum	89.00	88.40	84.80	91.20	73.00	96.80	113.80	88.40	83.00	94.60	101.60	100.40

Key: mg/L = milligrams per liter

Relative Results

Relative changes in both surface water quantity and quality were determined by comparing the High Flow Alternative under Future Conditions outputs to the No Project Alternative outputs. When comparing the scenarios, differences in volumetric deliveries are due to the either the exchange of Millerton supply for existing program supply and/or the net increase of supply due to additional pump-back deliveries. Because reverse-flow pump-back facilities have increased capacity under the High Flow Alternative under Future Conditions as compared to the No Project Alternative, there is additional opportunity to increase or maximize direct delivery of existing program supply, and thus volumetric increases are seen in Wet water years and on average for all years for those supply sources.

Table 3-292 to Table 3-294 show the volumetric differences by source between the High Flow Alternative under Future Conditions compared to the No Project Alternative for an average of all years and by Wet and Critical water year types. Across all years, the average overall total supply delivered to Reach A increased by 13,441 AF in the High Flow Alternative under Future Conditions compared to the No Project Alternative. This increase is a result of increased delivery of existing programs supply due to increased pump-back facility capacities and exchanges of Millerton supply for additional pump-back supply.

Table 3-295 to Table 3-298 shows the differences in monthly average and monthly maximum water quality trends for individual constituents between the High Flow Alternative under Future Conditions compared to No Project Alternative. For TDS, nitrate, chloride, and boron, there is a correlation between additional reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-292. Average Monthly Change in Delivery (acre-feet) to the Friant Contractor in Reach A by Source for an Average of All Years, High Flow Alternative under Future Conditions compared to No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-2,098	-298	-751	-2,091	-5,564	-7,209	-3,366	-1,317	-850	-824	-2,693	-6,067	-33,126
Existing Programs	419	70	72	216	5,179	5,264	3,082	1,285	0	0	0	0	15,586
Additional Pump-Back Supply	3,084	740	1,340	2,784	1,283	3,284	1,461	1,007	1,463	1,442	4,092	9,002	30,982
Total Supply	1,406	512	661	909	898	1,339	1,177	975	613	617	1,399	2,935	13,441

Table 3-293. Average Monthly Change in Delivery (acre-feet) to the Friant Contractor in Reach A by Source for Wet Water Year Types, High Flow Alternative under Future Conditions compared to No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-2,275	0	0	0	-4,611	-16,203	-8,944	-1,667	-1,081	-302	-2,471	-7,409	-44,963
Existing Programs	282	0	0	0	3,942	10,651	8,043	1,418	0	0	0	0	24,336
Additional Pump-Back Supply	3,153	0	0	0	1,082	7,453	2,588	1,257	1,750	614	3,746	10,933	32,574
Total Supply	1,161	0	0	0	412	1,901	1,687	1,008	669	311	1,274	3,524	11,947

Table 3-294. Average Monthly Change in Delivery (acre-feet) to the Friant Contractor in Reach A by Source for Critical Water Year Types, High Flow Alternative under Future Conditions compared to No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	0	0	-108	-910	-388	-68	0	0	0	0	-113	-1,650	-3,238
Existing Programs	0	0	0	0	402	72	0	0	0	0	0	0	474
Additional Pump-Back Supply	485	657	1,155	2,264	1,017	1,003	855	661	192	58	180	2,801	11,327
Total Supply	485	657	1,047	1,353	1,030	1,007	855	661	192	58	67	1,151	8,562

Water Quality

Table 3-295. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the High Flow Alternative under Future Conditions Relative to No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	133.02	43.78	76.06	79.98	87.91	110.51	115.76	91.59	97.72	105.22	196.00	218.59
Maximum	132.89	82.87	126.59	114.60	122.00	152.60	183.00	110.50	87.83	125.00	346.90	3.93
Wet Water Years												
Average	45.36	-2.48	-1.68	-9.22	26.49	107.33	94.24	47.14	74.29	90.19	165.75	196.09
Maximum	20.69	-12.77	-2.49	-17.44	106.90	95.81	38.67	30.20	54.33	97.80	198.90	69.78
Critical Water Years												
Average	186.66	82.87	142.54	133.12	126.73	154.06	183.00	134.49	121.43	54.62	108.87	255.91
Maximum	186.66	82.87	139.13	114.60	122.00	152.60	183.00	134.49	121.43	150.20	299.40	191.26

Key: mg/L = milligrams per liter

Table 3-296. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the High Flow Alternative under Future Conditions Relative to No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.22	-0.58	-0.84	-0.49	-0.10	-0.94	-1.01	-1.47	-1.10	0.30	2.22	2.73
Maximum	-0.94	-1.43	-2.67	-1.54	-2.00	-3.45	-3.22	-1.18	-1.10	-0.48	3.60	0.67
Wet Water Years												
Average	0.97	-0.13	-0.09	-0.15	0.60	1.10	1.08	-1.58	-1.28	0.27	1.90	3.03
Maximum	1.27	-0.68	-0.13	-0.29	1.81	1.06	0.76	-1.82	-1.68	0.15	2.28	1.96
Critical Water Years												
Average	-3.52	-2.49	-3.65	-2.43	-2.57	-4.45	-3.96	-1.80	-1.64	-0.41	1.04	1.85
Maximum	-3.52	-2.49	-3.80	-2.72	-2.72	-4.50	-3.96	-1.80	-1.64	-1.13	2.85	0.32

Key: mg/L = milligrams per liter

Table 3-297. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the High Flow Alternative under Future Conditions Relative to No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.13	0.07	0.06	0.04	0.05	0.06	0.07	0.05	0.05	0.07	0.13	0.01
Maximum	0.17	0.14	0.10	0.07	0.06	0.09	0.14	0.09	0.09	0.12	0.23	-0.09
Wet Water Years												
Average	0.09	0.01	0.00	-0.01	0.01	0.08	0.08	0.00	0.00	0.06	0.11	-0.09
Maximum	0.17	0.07	0.01	-0.01	0.07	0.07	0.06	-0.01	-0.01	0.06	0.14	-0.12
Critical Water Years												
Average	0.15	0.12	0.11	0.06	0.07	0.09	0.14	0.11	0.07	0.05	0.06	0.16
Maximum	0.15	0.12	0.10	0.05	0.06	0.09	0.14	0.11	0.07	0.13	0.16	0.12

Key: mg/L = milligrams per liter

Table 3-298. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractor in Reach A for the High Flow Alternative under Future Conditions Relative to No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	37.88	21.47	24.30	27.34	23.53	34.62	37.67	23.65	31.19	36.39	60.06	46.57
Maximum	27.05	26.45	25.05	49.49	40.71	57.13	65.30	26.17	27.50	37.80	112.80	-29.09
Wet Water Years												
Average	5.38	-3.64	-1.90	-3.08	6.22	26.42	20.45	4.38	26.88	34.38	48.67	16.23
Maximum	-18.95	-18.73	-2.81	-5.83	25.64	22.97	3.38	-2.13	20.00	37.80	58.40	-31.65
Critical Water Years												
Average	67.43	67.40	55.65	54.65	42.00	57.52	65.30	45.54	36.00	19.96	36.21	76.48
Maximum	67.43	67.40	54.97	49.49	40.71	57.13	65.30	45.54	36.00	54.89	99.58	60.14

Key: mg/L = milligrams per liter

Reach B

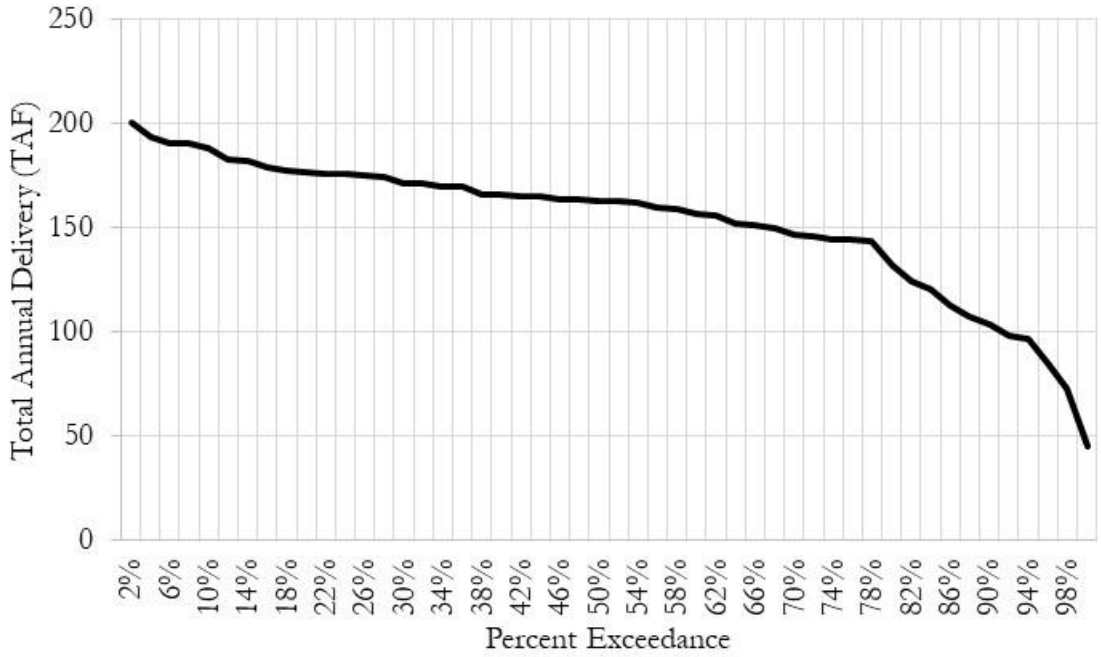
This section summarizes the total water supply delivery and the total water quality to Friant Contractors in Reach B. The Friant Contractors within Reach B include Shafter-Wasco Irrigation District and South San Joaquin Municipal Utility District.

Water Supply

For the High Flow Alternative under Future Conditions, the Reach B Shafter-Wasco check structure capacity is assumed to be 500 cfs. Figure 3-127 shows the probability of exceedance of total annual delivery to Friant Contractors in Reach B under the High Flow Alternative under Future Conditions. Figure 3-128 shows the probability of exceedance of total annual supply delivered to Friant Contractors in Reach B via reverse-flow pump back operations by San Joaquin Valley Water Year Type under the High Flow Alternative under Future Conditions. These volumes represent all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach B and not at the Intertie.

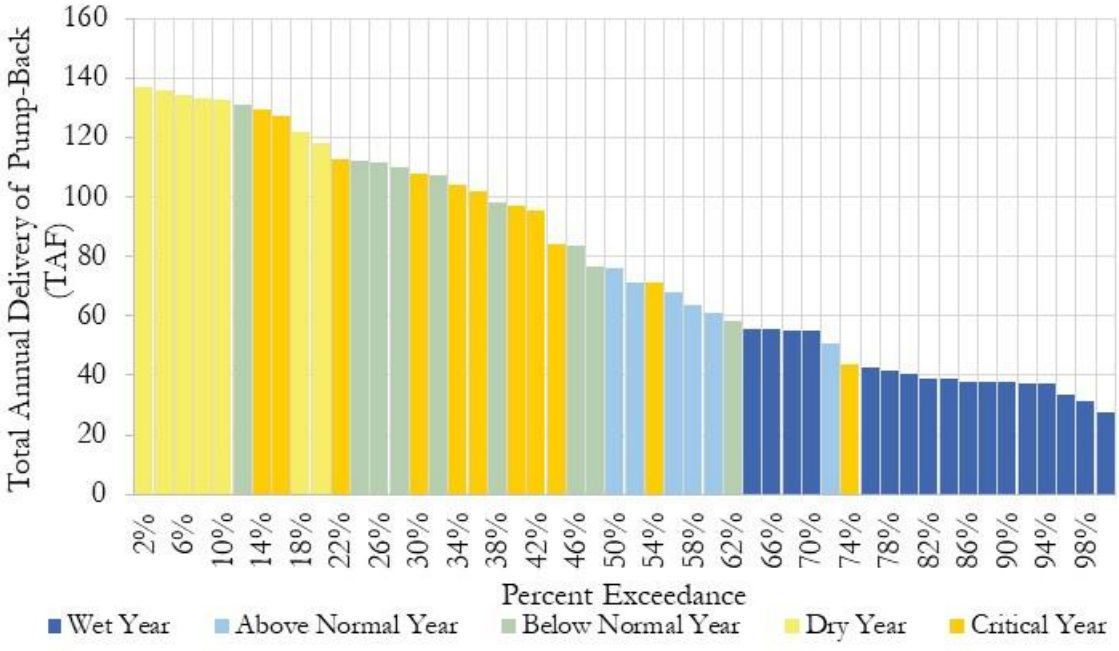
Table 3-299 summarize the average total annual delivery to Friant Contractors in Reach B by source for an average of all years and by San Joaquin Valley Water Year Type under the High Flow Alternative under Future Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the average total delivery is 153 TAF with 52 percent from existing programs and additional pump-back supply (total mitigation is 3 percent of the total delivery). For an average Wet water year, the total delivery is 170 TAF with 20 percent from existing programs and additional pump-back supply (total mitigation is 1 percent of the total delivery). For an average Critical water year, the total delivery is 106 TAF with 97 percent from existing programs and additional pump-back supply (total mitigation is 6 percent of the total delivery).

Table 3-300 to Table 3-302 and Figure 3-129 summarizes the average monthly delivery to Friant Contractors in Reach B by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-127. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to Friant Contractors in Reach B for the High Flow Alternative under Future Conditions



Key: TAF = thousand acre-feet

Figure 3-128. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to Friant Contractors in Reach B by San Joaquin Valley Water Year Type for the High Flow Alternative under Future Conditions

Table 3-299. Average Annual Delivery (thousand acre-feet) to Friant Contractors in Reach B by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the High Flow Alternative under Future Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	73	137	102	53	25	3
Existing Programs	20	9	20	33	18	27
Additional Pump-Back Supply	60	24	54	66	121	75
Total Supply	153	170	176	153	163	106

Table 3-300. Average Monthly Delivery (acre-feet) to Friant Contractors in Reach B by Source for the High Flow Alternative under Future Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	1,542	5,582	9,827	17,072	19,513	14,656	2,819	408	11	0	163	1,132	72,724
Existing Programs	326	408	416	156	2,917	3,980	6,881	4,111	422	305	0	0	19,924
Additional Pump-Back Supply	5,179	3,873	5,986	10,276	9,101	8,273	5,148	2,613	1,547	910	1,572	5,470	59,949
Total Supply	7,047	9,863	16,229	27,504	31,531	26,909	14,849	7,132	1,981	1,216	1,734	6,601	152,596

Table 3-301. Average Monthly Delivery (acre-feet) to Friant Contractors in Reach B by Source for the High Flow Alternative under Future Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	4,535	9,648	17,146	29,410	34,767	30,823	8,292	841	32	0	70	1,527	137,092
Existing Programs	26	0	0	0	0	89	4,721	3,310	470	402	0	0	9,018
Additional Pump-Back Supply	2,048	0	0	0	1,210	2,598	7,033	2,308	1,248	584	1,570	5,267	23,866
Total Supply	6,609	9,648	17,146	29,410	35,977	33,510	20,046	6,459	1,749	986	1,640	6,794	169,976

Table 3-302. Average Monthly Delivery (acre-feet) to Friant Contractors in Reach B by Source for the High Flow Alternative under Future Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	0	0	0	822	2,478	15	0	0	0	0	0	0	3,315
Existing Programs	1,035	1,556	1,549	577	4,761	6,352	5,934	4,682	476	189	0	0	27,112
Additional Pump-Back Supply	3,692	4,850	9,569	19,339	16,422	9,919	3,028	1,887	1,254	229	415	4,451	75,056
Total Supply	4,728	6,406	11,118	20,738	23,661	16,287	8,961	6,569	1,731	418	415	4,451	105,483

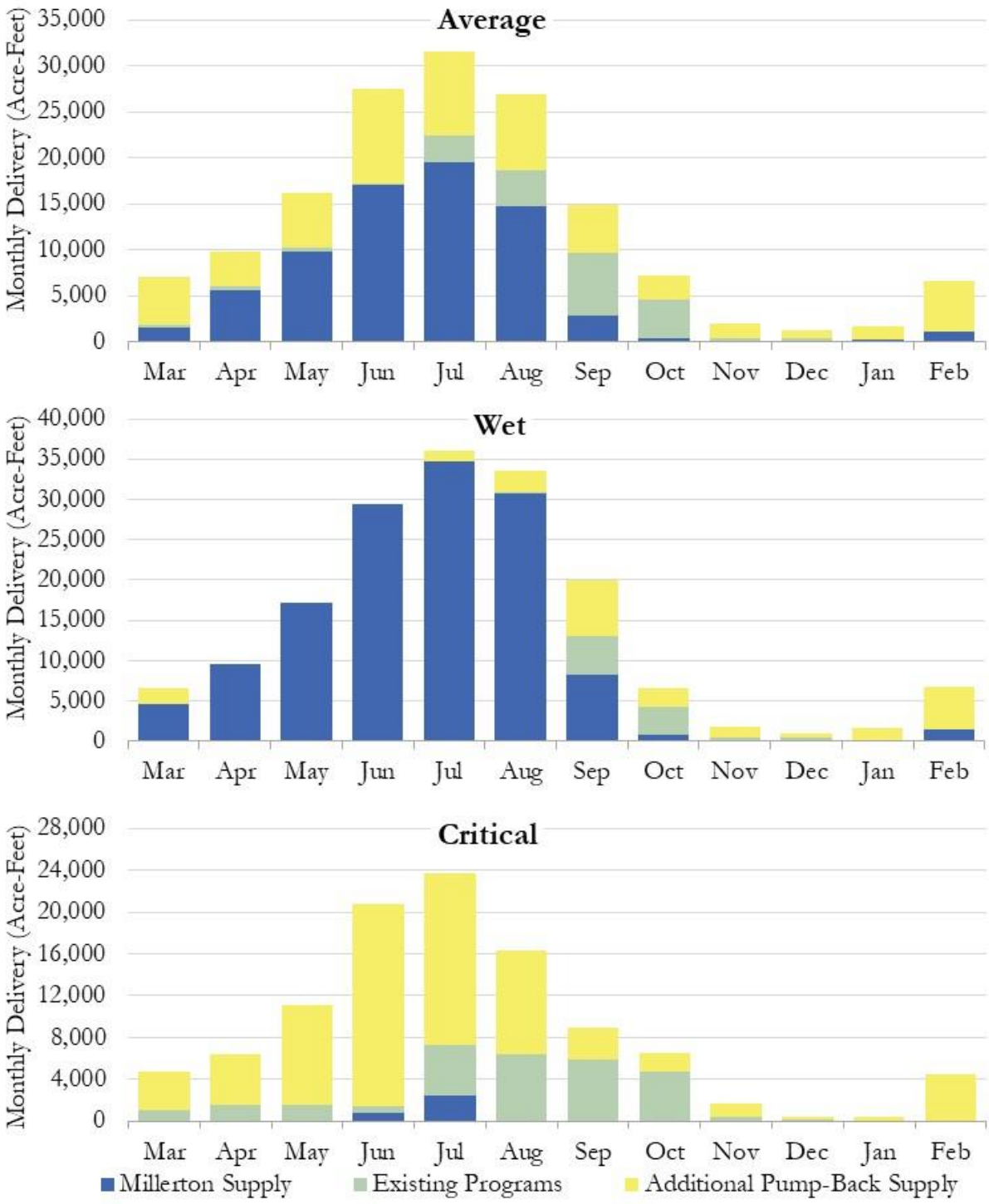


Figure 3-129. Average Monthly Delivery (acre-feet) to Friant Contractors in Reach B by Source for the High Flow Alternative under Future Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach B deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-303 to Table 3-306 show the monthly average and monthly maximum water quality trends for individual constituents under the High Flow Alternative under Future Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply being delivered via reverse-flow pump-back operations (i.e., existing programs and additional pump-back supply) and FKC groundwater pump-in programs, water quality concentrations tend to increase. For TDS, nitrate, chloride, and boron, there is a correlation between reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-303. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the High Flow Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	221.41	148.30	139.06	136.91	109.08	145.43	227.46	276.97	286.09	233.64	214.15	283.75
Maximum	333.80	321.20	327.50	305.07	273.00	322.76	367.33	340.50	314.50	335.00	378.50	366.20
Wet Water Years												
Average	77.68	28.00	21.33	21.00	17.66	28.29	115.42	247.54	279.98	256.50	188.05	245.16
Maximum	221.60	28.00	21.33	21.00	37.99	74.28	172.00	265.89	281.00	307.80	228.40	285.80
Critical Water Years												
Average	333.80	321.20	301.37	297.36	253.31	322.48	366.97	300.87	300.00	116.44	120.36	366.20
Maximum	333.80	321.20	302.09	305.07	273.00	322.76	367.33	301.34	300.00	320.20	331.00	366.20

Key: mg/L = milligrams per liter

Table 3-304. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the High Flow Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	3.02	1.27	1.13	1.06	0.84	0.52	0.97	1.40	2.39	2.47	3.21	3.80
Maximum	5.90	3.30	3.15	2.49	1.81	1.11	1.53	1.96	3.10	3.55	5.40	4.45
Wet Water Years												
Average	1.14	0.16	0.03	0.08	0.10	0.22	1.01	1.39	2.52	2.77	3.37	3.72
Maximum	3.73	0.16	0.03	0.08	0.38	0.62	1.53	1.96	2.53	3.33	4.08	4.28
Critical Water Years												
Average	3.32	2.24	2.17	1.72	1.70	0.61	1.01	1.24	1.76	1.05	1.13	4.10
Maximum	3.32	2.24	2.37	1.79	1.81	0.82	1.11	1.38	1.76	2.90	3.12	4.10

Key: mg/L = milligrams per liter

Table 3-305. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the High Flow Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.18	0.11	0.10	0.09	0.07	0.08	0.13	0.15	0.15	0.14	0.14	0.24
Maximum	0.28	0.26	0.22	0.18	0.17	0.20	0.25	0.20	0.20	0.24	0.25	0.31
Wet Water Years												
Average	0.09	0.02	0.02	0.02	0.01	0.02	0.09	0.09	0.10	0.15	0.12	0.24
Maximum	0.28	0.02	0.02	0.02	0.02	0.05	0.13	0.10	0.10	0.18	0.15	0.31
Critical Water Years												
Average	0.26	0.24	0.22	0.17	0.16	0.20	0.24	0.20	0.18	0.09	0.07	0.24
Maximum	0.26	0.24	0.22	0.18	0.17	0.20	0.25	0.20	0.18	0.24	0.18	0.24

Key: mg/L = milligrams per liter

Table 3-306. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the High Flow Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	54.73	34.39	35.16	35.48	25.19	40.39	67.32	83.70	87.77	72.07	60.41	65.46
Maximum	89.00	88.40	87.00	90.63	72.61	96.14	112.43	109.50	100.50	100.80	115.00	100.40
Wet Water Years												
Average	13.16	2.23	1.30	1.08	1.79	4.47	26.67	75.56	92.64	84.00	49.83	36.07
Maximum	43.00	2.23	1.30	1.08	6.72	16.28	41.00	81.20	93.00	100.80	60.60	42.40
Critical Water Years												
Average	89.00	88.40	83.58	87.90	66.71	95.73	111.69	86.91	83.00	34.40	36.95	100.40
Maximum	89.00	88.40	84.16	90.63	72.61	96.14	112.43	88.40	83.00	94.60	101.60	100.40

Key: mg/L = milligrams per liter

Relative Results

Relative changes in both surface water quantity and quality were determined by comparing the High Flow Alternative under Future Conditions outputs to the No Project Alternative outputs. When comparing the scenarios, differences in volumetric deliveries are due to the either the exchange of Millerton supply for existing program supply and/or the net increase of supply due to additional pump-back deliveries. Because reverse-flow pump-back facilities have increased capacity under the High Flow Alternative under Future Conditions as compared to the No Project Alternative, there is additional opportunity to increase or maximize direct delivery of existing program supply, and thus volumetric increases are seen in Wet water years and on average for all years for those supply sources.

Table 3-307 to Table 3-309 show the volumetric differences by source between the High Flow Alternative under Future Conditions compared to the No Project Alternative for an average of all years and by Wet and Critical water year types. Across all years, the overall total supply delivered to Reach B increased by 20,692 AF in the High Flow Alternative under Future Conditions compared to the No Project Alternative. This increase is a result of increased delivery of existing programs supply due to increased pump-back facility capacities and exchanges of Millerton supply for additional pump-back supply.

Table 3-310 to Table 3-313 shows the differences in monthly average and monthly maximum water quality trends for individual constituents between the High Flow Alternative under Future Conditions compared to the No Project Alternative. For TDS, nitrate, chloride, and boron, there is a correlation between additional reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Water Supply

Table 3-307. Average Monthly Change in Delivery (acre-feet) to Friant Contractors in Reach B by Source for an Average of All Years, High Flow Alternative under Future Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-3,253	-2,423	-4,097	-7,658	-9,716	-9,069	-7,785	-2,052	-869	-487	-970	-3,313	-51,692
Existing Programs	37	27	24	0	2,634	3,288	5,154	1,271	0	0	0	0	12,435
Additional Pump-Back Supply	5,179	3,873	5,986	10,276	9,101	8,273	5,148	2,614	1,547	910	1,572	5,470	59,949
Total Supply	1,963	1,477	1,913	2,619	2,019	2,492	2,518	1,833	678	423	601	2,156	20,692

Table 3-308. Average Monthly Change in Delivery (acre-feet) to Friant Contractors in Reach B by Source for Wet Water Year Types, High Flow Alternative under Future Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-1,285	0	0	0	-874	-1,378	-9,811	-1,100	-667	-250	-997	-3,115	-19,476
Existing Programs	0	0	0	0	0	89	4,721	480	0	0	0	0	5,290
Additional Pump-Back Supply	2,048	0	0	0	1,210	2,598	7,033	2,308	1,248	584	1,570	5,267	23,866
Total Supply	763	0	0	0	336	1,309	1,943	1,688	582	334	573	2,152	9,679

Table 3-309. Average Monthly Change in Delivery (acre-feet) to Friant Contractors in Reach B by Source for Critical Water Year Types, High Flow Alternative under Future Conditions

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-2,027	-2,603	-5,926	-14,360	-16,296	-10,574	-2,042	-961	-650	-89	-261	-2,771	-58,560
Existing Programs	0	0	0	0	3,610	4,414	1,908	1,045	0	0	0	0	10,978
Additional Pump-Back Supply	3,692	4,850	9,570	19,339	16,422	9,919	3,028	1,887	1,255	229	415	4,451	75,056
Total Supply	1,665	2,246	3,644	4,979	3,735	3,760	2,894	1,971	605	140	154	1,680	27,474

Water Quality

Table 3-310. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the High Flow Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	181.11	96.56	104.85	98.95	80.94	116.79	172.21	122.27	152.51	130.51	191.26	259.40
Maximum	132.89	82.87	153.99	183.78	163.35	143.64	174.59	98.85	87.83	125.00	346.90	340.53
Wet Water Years												
Average	42.96	0.00	0.00	0.00	4.66	14.54	102.42	58.97	107.26	113.50	163.47	219.49
Maximum	20.69	0.00	0.00	0.00	24.99	60.53	159.00	24.24	54.33	97.80	198.90	260.13
Critical Water Years												
Average	259.68	191.20	229.69	226.20	194.52	258.50	224.66	156.89	205.05	69.69	108.87	344.20
Maximum	186.66	82.87	128.58	183.78	163.35	143.64	174.59	125.71	121.43	150.20	299.40	344.20

Key: mg/L = milligrams per liter

Table 3-311. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the High Flow Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	2.15	0.38	0.65	0.14	0.33	0.03	-0.12	-0.91	0.01	0.81	2.18	3.29
Maximum	-0.94	-1.43	-2.90	-0.83	-1.26	-4.11	-3.46	-1.87	-1.10	-0.48	3.60	3.76
Wet Water Years												
Average	0.82	0.00	0.00	0.00	0.06	0.13	0.94	-1.28	-0.61	0.65	1.87	3.02
Maximum	1.27	0.00	0.00	0.00	0.34	0.53	1.46	-1.87	-1.68	0.15	2.28	3.58
Critical Water Years												
Average	0.51	-0.58	0.28	-0.75	0.24	-0.97	-2.59	-1.33	0.08	0.00	1.04	3.94
Maximum	-3.52	-2.49	-3.68	-1.53	-1.26	-4.39	-3.88	-1.84	-1.64	-1.13	2.85	3.94

Key: mg/L = milligrams per liter

Table 3-312. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the High Flow Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.15	0.09	0.08	0.06	0.05	0.06	0.09	0.07	0.08	0.08	0.13	0.01
Maximum	0.17	0.14	0.11	0.10	0.11	0.09	0.14	0.09	0.09	0.12	0.23	-0.03
Wet Water												
Average	0.07	0.00	0.00	0.00	0.00	0.01	0.08	0.00	0.02	0.07	0.11	-0.10
Maximum	0.17	0.00	0.00	0.00	0.02	0.04	0.12	-0.01	-0.01	0.06	0.14	-0.03
Critical Water Years												
Average	0.21	0.17	0.18	0.13	0.13	0.15	0.17	0.12	0.12	0.05	0.06	0.22
Maximum	0.15	0.12	0.11	0.10	0.11	0.09	0.14	0.11	0.07	0.13	0.16	0.22

Key: mg/L = milligrams per liter

Table 3-313. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach B for the High Flow Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	49.64	29.76	31.46	32.23	22.64	36.83	55.39	35.02	48.45	44.20	58.78	63.67
Maximum	27.05	67.40	57.20	69.71	52.61	57.07	64.90	26.17	27.50	37.80	112.80	98.50
Wet Water Years												
Average	7.54	0.00	0.00	0.00	1.13	3.73	25.95	10.79	38.24	42.10	48.00	34.17
Maximum	-18.95	0.00	0.00	0.00	6.07	15.54	40.28	-2.13	20.00	37.80	58.40	40.50
Critical Water Years												
Average	79.43	76.55	72.99	80.07	59.85	85.07	77.31	52.17	59.85	23.96	36.21	98.80
Maximum	67.43	67.40	54.35	69.71	52.61	57.07	64.90	46.27	36.00	54.89	99.58	98.80

Key: mg/L = milligrams per liter

Reach C

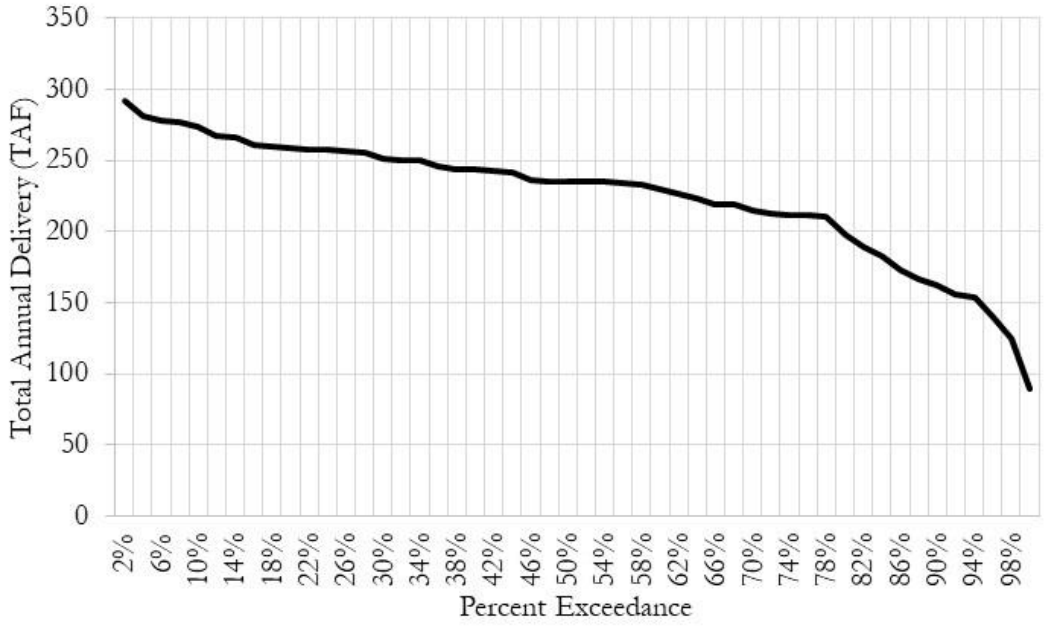
This section summarizes the total water supply delivery and the total water quality to Friant Contractors in Reach C. The Friant Contractors within Reach C include South San Joaquin Municipal Utility District, Kern-Tulare Water District, Delano-Earlimart Irrigation District, Saucelito Irrigation District, and Terra Bella Irrigation District.

Water Supply

For the High Flow Alternative under Future Conditions, the Reach C Lake Woollomes check structure capacity is modeled as 250 cfs. Figure 3-130 shows the probability of exceedance of total annual delivery to Friant Contractors in Reach C under the High Flow Alternative under Future Conditions. Figure 3-131 shows the probability of exceedance of total annual supply delivered to Friant Contractors in Reach C via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the High Flow Alternative under Future Conditions. This volume represents all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach C and not at the Intertie.

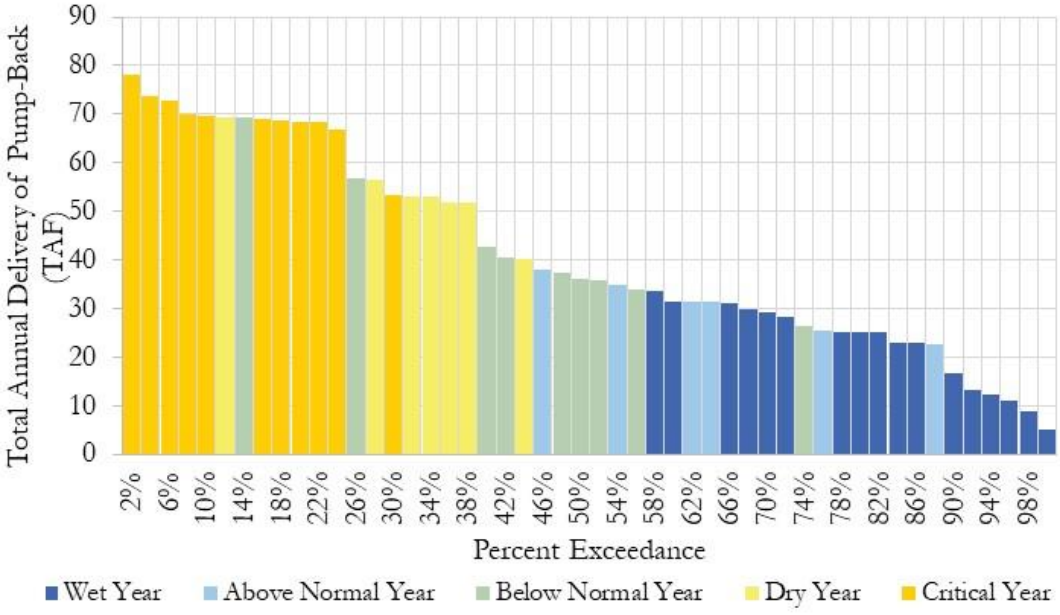
Table 3-314 summarizes the average total annual delivery to Friant Contractors in Reach C by source for an average all years and by San Joaquin Valley Water Year Type under the High Flow Alternative under Future Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the total delivery is 225 TAF with 19 percent from existing programs and additional pump-back supply (total mitigation is 1 percent of total delivery). For an average Wet water year, the total delivery is 250 TAF with 7 percent from existing programs and additional pump-back supply (total mitigation is less than 1 percent of total delivery). For an average Critical water year, the total delivery is 164 TAF with 46 percent from existing programs and additional pump-back supply (total mitigation is 3 percent of total delivery).

Table 3-315 to Table 3-317 and Figure 3-132 summarizes the average monthly delivery to Friant Contractors in Reach C by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-130. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to Friant Contractors in Reach C for the High Flow Alternative under Future Conditions



Key: TAF = thousand acre-feet

Figure 3-131. Probability of Exceedance of Total Annual Pump-Back Delivery (thousand acre-feet) to Friant Contractors in Reach C by San Joaquin Valley Water Year Type for the High Flow Alternative under Future Conditions

Table 3-314. Average Annual Delivery (thousand acre-feet) to Friant Contractors in Reach C by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the High Flow Alternative under Future Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	182	232	232	178	172	88
Existing Programs	9	6	5	12	10	13
Additional Pump-Back Supply	34	12	20	35	53	63
Total Supply	225	250	256	225	234	164

Table 3-315. Average Monthly Delivery (acre-feet) to Friant Contractors in Reach C for the High Flow Alternative under Future Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	5,649	10,982	20,741	38,337	44,300	36,555	14,423	2,434	1,307	749	1,340	5,511	182,327
Existing Programs	15	21	277	275	282	402	1,588	5,847	46	253	0	0	9,006
Additional Pump-Back Supply	5,054	3,965	3,449	948	637	2,159	6,560	3,690	2,012	1,425	908	3,209	34,016
Total Supply	10,718	14,968	24,466	39,560	45,219	39,116	22,571	11,970	3,365	2,427	2,248	8,720	225,349

Table 3-316. Average Monthly Delivery (acre-feet) to Friant Contractors in Reach C by Source for the High Flow Alternative under Future Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	8,248	14,633	26,188	42,963	51,382	48,600	28,439	2,470	1,296	530	1,375	6,270	232,394
Existing Programs	19	0	0	0	0	0	0	5,313	71	210	0	0	5,612
Additional Pump-Back Supply	1,615	0	0	0	0	0	785	3,132	1,715	1,383	726	2,704	12,060
Total Supply	9,881	14,633	26,188	42,963	51,382	48,600	29,224	10,914	3,083	2,122	2,101	8,974	250,066

Table 3-317. Average Monthly Delivery (acre-feet) to Friant Contractors in Reach C by Source for the High Flow Alternative under Future Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	2,388	3,239	7,029	25,013	30,906	14,867	548	0	888	219	216	2,413	87,726
Existing Programs	41	96	772	765	796	1,342	2,751	6,067	15	587	0	0	13,232
Additional Pump-Back Supply	5,519	7,624	10,084	4,308	2,894	8,813	11,923	5,723	2,128	605	298	3,479	63,397
Total Supply	7,948	10,960	17,885	30,085	34,596	25,022	15,222	11,790	3,031	1,411	513	5,892	164,355

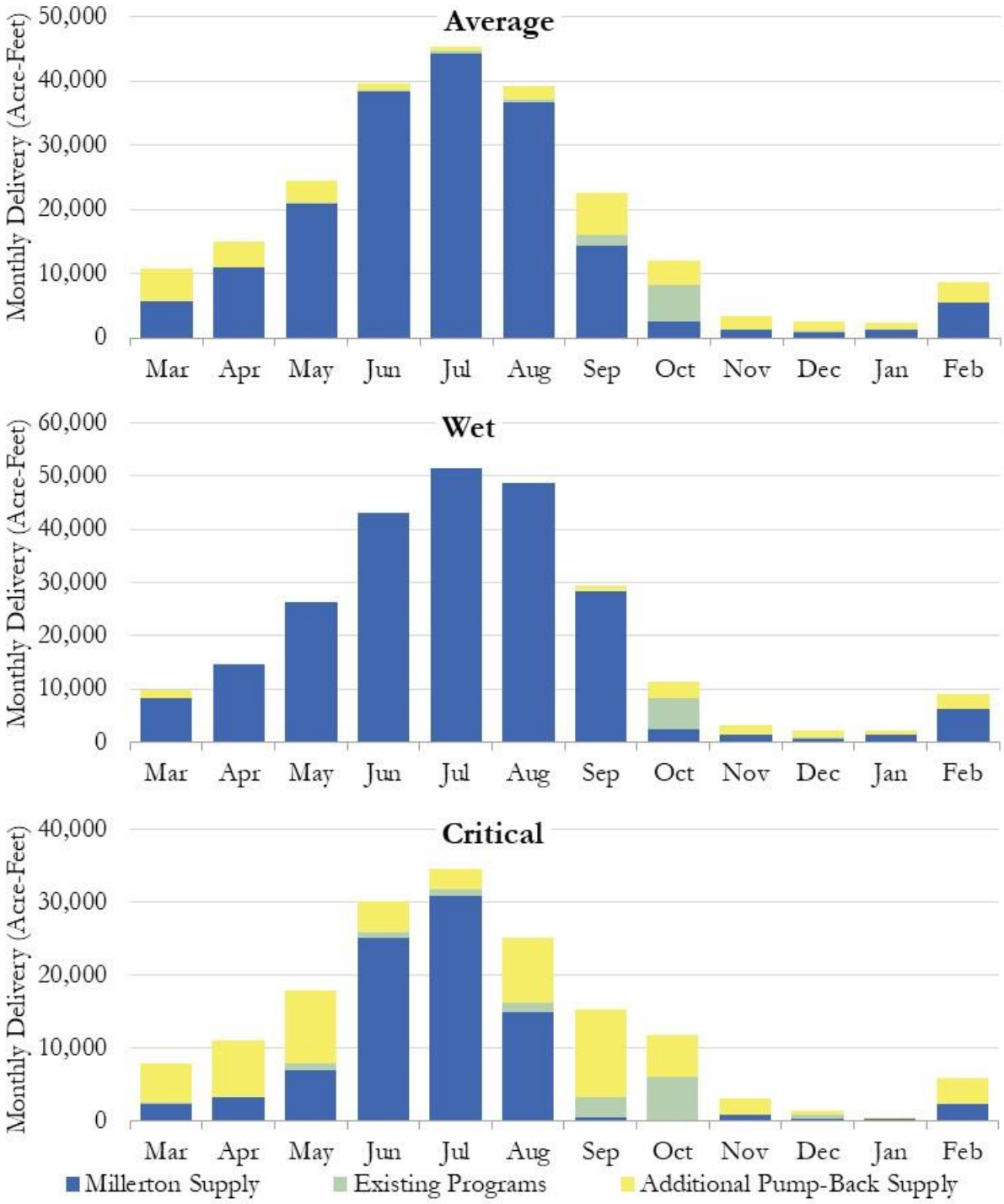


Figure 3-132. Average Monthly Delivery (acre-feet) to Friant Contractors in Reach C by Source for the High Flow Alternative under Future Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach C deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-318 to Table 3-321 show the monthly average and monthly maximum water quality trends for individual constituents for the High Flow Alternative under Future Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is a greater volume of supply being delivered via reverse-flow pump-back operations (i.e., existing programs and additional pump-back supply) and FKC groundwater pump-in programs, water quality concentrations tend to increase. For TDS, nitrate, chloride, and boron, there is a correlation between reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-318. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the High Flow Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	148.82	105.20	76.90	47.30	33.51	51.31	146.51	256.86	208.18	250.78	126.98	158.21
Maximum	268.19	264.14	244.59	238.28	243.35	322.86	366.17	340.50	252.25	335.00	232.56	228.76
Wet Water Years												
Average	49.76	28.00	21.33	21.00	13.00	13.75	18.47	235.52	205.47	249.55	108.68	126.11
Maximum	153.68	28.00	21.33	21.00	13.00	13.75	67.29	269.25	228.59	307.80	145.23	186.87
Critical Water Years												
Average	242.96	237.53	204.28	111.93	81.51	164.84	356.09	301.50	219.02	292.63	74.55	224.74
Maximum	268.19	264.14	244.59	238.28	243.35	322.86	366.17	302.26	237.85	320.20	205.66	228.76

Key: mg/L = milligrams per liter

Table 3-319. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the High Flow Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	1.87	0.95	0.58	0.90	0.50	0.31	0.58	1.40	1.70	2.56	2.23	2.19
Maximum	3.96	2.59	2.19	2.42	1.88	1.03	1.37	2.35	2.46	3.55	3.89	2.91
Wet Years												
Average	0.64	0.16	0.03	0.08	0.04	0.09	0.13	1.45	1.82	2.67	2.46	2.08
Maximum	2.51	0.16	0.03	0.08	0.04	0.09	0.57	2.35	2.03	3.33	3.12	2.91
Critical Years												
Average	2.37	1.89	1.67	2.33	1.35	0.74	1.21	1.43	1.28	2.64	0.70	2.48
Maximum	2.64	2.00	2.18	2.42	1.88	1.03	1.37	1.66	1.39	2.90	1.93	2.53

Table 3-320. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the High Flow Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.12	0.08	0.05	0.03	0.02	0.03	0.08	0.14	0.11	0.16	0.08	0.24
Maximum	0.21	0.20	0.16	0.13	0.15	0.19	0.24	0.20	0.16	0.24	0.15	0.34
Wet Years												
Average	0.05	0.02	0.02	0.02	0.01	0.01	0.02	0.09	0.07	0.15	0.07	0.29
Maximum	0.19	0.02	0.02	0.02	0.01	0.01	0.06	0.10	0.08	0.18	0.09	0.34
Critical Years												
Average	0.19	0.18	0.14	0.06	0.04	0.10	0.23	0.19	0.13	0.22	0.04	0.15
Maximum	0.21	0.20	0.16	0.13	0.15	0.19	0.24	0.20	0.14	0.24	0.11	0.15

Key: mg/L = milligrams per liter

Table 3-321. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the High Flow Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	35.59	23.31	16.74	6.35	4.02	10.99	42.87	76.70	62.68	75.74	33.78	35.40
Maximum	70.41	71.88	62.81	64.87	61.93	92.44	110.06	109.50	79.63	100.80	67.83	60.95
Wet Years												
Average	7.37	2.23	1.30	1.08	0.66	0.74	2.10	70.45	66.59	80.38	26.52	17.54
Maximum	28.92	2.23	1.30	1.08	0.66	0.74	14.47	81.20	74.68	100.80	36.18	27.00
Critical Years												
Average	63.26	64.18	52.94	21.77	13.40	43.91	106.29	85.51	59.51	85.86	21.71	59.79
Maximum	70.41	71.88	62.81	64.87	61.93	92.44	110.06	88.40	64.97	94.60	59.91	60.95

Key: mg/L = milligrams per liter

Relative Results

Relative changes in both surface water quantity and quality were determined by comparing the High Flow Alternative under Future Conditions outputs to the No Project Alternative outputs. When comparing the scenarios, differences in volumetric deliveries are due to the either the exchange of Millerton supply for existing program supply and/or the net increase of supply due to additional pump-back deliveries. Because reverse-flow pump-back facilities have increased capacity under the High Flow Alternative under Future Conditions as compared to the No Project Alternative, there is additional opportunity to increase or maximize direct delivery of existing program supply, and thus volumetric increases are seen in Wet water years and on average for all years for those supply sources.

Table 3-322 to Table 3-324 show the volumetric differences by source between the High Flow Alternative under Future Conditions compared to the No Project Alternative for an average of all years and by Wet and Critical water year types. Across all years, the overall average total supply delivered to Reach C increased by 33,048 AF in the High Flow Alternative under Future Conditions compared to the No Project Alternative. This increase is a result of increased delivery of existing programs due to increased pump-back facility capacities and exchanges of Millerton supply for additional pump-back supply.

Table 3-325 to Table 3-328 shows the differences in monthly average and monthly maximum water quality trends for individual constituents between the High Flow Alternative under Future Conditions compared to the No Project Alternative. For TDS, nitrate, chloride, and boron, there is a correlation between additional reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-322. Average Monthly Change in Delivery (acre-feet) to Friant Contractors in Reach C by Source for an Average of All Years, High Flow Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-2,206	-2,052	-1,172	1,900	3,713	2,744	-2,796	-4,805	-1,132	-849	-191	-705	-7,553
Existing Programs	0	0	0	0	7	99	1,276	5,204	0	0	0	0	6,585
Additional Pump-Back Supply	5,054	3,965	3,449	948	637	2,159	6,560	3,690	2,012	1,425	908	3,209	34,016
Total Supply	2,848	1,913	2,276	2,848	4,356	5,002	5,040	4,089	880	575	718	2,504	33,048

Table 3-323. Average Monthly Change in Delivery (acre-feet) to Friant Contractors in Reach C by Source for Wet Water Year Types, High Flow Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-417	0	0	0	1,403	4,239	3,484	-4,144	-950	-898	-63	-243	2,410
Existing Programs	0	0	0	0	0	0	0	4,837	0	0	0	0	4,837
Additional Pump-Back Supply	1,615	0	0	0	0	0	785	3,132	1,715	1,383	726	2,704	12,060
Total Supply	1,198	0	0	0	1,403	4,239	4,269	3,825	765	485	663	2,461	19,308

Table 3-324. Average Monthly Change in Delivery (acre-feet) to Friant Contractors in Reach C by Source for Critical Water Year Types, High Flow Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	-3,342	-4,663	-5,562	832	2,824	-2,976	-8,221	-6,536	-1,318	-400	-118	-1,520	-30,999
Existing Programs	0	0	0	0	31	449	1,820	5,391	0	0	0	0	7,691
Additional Pump-Back Supply	5,519	7,624	10,084	4,308	2,894	8,813	11,923	5,723	2,128	605	298	3,479	63,397
Total Supply	2,177	2,961	4,522	5,140	5,748	6,286	5,523	4,579	810	205	179	1,959	40,089

Water Quality

Table 3-325. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the High Flow Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	123.12	76.78	47.95	9.20	5.73	27.95	122.71	213.53	182.69	179.72	104.10	133.86
Maximum	203.51	189.62	185.47	161.56	180.82	236.41	287.13	123.70	189.43	125.00	200.96	203.10
Wet Water Years												
Average	23.06	0.00	0.00	0.00	0.00	0.00	5.47	181.40	175.35	182.92	84.09	100.44
Maximum	89.00	0.00	0.00	0.00	0.00	0.00	54.29	52.45	165.77	97.80	115.73	161.20
Critical Water Years												
Average	216.51	206.67	158.65	42.24	26.50	120.93	308.07	259.95	199.43	172.94	63.06	202.74
Maximum	227.26	189.62	185.47	161.56	180.82	236.41	287.13	230.69	202.37	150.20	174.06	206.76

Key: mg/L = milligrams per liter

Table 3-326. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the High Flow Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	1.69	0.47	0.35	-0.04	0.00	-0.04	0.21	0.70	1.49	1.46	1.20	1.68
Maximum	2.98	0.74	1.09	-0.25	0.34	-1.18	-0.51	-1.38	1.53	-0.48	2.09	2.22
Wet Water Years												
Average	0.43	0.00	0.00	0.00	0.00	0.00	0.05	0.55	1.54	1.85	0.96	1.38
Maximum	1.80	0.00	0.00	0.00	0.00	0.00	0.50	-1.38	1.10	0.15	1.32	2.22
Critical Water Years												
Average	2.19	0.81	0.99	-0.16	0.03	-0.17	0.18	0.58	1.16	-0.01	0.60	2.32
Maximum	1.66	0.16	1.09	-0.25	0.34	-1.18	-0.51	0.11	0.94	-1.13	1.66	2.36

Key: mg/L = milligrams per liter

Table 3-327. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the High Flow Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.10	0.06	0.04	0.01	0.00	0.02	0.07	0.11	0.09	0.11	0.07	0.01
Maximum	0.17	0.16	0.14	0.10	0.13	0.15	0.21	0.12	0.13	0.12	0.13	0.00
Wet Water Years												
Average	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.11	0.06	-0.05
Maximum	0.15	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.05	0.06	0.08	0.00
Critical Water Years												
Average	0.17	0.16	0.12	0.03	0.02	0.07	0.22	0.18	0.12	0.13	0.03	0.13
Maximum	0.18	0.16	0.14	0.10	0.13	0.15	0.21	0.18	0.12	0.13	0.09	0.13

Key: mg/L = milligrams per liter

Table 3-328. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach C for the High Flow Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	33.38	20.68	14.43	3.35	1.85	9.23	40.76	69.02	59.04	60.37	32.15	33.61
Maximum	54.63	64.73	57.09	57.72	56.29	80.19	97.68	47.38	63.11	37.80	65.63	59.05
Wet Water Years												
Average	4.47	0.00	0.00	0.00	0.00	0.00	1.38	59.84	61.35	64.86	24.69	15.64
Maximum	13.14	0.00	0.00	0.00	0.00	0.00	13.75	19.08	58.16	37.80	33.98	25.10
Critical Water Years												
Average	61.52	60.71	48.57	15.25	8.43	39.86	100.97	81.49	57.85	59.51	20.97	58.19
Maximum	66.29	64.73	57.09	57.72	56.29	80.19	97.68	78.79	58.79	54.89	57.89	59.35

Key: mg/L = milligrams per liter

Reach D

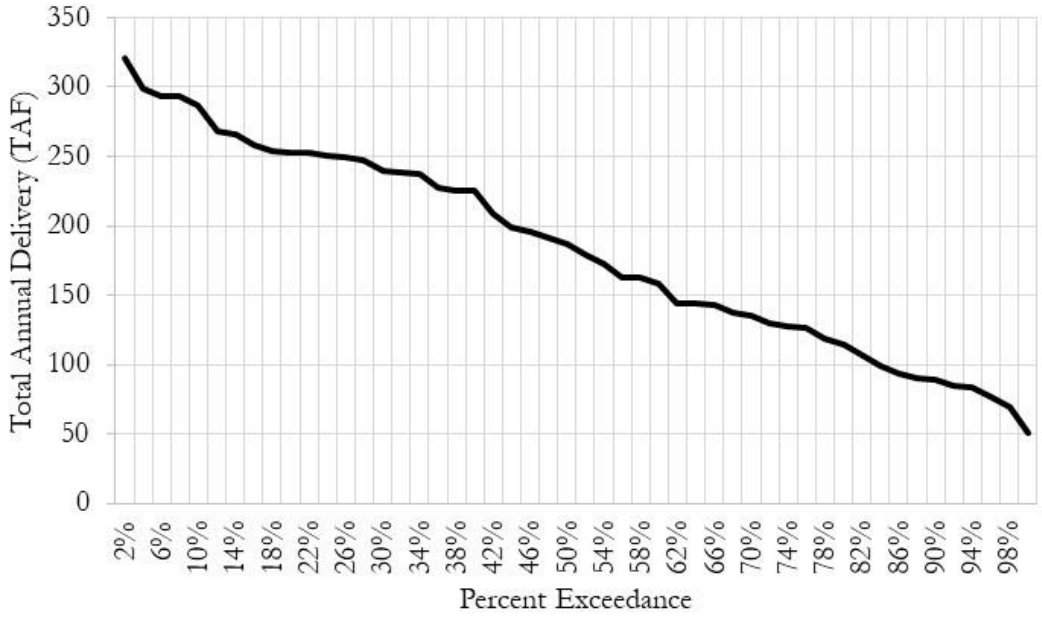
This section summarizes the total water supply delivery and the total water quality to Friant Contractors in Reach D. The Friant Contractors within Reach D include Saucelito Irrigation District, Terra Bella Irrigation District, Tea Pot Dome Water District, Pixley Irrigation District, Lower Tule River Irrigation District, and Porterville Irrigation District.

Water Supply

For the High Flow Alternative under Future Conditions, the Reach D Deer Creek check structure capacity is modeled as 250 cfs. Figure 3-133 shows the probability of exceedance of total annual delivery to Friant Contractors in Reach D under the High Flow Alternative under Future Conditions. Figure 3-134 shows the probability of exceedance of total annual supply delivered to Friant Contractors in Reach D via reverse-flow pump-back operations by San Joaquin Valley Water Year Type under the High Flow Alternative under Future Conditions. These volumes represent all supply being delivered via reverse-flow pump-back operations and is inclusive of existing program deliveries (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and additional pump-back supply. The water delivered from the FKC groundwater pump-in programs are pumped into and conveyed via the FKC within Reach D and not at the Intertie.

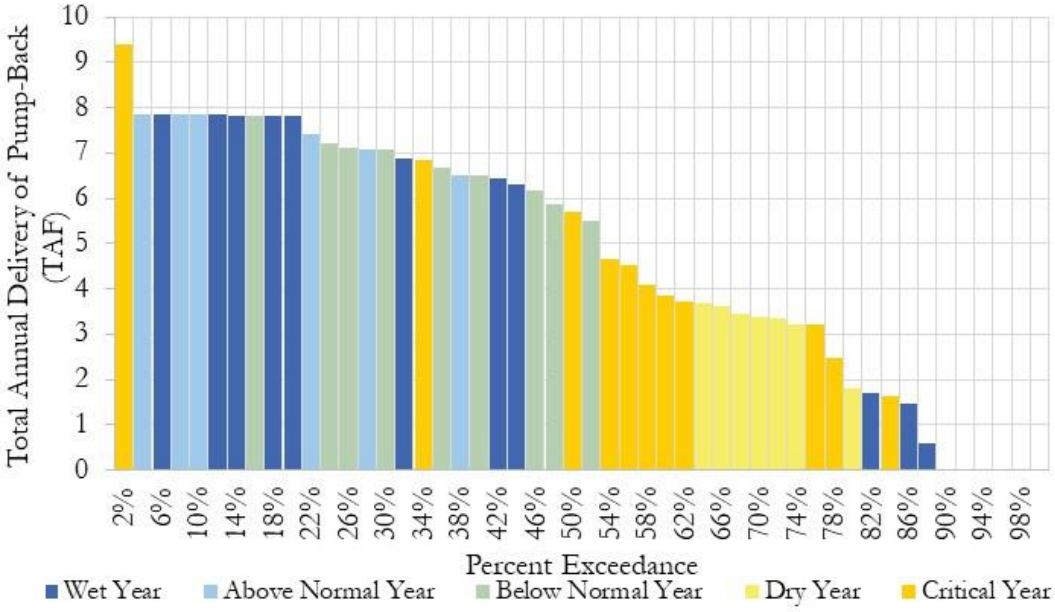
Table 3-329 summarizes the average total annual delivery to Friant Contractors in Reach D by source for an average of all years and by San Joaquin Valley Water Year Type under the High Flow Alternative under Future Conditions. In this table, existing programs include the water delivered via reverse-flow pump-back operations (Cross Valley Contract supplies for KTWD, LTRID, and Pixley ID, and the Rosedale Banking and West Kern Banking programs) and from FKC groundwater pump-in programs. Across all years, the average total delivery is 183 TAF with 3 percent from existing programs and additional pump-back supply (total mitigation is less than 1 percent of total delivery). For an average Wet water year, the total delivery is 245 TAF with 2 percent from existing programs and additional pump-back supply (total mitigation is less than 1 percent of total delivery). For an average Critical water year, the total delivery is 93 TAF with 7 percent from existing programs and additional pump-back supply (total mitigation is less than 1 percent of total delivery).

Table 3-330 to Table 3-332 and Figure 3-135 summarizes the average monthly delivery to Friant Contractors in Reach D by source for an average of all years and Wet and Critical water year types.



Key: TAF = thousand acre-feet

Figure 3-133. Probability of Exceedance of Total Annual Delivery (thousand acre-feet) to Friant Contractors in Reach D for the High Flow Alternative under Future Conditions



Key: TAF = thousand acre-feet

Figure 3-134. Probability of Exceedance for Total Annual Pump-Back Delivery (thousand acre-feet) to Friant Contractors in Reach D by San Joaquin Valley Water Year Type for the High Flow Alternative under Future Conditions

Table 3-329. Average Annual Delivery (thousand acre-feet) to Friant Contractors in Reach D by Source for an Average of All Years and by San Joaquin Valley Water Year Type for the High Flow Alternative under Future Conditions

Source of Supply	Average	Wet	Above Normal	Below Normal	Dry	Critical
Millerton Supply	178	240	237	165	138	87
Existing Programs	<1	0	0	0	<1	<1
Additional Pump-Back Supply	5	5	3	6	4	6
Total Supply	183	245	240	171	143	93

Table 3-330. Average Monthly Delivery (acre-feet) to Friant Contractors in Reach D by Source for the High Flow Alternative under Future Conditions for an Average of All Years

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	7,495	10,666	17,850	26,015	34,098	33,603	22,931	11,307	1,893	1,475	2,949	7,926	178,208
Existing Programs	0	0	48	48	48	48	48	48	0	0	0	0	291
Additional Pump-Back Supply	0	0	0	0	0	72	304	4,414	0	0	0	0	4,790
Total Supply	7,495	10,666	17,899	26,063	34,147	33,723	23,284	15,769	1,893	1,475	2,949	7,926	183,289

Table 3-331. Average Monthly Delivery (acre-feet) to Friant Contractors in Reach D by Source for the High Flow Alternative under Future Conditions for Wet Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	10,849	15,897	28,395	38,803	40,347	47,525	33,514	9,921	1,905	909	2,714	8,974	239,753
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	0	0	0	0	0	0	0	4,677	0	0	0	0	4,677
Total Supply	10,849	15,897	28,395	38,803	40,347	47,525	33,514	14,598	1,905	909	2,714	8,974	244,430

Table 3-332. Average Monthly Delivery (acre-feet) to Friant Contractors in Reach D by Source for the High Flow Alternative under Future Conditions for Critical Water Year Types

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	2,932	3,970	6,811	12,855	21,144	15,661	9,736	8,285	1,090	279	280	3,633	86,674
Existing Programs	0	0	135	135	135	135	135	98	0	0	0	0	771
Additional Pump-Back Supply	0	0	0	0	0	325	1,301	3,937	0	0	0	0	5,564
Total Supply	2,932	3,970	6,945	12,989	21,278	16,121	11,172	12,320	1,090	279	280	3,633	93,008

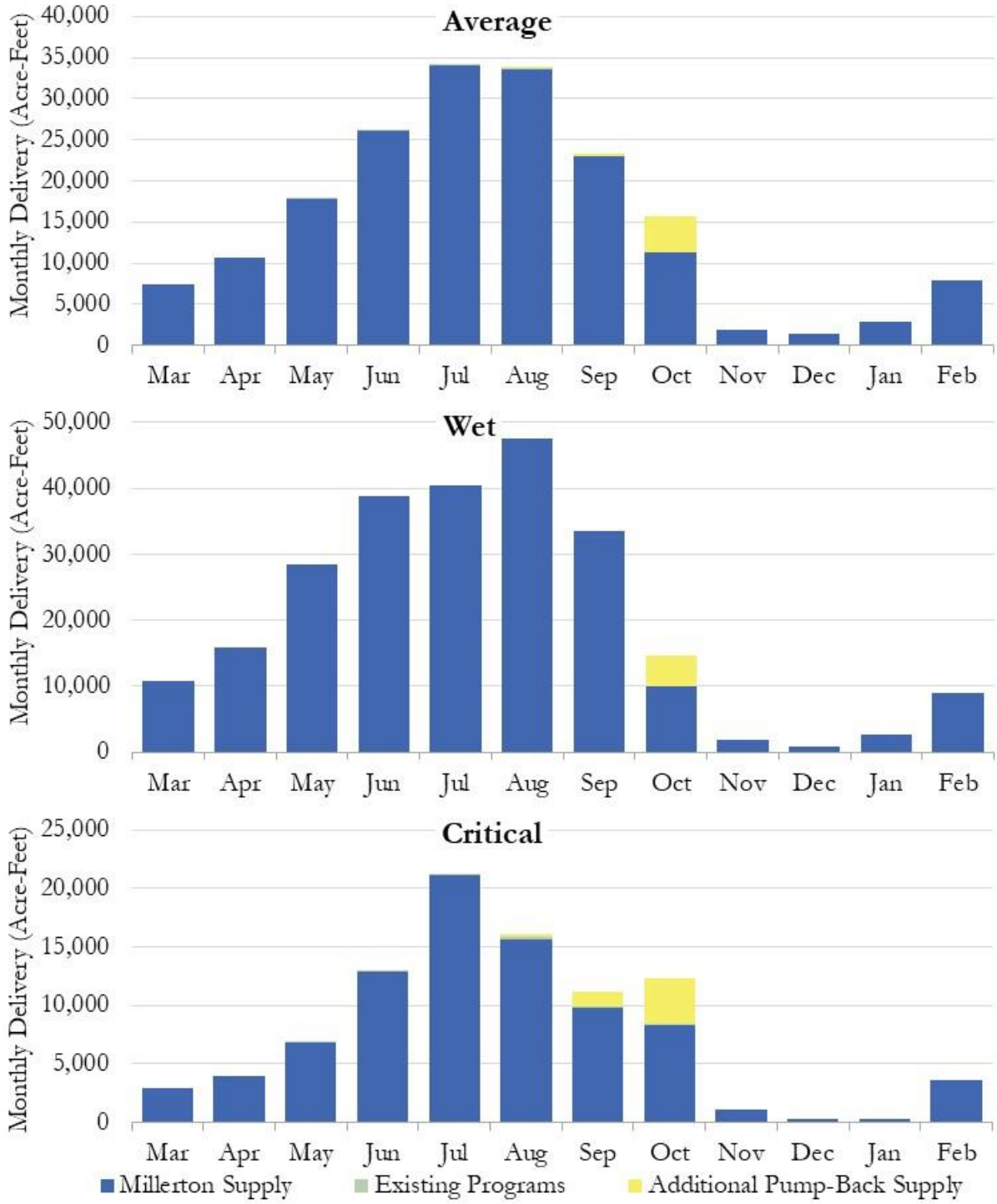


Figure 3-135. Average Monthly Delivery (acre-feet) to the Friant Contractors in Reach D by Source for the High Flow Alternative under Future Conditions for an Average of All Years and Wet and Critical Water Year Types

Water Quality

Simulated monthly in-prism water quality for Reach D deliveries is summarized for an average of all years and Wet and Critical water year types. Table 3-333 to Table 3-336 show the monthly average and monthly maximum water quality trends for individual constituents for the High Flow Alternative under Future Conditions. The individual constituents considered are TDS, nitrate, boron, and chloride. In months where there is supply delivered via reverse-flow pump-back and/or FKC groundwater pump-in programs being delivered, water quality concentrations also increase. For TDS, nitrate, chloride, and boron, the concentration trends seem to be more influenced by seasonal water quality trends of the source water. This is best exemplified for nitrate, where regardless of water year type, nitrate concentrations in surface water drop very low, during the peak summer months.

Table 3-333. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the High Flow Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	24.57	27.46	25.32	36.32	25.84	21.83	26.42	107.16	19.28	21.82	22.88	24.35
Maximum	25.00	28.00	42.26	66.83	49.80	144.77	141.12	185.69	20.00	29.00	31.60	25.67
Wet Water Years												
Average	24.33	28.00	21.33	21.00	13.00	13.75	13.00	110.32	20.00	24.17	24.58	25.67
Maximum	24.33	28.00	21.33	21.00	13.00	13.75	13.00	146.53	20.00	29.00	29.50	25.67
Critical Water Years												
Average	25.00	26.50	33.75	63.97	48.83	40.52	67.44	106.01	18.00	10.18	11.49	22.00
Maximum	25.00	26.50	42.26	66.83	49.80	144.77	141.12	135.65	18.00	28.00	31.60	22.00

Key: mg/L = milligrams per liter

Table 3-334. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the High Flow Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.15	0.46	0.12	0.89	0.44	0.24	0.17	0.56	0.08	0.14	1.03	0.50
Maximum	0.18	1.00	0.58	2.42	1.18	0.58	0.53	1.05	0.09	0.20	1.80	0.70
Wet Water Years												
Average	0.18	0.16	0.03	0.08	0.04	0.09	0.08	0.62	0.08	0.17	1.50	0.70
Maximum	0.18	0.16	0.03	0.08	0.04	0.09	0.08	0.93	0.08	0.20	1.80	0.70
Critical Water Years												
Average	0.10	1.00	0.33	2.35	1.15	0.51	0.38	0.48	0.09	0.05	0.10	0.17
Maximum	0.10	1.00	0.58	2.42	1.18	0.58	0.53	0.60	0.09	0.13	0.27	0.17

Key: mg/L = milligrams per liter

Table 3-335. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the High Flow Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.06	0.01	0.02	0.01	0.23
Maximum	0.02	0.02	0.02	0.04	0.02	0.09	0.09	0.12	0.01	0.05	0.02	0.34
Wet Water Years												
Average	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.05	0.01	0.02	0.01	0.34
Maximum	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.06	0.01	0.02	0.02	0.34
Critical Water Years												
Average	0.02	0.02	0.01	0.04	0.02	0.03	0.04	0.07	0.01	0.02	0.01	0.02
Maximum	0.02	0.02	0.01	0.04	0.02	0.09	0.09	0.09	0.01	0.05	0.02	0.02

Key: mg/L = milligrams per liter

Table 3-336. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the High Flow Alternative under Future Conditions for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	1.88	2.55	1.98	2.84	2.00	2.04	4.51	30.25	1.55	2.09	1.63	1.79
Maximum	2.10	3.10	4.06	6.27	4.50	38.73	40.09	57.78	1.75	3.05	2.20	1.90
Wet Water Years												
Average	2.10	2.23	1.30	1.08	0.66	0.74	0.72	31.52	1.75	2.54	1.83	1.90
Maximum	2.10	2.23	1.30	1.08	0.66	0.74	0.72	43.00	1.75	3.05	2.20	1.90
Critical Water Years												
Average	1.50	3.10	3.30	6.01	4.41	5.66	16.65	28.45	1.20	0.73	0.73	1.60
Maximum	1.50	3.10	4.06	6.27	4.50	38.73	40.09	38.17	1.20	2.01	2.02	1.60

Key: mg/L = milligrams per liter

Relative Results

Relative changes in both surface water quantity and quality were determined by comparing the High Flow Alternative under Future Conditions outputs to the No Project Alternative outputs. When comparing the scenarios, differences in volumetric deliveries are due to the either the exchange of Millerton supply for existing program supply and/or the net increase of supply due to additional pump-back deliveries. Because reverse-flow pump-back facilities have increased capacity under the High Flow Alternative under Future Conditions as compared to the No Project Alternative, there is additional opportunity to increase or maximize direct delivery of existing program supply, and thus volumetric increases are seen in Wet water years and on average for all years for those supply sources.

Table 3-337 to Table 3-339 show the volumetric differences by source between the High Flow Alternative under Future Conditions compared to the No Project Alternative for an average of all years and by Wet and Critical water year types. Across all years, the average total supply delivered to Reach D increased by 37,740 AF in the High Flow Alternative under Future Conditions compared to the No Project Alternative. This increase is a result of increased pump-back facility capacities which results in increased exchanges of existing program supply for Millerton supply.

Table 3-340 to Table 3-343 shows the differences in monthly average and monthly maximum water quality trends for individual constituents between the High Flow Alternative under Future Conditions compared to the No Project Alternative. For TDS, nitrate, chloride, and boron, there is a correlation between additional reverse-flow pump-back supply and higher concentrations, but concentration trends seem to be more influenced by seasonal water quality trends of the source water.

Table 3-337. Average Monthly Change in Delivery (acre-feet) to Friant Contractors in Reach D by Source for an Average of All Years, High Flow Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	1,456	854	1,076	1,400	6,369	7,132	7,838	2,857	565	455	857	2,093	32,950
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	0	0	0	0	0	72	304	4,414	0	0	0	0	4,790
Total Supply	1,456	854	1,076	1,400	6,369	7,203	8,142	7,271	565	455	857	2,093	37,740

Table 3-338. Average Monthly Change in Delivery (acre-feet) to Friant Contractors in Reach D by Source for Wet Water Year Types, High Flow Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	840	0	0	0	3,004	8,647	10,475	1,756	549	288	782	2,276	28,615
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	0	0	0	0	0	0	0	4,677	0	0	0	0	4,677
Total Supply	840	0	0	0	3,004	8,647	10,475	6,432	549	288	782	2,276	33,292

Table 3-339. Average Monthly Change in Delivery (acre-feet) to Friant Contractors in Reach D by Source for Critical Water Year Types, High Flow Alternative under Future Conditions compared to the No Project Alternative

Source of Supply	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Millerton Supply	946	1,280	2,042	2,543	4,252	4,346	2,624	1,998	349	89	89	1,146	21,703
Existing Programs	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional Pump-Back Supply	0	0	0	0	0	326	1,301	3,937	0	0	0	0	5,564
Total Supply	946	1,280	2,042	2,542	4,252	4,672	3,925	5,935	349	89	89	1,146	27,267

Water Quality

Table 3-340. Average and Maximum Concentration of Total Dissolved Solids (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the High Flow Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.00	0.00	-0.80	-0.23	-0.15	1.93	9.40	88.84	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-6.78	-2.70	-1.30	109.74	114.97	158.97	0.00	0.00	0.00	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	90.23	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	119.81	0.00	0.00	0.00	0.00
Critical Water Years												
Average	0.00	0.00	-3.01	-0.87	-0.51	9.06	42.62	86.89	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-6.78	-2.70	-1.30	109.74	114.97	113.72	0.00	0.00	0.00	0.00

Key: mg/L = milligrams per liter

Table 3-341. Average and Maximum Concentration of Nitrate (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the High Flow Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.00	0.00	-0.02	-0.01	0.00	-0.01	0.00	0.38	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-0.20	-0.07	-0.04	-0.07	0.13	0.65	0.00	0.00	0.00	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.00
Critical Water Years												
Average	0.00	0.00	-0.09	-0.02	-0.01	-0.03	0.02	0.23	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-0.20	-0.07	-0.04	-0.07	0.13	0.27	0.00	0.00	0.00	0.00

Key: mg/L = milligrams per liter

Table 3-342. Average and Maximum Concentration of Boron (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the High Flow Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.07	0.08	0.09	0.00	0.00	0.00	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
Critical Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.06	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.07	0.08	0.08	0.00	0.00	0.00	0.00

Key: mg/L = milligrams per liter

Table 3-343. Average and Maximum Concentration of Chloride (mg/L) in Mixed Source Deliveries to the Friant Contractors in Reach D for the High Flow Alternative under Future Conditions Relative to the No Project Alternative for All Years, Wet Water Years and Critical Water Years

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
All Years												
Average	0.00	0.00	-0.07	-0.02	-0.01	0.69	3.16	28.85	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-0.60	-0.24	-0.12	35.93	37.45	55.59	0.00	0.00	0.00	0.00
Wet Water Years												
Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.93	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.81	0.00	0.00	0.00	0.00
Critical Water Years												
Average	0.00	0.00	-0.27	-0.08	-0.05	3.18	14.13	27.01	0.00	0.00	0.00	0.00
Maximum	0.00	0.00	-0.60	-0.24	-0.12	35.93	37.45	36.48	0.00	0.00	0.00	0.00

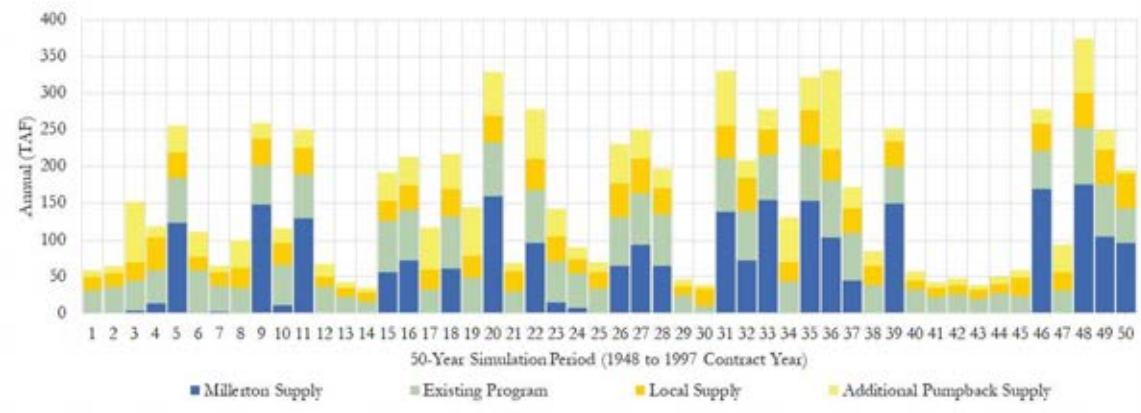
Key: mg/L = milligrams per liter

Total Surface Water Delivery to Friant Contractors

This section summarizes the annual total surface water delivery to the Friant Contractors in the study area under the High Flow Alternative under Future Conditions. The Distribution Module simulates the delivery of Millerton supply and exiting program supply. The local supplies are added to the individual Friant Contractors after the Distribution Module deliveries. Local supplies were considered in this analysis for several Friant Contractors. AEWSD receives deliveries from the Kern River and directly from the California Aqueduct. Porterville ID, LTRID, and TBID all receive deliveries from the Tule River.

Arvin-Edison Water Storage District

Figure 3-136 the total annual surface water delivery to AEWSD in the High Flow Alternative under Future Conditions. AEWSD receives local sources of water supply directly from the Kern River and directly from the California Aqueduct.

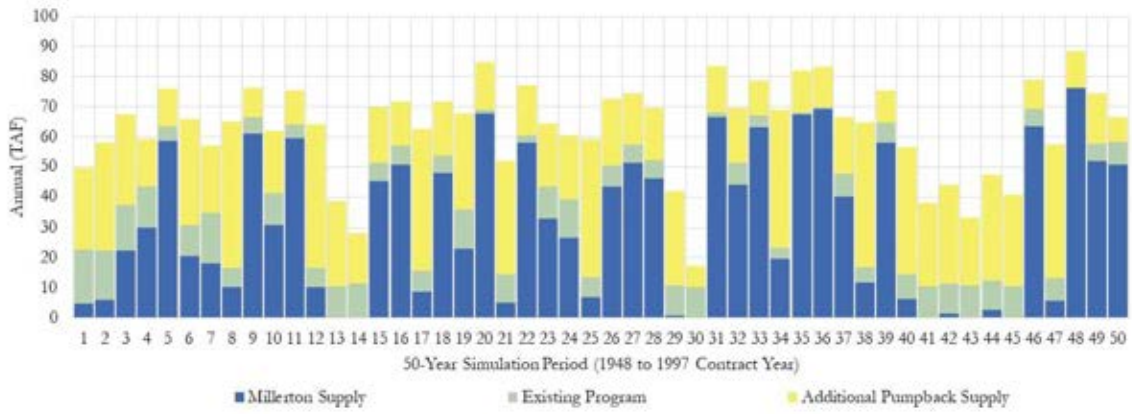


Key: TAF = thousand acre-feet

Figure 3-136. Total Annual Surface Water Delivery (thousand acre-feet) to Arvin-Edison Water Storage District for the High Flow Alternative under Future Conditions

Shafter-Wasco Irrigation District

Figure 3-137 summarizes the total annual surface water delivery to SWID in the High Flow Alternative under Future Conditions.

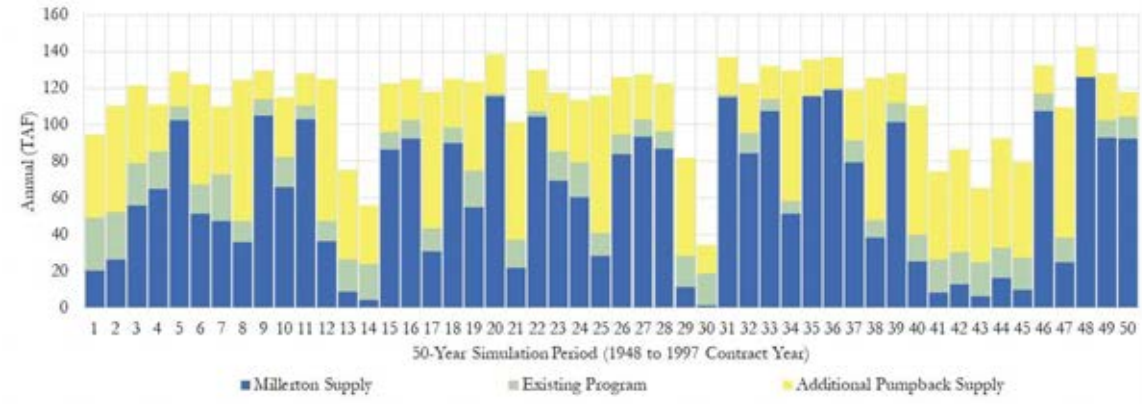


Key: TAF = thousand acre-feet

Figure 3-137. Total Annual Surface Water Delivery (thousand acre-feet) to Shafter-Wasco Irrigation District for the High Flow Alternative under Future Conditions

Southern San Joaquin Municipal Utility District

Figure 3-138 summarizes the total annual surface water delivery to SSJMUD in the High Flow Alternative under Future Conditions.

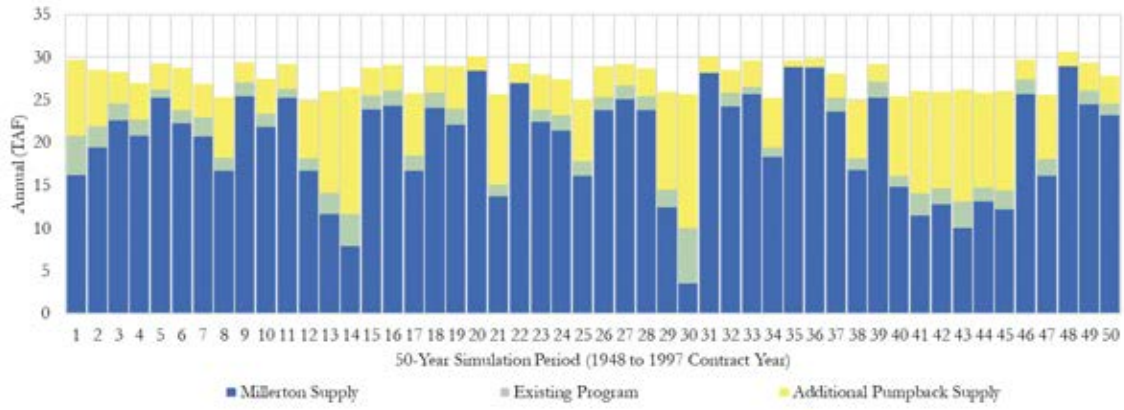


Key: TAF = thousand acre-feet

Figure 3-138. Total Annual Surface Water Delivery (thousand acre-feet) to Southern San Joaquin Municipal Utility District for the High Flow Alternative under Future Conditions

Kern-Tulare Water District

Figure 3-139 summarizes the total annual surface water delivery to KTWD in the High Flow Alternative under Future Conditions.

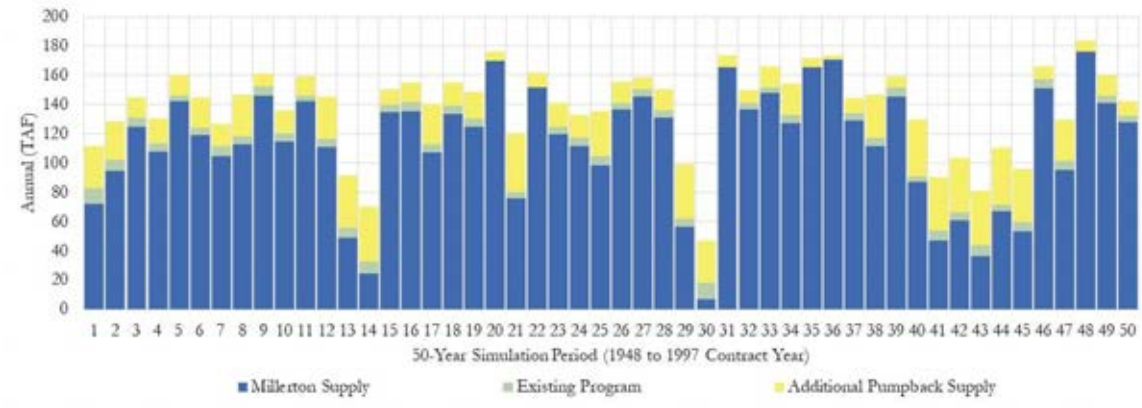


Key: TAF = thousand acre-feet

Figure 3-139. Total Annual Surface Water Delivery (thousand acre-feet) to Kern-Tulare Water District for the High Flow Alternative under Future Conditions

Delano-Earlimart Irrigation District

Figure 3-140 summarizes the total annual surface water delivery to DEID in the High Flow Alternative under Future Conditions.

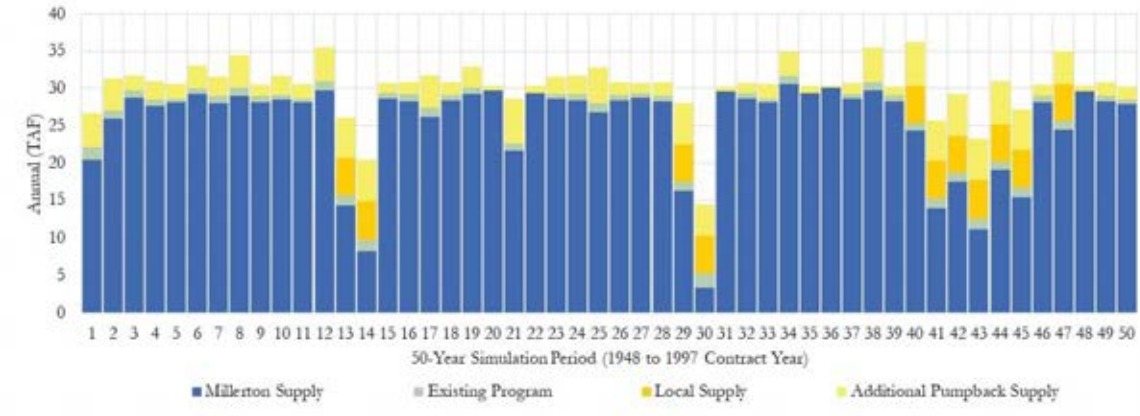


Key: TAF = thousand acre-feet

Figure 3-140. Total Annual Surface Water Delivery (thousand acre-feet) to Delano-Earlimart Irrigation District for the High Flow Alternative under Future Conditions

Terra Bella Irrigation District

Figure 3-141 summarizes the total annual surface water delivery to TBID in the High Flow Alternative under Future Conditions. TBID receives local sources of water supply directly from the Tule River.

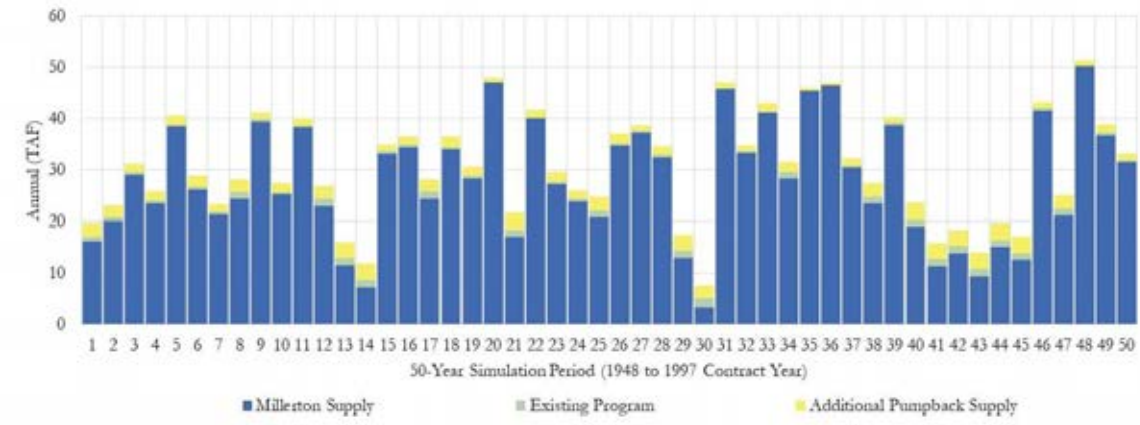


Key: TAF = thousand acre-feet

Figure 3-141. Total Annual Surface Water Delivery (thousand acre-feet) to Terra Bella Irrigation District for the High Flow Alternative under Future Conditions

Saucelito Irrigation District

Figure 3-142 summarizes the total annual surface water delivery to Saucelito ID in the High Flow Alternative under Future Conditions.

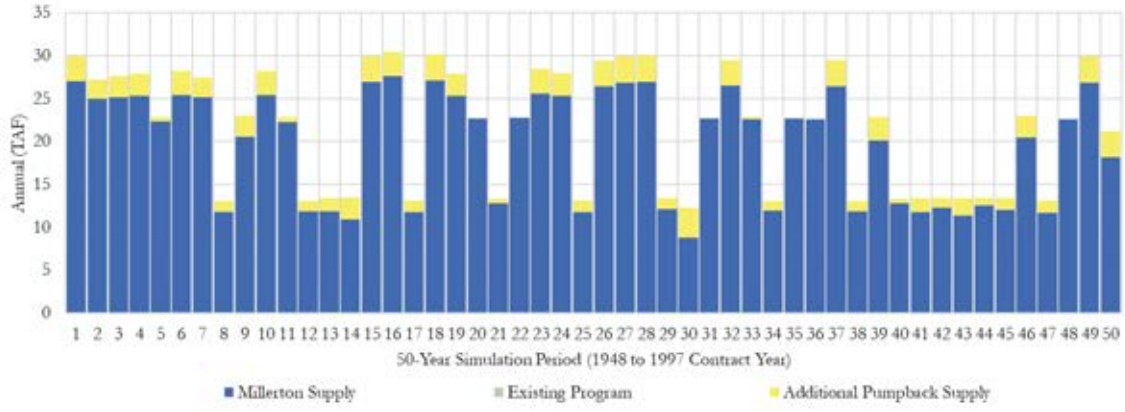


Key: TAF = thousand acre-feet

Figure 3-142. Total Annual Surface Water Delivery (thousand acre-feet) to Saucelito Irrigation District for the High Flow Alternative under Future Conditions

Pixley Irrigation District

Figure 3-143 summarizes the total annual surface water delivery to Pixley ID in the High Flow Alternative under Future Conditions.

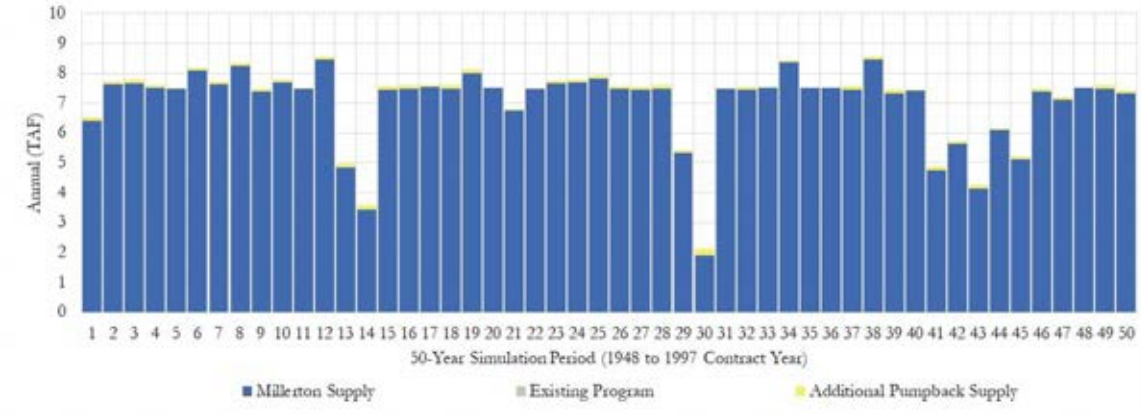


Key: TAF = thousand acre-feet

Figure 3-143. Total Annual Surface Water Delivery (thousand acre-feet) to Pixley Irrigation District for the High Flow Alternative under Future Conditions

Tea Pot Dome Water District

Figure 3-144 summarizes the total annual surface water delivery to TPDWD in the High Flow Alternative under Future Conditions.

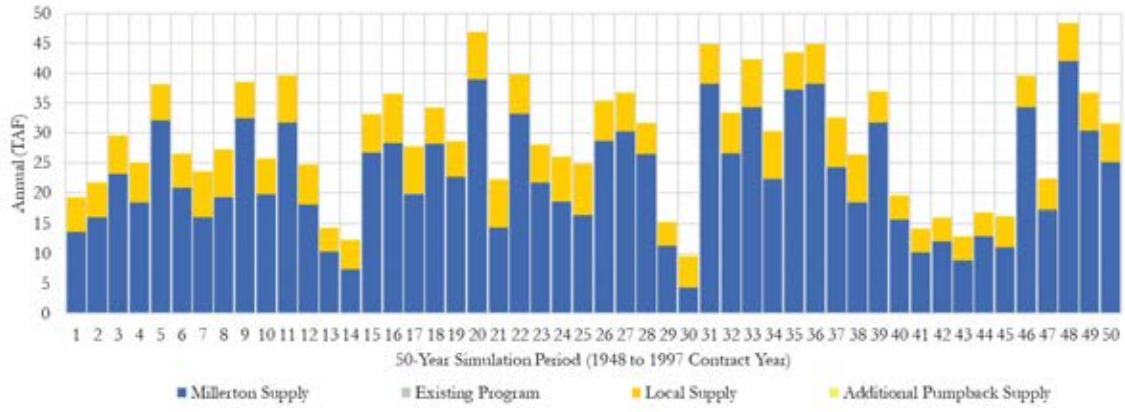


Key: TAF = thousand acre-feet

Figure 3-144. Total Annual Surface Water Delivery (thousand acre-feet) to Tea Pot Dome Water District for the High Flow Alternative under Future Conditions

Porterville Irrigation District

Figure 3-145 summarizes the total annual surface water delivery to Porterville ID in the High Flow Alternative under Future Conditions. Porterville ID receives local sources of water supply directly from the Tule River.

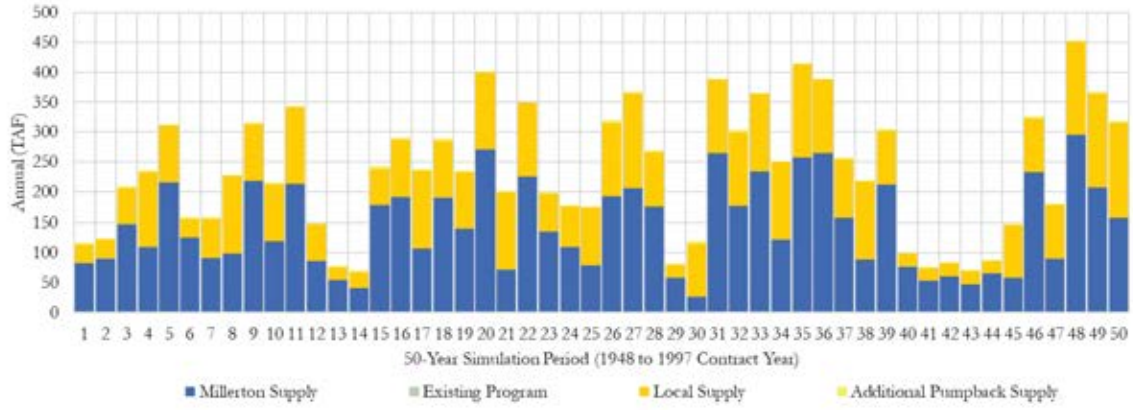


Key: TAF = thousand acre-feet

Figure 3-145. Total Annual Surface Water Delivery (thousand acre-feet) to Porterville Irrigation District for the High Flow Alternative under Future Conditions

Lower Tule River Irrigation District

Figure 3-146 summarizes the total annual surface water delivery to LTRID in the High Flow Alternative under Future Conditions. LTRID receives local sources of water supply directly from the Tule River.



Key: TAF = thousand acre-feet

Figure 3-146. Total Annual Surface Water Delivery (thousand acre-feet) to Lower Tule River Irrigation District for the High Flow Alternative under Future Conditions

Chapter 4 Groundwater Modeling

4.1 Model Descriptions and Assumptions

4.1.1 Groundwater Balance Calculation Model

4.1.1.1 Model Description

The Groundwater Balance Calculation Model (Groundwater Model) utilizes outputs from the Distribution Module and Water Quality Module to simulate long-term trends in groundwater quantity and quality on a monthly time-step over a 50-year simulation period. The Groundwater Model uses a mass-balance approach, focusing on the changes to groundwater conditions in the defined upper aquifer unit for each district (area of land) served by the Friant Contractors within the study area (referred to herein as "districts"). All results shown are for the upper aquifer unit underlying each district.

The fundamental principles behind the Groundwater Model are consistent with methods developed and implemented to support the Central Valley Regional Water Quality Control Board's (Water Board) Central Valley Salt and Nitrate Management Plan (SNMP) (LWA, 2013) under the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) program. This water, salt, and nitrate balance calculation methodology, approved by the Central Valley Water Board and other stakeholders in the Central Valley Salinity Coalition (CVSC), allows for the simulation and tracking of the movement of water, salt, and nitrate utilizing a mixing model. The CV-SALTS program approach utilized surface loading of water, salt, and nitrate, paired with subsurface flow components extracted from the United States Geological Survey's (USGS) Central Valley Hydrologic Model (CVHM) for different spatial and vertical zones across the Central Valley, referred to as Initial Analysis Zones.

The Groundwater Model uses the same basic balance calculation methodology for the flow components applied in DWR's regional groundwater flow model, Fine Grid California Central Valley Groundwater-Surface Water Simulation Model, (C2VsimFG_v1, available for public release December 2020). C2VsimFG_v1 was released with a simulation period from 1974 to 2015 (a period of 42 years) and utilizes more recent land use, surface water deliveries, groundwater pumping, climate, and other components than other regional models, such as CVHM, which has a simulation period from 1962 to 2003 (a period of 42 years).

The following key components are applied in the Groundwater Model to better represent subsurface conditions and flows within each of the Friant Contractor's district boundaries (each district has distinct, locally defined properties):

- Districts are delineated into subareas, as appropriate, to simulate lateral spatial differences within district boundaries.
- The upper aquifer is delineated into two slices, as appropriate, to simulate vertical spatial variances in the subsurface.
- The model includes vertical lag times (temporal delays over the analysis period) to account for the time it takes the applied water to move from the land surface to the top of the water table and, subsequently, to the bottom of the upper aquifer unit.
- The flux or lateral flow of groundwater between districts that are adjacent to each other is simulated.

Subarea Delineation (Lateral Spatial Discretization)

The districts of the Friant Contractors were discretized into smaller subareas to better analyze lateral spatial differences when simulating long-term trends of groundwater conditions. Discretizing the districts into smaller subareas provided the ability to observe potential changes in groundwater quality over time based on important differences observed within some of the district areas related to groundwater use or the presence of the Corcoran Clay layer in the subsurface. The presence of Corcoran Clay provided the basis for most of the subarea delineations because it is the most significant impedance to vertical flow of mass and volume in the study area between the upper and lower aquifers. This discretization allowed for mass and volume balance calculations to occur for a smaller area, thereby improving the appropriateness of the calculations for each area. The conceptual schematic in Figure 4-1 illustrates the methodology of the spatial discretization described above, whereby a subarea is defined for an area of land that is not served by surface water. The subarea delineations used in the analysis for each of the districts in the study area are presented in Figure 4-2. Table 4-1 summarizes the subarea delineation approach for each district.

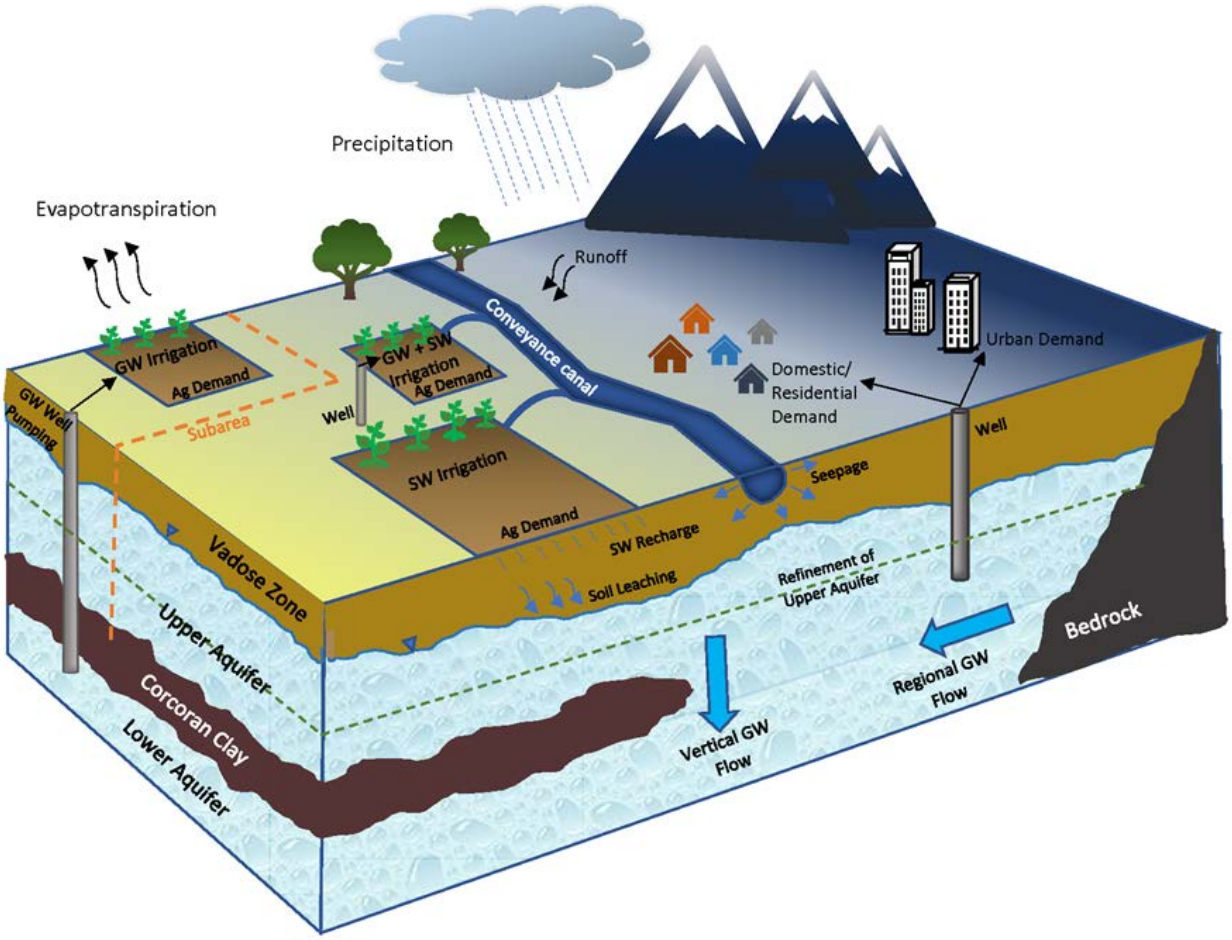
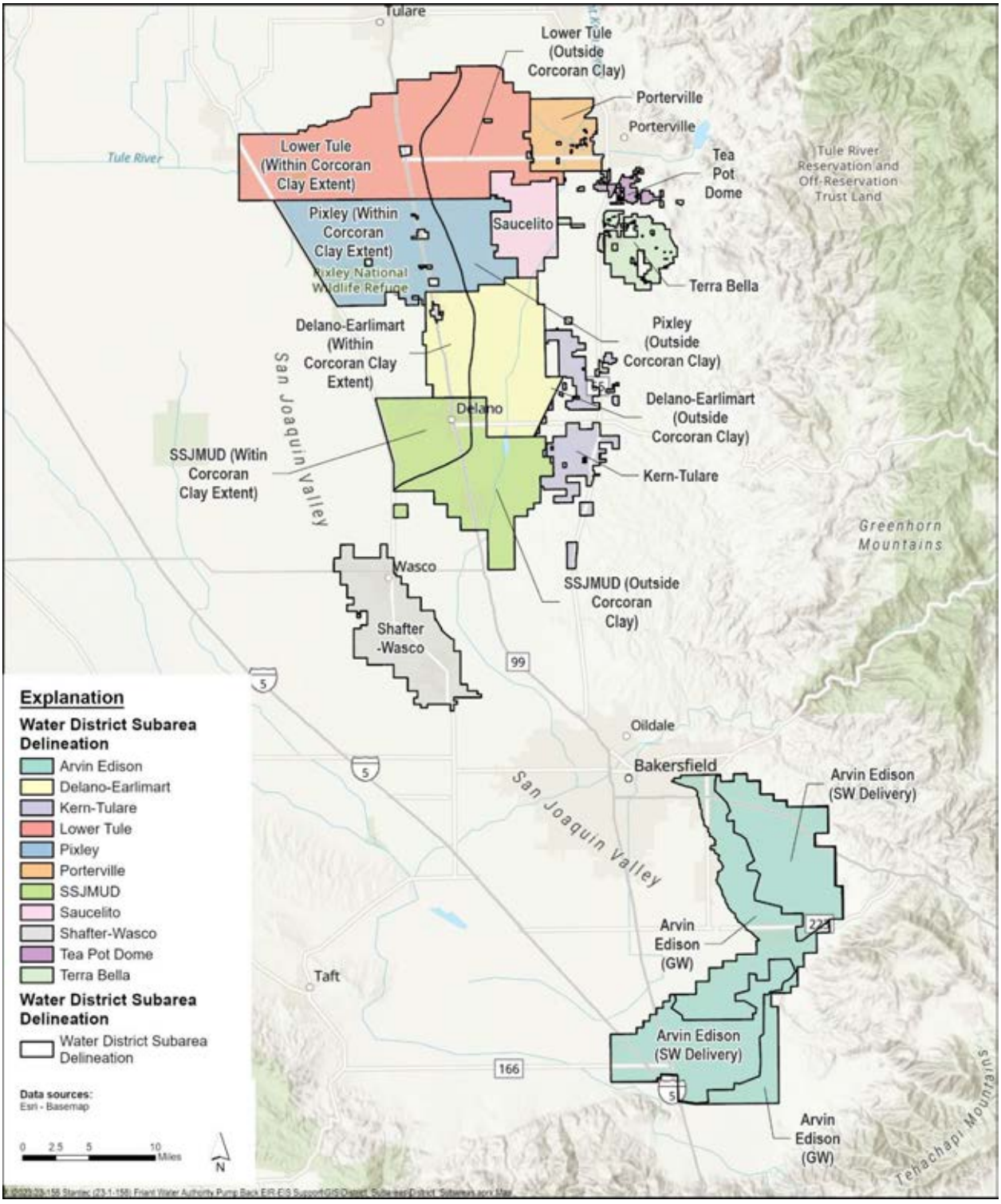


Figure 4-1. Subarea Delineation and Spatial Discretization Conceptual Schematic



Key: GW = groundwater, SSJMUD = Southern San Joquin Municipal Utility District, SW = surface water

Figure 4-2. Subarea Delineations for Friant Contractors in the Study Area

Table 4-1. Subarea Delineation and Spatial Discretization Approach for Friant Contractors in the Study Area

Friant Contractor	Subarea Delineation Approach	Subarea Delineation
AEWSD	Irrigation Source-Water Practices	Two subareas: 1) northeast and southern where surface water is the source of irrigation water; 2) outside of the surface water delivery area where groundwater is the source of irrigation water.
DEID	Extent of the Corcoran Clay	Two subareas: 1) the eastern section beyond the boundary of the Corcoran Clay; 2) the western section within the Corcoran Clay extent.
KTWD	None	No subarea delineation recommended (outside the Corcoran Clay extent, and no spatial ambient groundwater quality contrasts).
LTRID	Extent of Corcoran Clay	Two subareas: 1) western portion within the Corcoran Clay extent; 2) the eastern portion outside the Corcoran Clay extent.
Pixley ID	Extent of Corcoran Clay	Two subareas: 1) western portion within the Corcoran Clay extent; 2) the eastern portion outside the Corcoran Clay extent.
Porterville ID	None	No subarea delineation recommended (outside the Corcoran Clay extent, and no spatial ambient groundwater quality contrasts).
Saucelito ID	None	No subarea delineation recommended (outside the Corcoran Clay extent).
SWID	None	No subarea delineation recommended – most of the district (85%) is within the Corcoran Clay extent.
SSJMUD	Extent of Corcoran Clay	Two subareas: 1) western portion within the Corcoran Clay extent; 2) the eastern portion outside the Corcoran Clay extent.
TPDWD	None	No subarea delineation recommended (outside the Corcoran Clay extent).
TBID	None	No subarea delineation recommended (outside the Corcoran Clay extent)

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TDS = total dissolved solids
TPDWD = Tea Pot Dome Water District

Upper Aquifer Delineation (Vertical Discretization)

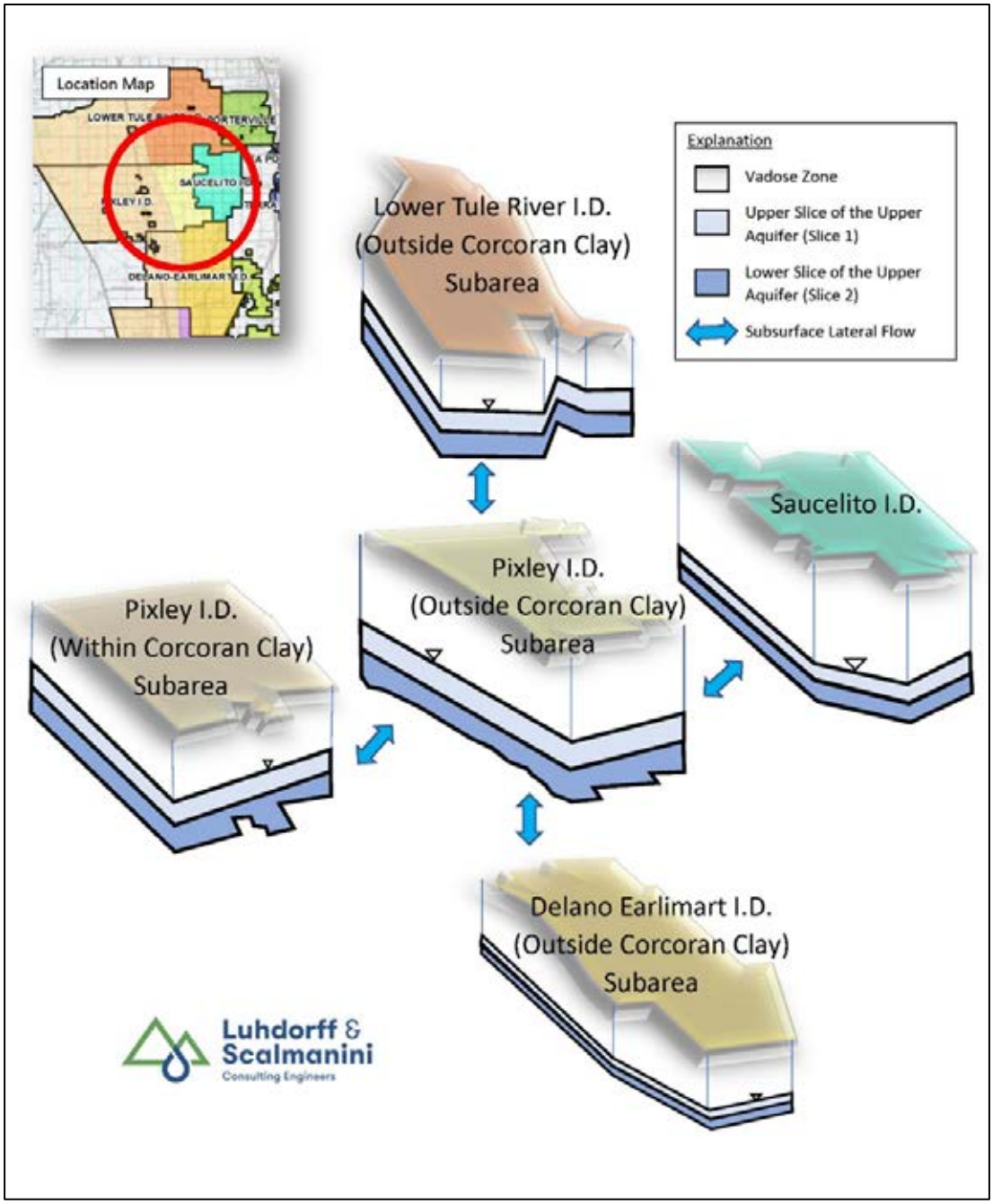
The upper aquifer is assumed to be most influenced by Project operations and is the focus of groundwater analysis, although it is recognized that groundwater underlying the districts is pumped from both the upper and lower aquifer units. The thickness of the upper aquifer for each district (and/or subarea, as applicable) is defined based on data from the C2VSimFG_v1 model framework and groundwater level data. For each Friant Contractor, the saturated thickness of the upper aquifer is defined as the saturated portion of C2VSimFG_v1 model layer 1. The upper aquifer unit was then subdivided in half, into two horizontal slices, each with an equal saturated thickness. While the upper aquifer thickness data applied for analysis (which were provided directly by the Friant Contractors) may not be exactly representative of actual conditions for the districts, this assumption was necessary to make use of the upper aquifer data from C2VSimFG_v1 and provided consistency in the analytical approach used to simulate effects of Project operations under the Project alternatives. Furthermore, some districts may not have a distinct lower and upper unit, but for consistency throughout the analysis and because C2VSimFG_v1 provided the best available data during development of this project, the upper aquifer is defined using this approach for all districts within the study area. The saturated thickness varies over time, but the proportion of the upper slice to the lower slice remains constant (50%). This assumption avoids any potential de-watering of the upper slice while still allowing the two slices to be evaluated for impacts during the 50-year simulation period. Table 4-2 summarizes the initial saturated thickness for each district.

Table 4-2. Initial Total Saturated Thickness of the Upper Aquifer by Friant Contractor and Subarea

Friant Contractor	Subarea	Initial Total Saturated Thickness of the Upper Aquifer (feet)
AEWSD	Groundwater-sourced area	200
	Surface-water delivery area	248
DEID	Within Corcoran Clay extent	148
	Outside the extent of the Corcoran Clay	45
KTWD	-	28
LTRID	Within Corcoran Clay extent	284
	Outside the extent of the Corcoran Clay	96
Pixley ID	Within Corcoran Clay extent	312
	Outside the extent of the Corcoran Clay	15
Porterville ID	-	73
Saucelito ID	-	23
SWID	-	59
SSJMUD	Within Corcoran Clay extent	192
	Outside the extent of the Corcoran Clay	165
TPDWD	-	180
TBID	-	162

Key:
AEWSD = Arvin Edison Water Storage District
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ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District

Using Pixley ID as an example, Figure 4-3 illustrates how the vertical discretization was used when developing the subsurface lateral flows (described in Chapter 4.1.1.2) between districts (and/or subareas, as applicable). All discretized spatial units surrounding the Pixley ID (Outside Corcoran Clay) subarea, including Pixley ID (Within Corcoran Clay) subarea, LTRID (Outside Corcoran Clay) subarea, Saucelito ID, and DEID (Outside Corcoran Clay) subarea are depicted in this figure. Vertical layers shown in Figure 4-3 represent the vadose zone and the upper and lower slices of the upper aquifer.



Key: I.D. = Irrigation District

Figure 4-3. Example of Vertical Discretization and Subsurface Lateral Flows

Lag in Vertical Migration

The travel times for water to migrate from the land surface through the unsaturated zone (vadose zone) to the water table beneath each district (and/or subarea, where applicable) were estimated to understand the lag time for applied water to reach the water table. This lag time is also applicable to the solute mass carried by the applied water. An understanding of the lag time between surface application loading and the time the solute mass reaches the water table is important for evaluating effects of operations under Project alternatives on groundwater quality conditions. Additionally, the travel time for water to fully penetrate the upper aquifer is also of interest. A travel time velocity analysis was performed to determine:

1. The length of time for a drop of water applied to land surface to reach the water table; and
2. The time it takes for water at the top of the water table to fully penetrate or reach the bottom of the upper aquifer (mixing zone).

This analysis was performed for each district due to variable conditions between districts (and even within subareas, as applicable). The analysis utilized recent water table elevations derived from DWR groundwater contour data for Spring 2018, and Friant Contractor-specific saturated thicknesses (total depth of upper aquifer). For the vadose zone travel time, or the time it takes applied water or precipitation to reach the water table, the best available soil dataset (Central Valley Soil and Water Assessment Tool, SWAT) was used to determine the most common soil type for each district (and/or subarea, as applicable) and assign a representative vertical hydraulic conductivity value based on soil thicknesses (Miller, 2021). Vertical hydraulic conductivity values for the portion of the vadose zone between the bottom of the soil horizon in the SWAT dataset and the water table in the upper aquifer were developed from extracted vertical hydraulic conductivity values from C2VsimFG_v1 (DWR, 2020a).

The travel time through the vadose zone was used as a delay function for the modeling tool to represent the timing of potential effects of operations under Project alternatives on groundwater quality conditions. The travel time through the upper slice (which includes both the vadose zone and the upper saturated portion of the upper aquifer) was also used as a delay function for the modeling tool, to allow for better timing of mass moving through the subsurface.

Lag times were applied when simulating the vertical migration of water (mass and volume). The conceptual schematic in Figure 4-4 illustrates the vertical movement of water from the land surface down through the vadose zone and the upper aquifer. For the vadose zone calculation of lag time, soil thicknesses and vertical saturated hydraulic conductivity values were used from the SWAT dataset from the land surface to the depth of the soil zone, as well as the vertical conductivity of model layer 1 from C2VsimFG_v1. The effective hydraulic conductivity for groundwater flow perpendicular to the bedding plane (vertical downward migration of water) was derived as follows:

$$K_{ze} = \frac{\sum d_i}{\sum \frac{d_i}{K_{zi}}}$$

Where:

K_{zi} is the hydraulic conductivity of a specific depth layer i in the z-direction; and d_i is the thickness of layer i.

The effective vertical hydraulic conductivity was converted into velocity, v using the equation for linear velocity:

$$v = K_{ze}/n$$

Where

n = default porosity of 0.2.

The linear velocity, v was then used to estimate the travel time from the land surface to the water table (the vertical thickness of the vadose zone). The average depth to water (based on DWR groundwater contour data for Spring 2018), the SWAT soil thickness for the most common soil type, the calculated effective vertical hydraulic conductivity of the vadose zone, the average linear vadose zone velocity, and the vadose zone travel time rounded to the nearest month is provided in Table 4-3.

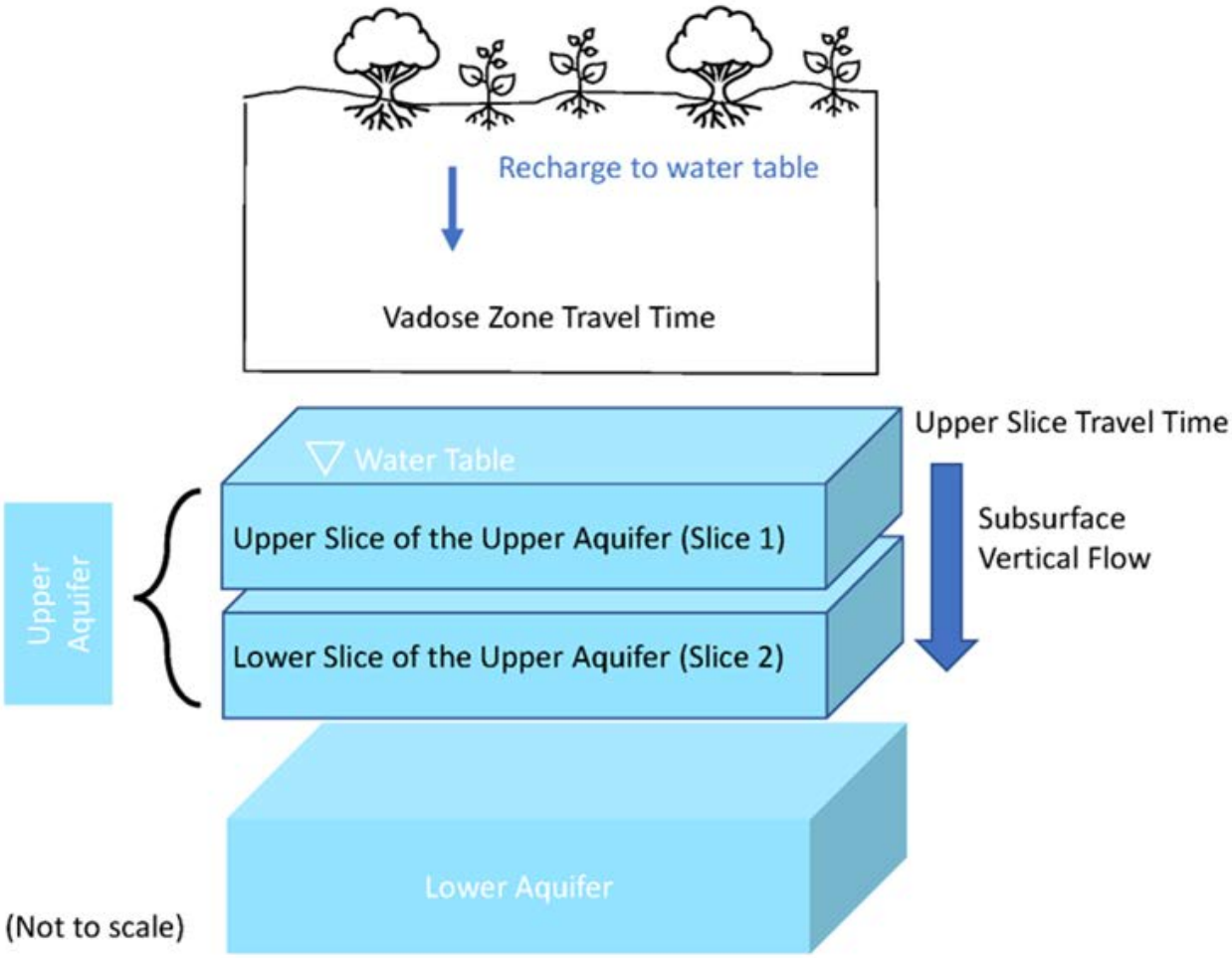


Figure 4-4. Conceptual Schematic Illustrating Lag in Vertical Migration

Table 4-3. Lag Time Input Values and Vadose Zone Travel Time by Friant Contractor Area and Subarea

Friant Contractor (and/or Subarea)	Average Depth to Water (ft)	SWAT Soil Thickness (ft)	Thickness of Remaining Unsaturated Zone (DTW minus total thickness of SWAT soil, in feet)	Effective Vertical Hydraulic Conductivity of the Vadose Zone (ft/d)	Average Linear Vadose Zone Velocity[1] (ft/d)	Vadose Zone Travel Time (months)
AEWSD (GW)	328.5	29.8	298.7	0.30	1.49	7
AEWSD (SW Delivery)	352.1	22.4	329.6	0.28	1.39	8
DEID (Outside Corcoran Clay)	229.5	13.9	215.6	0.29	1.44	5
DEID (Within Corcoran Clay Extent)	144.5	13.9	130.6	0.27	1.35	4
KTWD	490.2	10.3	479.8	0.24	1.21	14
LTRID (Outside Corcoran Clay)	133.7	26.6	107.1	0.78	3.90	1
LTRID (Within Corcoran Clay Extent)	138.7	8.2	130.6	0.69	3.45	1
Pixley ID (Outside Corcoran Clay)	224.6	11.9	212.7	0.43	2.14	4
Pixley ID (Within Corcoran Clay Extent)	186.2	26.6	159.6	0.33	1.63	4
Porterville ID	82.7	5.4	77.3	0.45	2.27	1
Saucelito ID	208.9	8.1	200.9	0.38	1.89	4
SWID	296.6	12.3	284.2	0.36	1.79	6
SSJMUD (Outside Corcoran Clay)	284.3	12.1	272.2	0.35	1.76	5
SSJMUD (Within Corcoran Clay Extent)	157.6	12.3	145.2	0.30	1.51	3
TPDWD	127.3	7.5	119.8	0.22	1.12	4
TBID	162.5	7.5	155.0	0.22	1.11	5

Notes: 1. Determined using a default porosity value of 0.2.

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
DTW = depth to water
ft = feet
ft/d = feet per day
GW = groundwater
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SW = surface water
SWAT = Central Valley Soil and Water Assessment Tool
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District

Similarly, for the travel time through the upper slice of the upper aquifer, the average vertical hydraulic conductivity for each district (and/or subarea, as applicable) was extracted from C2VsimFG_v1, converted into velocity using a default porosity of 0.2, and used to estimate the travel time associated with vertical migration through the upper slice of the upper aquifer. These data are summarized in Table 4-4 where travel times are rounded to the nearest month. A minimum one-month lag was applied because this is the smallest temporal unit, and the model calculates concentration on one-month time steps. Calculated travel times used for the lag time function in delaying the arrival of solute mass for both the vadose zone and the upper slice (rounded to the nearest month) are provided below in Table 4-5.

Table 4-4. Upper Slice Lag Time Values and Results by Friant Contractor and Subarea

Friant Contractor (and/or Subarea)	Thickness of the Upper Slice of the Upper Aquifer (ft)	Average Vertical Hydraulic Conductivity from C2VsimFG Version 1.0 for the Upper Slice (ft/d)	Upper Slice Linear Velocity[1] (ft/d)	Upper Slice Travel Time (months)
AEWSD (GW)	99.89	0.27	1.36	2
AEWSD (SW Delivery)	123.97	0.27	1.34	3
DEID (Outside Corcoran Clay)	22.49	0.27	1.36	1
DEID (Within Corcoran Clay Extent)	73.88	0.25	1.23	2
KTWD	13.76	0.24	1.19	1
LTRID (Outside Corcoran Clay)	47.90	0.66	3.32	1
LTRID (Within Corcoran Clay Extent)	142.16	0.71	3.56	1
Pixley ID (Outside Corcoran Clay)	7.55	0.42	2.08	1
Pixley ID (Within Corcoran Clay Extent)	156.07	0.28	1.42	4
Porterville ID	36.44	0.44	2.18	1
Saucelito ID	11.62	0.37	1.84	1
SWID	29.67	0.34	1.72	1
SSJMUD (Outside Corcoran Clay)	82.47	0.36	1.79	2
SSJMUD (Within Corcoran Clay Extent)	95.93	0.28	1.41	2
TPDWD	89.86	0.25	1.27	2
TBID	81.15	0.24	1.21	2

Notes: 1. Determined using a default porosity value of 0.2.

Key:
AEWSD = Arvin Edison Water Storage District
C2VsimFG = Fine Grid California Central Valley Groundwater-Surface Water Simulation Model
DEID = Delano-Earlimart Irrigation District
ft = feet
ft/d = feet per day
GW = groundwater
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SW = surface water
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District

Table 4-5. Vadose Zone and Upper Slice Travel Time by Friant Contractor and Subarea

Friant Contractor (and/or Subarea)	Vadose Zone Travel Time (months)	Upper Slice (of the Upper Aquifer) Travel Time (months)
AEWSD (GW)	7	2
AEWSD (SW Delivery)	8	3
DEID (Outside Corcoran Clay)	5	1
DEID (Within Corcoran Clay Extent)	4	2
KTWD	14	1
LTRID (Outside Corcoran Clay)	1	1
LTRID (Within Corcoran Clay Extent)	1	1
Pixley ID (Outside Corcoran Clay)	4	1
Pixley ID (Within Corcoran Clay Extent)	4	4
Porterville ID	1	1
Saucelito ID	4	1
SWID	6	1
SSJMUD (Outside Corcoran Clay)	5	2
SSJMUD (Within Corcoran Clay Extent)	3	2
TPDWD	4	2
TBID	5	2

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ft/d = feet per day
GW = groundwater
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SW = surface water
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District

Time Steps (Temporal Discretization)

Consistent with the surface water module, the Groundwater Model uses monthly time steps to evaluate changes in concentration, mass, and storage. For the 50-year period, there are a total of 600-time steps used in the Groundwater Model.

4.1.1.2 Additional Data Development and Assumptions

There are many different additional categories of data that are input into the Groundwater Model, including:

- Groundwater pumping and vertical distribution of pumping;
- Groundwater quality conditions;
- Groundwater level and flow data;
- Water demand estimates (including drinking water, municipal, and agricultural supply);
- Precipitation and effective precipitation;
- Surface water deliveries and surface water quality conditions;
- Future changes anticipated in the management of groundwater for each Friant Contractor due to implementation of SGMA.

Groundwater Volumetric Budget

This section describes the water budget components considered in the Groundwater Model mass balance to simulate long-term effects of Project operations on groundwater quality conditions within each Friant Contractor's district in the study area. While the water demands are consistent across the Project alternatives evaluated, the surface water deliveries, groundwater pumping, and recharge vary between Project alternatives. The description of these terms is followed by other terms that were derived from C2VsimFG_v1 and other sources, and do not vary between Project alternatives (subsurface flows, stream leakage, conveyance leakage, mountain recharge, initial groundwater levels, precipitation, and plant uptake percentage).

Water Demand

Water demands were developed for each district using a combination of data provided directly by the Friant Contractors, or demand values published from the various GSPs that cover the two subbasins (Kern County and Tule Subbasins) underlying the study area[1]. The demand data include both municipal and industrial (M&I), as well as agricultural water demands on an annual basis. Projections of future demands on an annual basis were developed using either the projected average demand reported by the Friant Contractors in their respective GSPs or specifically provided by the Friant Contractors to show projections on an annual basis for the next 50 years. In cases where projected data were not available, current data were used for all 50 years. All demand values were verified by the Friant Contractors. Evapotranspiration values from the California Polytechnic State University, San Luis Obispo, Irrigation Training & Research Center (ITRC) were used to proportion the annual demand values by month for each Friant Contractor (ITRC, 2021).

[1] The GSPs utilized were the most current versions available at the time of model development. Since the submittal of these GSPs, they have been revised and resubmitted (2022) and are currently undergoing further revisions (2024). The following GSPs and management area plans (MAP) were utilized: DEID GSP 2020, ETGSA 2020, AEWSD MAP 2019, KTWD GSP 2019, LTRID GSP 2020, NKWSD and SWID MAP 2019, PID GSP 2020, SWID 7th Annex Management Area MAP 2019, SSJMUD MAP 2019.

Surface Water Deliveries

Surface water deliveries are defined as the volume of surface water delivered to each district. These deliveries were used to meet remaining demand after precipitation was applied. Surface water delivery volumes (and surface water quality conditions) were simulated in the Surface Water Module as described in Chapter 3. Surface water delivery volumes to each Friant Division Contractor were quantified by source for each scenario in Chapter 3.2.

Groundwater Pumping

Groundwater pumping in the Groundwater Model is a function of the monthly distribution of annual water demand (based on GSP data that was current at the time of model development and represented the best available information[2]), effective precipitation (utilizing a factor of 80%), monthly surface water deliveries, irrigation efficiency, and a 10% increase in agricultural water demand during months of January and February for pre-irrigation activities. For each Friant Contractor in the study area, the amount of groundwater pumping required to meet demand was simulated. The proportion of pumping was distributed vertically across the upper aquifer and lower aquifer using information about well depths from each GSP and the layering defined in the calibrated C2VSimFG_v1 model, which is shown in Table 4-6. As stated previously, simulated long-term trends or changes in groundwater conditions were only quantified for the upper aquifer; lower aquifer pumping was only applied to simulate vertical, subsurface flows from the upper to lower aquifer units.

[2] It is recognized that the groundwater pumping data in the GSPs have been and/or will be updated after the development of this model, as described for GSPs in the footnote above.

Table 4-6. Pumping Proportions by Depth for Friant Contractors and Subarea

Friant Contractor	Subarea	Upper Pumping Proportion	Lower Pumping Proportion
AEWSD	Groundwater-sourced area	3%	97%
	Surface-water delivery area	3%	97%
DEID	Within Corcoran Clay extent	7%	93%
	Outside the extent of the Corcoran Clay	3%	97%
KTWD	-	4%	96%
LTRID	Within Corcoran Clay extent	67%	33%
	Outside the extent of the Corcoran Clay	26%	74%
Pixley ID	Within Corcoran Clay extent	25%	75%
	Outside the extent of the Corcoran Clay	7%	93%
Porterville ID	-	30%	70%
Saucelito ID	-	7%	93%
SWID	-	3%	97%
SSJMUD	Within Corcoran Clay extent	7%	93%
	Outside the extent of the Corcoran Clay	1%	99%
TPDWD	-	21%	79%
TBID	-	30%	70%

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District

Recharge

Groundwater recharge (or deep percolation of water that moves vertically/downward through the root zone and enters the upper aquifer at the water table) was estimated as a proportion of precipitation and applied water. The proportion of recharge was developed using recharge values extracted from C2VSimFG_v1(using the post-processing tool called "zonebudget") and adjusted locally as needed according to the Soil Agricultural Groundwater Banking Index (SAGBI)[3] for each Friant Contractor. Recharge proportions developed from the comparison of simulated future demand and recharge ratios for each Friant Contractor (and/or subarea, as applicable) were compared to SAGBI.[4] Qualitatively comparing the area-weighted average SAGBI rating for unmodified and modified soils to the C2VsimFG_v1-based recharge percentages improved the defensibility of this parameter. From the upper aquifer perspective, a positive recharge number indicates water (from precipitation and/or applied water) entering the upper aquifer.

Regional Model Constant Water Budget Terms

This section describes the water budget terms that were extracted from C2VsimFG_v1 for use in the Groundwater Model. Each of these terms were held constant under the various Project alternatives as they are the calibrated and widely accepted terms applied in C2VsimFG_v1.

Subsurface Lateral Flow

Time-series subsurface lateral flow values were developed for each district (and/or subarea, as applicable) for the upper aquifer using calibrated flow values extracted from C2VsimFG_v1 (using the post-processing tool called "zonebudget"). The 600 monthly time steps used to simulate a 50-year period were based on the water year type for years 1948 to 1997. Since the C2VsimFG_v1 simulation period begins in 1974, substitute, or proxy, water years were selected to represent the 1948 through 1973 water years and account for variations in water year type and other factors. Proxy water years were selected from the C2VSimFG_v1 dataset for those approximately 25 years of historic simulation prior to the start of the C2VSimFG_v1 simulation period, based on water year type, annual precipitation, and annual runoff in the basin. The water years selected as proxies to represent subsurface lateral (and vertical) monthly flow values for 1948 through 1973 are listed below in Table 4-7. Under the upper aquifer perspective, a positive subsurface lateral flow number indicates subsurface water flowing into the upper aquifer from neighboring area(s), whereas a negative subsurface lateral flow number indicates subsurface water leaving the upper aquifer and entering neighboring area(s).

For analysis of groundwater quality conditions, constituent concentrations of subsurface lateral flows were based on the initial ambient upper aquifer concentration to start, followed by calculated concentrations at the end of the monthly time step for subsequent months. For outside subsurface lateral flow that flows to a Friant Contractor, constant upper aquifer constituent concentrations were applied.

[3] The SAGBI is a suitability index for groundwater recharge on agricultural land, developed by the California Soil Resource Lab at UC Davis and UC Agriculture and Natural Resources, and is based on five major factors: deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition (DWR, 2022).

[4] The SAGBI rating classifies soils based on their suitability for accepting recharge, and ranges from excellent to very poor in classification. The SAGBI index was extracted for each subarea and Friant Contractor to qualitatively compare it to the assigned recharge percentage used in the module (DWR, 2022).

Table 4-7. Proxy Year Selection from 1948 through 1973 for Water Year Simulation

C2VsimFG Version 1.0 Proxy Year Used to Simulate Water Year	Water Year	Water Year Type
2009	1948	Below Normal
2009	1949	Below Normal
2009	1950	Below Normal
2010	1951	Above Normal
2011	1952	Wet
2003	1953	Below Normal
2003	1954	Below Normal
2004	1955	Dry
2005	1956	Wet
2009	1957	Below Normal
2011	1958	Wet
2012	1959	Dry
2013	1960	Critical
2014	1961	Critical
2009	1962	Below Normal
2010	1963	Above Normal
2004	1964	Dry
2005	1965	Wet
2009	1966	Below Normal
2011	1967	Wet
2012	1968	Dry
1998	1969	Wet
1999	1970	Above Normal
2003	1971	Below Normal
2004	1972	Dry
2010	1973	Above Normal

Notes:

Water Year Types are based on the San Joaquin Valley Water Year Type.

C2VsimFG Version 1.0 is the Fine Grid California Central Valley Groundwater-Surface Water Simulation Model

Subsurface Vertical Flow

Time-series subsurface vertical flow values were developed for each district (and/or subarea, as applicable) for the upper aquifer using calibrated flow values extracted from C2VsimFG_v1. Subsurface vertical flows, using zone budget output from C2VsimFG_v1, were developed between the two slices of the upper aquifer, as well as for the volume of water moving vertically between the upper and lower aquifer. The approach to develop these vertical flow components was similar as applied to the subsurface lateral flows, where proxy water years were used to construct the 50-year period. Vertical flow simulated in C2VsimFG_v1 was uniformly applied to the entire area of the upper aquifer. The total vertical flow volume was applied to each district (and/or subarea, as applicable). Monthly values of vertical flow were assigned to each district (and/or subarea, as applicable) and each vertical slice (flowing through the bottom of the upper slice and through the bottom of the lower slice). From the upper aquifer perspective, a positive number indicates subsurface flow from the lower aquifer entering the upper aquifer and a negative number indicates subsurface (downward) flow exiting the upper aquifer and entering the lower aquifer.

The concentration of chemical constituents entering the upper slice of the upper aquifer via vertical (downward) migration was based on the resultant concentration of applied water and precipitation concentrations (after uptake by the root zone – which is addressed later in this document).[5] The concentration of chemical constituents entering the lower slice of the upper aquifer via vertical (downward) migration was based on calculated ambient concentrations from the upper slice.

Stream Leakage, Conveyance Leakage, and Mountain Recharge

Time-series stream leakage, conveyance leakage, and mountain recharge values were developed for each district (and/or subarea, as applicable) using calibrated values extracted from C2VsimFG_v1. These terms are directional with relation to the upper aquifer, where conveyance leakage and mountain recharge are always inflow components, and stream leakage can be an inflow or outflow component (depending on whether C2VsimFG_v1 simulated gaining or losing stream conditions during different months). Large year-to-year variations in these terms (and specifically in stream leakage and conveyance leakage) are observed in districts where surface and upper aquifer dynamics are largely influenced by local rivers and/or conveyance ditches (like LTRID). For example, the calibrated values in C2VsimFG_v1 reflect whether a major river (like the Tule River) is gaining or losing in different year types based on river and subsurface conditions. Districts not influenced by large rivers and conveyance ditches do not have large variations in their water budget components. Groundwater quality constituent concentrations applied for conveyance leakage into the upper aquifer were based on the output from the Distribution Model. The concentrations of stream

[5] Uniform mass uptake by the root zone is assumed to be 10%.

leakage, mountain recharge and precipitation were based on water quality data for nearby rain gages, as available.[6]

When evaluating these terms under the land surface perspective, a positive number indicates gaining stream conditions where groundwater from the upper aquifer enters the stream, whereas a negative number indicates losing stream conditions where surface water exits the stream and enters the upper aquifer. Similarly, when evaluating these terms under the upper aquifer perspective, a positive number indicates surface water entering the upper aquifer through losing stream conditions, whereas a negative number indicates groundwater exiting the upper aquifer and entering the stream through gaining stream conditions.

Other Considerations

This section describes other water budget components that were held constant under the various Project alternatives.

Initial Groundwater Levels

Initial groundwater level data, depth to water contour maps, and groundwater elevation contour maps from Groundwater Sustainability Agencies (GSAs) or DWR were used to determine the thickness of the unsaturated zone from the land surface to the top of the water table for each Friant Contractor. This calculation was conducted to estimate travel time for water applied as irrigation on the land surface to migrate downward to the water table. Travel times are summarized in Table 4-5 and discussed previously, in sections above.

Precipitation

Future precipitation amounts were developed similar to the water demands, where annual projections were provided by the various GSP documents that cover the Friant Contractors within the study area. Monthly proportions were used to allocate precipitation volumes to each Friant Contractor, using an 80% effective precipitation factor. This effective precipitation factor was determined through consultation with the Friant Contractors and deemed appropriate for this area of study.

Plant Uptake Percentage

A plant uptake factor is uniformly applied to the concentration of water recharged into the upper aquifer to account for mass uptake by plants during transpiration. It was assumed that 10% of the mass of boron, chloride and TDS in the recharge water is taken up by plants. It was assumed that 80% of the mass of nitrate in the recharge water is taken up by plants. The nitrate uptake factor is higher than the other constituents because plants readily utilize nitrate during transpiration

[6] TDS concentrations were adopted from the surface water model, but the other concentrations were researched:
Boron: 6.6 ug/L (source: Park, Haewon and Schlesinger, William, 2002, Global biochemical cycle of boron, Global Biogeochemical Cycles, December 2002. Boron Concentration in Rainwater From Various Regions | Download Table (researchgate.net) accessed 7/6/2022, boron concentration from the Niwot ridge, Colorado, USA from Fogg and Duce, 1985)Chloride: 0.12 mg/L (source: National Atmospheric Deposition Program, annual average from 1980-2022 at Site CA75 Sequoia National Park-Giant Forest, nadp.slh.wisc.edu/sites/ntn-CA75/ accessed 7/6/2022)
Nitrate: 0.1 mg/L as N (source: National Atmospheric Deposition Program, annual average from 1980-2022 at Site CA75 Sequoia National Park-Giant Forest, nadp.slh.wisc.edu/sites/ntn-CA75/ accessed 7/6/2022)

(CDFA, 2023). This model does not account for individual farming practices such as the application of fertilizer.

Groundwater Quality

Data were collected from publicly available data sources and/or requested from the Friant Contractors. Publicly available data included data from submitted Groundwater Sustainability Plans[7] (GSPs) as part of SGMA, online water quality databases from the State Water Resources Control Board's (SWRCB) Division of Drinking Water (DDW) and Groundwater Ambient Monitoring and Assessment (GAMA) Program (CWB, 2021) which includes data from the California Department of Pesticide Regulation (DPR), DWR, and USGS's National Water Information System (NWIS). The publicly available groundwater quality data were spatially declustered and filtered for only recent, post-2010 data to obtain a more accurate representation of current ambient groundwater quality conditions. Median concentrations for the four groundwater quality parameters of interest (TDS, nitrate (as nitrogen), chloride, and boron) were developed for each Friant Contractor within the study area for the upper and lower aquifers. The starting concentrations for all constituents in the upper and lower aquifer are presented in Table 4-8.

Publicly available groundwater quality data were utilized, where available, to provide consistency in the analysis of effects of Project operations under the Project alternatives. When public data were not available, required inputs were supplemented by data directly provided by the Friant Contractors. When both public and local data were available and a variance was identified, public data were utilized.

[7] The GSPs utilized were the most current versions available at the time of model development. Since the submittal of these GSPs, they have been revised and resubmitted (2022) and are currently undergoing further revisions (2024). The following GSPs and management area plans (MAP) were utilized: DEID GSP 2020, ETGSA 2020, AEWSD MAP 2019, KTWD GSP 2019, LTRID GSP 2020, NKWSD and SWID MAP 2019, PID GSP 2020, SWID 7th Annex Management Area MAP 2019, SSJMUD MAP 2019.

Table 4-8. Starting Concentrations for each Friant Contractor in the Study Area

Friant Contractor	Starting Concentrations (mg/L)							
	Total Dissolved Solids (TDS)		Nitrate (as Nitrogen)		Chloride		Boron	
	Upper Aquifer	Lower Aquifer	Upper Aquifer	Lower Aquifer	Upper Aquifer	Lower Aquifer	Upper Aquifer	Lower Aquifer
AEWSD	454	767	8	7	28	33	0	1
DEID	277	268	9	9	7	29	0	0
KTWD	632	447	5	7	0	38	0	0
LTRID	284	289	16	11	42	24	0	0
Pixley ID	193	197	10	8	35	32	0	0
Porterville ID	638	227	15	5	28	12	0	0
Saucelito ID	363	236	10	6	23	20	0	0
SWID	807	465	9	10	6	28	0	0
SSJMUD	875	554	9	10	12	29	0	0
TPDWD	400	271	20	24	7	18	0	0
TBID	335	247	27	8	1	23	0	0

Source: Groundwater Ambient Monitoring and Assessment (GAMA) accessed Nov 5, 2021 (CWB, 2021) and supplemented by Friant Contractor-provided groundwater quality data as needed. AEWSD provided boron concentrations for the upper aquifer on August 12, 2022 (AEWSD, 2022).

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
mg/L = milligrams per liter
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TDS = total dissolved solids
TPDWD = Tea Pot Dome Water District

Uncertainty

All analytical and numerical model methodologies used to simulate human interactions with a natural environment have certain degrees of uncertainty in representing the natural environmental system. Table 4-9 identifies and qualitatively describes the uncertainty associated with the components of the groundwater analysis with the degree of uncertainty in the model components and the likely impact on model results. The use of the state's calibrated C2VSim model reflects the selection of the best available data at the time of development. Furthermore, the C2VSim domain covers the entire study area such that simulated effects of alternatives on long-term trends in groundwater quality can be assessed using a common methodology. It is recognized that districts within the Kern Subbasin, including KTWD and AEWSD, may have developed their own service area modeling tools, but these enhancements were not available for use at the time of the development of the analysis and are not available for other regions in the study area. Consequently,

it was determined that C2VSim was the best available tool to simulate effects of operations on groundwater quality.

Table 4-9. Assumptions and Uncertainty Qualitative Summary

Mixing Model Component	Assumptions/Data Source	Uncertainty Level (Low, Moderate, High)	Likely Impact on Model Results (Low, Moderate, High)
Model Design: Instantaneous Mixing	The Groundwater Model assumes instantaneous mixing occurs within each month for the discretized units (vertically and spatially) within each Friant Contractor. This assumption allows for conservative realizations of potential impacts of operations under Project alternatives on the aquifer system. The Groundwater Model attempts to reduce uncertainty associated with this design component by improving the spatial discretization and applying a lag time (delay function) for mass entering the water table and the bottom slice of the upper aquifer.	Moderate: In the absence of a numerical flow and transport model, this approach provides an acceptable amount of uncertainty	Moderate
Model Design: Average Initial/Ambient Groundwater Quality	The Groundwater Model uses an average initial or ambient groundwater quality concentration to represent the entire upper aquifer's constituent concentration throughout the entire Friant Contractor as a starting point at the beginning of the analysis. This empirical approach does not allow for spatial variability within the Friant Contractor either vertically within the upper aquifer or spatially/laterally within the Friant Contractor's subareas. The actual starting point of ambient groundwater quality has moderate impact on the "Project/No-Project" comparison between baseline and alternatives, although it does have a high impact on the resultant final value of water quality.	Moderate: The level of uncertainty on the ambient and initial groundwater quality concentration depends on the data available/provided	High: Higher starting ambient concentrations would lead to higher ending concentration and vice versa

Mixing Model Component	Assumptions/Data Source	Uncertainty Level (Low, Moderate, High)	Likely Impact on Model Results (Low, Moderate, High)
Model Design: Average Initial Saturated Thickness of the Mixing Zone	The Groundwater Model utilizes an average saturated thickness of the upper aquifer to begin the analysis. This average value smooths the variability of aquifer depths within the Friant Contractor, particularly for Friant Contractors that have sloping stratigraphy (e.g., close to the eastern edge of the San Joaquin Valley).	Moderate: Well depth data and stratigraphic/geologic cross sections were used to develop the C2VsimFG_v1 model layering and inform the average thickness of the aquifer unit(s). KTWD has voiced concerns regarding the saturated thickness developed.	Moderate: Saturated thickness impacts the volume available within the mixing zone to mitigate increases in mass
Water Budget Component: Surface Water Deliveries and Water Quality	Surface water delivery volumes and water quality for the Millerton, existing programs, local, and additional pump-back supplies are derived from the Water Quality Model. Values for each alternative or model scenarios are used as inputs for the Groundwater Model. The volume and quality of surface water deliveries have direct impacts on deep percolation (groundwater recharge).	Moderate	High: Increases in surface water deliveries will decrease pumping thus on average, decreasing ending concentrations
Water Budget Component: Total Water Supply and Demand	The data source for the water supply (surface water deliveries plus groundwater pumping) and demand is based on information extracted from the various Groundwater Sustainability Plans that cover the Friant Contractors.	Low to Moderate: Future water supply and demands are developed following SGMA and GSP standards.	Moderate: Amount of demand dictates eventual pumping amounts
Water Budget Component: Precipitation	The precipitation data for each Friant Contractor are based on future projections from the various GSP documents that cover the Friant Contractor. An effective precipitation factor of 0.8 was used to account for any evaporation of precipitation occurring on bare soil, canopy interception, etc.	Low to Moderate: The effective precipitation factor has moderate uncertainty, and is based on typical values for the area considering that any precipitation runoff is captured within the Friant Contractor.	Low: Higher precipitation fulfills more demand, thus decreasing pumping and vice versa

Mixing Model Component	Assumptions/Data Source	Uncertainty Level (Low, Moderate, High)	Likely Impact on Model Results (Low, Moderate, High)
Water Budget Component: Groundwater Extraction	Groundwater extraction is simulated in the Groundwater Model based on future supply values from the GSP documents. The proportion of groundwater extraction that occurs within the upper and lower aquifers is an assumption that is based on the proportions of pumping within the C2VsimFG_v1 calibrated flow model.	Moderate: The proportion of upper to lower aquifer pumping is not well-documented and has a moderate level of uncertainty.	Moderate: Higher levels of pumping lead to higher ending concentrations and vice versa
Water Budget Component: Deep Percolation	Deep percolation is estimated based on a percent of the total applied water (from effective precipitation, surface water deliveries, and groundwater extraction), based on the proportion of recharge from the C2VsimFG_v1 calibrated flow model.	Low: Deep percolation values of 10-20% of total applied water are typical values used to estimate deep percolation or groundwater recharge	High: Recharge dictates the percentage of applied water that will reach the upper aquifer
Water Budget Component: Subsurface Lateral Flow	Variable monthly lateral flows were derived from C2VsimFG_v1 groundwater model simulated results. Monthly flow values were taken from water year types that were similar to the CalSim 50-year period used to develop the Distribution Model.	Moderate: Several Friant Contractors have voiced concerns with DWR's C2VsimFG_v1 previously-simulated lateral flows.	Low: Lateral flows impact volume and mass movement in and out of the Friant Contractor area
Water Budget Component: Subsurface Vertical Downward Flow to lower aquifer	Average vertical downward flow values were derived from C2VsimFG_v1 groundwater model simulated results. Although previous sensitivity analyses on vertical flow values indicate minimal impacts on resultant groundwater quality, their impact on groundwater storage was moderate over longer time periods. Values of vertical downward flow may be adjusted to avoid dewatering the upper aquifer.	High	Low to Moderate: Vertical flows impact volume and mass movement in and out of the Friant Contractor area

Key:
C2VsimFG_v1 = Fine Grid California Central Valley Groundwater-Surface Water Simulation Model
GSP = groundwater sustainability plan
KTWD = Kern Tulare Water District
SGMA = Sustainable Groundwater Management Act

4.1.1.3 Development of the Groundwater Model

The Groundwater Model employs a mass balance approach which was simulated through calculations conducted within several modules of the Groundwater Model. This approach and the subsequent modules are described below.

Mass Balance Approach

The concept of conservation of mass was applied in the Groundwater Model. Each Friant Contractor has volumetric flow and mass components associated with inflows and outflows. Water volume calculations were performed each month during the simulation period such that the difference between inflows and outflows determined the change in aquifer storage. Solute mass calculations were performed for each monthly time step, such that the difference between inflows and outflows determined the change in solute mass. Groundwater inflow and outflow components are listed in Table 4-10.

Table 4-10. Inflow and Outflow Groundwater Components

Upper Aquifer Inflows	Upper Aquifer Outflows
• Groundwater recharge (via precipitation and applied water) • Subsurface lateral flow • Subsurface vertical flow • Stream leakage • Conveyance leakage • Mountain front recharge	• Groundwater pumping • Subsurface lateral flow • Subsurface vertical flow • Stream leakage

Inflow and outflow components each have assigned initial concentrations which yield a mass value when isolating the mass variable in the simple equation: concentration = mass/volume (and following, mass = concentration/volume).

Modules

The Groundwater Model is made up of several different modules that provide separate calculations to simulate various features of the subsurface interactions over the analysis period. This section provides a summary of the various modules that were developed using Python code to make the Groundwater Model a robust tool for analyzing the potential impacts of operations under Project alternatives and evaluating long-term trends of groundwater conditions.

Initial Values Module

This module reads all the starting aquifer properties into the Groundwater Model, and the initial volumes of each slice of the upper aquifer are calculated based on saturated thickness, area, and porosity.

Applied Water Volume Module

The Applied Water Volume Module calculates the volume of water from each source that is applied to the ground surface. This module utilizes the monthly water demand values (based on annual values from GSP documents) to determine how much of that demand can be met by effective precipitation. It also calculates the remaining demand to be met by surface water deliveries and

groundwater pumping. This results in volumes of applied water from groundwater (from the upper and lower aquifers), surface water, and effective precipitation.

Applied Water Mass Module
This module calculates the water quality constituent, or solute, mass associated with applied water volumes calculated in the previous module. The solute mass is calculated based on concentration (using the equation: mass = concentration/volume). The precipitation concentration is held constant, the surface water concentration is provided in monthly time step values from the Water Quality Module, and the concentration of groundwater pumping is represented by the concentration of lower aquifer water pumped and the initial (then calculated) concentration of upper aquifer water.

Groundwater Recharge Summary Values Module
This module calculates applied water total mass, applied water volume, excess water volume to recharge, and excess mass to recharge. In the case where the monthly demand is fully met by precipitation, but there is more monthly precipitation than monthly demand, excess precipitation turns into groundwater recharge. Similarly, in the case where the monthly demand is satisfied by precipitation and/or partially by surface water deliveries, the excess reported surface water deliveries are assumed to leave as runoff. When precipitation and/or surface water deliveries fully satisfies the monthly demand, groundwater pumping does not occur. Variable recharge percentages of the applied water are estimated based on C2VsimFG_v1 proportions of groundwater recharge (deep percolation).

Lateral Flows Module
This module calculates the volumes and masses associated with the lateral time-series flow data (post-processed simulated output from C2VsimFG_v1).

Vertical Flows Module
This module calculates the volumes and masses associated with the vertical time-series flow data (post-processed simulated output from C2VsimFG_v1).

Monthly Summary Module– Upper Slice of the Upper Aquifer (Slice 1)
This module performs the volume and solute mass calculations (inflow minus outflow) associated with the upper slice of the upper aquifer or slice 1. These calculations include components such as recharge volume and mass, pumping volume and mass, subsurface inflow volume and mass, and subsurface outflow volume and mass. The volumes and masses are calculated, resulting in a final volume, mass, and resultant concentration for the upper slice of the upper aquifer for each monthly time step.

The delay function associated with the travel time for the vertical migration of applied water is used to delay the solute mass and volume of recharge on a monthly basis, based on the amount of time it takes for water (and solute mass) to travel through the vadose zone. The initial recharge concentrations (using existing surface water concentrations and supply volumes) are repeated until the lag time is achieved, and then the upper slice calculations receive the recharge (from the applied water module) associated with simulated surface water deliveries.

There are two main scripts that are used to quantify the monthly volumes and masses associated with changing subsurface inflows and outflows over time: 1) Calculation of volume for subsurface lateral and vertical flows; and 2) Calculation of solute mass for subsurface lateral and vertical flows. Because there is interflow between adjoining Friant Contractors (and/or subareas, as applicable), the solute mass varies with each time step as the solute concentration for each discretized unit (vertical slices, Friant Contractors, and Friant Contractor subareas) changes at the end of the previous time step. These two key calculation steps ensure that the appropriate amount of solute mass is transferred between subsurface units.

Monthly Summary Module – Lower Slice of the Upper Aquifer (Slice 2)
Similar to the module above, this module performs the volume and solute mass calculations for the subsurface inflow volume and mass, subsurface outflow volume and mass, to produce a final volume, mass, and concentration for the lower slice of the upper aquifer or slice 2 for each monthly time step.

The delay function associated with the travel time for the vertical migration of water through the upper slice to the lower slice of the upper aquifer is used to delay the solute mass and volume of the vertical downward flow component on a monthly basis. The initial ambient concentration of the upper slice is used until the lag time is satisfied, when the upper slice's concentration is then used to calculate the mass entering the lower slice of the upper aquifer.

Summary of Assumptions
There are many key assumptions applied in the Groundwater Model. These assumptions are listed below:

- An applied uniform uptake factor (10%) accounts for salinity uptake by plants during transpiration.
- An 80% uptake factor is applied for nitrate as nitrate is readily utilized by plants during transpiration.
  - This is considered a conservative approach rather than assuming that 100% nitrate-nitrogen mass from applied water uptake by plants despite common understanding that nitrogen demand by crops largely exceeds mass irrigation input annually (due to need for on-farm applications of nitrate nitrate).
  - Mass nitrate-uptake by plants likely exceeds 80% during the late spring, summer months when evapotranspiration (ET) is high and water demand is high (therefore, applied water is also higher). This assumption is consistent with literature regarding the amounts of nitrate taken up by crops.
  - As evidenced by nitrate concentrations in groundwater, we know that not all nitrate is taken up by crops, so the 80% uptake will allow for some nitrate to bypass the root zone due to deep percolation losses from irrigation inefficiencies or unsaturated flow losses during the off-season. This 80% also covers variability in uptake due to crop type, but assumes good on-farm practices, etc. throughout the study area and over time.
- Future water supply (groundwater pumping and surface water deliveries) and demand is based on the monthly apportioning of annual values under the projected baseline condition as

provided in the SGMA GSPs for each Friant Contractor (where available). These demand values do not account for any management actions proposed in the GSPs to reduce groundwater pumping. Monthly apportioning is based on evapotranspiration values from ITRC.

- Precipitation amounts are based on values defined in GSP documents and reduced by applying an effective precipitation factor of 80%.
- The mass balance approach assumes instantaneous mixing within each discretized unit of the upper aquifer (e.g., upper slice and lower slice) each month. This allows the Groundwater Model to provide updated ambient groundwater quality (solute concentrations) for use in the next monthly time step.
- Groundwater quality analysis focused on changes in concentrations of key constituents in applied water under water operations simulated for Project alternatives and does not consider site-specific, on-farm application of fertilizers (e.g., nitrate) and/or soil amendments.
- Initial ambient groundwater quality is assumed for the entirety of each Friant Contractor and does not account for any spatial variability.
- Similarly, although the depth to the bottom of the upper aquifer is variable for each Friant Contractor, one value of average saturated thickness is determined for each Friant Contractor for developing the initial saturated thickness and starting water volume in each slice of the upper aquifer. While the upper aquifer thickness applied for analysis may not be representative of actual conditions for a Friant Contractor (based on data provided directly by the Friant Contractors), this assumption for use of upper aquifer data from C2VSimFG_v1model layer 1 provided for consistency in analytical approach and determined to be appropriate for analysis of effects of Project operations under the alternatives.
- The volume of recharge (or deep percolation) is estimated on a monthly basis, using a percent of the total applied water that is based on the proportion of recharge in the C2vSimFG_v1.
- Subsurface lateral and vertical flows are variable and based on monthly values from the post-processed C2vSimFG_v1, using proxy water years for a portion of the 50-year simulation period.
- The saturated thicknesses of the upper and lower slices of the upper aquifer are variable throughout the analysis, allowing the water table elevation to fluctuate monthly, while maintaining the original volumetric proportion of the volume of water in the upper and lower slices of the upper aquifer.
- The lag times estimated and described above for the vadose zone and upper slice delay function in downward migration are held constant throughout the analysis period.
- A 10% increase in demand is applied to January and February for pre-irrigation.

4.1.2 Sensitivity Analysis

To evaluate responses of the Groundwater Model to changes in model inputs, several sensitivity analyses were performed. Sensitivity tests were performed for the following parameters:

- Starting ambient groundwater concentrations.
- Surface water delivery concentrations.

- Saturated thickness of the upper aquifer and lower aquifer (including future potential water level changes under GSPs that would impact saturated thickness of the upper aquifer).
- Subsurface vertical flow amounts.
- Groundwater pumping amounts in the upper versus lower aquifers (including any future potential changes in pumping amounts and depth distributions related to SGMA implementation)

The starting ambient groundwater concentration was adjusted to half and double the initial TDS concentration. Results show that the concentrations increased for all Friant Contractors when ambient TDS was doubled and decreased when ambient TDS was halved. These results highlight the model's sensitivity to ambient conditions. No clear pattern or trend was observed in the amount of increase or decrease when the sensitivity runs were compared to the baseline condition. Furthermore, the Friant Contractors were not equally sensitive to a change in the starting concentration. This difference could be the result of different starting concentrations of TDS in the lower aquifer, different pumping proportions from each aquifer, whether a Friant Contractor has a net inflow or outflow, and different saturate thicknesses of the upper aquifer.

The saturated thickness of the upper and lower aquifers was tested using Friant Contractor provided data and GSP-based values and compared to saturated thicknesses derived from C2vSimFG_v1 calibrated model amounts. Results show that the utilization of C2vSimFG_v1 values for saturated thickness provide greater consistency with the remaining subsurface groundwater flow components. The saturated thickness varies for the Friant Contractors that are split by surface water/groundwater delivery areas and in/out of the Corcoran clay. The sensitivity results for saturated thickness did not yield any trends in the changes in TDS. The results varied between Friant Contractors (even within subareas). These results suggest that the model is not sensitive to changes in saturated thickness.

Vertical flow amounts were adjusted to determine the role that vertical flow has on the movement of constituents and the resultant concentration of TDS. In the two sensitivity runs, vertical flows were increased by one order of magnitude and reduced by one order of magnitude. Results show that decreasing vertical flows increased the ending TDS concentration for the majority of Friant Contractors. In contrast, increasing the vertical flow reduced the ending concentration for all Friant Contractors. These results show the model's sensitivity to vertical flows. Vertical flow is one of the mechanisms by which mass leaves the upper aquifer system. Increasing vertical flows would allow more mass to travel from the upper aquifer to the lower aquifer, thus decreasing mass loading of the upper aquifer and in turn, concentration. Decreasing vertical flows would allow more mass to accumulate in the upper aquifer leading to the increase in concentration as seen in the sensitivity analysis.

The proportion of pumping from the upper and lower aquifers was tested with different values. Upper and lower pumping amounts based on Friant Contractor provided data were compared to pumping amounts developed and utilized in the C2vSimFG_v1 calibrated flow model and in GSP documentation. Documentation from DWR for the C2vSimFG_v1 indicated that the vertical distribution of groundwater pumping is based on urban well depths and agricultural depths taken from the previous DWR model (the Central Valley Regional Aquifer System and Analysis,

CV-RASA) (Brush et al., 2013). The model layering and vertical distribution of pumping was comparable to the information received from the Friant Contractors in most cases[8] and the vertical distribution of pumping from C2vSimFG_v1 was utilized. Maintaining C2vSimFG_v1 pumping proportions allowed for further consistency with the volumetric groundwater budgets used for the balance calculation model. Total pumping amounts were based on data from GSPs, and information provided by Friant Contractors for land use. These values informed the demand component of the model. The sensitivity runs on pumping amounts involved increasing demand by 10% and decreasing demand by 10%. This change in demand would impact pumping from both the upper and lower aquifers. When pumping amounts were increased by 10%, ending groundwater solute concentrations increased for all Friant Contractors. A decrease in pumping by 10% had the opposite effect of the pumping increase, with ending groundwater solute concentrations for all Friant Contractors decreased when pumping was decreased. The increases and decreases were not uniform, with differences across Friant Contractor subareas reflecting the differences in the other model inputs for each Friant Contractor.

4.2 Groundwater Quality Modeling Results

The following sections summarize the groundwater quality modeling results for operations under Existing Conditions, No Project Alternative, Low Flow Alternative, Seasonal Alternative, and High Flow Alternative. As explained in previous chapters, the Low Flow Alternative and Seasonal Alternative were modeled concurrently, and results are presented together. Consistent with the surface water modeling described above, two baseline conditions were simulated: an Existing Condition and No Project Alternative.

Results for groundwater quality modeling are provided for the Friant Contractors receiving water deliveries within each Project reach in the study area. The specific Friant Contractor receiving water deliveries within each Project reach are listed in Table 3-6. For quick reference, a description of each water budget component, the signage of water budget values from the land surface or upper aquifer perspective (as appropriate), and the source and calibration for each component are provided in Table 4-11 below.

[8] The vertical distribution of pumping in Porterville was adjusted from the C2VSimFG V1.0 pumping proportions, reducing the proportion of upper aquifer pumping to lower aquifer pumping.

Table 4-11. Descriptions and Information on Groundwater Budget Components.

Water Budget Component Term	Description	Flow Direction Signage	Source
Terms Varying Between Scenarios and Alternatives			
Surface Water to Demand	Amount of surface water applied to meet water demand.	Land surface perspective: positive number indicates amount of surface water applied to land surface to meet water demands.	Surface Water Module
Total (Groundwater) Pumping and Pumping	The amount of water pumped from the upper and lower aquifers to satisfy demand.	Land surface perspective: positive number indicates total groundwater pumping applied to land surface to meet water demand. Upper aquifer perspective: negative number indicates pumping from upper aquifer to meet demand.	Groundwater Module
Recharge (via precipitation and/or applied water)	Deep percolation of precipitation water and applied irrigation water that passes the root zone and enters the upper aquifer.	Upper aquifer perspective: positive number indicates water (from precipitation and/or applied water) entering the upper aquifer	Recharge percentages are from calibrated values in C2VSimFG. Percentages applied to surface water and precipitation.
Terms That Do Not Vary Between Scenarios and Alternatives			
Subsurface lateral and vertical flows	Horizontal flow in or out of the upper aquifer.	Upper aquifer perspective: positive number indicates subsurface water flowing into the upper aquifer from neighboring area(s); negative number indicates subsurface water leaving the upper aquifer and entering neighboring area(s).	Calibrated values in C2VSimFG.

Water Budget Component Term	Description	Flow Direction Signage	Source
Stream leakage	Water entering or exiting the upper aquifer from simulated streams.	Land surface perspective: positive number indicates gaining stream conditions where groundwater from the upper aquifer enters the stream; negative number indicates losing stream conditions where surface water exits the stream and enters the upper aquifer. Upper aquifer perspective: positive number indicates surface water entering the upper aquifer through losing stream conditions; negative number indicates groundwater exiting the upper aquifer and entering the stream through gaining stream conditions.	Calibrated values in C2VSimFG.
Conveyance leakage	Interaction between surface water in conveyances (canals, ditches, etc.) and the upper aquifer	Land surface perspective: positive number indicates groundwater entering the conveyance from the upper aquifer; negative number indicates surface water exiting the conveyance and entering the upper aquifer. Upper aquifer perspective: positive number indicates surface water leaking through the bottom of a conveyance to enter the upper aquifer; negative number indicates groundwater leaving the upper aquifer and entering the conveyance.	Calibrated values in C2VSimFG.

Water Budget Component Term	Description	Flow Direction Signage	Source
Mountain front recharge	Groundwater recharge originating from the foothills of the Sierra Nevada on the edges of the alluvial aquifer of the Central Valley.	Land surface perspective: positive numbers indicate water originating from the foothills of the Sierra Nevada on the eastern side of the Central Valley entering the landscape. Upper aquifer perspective: positive numbers indicate water originating from the foothills of the Sierra Nevada on the eastern side of the Central Valley entering the upper aquifer.	Calibrated values in C2VSimFG.
Precipitation to demand	Amount of precipitation used to satisfy demand. Precipitation volume is used to meet water demands before surface water and groundwater pumping.	Land surface perspective: positive number indicates amount of precipitation used to meet water demands.	Historical data from gauges within each district, from GSPs, or data provided by Districts.

4.2.1 Existing Conditions

Below subsections provide results of groundwater quality analysis for operations under the Existing Condition.

4.2.1.1 Groundwater Budget Components

The Groundwater Model considers several different water budget components. Water budget components that did not change between the Existing Condition, No Project Alternative, and three Project alternatives are: subsurface vertical flow, subsurface lateral flow, stream leakage, conveyance leakage, mountain recharge, precipitation, and the percentage of plant uptake. The values applied for these inputs remained constant for all modeled scenarios. The groundwater budget components that may change between the modeled scenarios include the surface water deliveries., groundwater pumping, and recharge. Variation in the volume and concentration of surface water deliveries between the scenarios, as described in Chapter 3, over the simulation period effects groundwater pumping volumes and recharge volumes (as simulated by the model). During periods when surface water deliveries increase, groundwater pumping to meet demand decreases and recharge in the upper aquifer increases. Thus, simulated groundwater pumping volumes and recharge vary across the six scenarios simulated. Total simulated groundwater pumping over the 50-year simulation period is shown in Table 4-12.

Table 4-12. Total Groundwater Pumping Over 50-Year Simulation Period

Friant Contractor	Total Simulated Groundwater Pumping (acre-feet)[1]					
	Existing Conditions	No Project Alternative	Low Flow Alternative and Seasonal Alternative		High Flow Alternative	
			Under Existing Conditions	Under Future Conditions	Under Existing Conditions	Under Future Conditions
AEWSD	6,608,800	6,856,400	6,457,900	6,757,900	6,307,400	6,620,200
SWID	2,274,900	2,402,600	2,065,200	2,219,100	1,811,100	2,032,600
SSJMUD	2,544,500	2,718,600	2,196,800	2,425,600	1,812,100	2,093,900
KTWD	1,032,100	1,338,100	908,300	967,400	814,900	864,400
DEID	999,200	1,216,000	786,700	1,006,600	583,300	748,500
TBID	486,500	506,900	429,000	463,200	369,200	405,800
Saucelito ID	1,257,700	1,346,600	1,183,800	1,293,900	1,092,900	1,236,500
Pixley ID	5,627,900	5,202,300	5,627,900	4,644,800	5,627,900	4,556,800
TPDWD	198,100	205,200	175,900	190,600	152,000	174,400
Porterville ID	976,000	1,042,200	922,200	1,007,800	854,000	968,800
LTRID	3,063,000	2,954,300	2,874,700	2,461,800	2,627,800	2,243,900

1. Total groundwater pumping for upper and lower aquifers. Values are rounded to nearest 100 acre-feet.

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District

Figure 4-5 to Figure 4-26 depict land surface water budgets and upper aquifer water budgets under the Existing Condition for each Friant Contractor district in the study area. These figures distinguish between the inflows and outflows of the upper aquifer and land surface (where positive numbers indicate water entering and negative numbers indicate water leaving). All volumes are expressed in acre-feet (AF).

The land surface water budget summarizes the changes in the following parameters over the simulation period: surface water to demand, precipitation to demand, mountain recharge, stream leakage, conveyance leakage, and total pumping. The surface water to demand and total pumping are the two components that vary between the Existing Conditions and the three Project alternatives. Variation in the surface water deliveries between the baseline and Project alternatives over the simulation period, as described in Chapter 3, effects groundwater pumping volumes. During periods when surface water deliveries increase, groundwater pumping to meet water demands decreases. All other land surface water budget components are considered the same between the Existing Conditions and three Project alternatives.

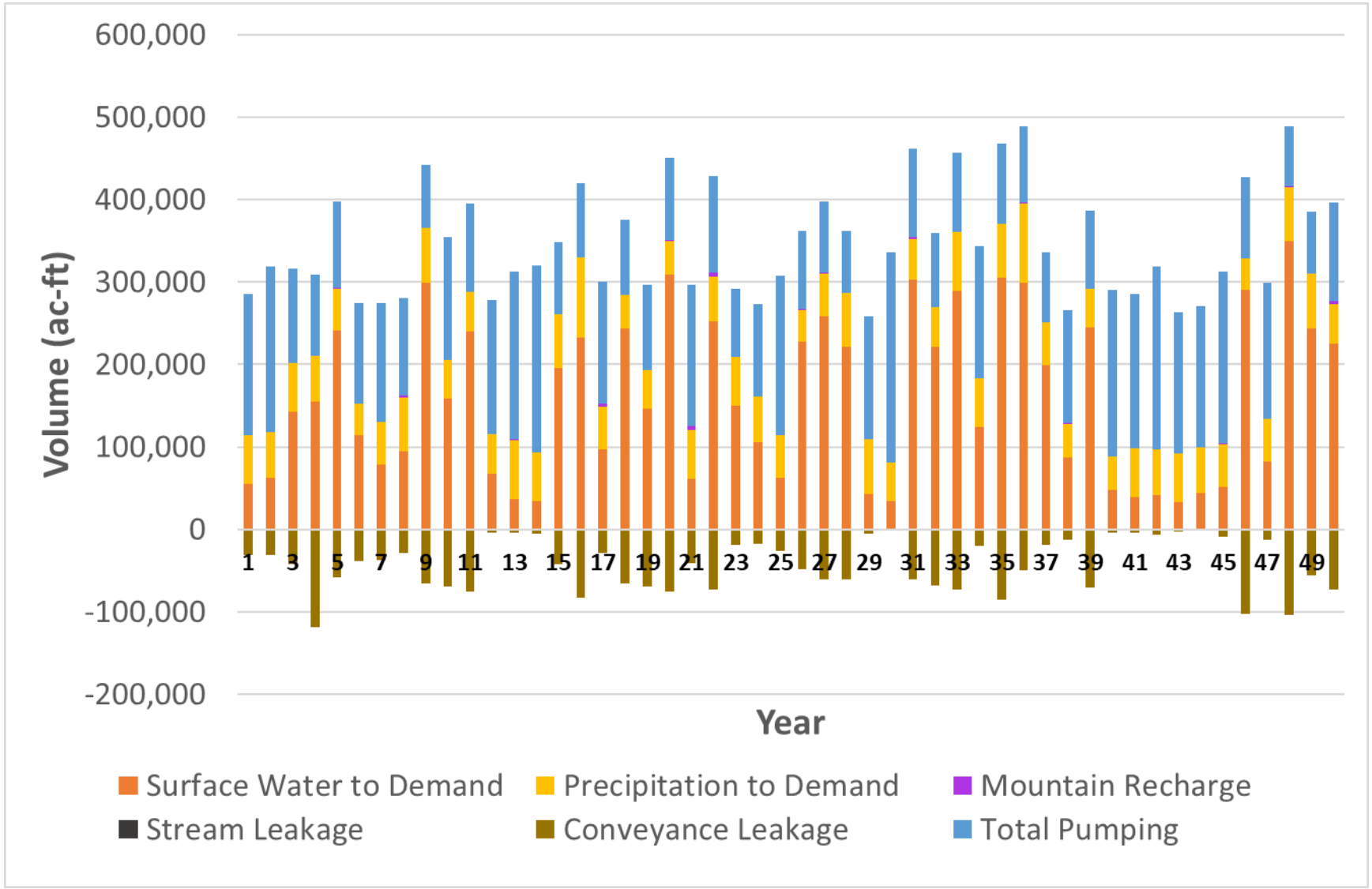
The upper aquifer water budget summarizes the changes in the following parameters over the simulation period: recharge, lateral flows, vertical flows, mountain recharge, pumping, stream leakage, and conveyance leakage. Recharge and pumping are the two components that vary between the Existing Conditions and the three Project alternatives. Variation in the surface water deliveries between the baseline and Project alternatives over the simulation period, as described in Chapter 3, effects groundwater pumping volumes and recharge volumes. During periods when surface water deliveries increase, groundwater pumping to meet water demands decreases to meet water demands and recharge in the upper aquifer increases. All other upper aquifer water budget components are considered the same between the Existing Conditions and alternative scenarios.

In the upper aquifer, pumping, lateral flows, and vertical flows are all outflow components. Depending on the conditions for a specific Friant Contractor, lateral flows and vertical flows can also serve as inflows. The vertical and lateral flows are the result of regional groundwater flow patterns and the gradient created by pumping from the upper and lower aquifers and adjacent Friant Contractors. However, it is important to note that both the volumetric amounts of vertical and lateral flows do not change in response to simulated changes in groundwater pumping during the simulation period, but reflect the established initial gradient and regional flow patterns. Both conveyance leakage and stream leakage are considered inflows entering the upper aquifer. In addition to these two inflows, the upper aquifer receives flow from mountain recharge and recharge from the applied water (water applied to the land surface to meet demand).

Recharge from applied water is calculated as a percentage of the total applied water (the sum of precipitation, surface water, and pumping used to meet demand) as described in Chapter 4.1.1.2. Recharge percentages vary between Friant Contractors (and/or subareas, as applicable) and determine the amount of the applied water that will percolate to the upper aquifer. In contrast, the mass entering the upper aquifer with the recharge water is determined by the plant uptake percentage (80% for nitrate and 10% for all other constituents). Any mass not taken up by the plants enters the upper aquifer with the recharge water.

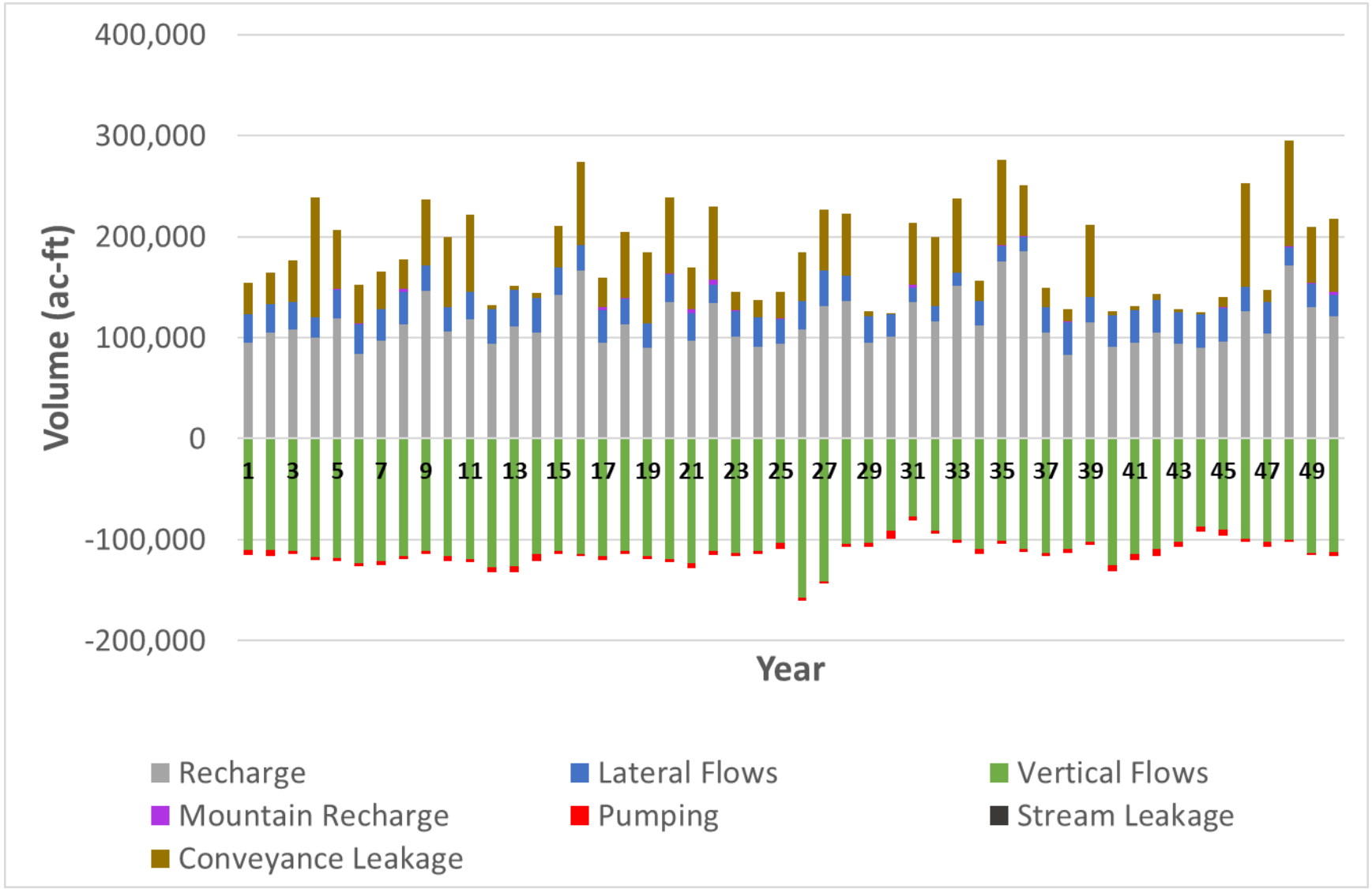
The combination of the above-mentioned components resulted in Friant Contractors experiencing varying inflows and outflows on a year-by-year basis, leading to some years with net inflow and others with net outflow from the upper aquifer. Although Friant Contractors experienced changes in net flow on a yearly basis, overall net inflow and outflow trends were identified for the Friant Contractors over the 50-year simulation period. Under the Existing Conditions, AEWSD, SSJMUD, DEID, Saucelito ID, Pixley ID, and LTRID experienced a net inflow of water over 50 years and SWID, KTWD, TBID, TPDWD, and Porterville ID experienced a net outflow of water over 50 years. These components and the resulting net inflow/outflow from Friant Contractors also impact the concentrations of constituents in the upper aquifer. Net outflow from an aquifer can result in increasing constituent concentrations if the amount of mass in the upper aquifer remains the same or increases. Conversely, net inflow coupled with decreasing or constant mass in the upper aquifer will result in decreasing constituent concentrations.

The concentration of recharge water also impacts constituent concentrations in the upper aquifer. The recharge percentages for Friant Contractors (and/or subareas, as applicable) range from 2% to 40% for water and plant uptake percentages for mass are 80% for nitrate and 10% for all other constituents. This percentages show that between 2% and 40% of applied water will enter the upper aquifer but 20% to 90% of applied mass will enter the upper aquifer. This difference in recharge percentages and plant uptake percentages can lead to increased concentrations of constituents in the recharge water entering the upper aquifer thus leading to more mass loading.



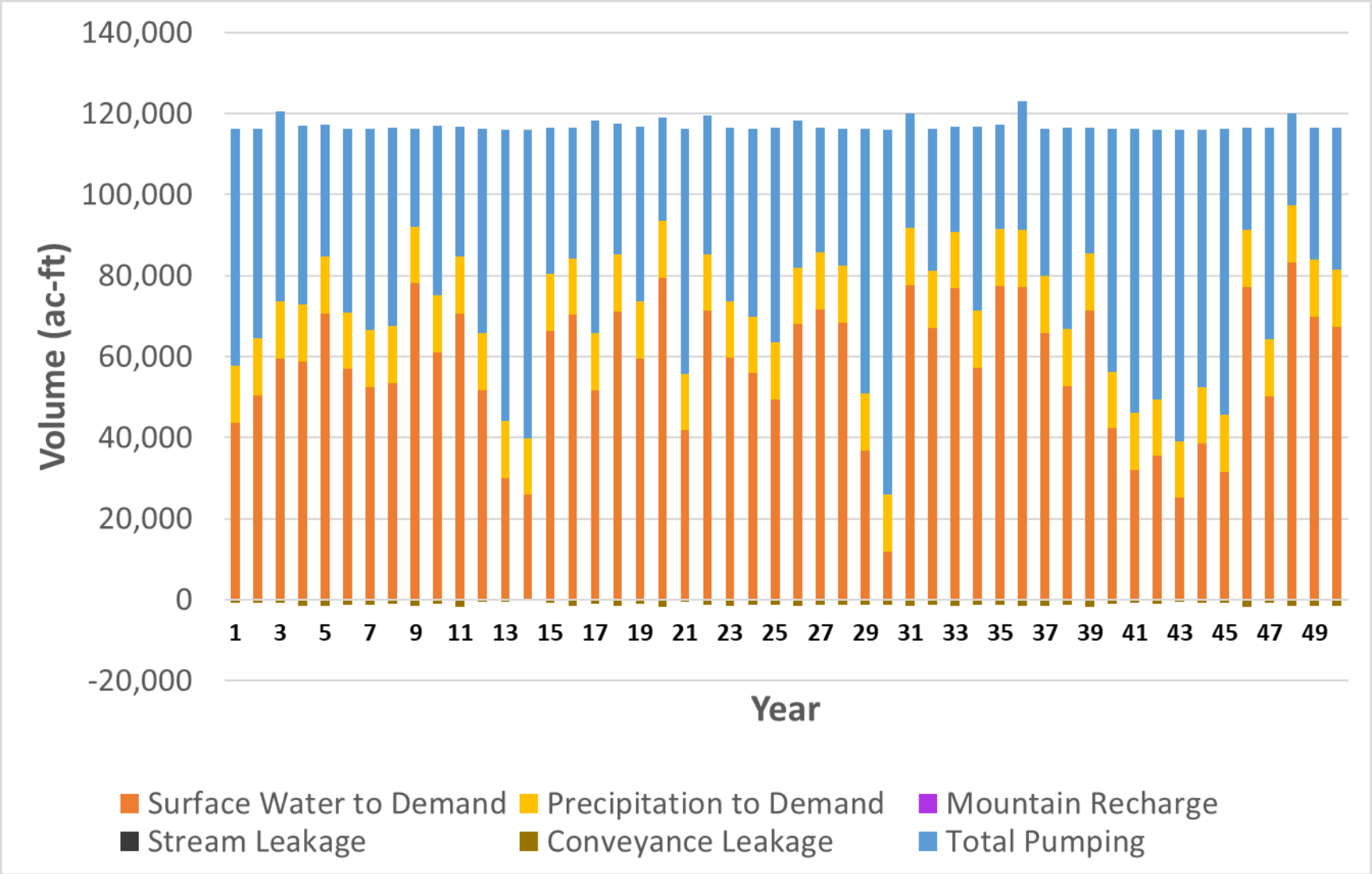
Key: ac-ft = acre-feet

Figure 4-5. Arvin Edison Water Storage District Land Surface Water Budget Components Aggregated by Year Under Existing Conditions



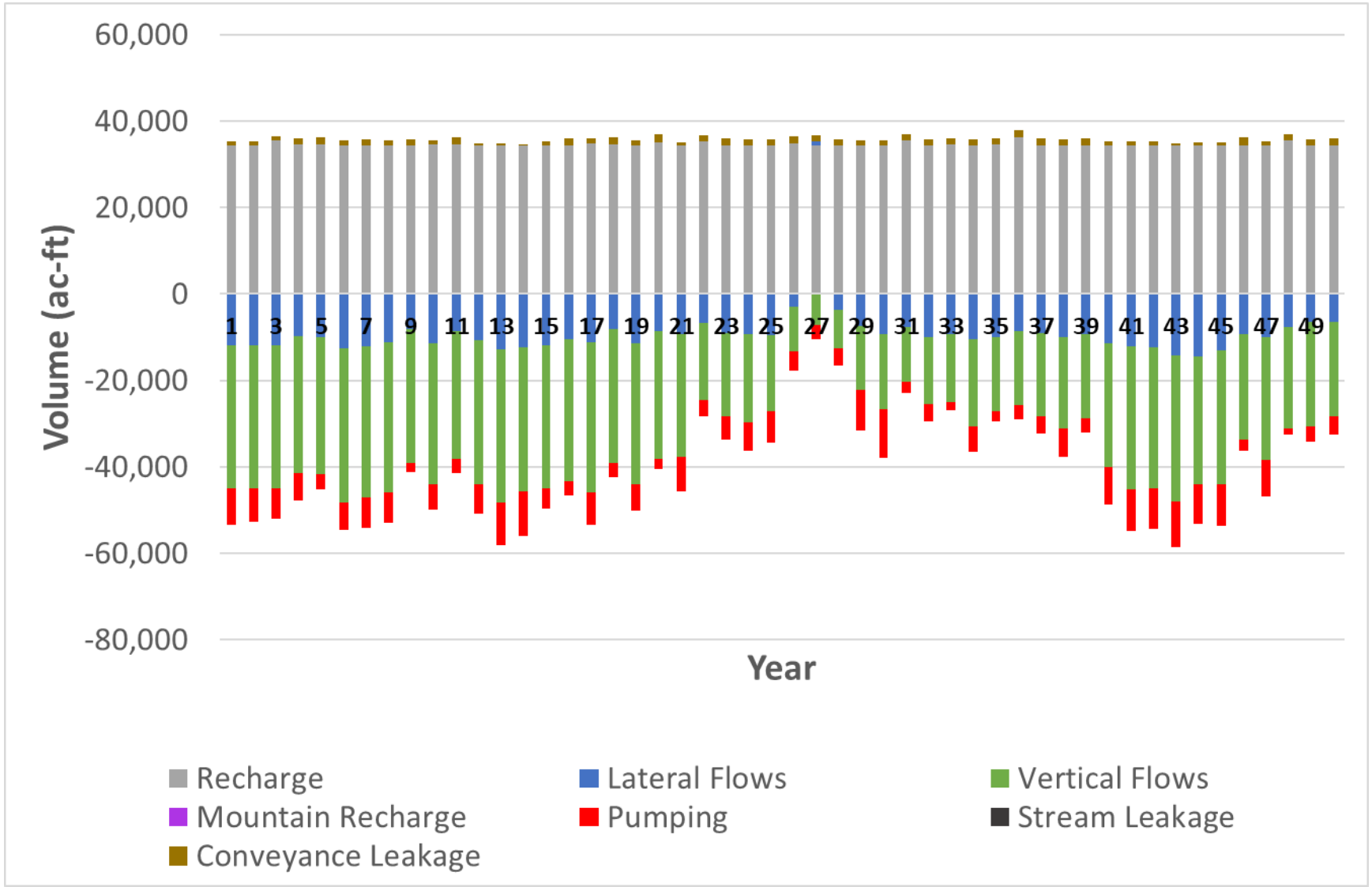
Key: ac-ft = acre-feet

Figure 4-6. Arvin Edison Water Storage District Upper Aquifer Water Budget Components Aggregated by Year Under Existing Conditions



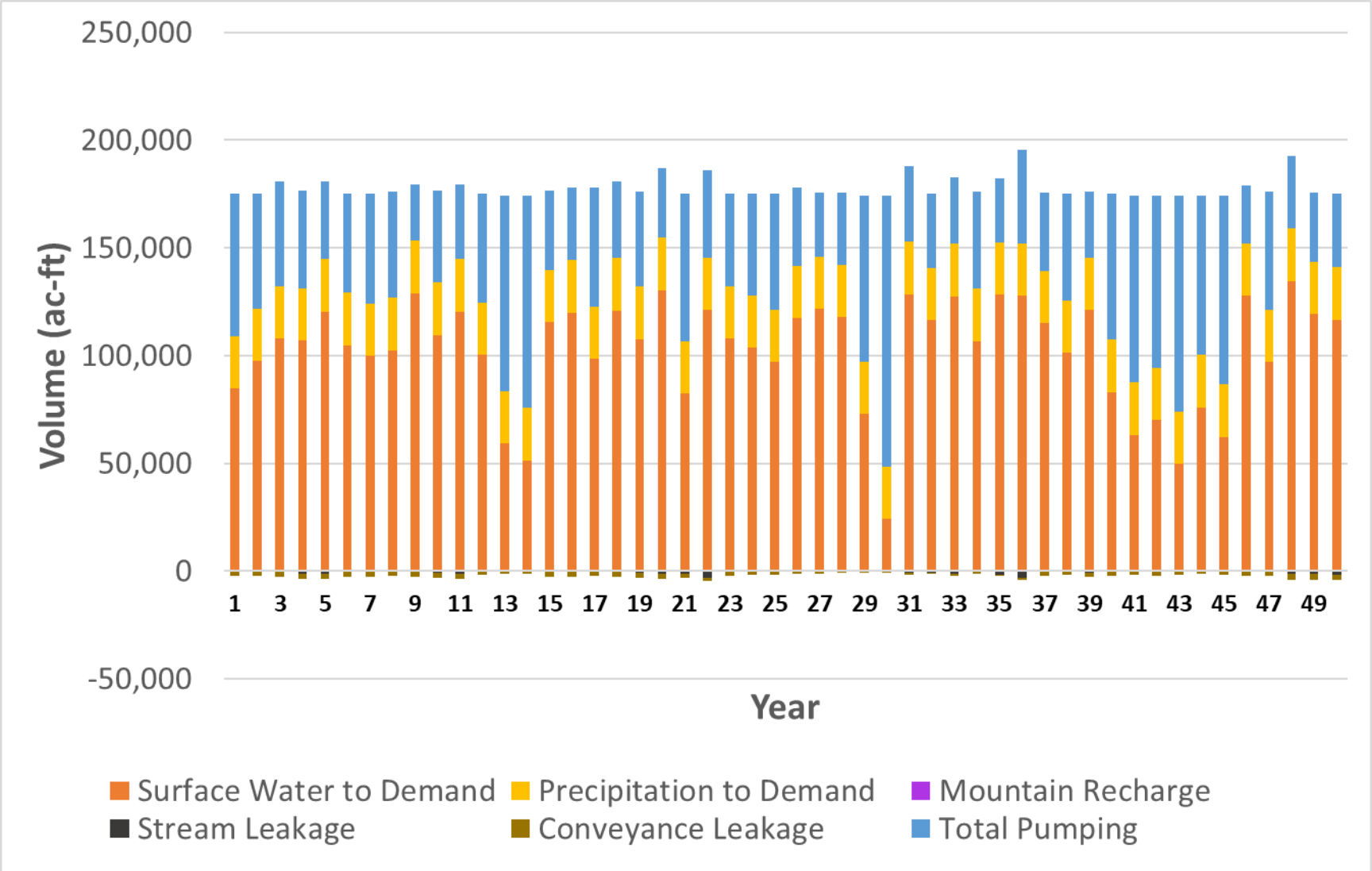
Key: ac-ft = acre-feet

Figure 4-7. Shafter-Wasco Irrigation District Land Surface Water Budget Components Aggregated by Year Under Existing Conditions



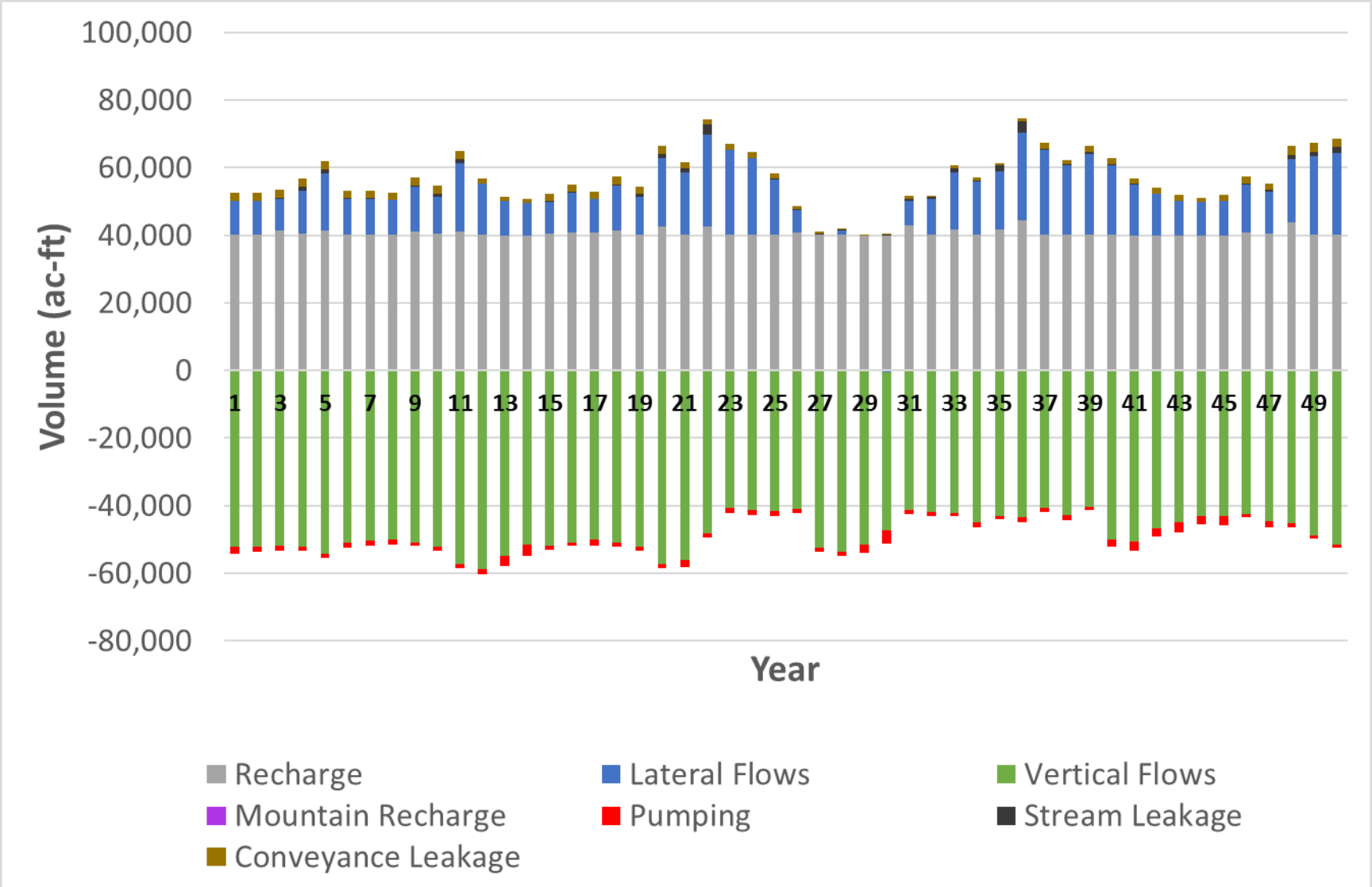
Key: ac-ft = acre-feet

Figure 4-8. Shafter-Wasco Irrigation District Upper Aquifer Water Budget Components Aggregated by Year Under Existing Conditions



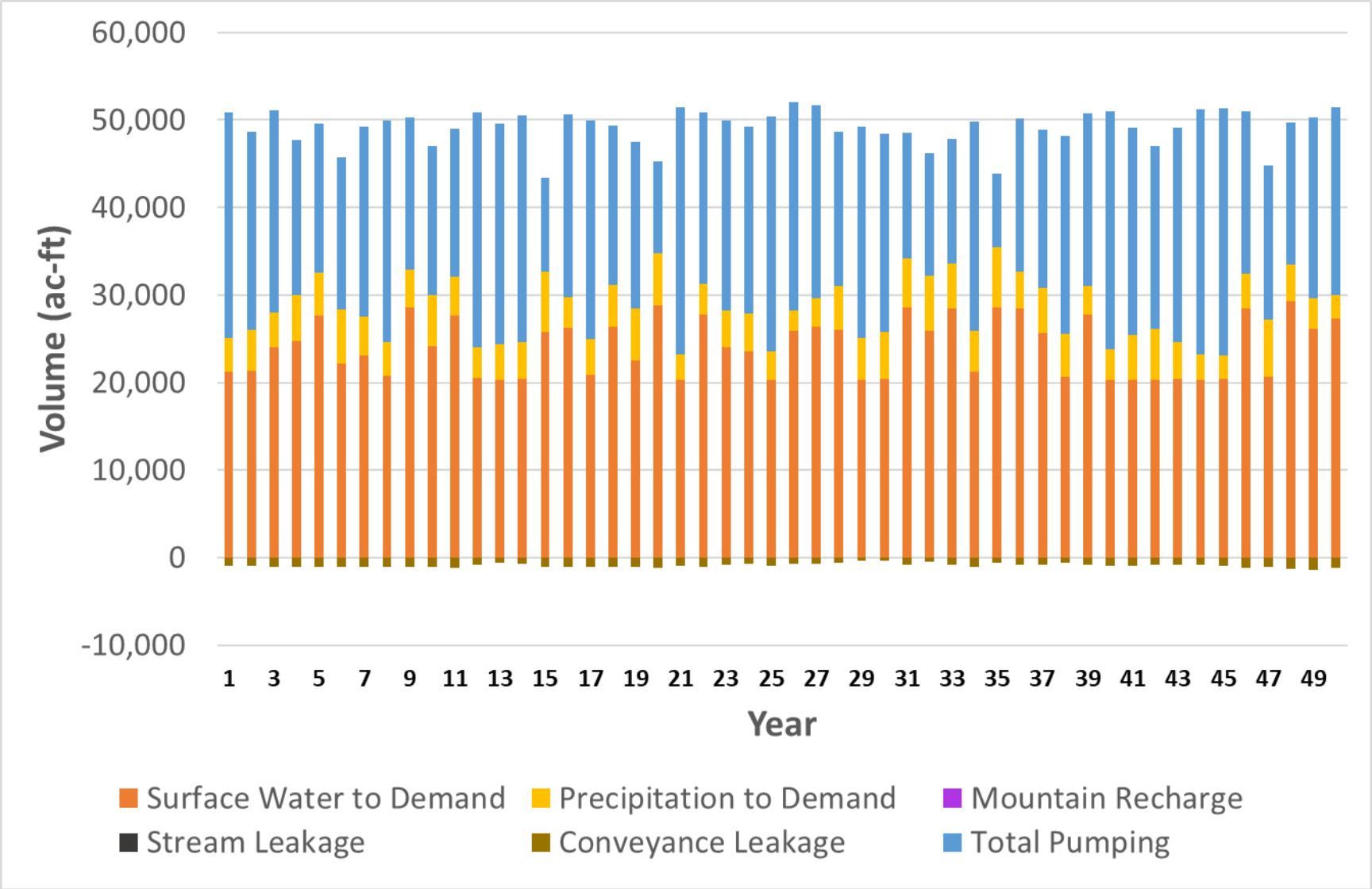
Key: ac-ft = acre-feet

Figure 4-9. Southern San Joaquin Municipal Utility District Land Surface Water Budget Components Aggregated by Year Under Existing Conditions



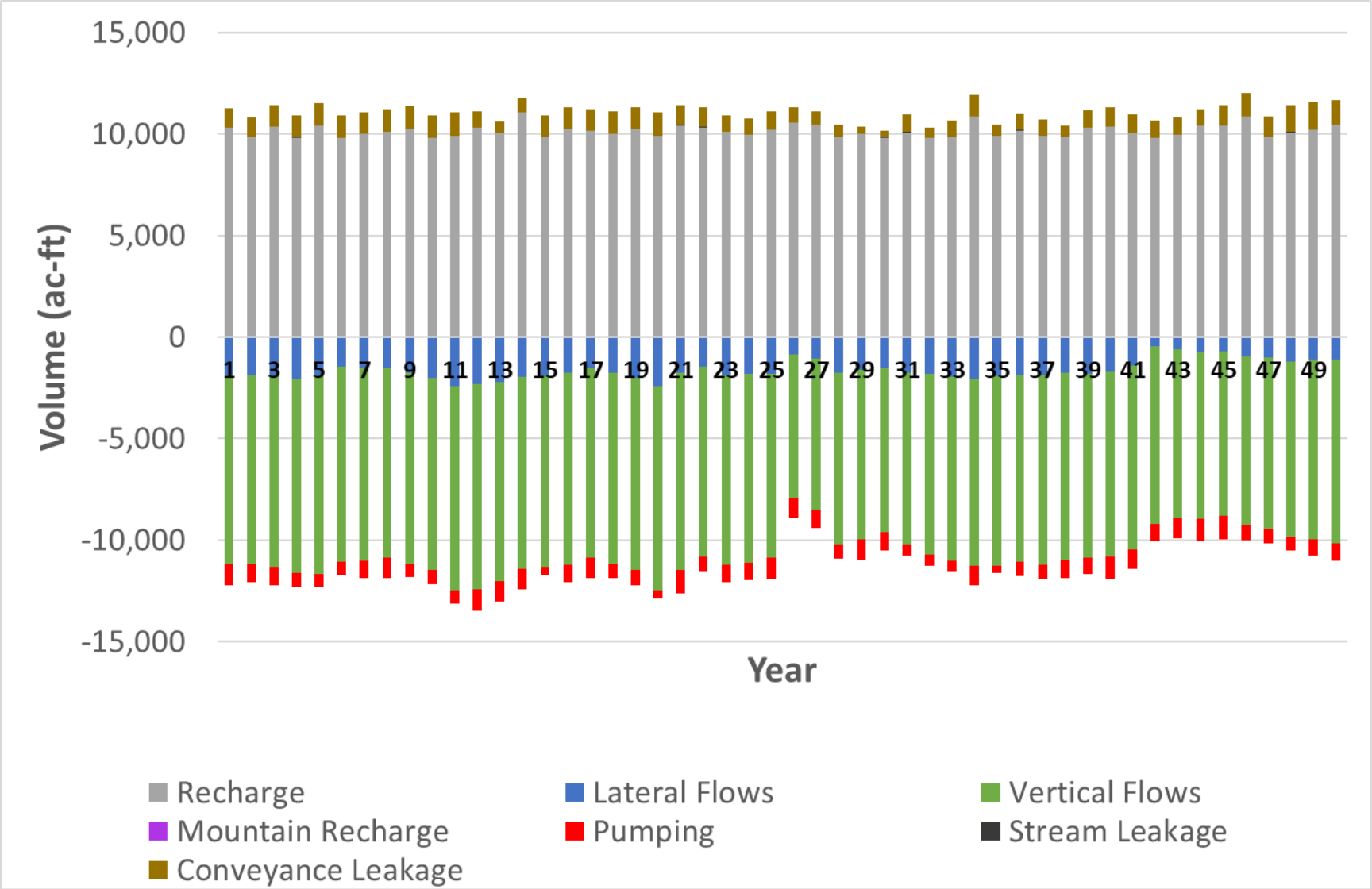
Key: ac-ft = acre-feet

Figure 4-10. Southern San Joaquin Municipal Utility District Upper Aquifer Water Budget Components Aggregated by Year Under Existing Conditions



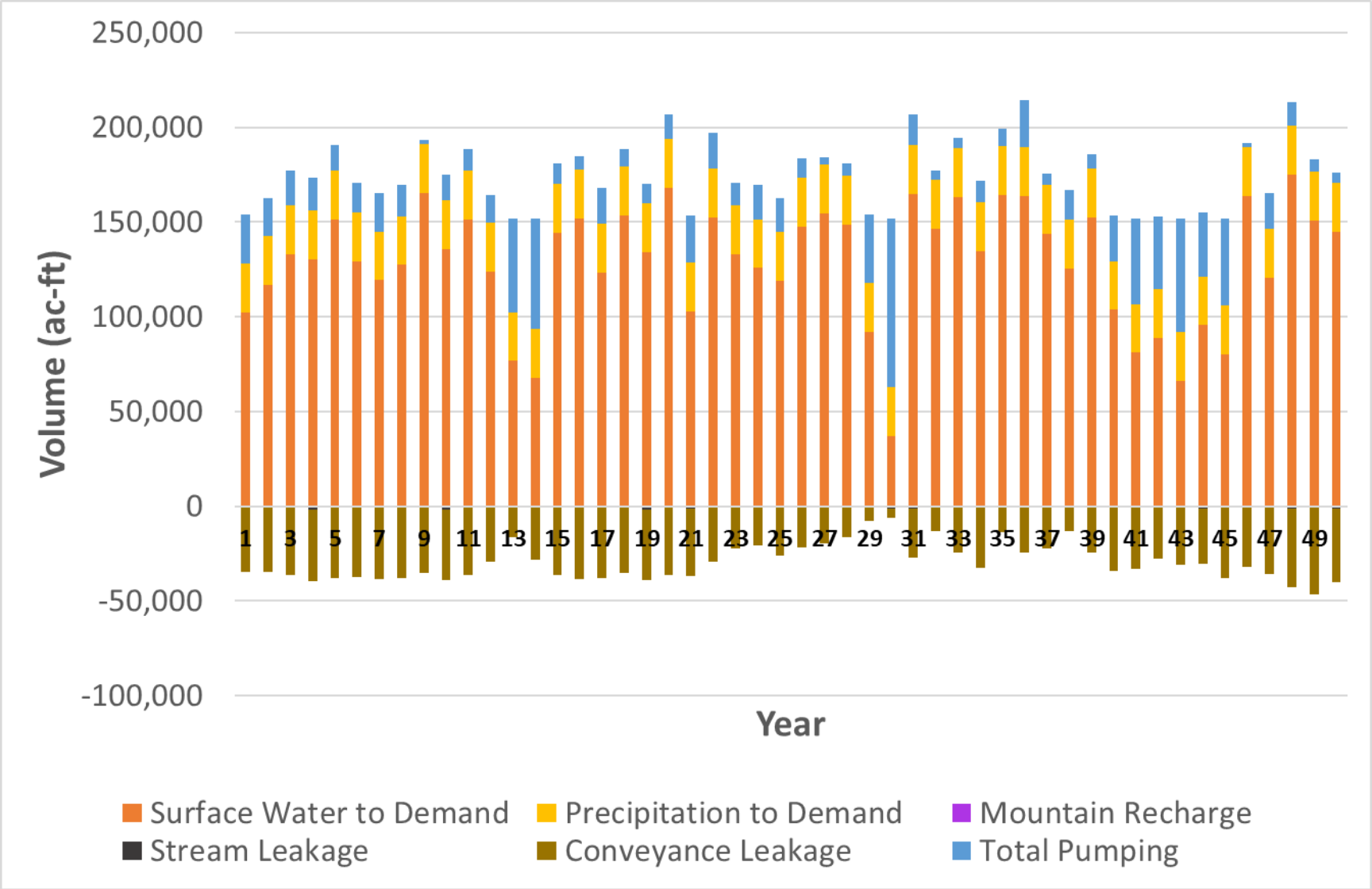
Key: ac-ft = acre-feet

Figure 4-11. Kern-Tulare Water District Land Surface Water Budget Components Aggregated by Year Under Existing Conditions



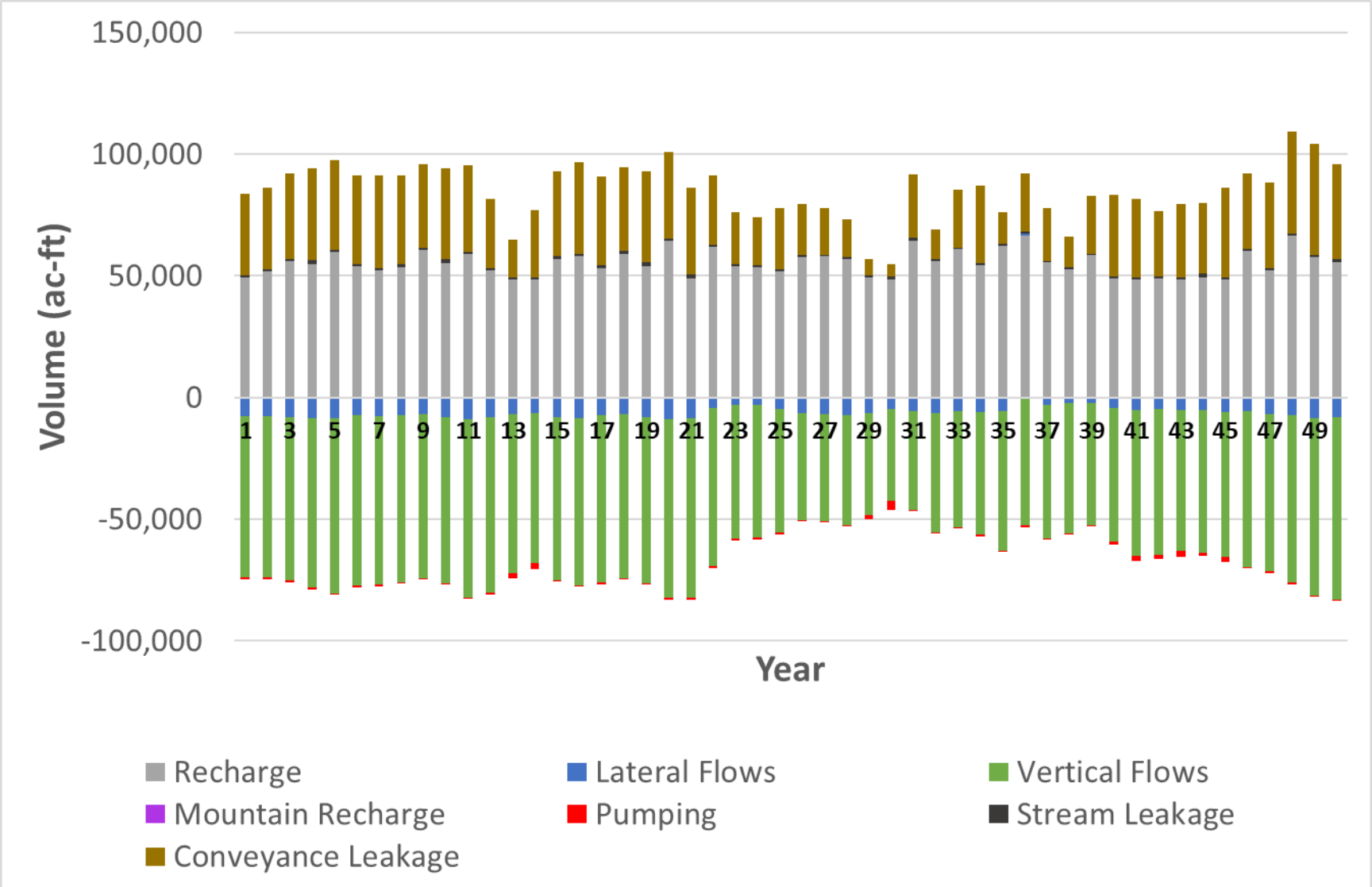
Key: ac-ft = acre-feet

Figure 4-12. Kern-Tulare Water District Upper Aquifer Water Budget Components Aggregated by Year Under Existing Conditions



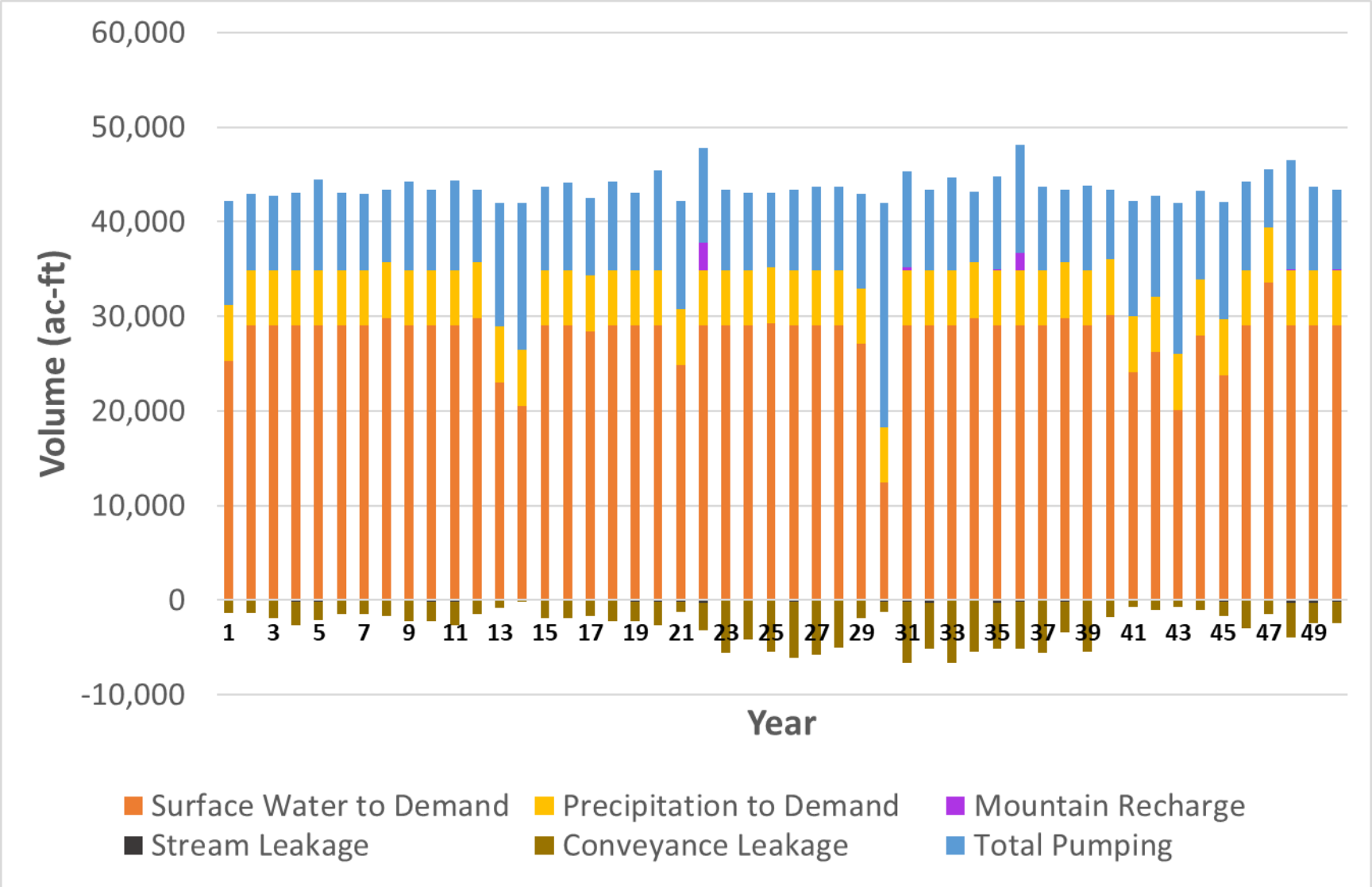
Key: ac-ft = acre-feet

Figure 4-13. Delano-Earlimart Irrigation District Land Surface Water Budget Components Aggregated by Year Under Existing Conditions



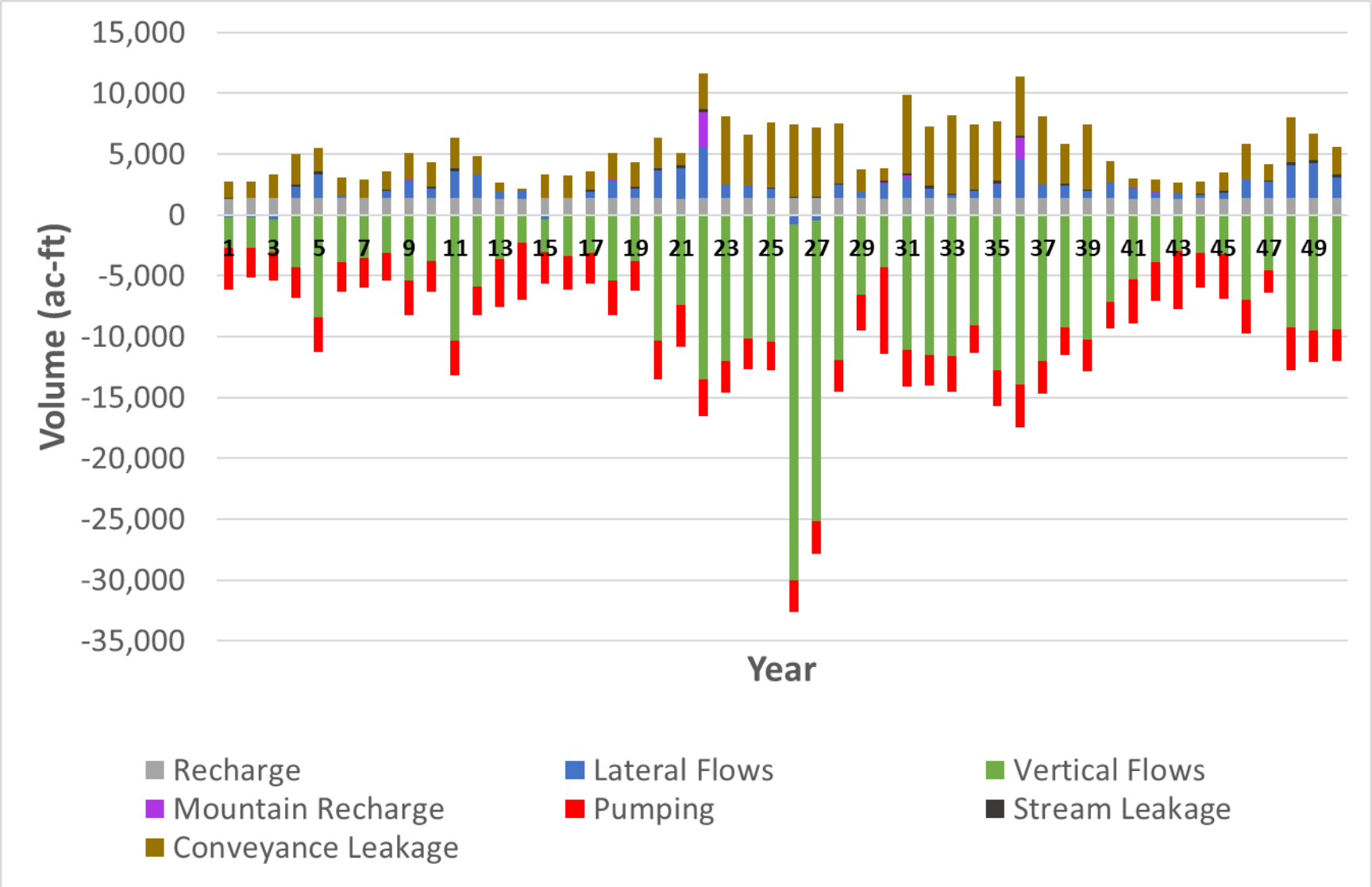
Key: ac-ft = acre-feet

Figure 4-14. Delano-Earlimart Irrigation District Upper Aquifer Water Budget Components Aggregated by Year Under Existing Conditions



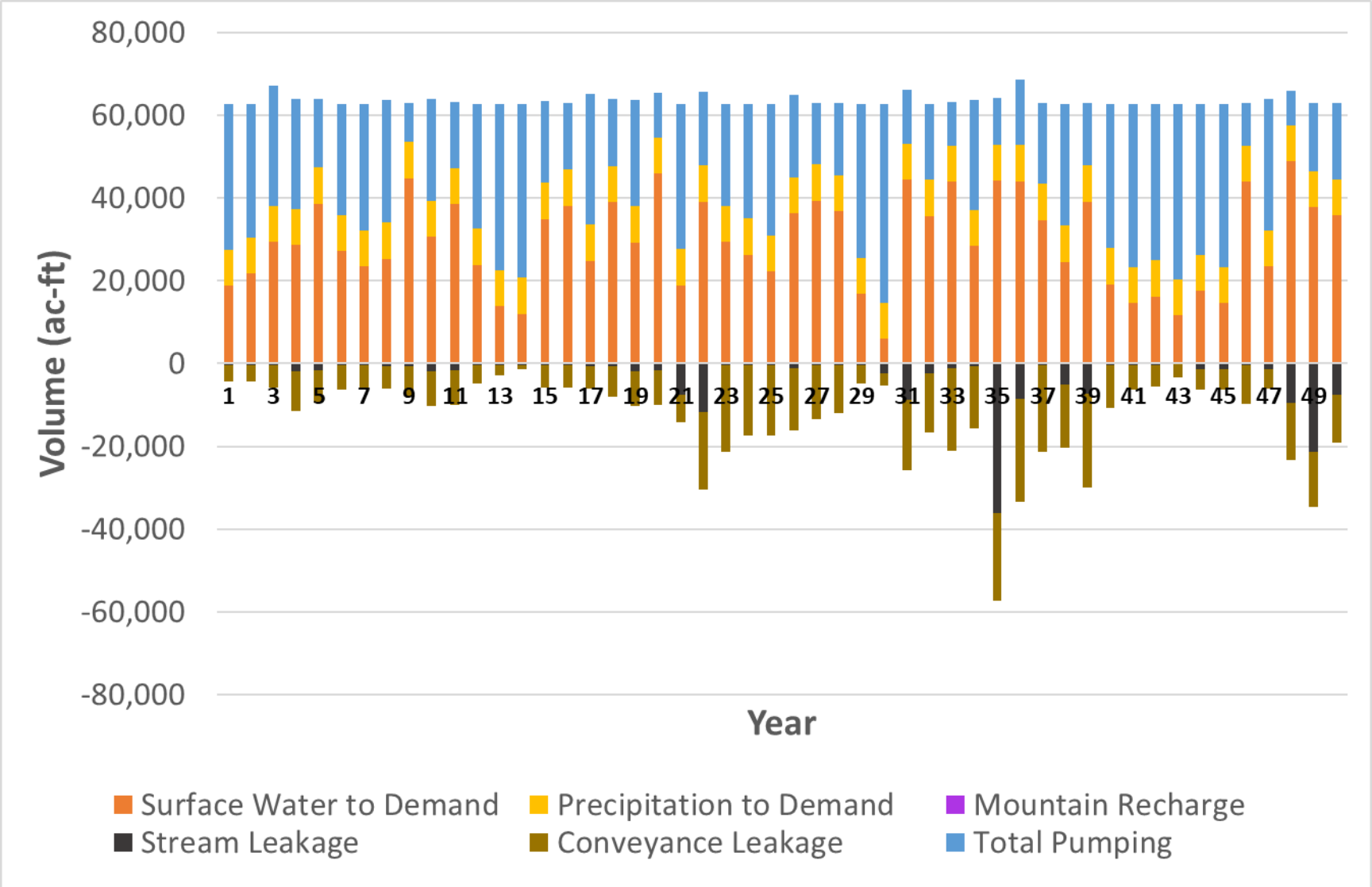
Key: ac-ft = acre-feet

Figure 4-15. Terra Bella Irrigation District Land Surface Water Budget Components Aggregated by Year Under Existing Conditions



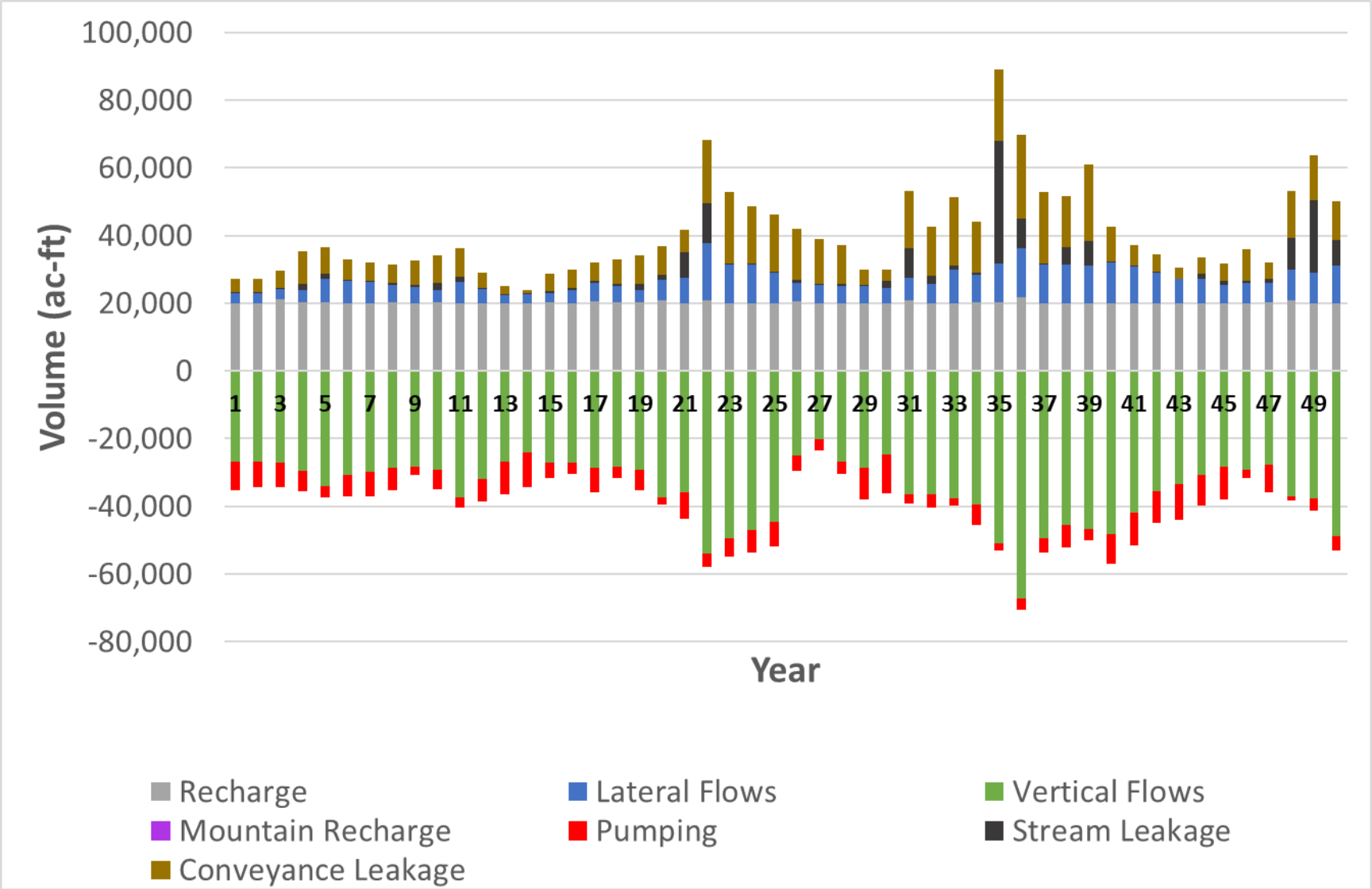
Key: ac-ft = acre-feet

Figure 4-16. Terra Bella Irrigation District Upper Aquifer Water Budget Components Aggregated by Year Under Existing Conditions



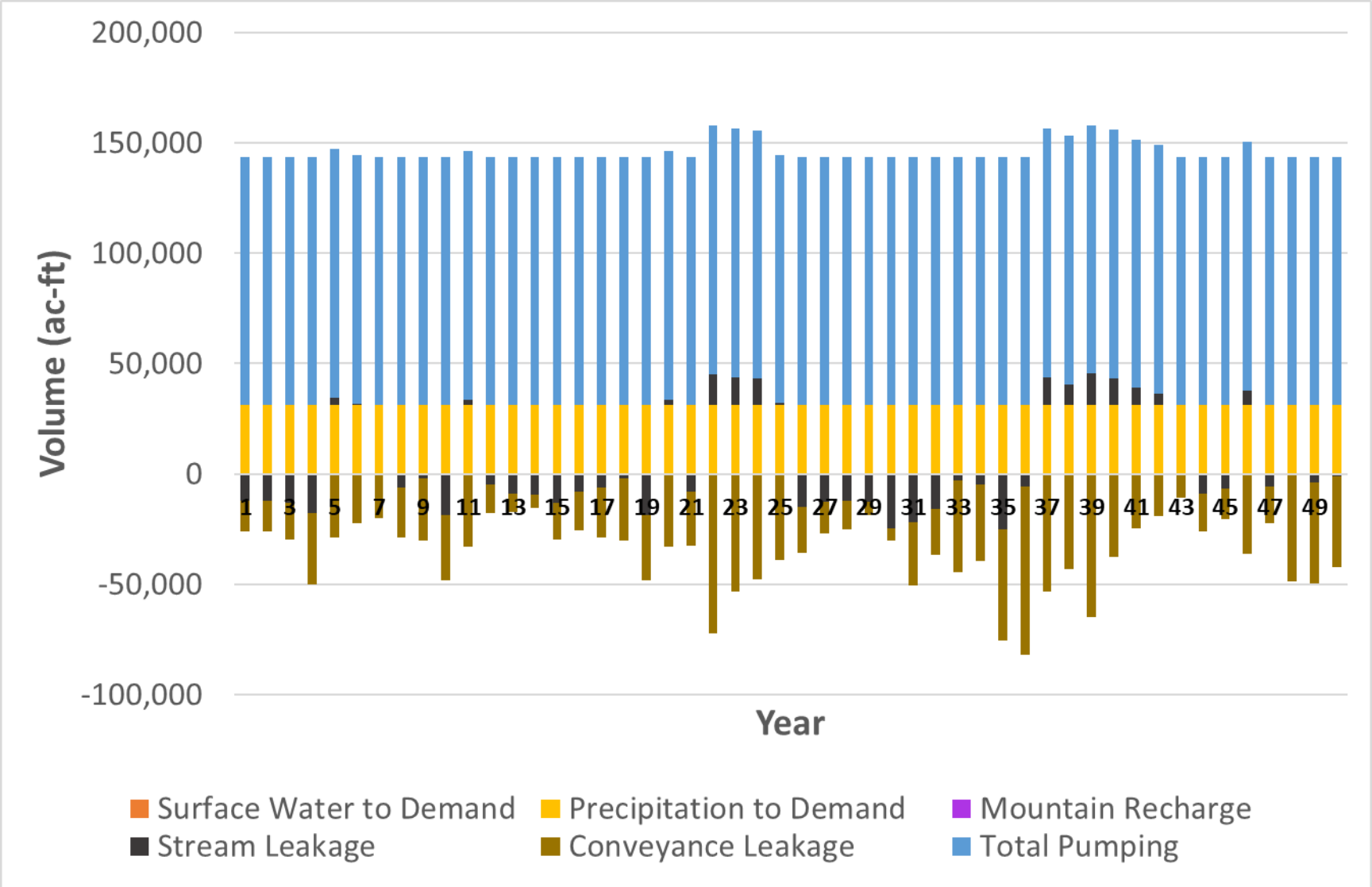
Key: ac-ft = acre-feet

Figure 4-17. Saucelito Irrigation District Land Surface Water Budget Components Aggregated by Year Under Existing Conditions



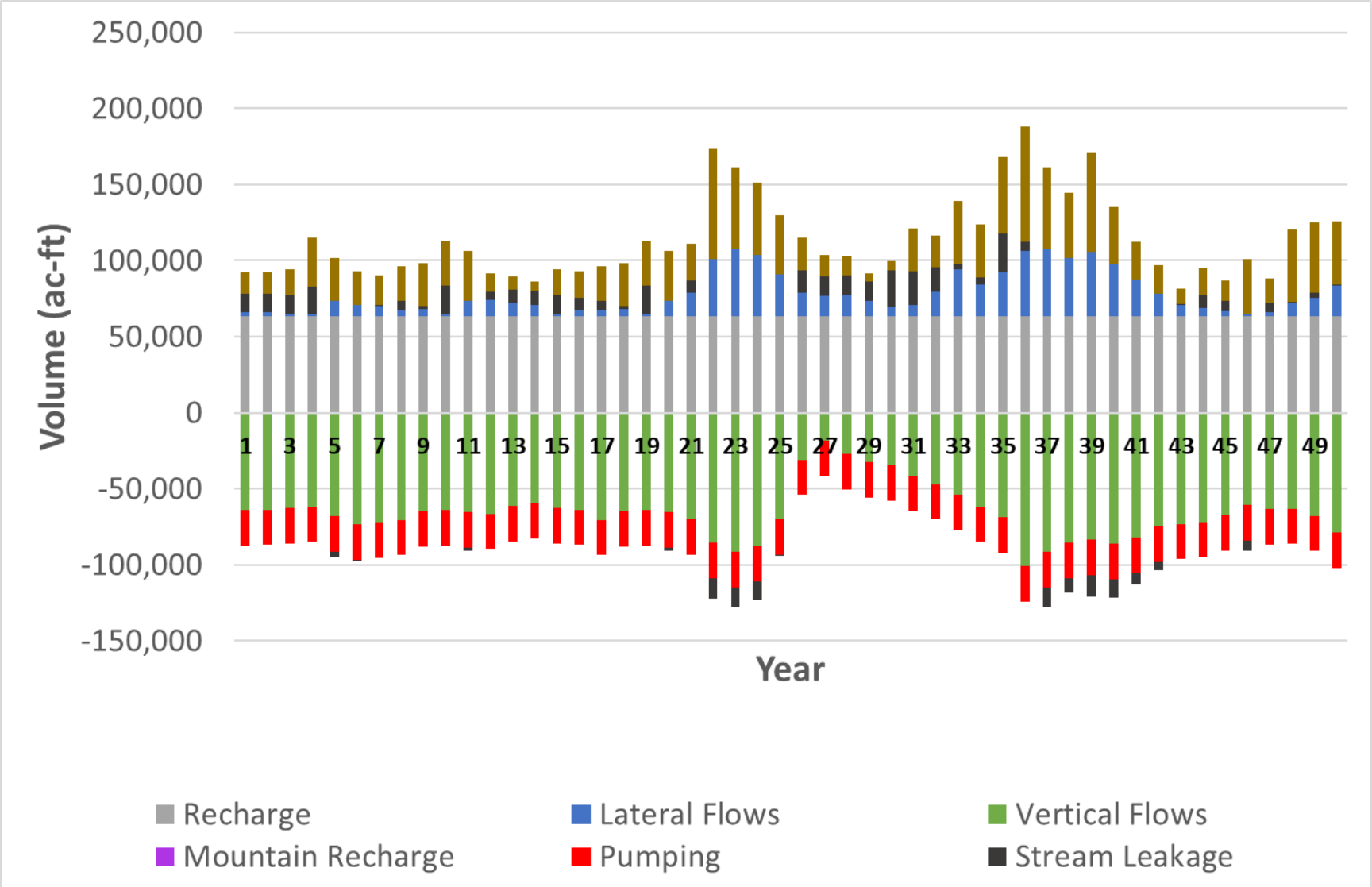
Key: ac-ft = acre-feet

Figure 4-18. Saucelito Irrigation District Upper Aquifer Water Budget Components Aggregated by Year Under Existing Conditions



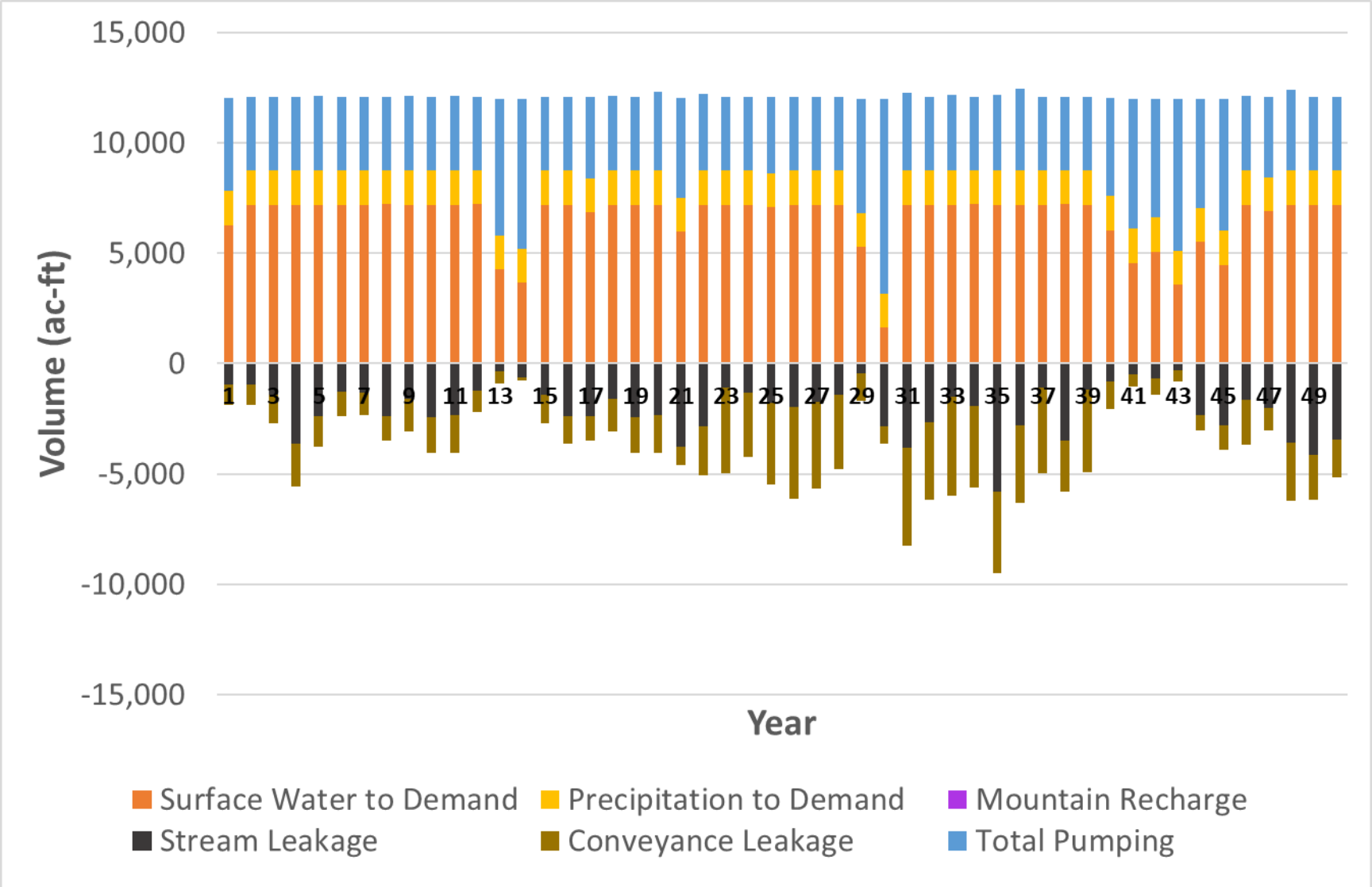
Key: ac-ft = acre-feet

Figure 4-19. Pixley Irrigation District Land Surface Water Budget Components Aggregated by Year Under Existing Conditions



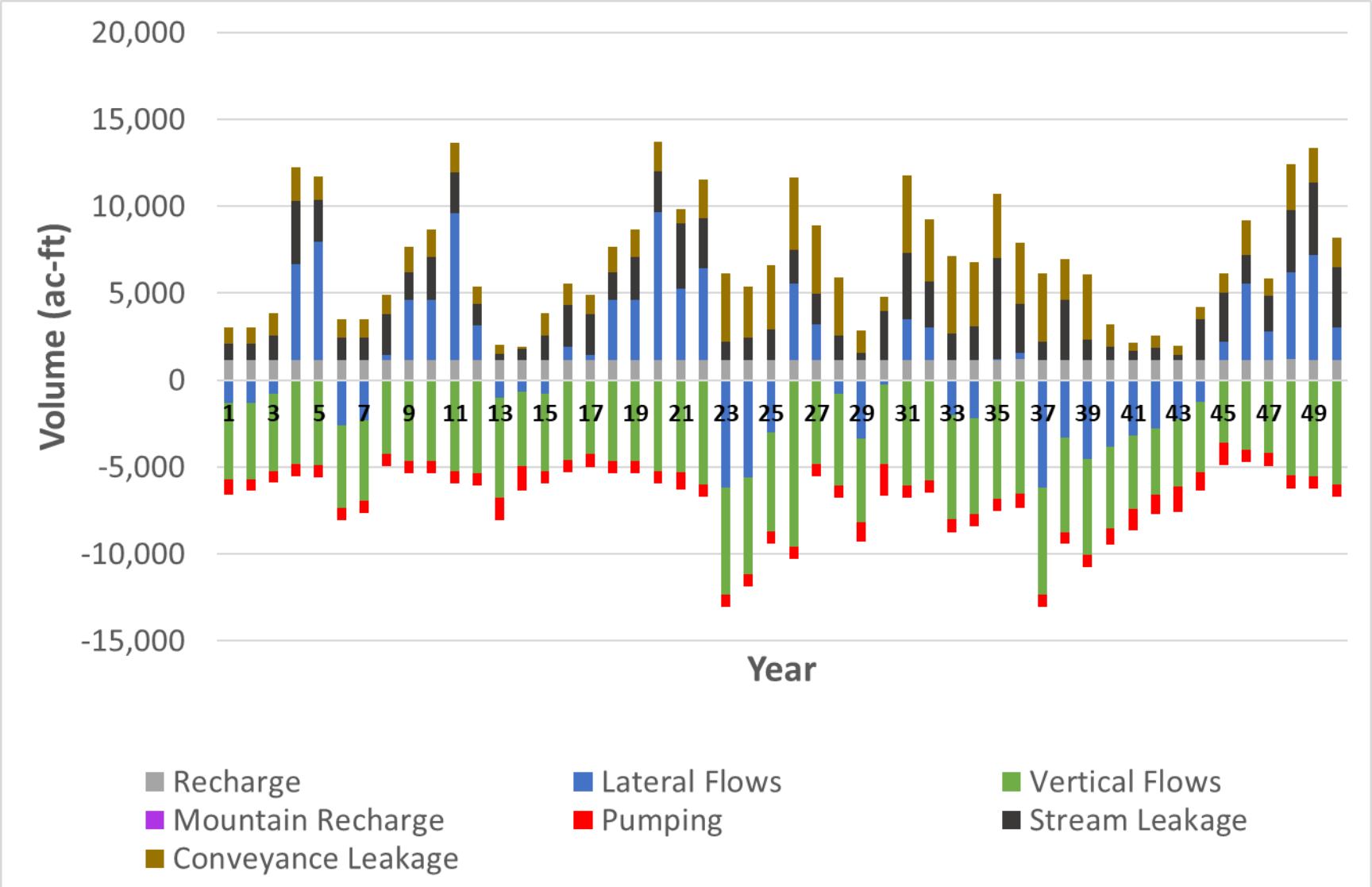
Key: ac-ft = acre-feet

Figure 4-20. Pixley Irrigation District Upper Aquifer Water Budget Components Aggregated by Year Under Existing Conditions



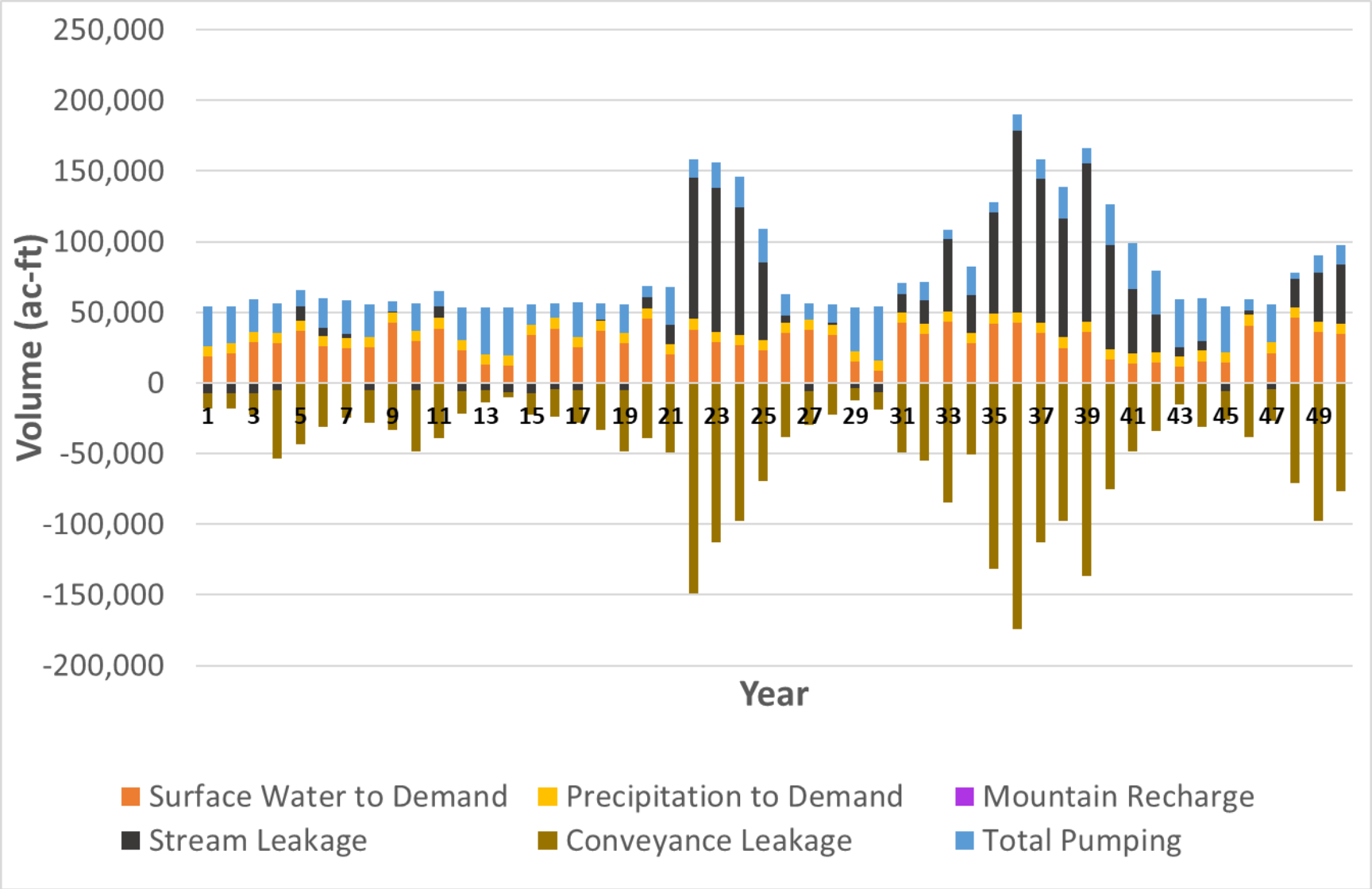
Key: ac-ft = acre-feet

Figure 4-21. Tea Pot Dome Water District Land Surface Water Budget Components Aggregated by Year Under Existing Conditions



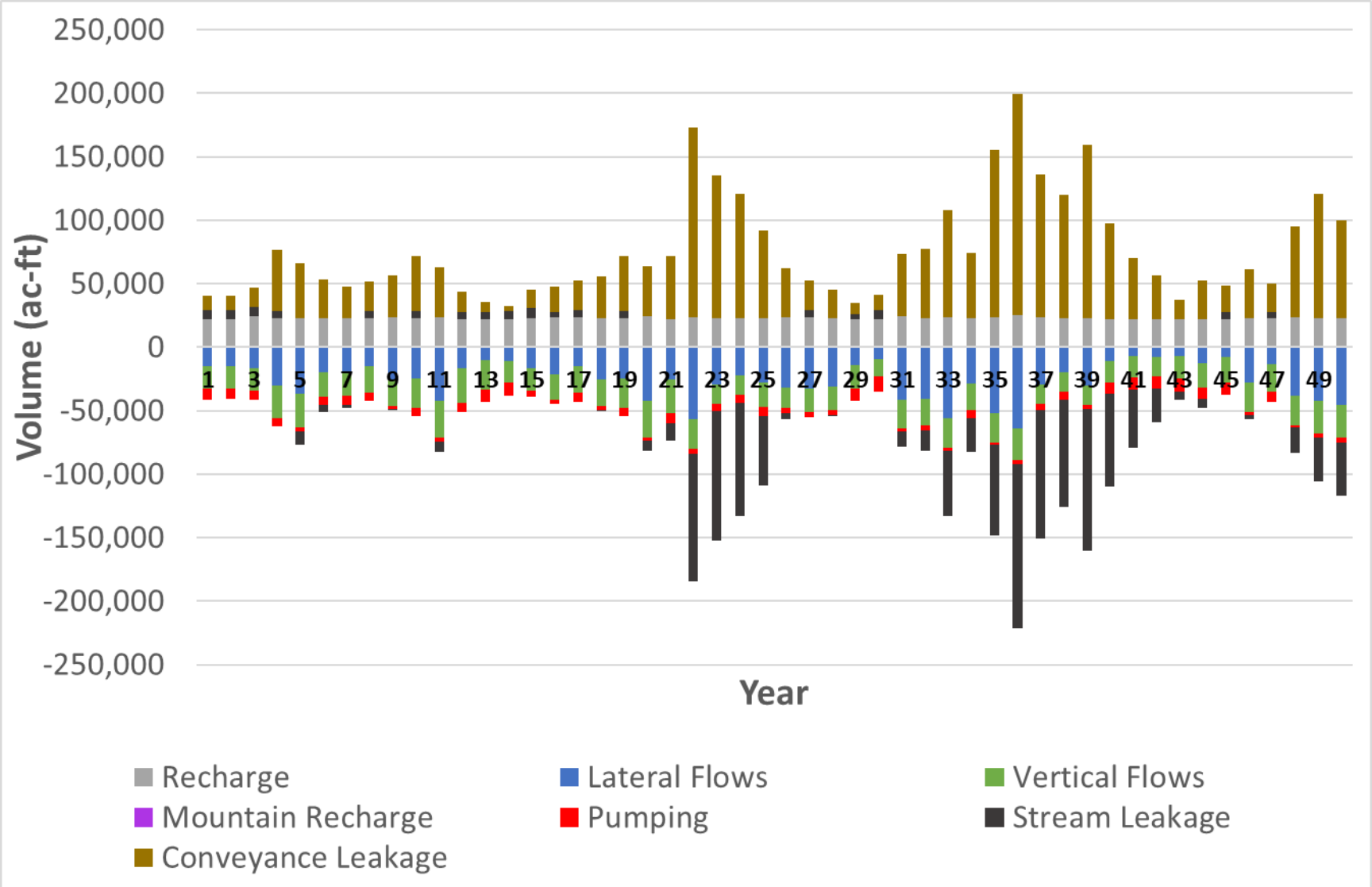
Key: ac-ft = acre-feet

Figure 4-22. Tea Pot Dome Water District Upper Aquifer Water Budget Components Aggregated by Year Under Existing Conditions



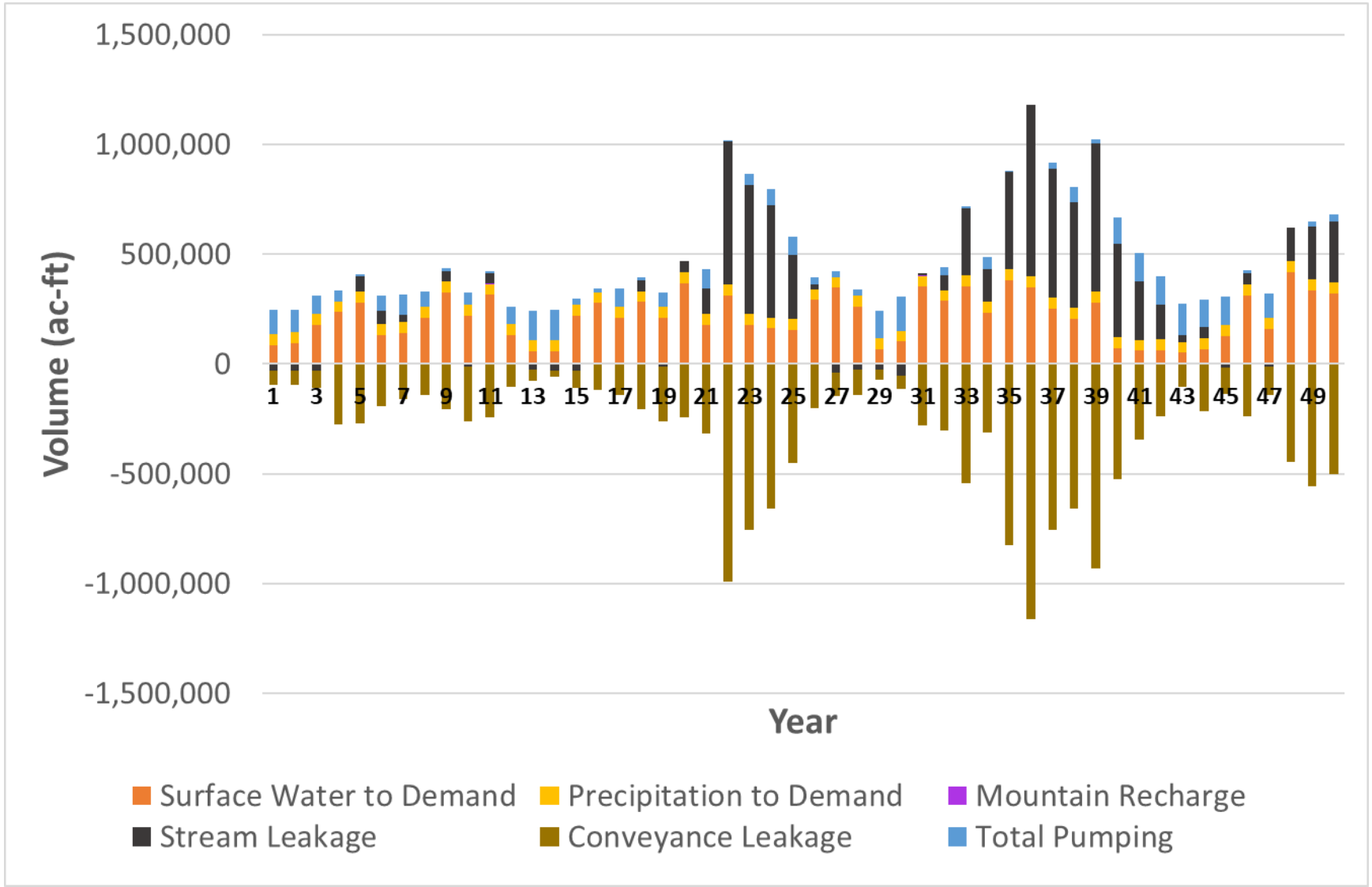
Key: ac-ft = acre-feet

Figure 4-23. Porterville Irrigation District Land Surface Water Budget Components Aggregated by Year Under Existing Conditions



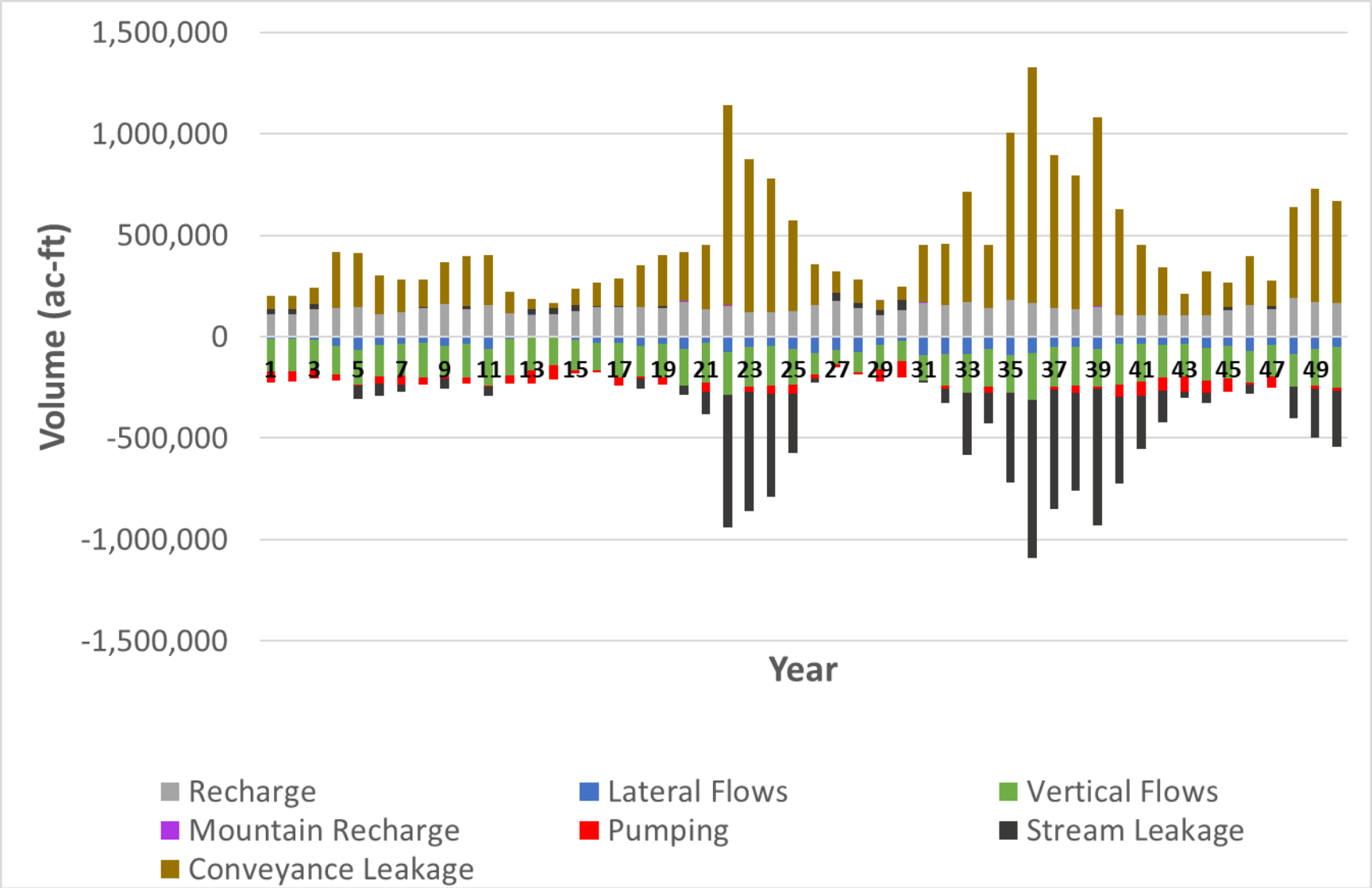
Key: ac-ft = acre-feet

Figure 4-24. Porterville Irrigation District Upper Aquifer Water Budget Components Aggregated by Year Under Existing Conditions



Key: ac-ft = acre-feet

Figure 4-25. Lower Tule River Irrigation District Land Surface Water Budget Components Aggregated by Year Under Existing Conditions



Key: ac-ft = acre-feet

Figure 4-26. Lower Tule River Irrigation District Upper Aquifer Water Budget Components Aggregated by Year Under Existing Conditions

4.2.1.2 Groundwater Quality Constituents

Results of groundwater quality analysis are compared against specific significance criteria developed to determine the significance of potential impacts in relation to groundwater quality. The significance criteria applied include those developed in accordance with Appendix G of the State CEQA Guidelines; criteria based on factual or scientific information; criteria based on regulatory standards of local, State, and federal agencies; and criteria developed by FWA. Impacts on groundwater quality would be considered significant if the project would violate water quality standards or waste discharge requirements or otherwise substantially degrade groundwater quality, such that it impairs reasonably anticipated beneficial uses of groundwater. The groundwater quality thresholds selected for constituents that may impact beneficial uses for groundwater within the region which were quantitatively evaluated using modeling tools are shown in Table 4-13 below.

Results from the groundwater model simulations for groundwater quality analysis under the Existing Conditions are presented in Table 4-14 to Table 4-17. Changes in concentrations for four key constituents that affect the suitability of groundwater for beneficial uses (FWA, 2023) were evaluated using modeling tools: salinity measured as TDS, chloride, boron, and nitrate. While salinity, chloride, and boron are important constituents for irrigation, nitrate was included because it is a major constituent of consideration in groundwater within the region affecting municipal use and public health. To evaluate potential effects of Project alternatives on groundwater quality conditions, the groundwater quality analysis focused on changes in concentrations of these key constituents in applied water under water operations simulated for Project alternatives and did not consider site-specific, on-farm application of fertilizers (e.g., nitrate) and/or soil amendments. The simulated starting concentrations for all Friant Contractors are based on publicly available data sources and/or data requested from the Friant Contractors, as described in Chapter 4.1.1.2 above.

Table 4-13. Groundwater Quality Significance Criteria for Select Constituents Quantitatively Evaluated Using Modeling Tools

Parameter	Water Quality Threshold
Boron	**0.7 mg/L** is set as the threshold for the California Agricultural Water Quality Goals which contains criteria protective of various agricultural uses of water, including irrigation of various types of crops and stock watering (Ayers and Westcott, 1985).
Chloride	**106 mg/L** is set as the threshold for the California Agricultural Water Quality Goals which contains criteria protective of various agricultural uses of water, including irrigation of various types of crops and stock watering (Ayers and Westcott, 1985).
Nitrate as Nitrogen	**10 mg/L** is set as the California Primary MCL and applies to all groundwater basins that are designated with the municipal and domestic supply (MUN) beneficial use.
Salinity as Total Dissolved Solids	**Annual rate of increase of 3.2-3.84 mg/L/year (TDS), depending on location.** The annual allowable rates of increase in EC chosen were established by the Basin Plan (Central Valley Water Board 2018a) and were converted to TDS equivalents[1]. The Basin Plan outlines the 7 groundwater hydrographic units within the Tulare Lake Basin and identifies the maximum average annual increase in EC allowed for each unit, measured as a 5-year average. AEWSD falls within the Kern River hydrographic unit, while all other Friant Contractors fall within the Tule River/Poso hydrographic unit, which are permitted annual EC increases of 3.2 mg/L and 6 µS/cm 3.84 mg/L, respectively. Limitations are proposed based on the applicable water quality objective that protects the most sensitive beneficial use and based on the application of the Antidegradation Policy.

Note:

1. TDS in mg/L converted from the values given for EC in µS/cm (5-6 µS/cm).

Units and conversions:

µS/cm = microsiemens per centimeter
1 µS/cm = 1 µmhos/cm = 1/1,000 dS/m
1000 µmhos/cm = 1 dS/m = 640 mg/L TDS (Porter and Marek, 2022)

Key:
AEWSD = Arvin-Edison Water Storage District
EC = Electrical conductivity
MCL = maximum contaminant level
MUN = municipal and domestic supply
mg/L = milligrams per liter
mg/L/year = milligrams per liter per year
TDS = Total dissolved solids

Total Dissolved Solids

As shown in Table 4-14, simulated TDS concentrations and annual rates of change in TDS concentrations in groundwater vary widely across Friant Contractors. While the simulated average annual rate of change in TDS concentration in groundwater over the 50-year simulation period under Existing Conditions is less than the specified significance threshold for the Friant Contractors, the simulated maximum 5-year annual rate of change in TDS concentration in groundwater is higher than the specified significance threshold for 8 of the 11 Friant Contractors in the study area. The simulated maximum 5-year annual rate of change occurs during times of increased pumping and thus increased utilization of groundwater for demand for the Friant Contractors. The increase in

pumping is a result of Dry water year types coupled with times of more outflow from the Friant Contractors. The timing of the simulated maximum 5-year annual rate of change varies between Friant Contractors depending on when they experience reduced surface water supplies due to a Dry water year and more outflow.

The impact of dry water years on constituent concentrations is most evident in Porterville ID. This district experiences a series of dry years from year 40 to year 45. These dry years also coincide with a sharp increase in constituent concentration. This increase is the result of reduced surface water supplies and an increased reliance on groundwater pumping. TDS concentrations decrease after year 45 once surface water supplies increase. This increase in concentration is observed across all constituents in all scenarios due to the presence of dry years in each scenario.

The Friant Contractors, except for TBID and Pixley ID, show a long term-trend of improved TDS concentrations (see Figure 4-27). Under Existing Conditions, Pixley ID was the only Friant Contractor in the study area that does not receive any surface water deliveries. Therefore, all crop demand was met through precipitation and groundwater pumping. Because groundwater was the primary source of the applied water, groundwater concentrations increased over time.

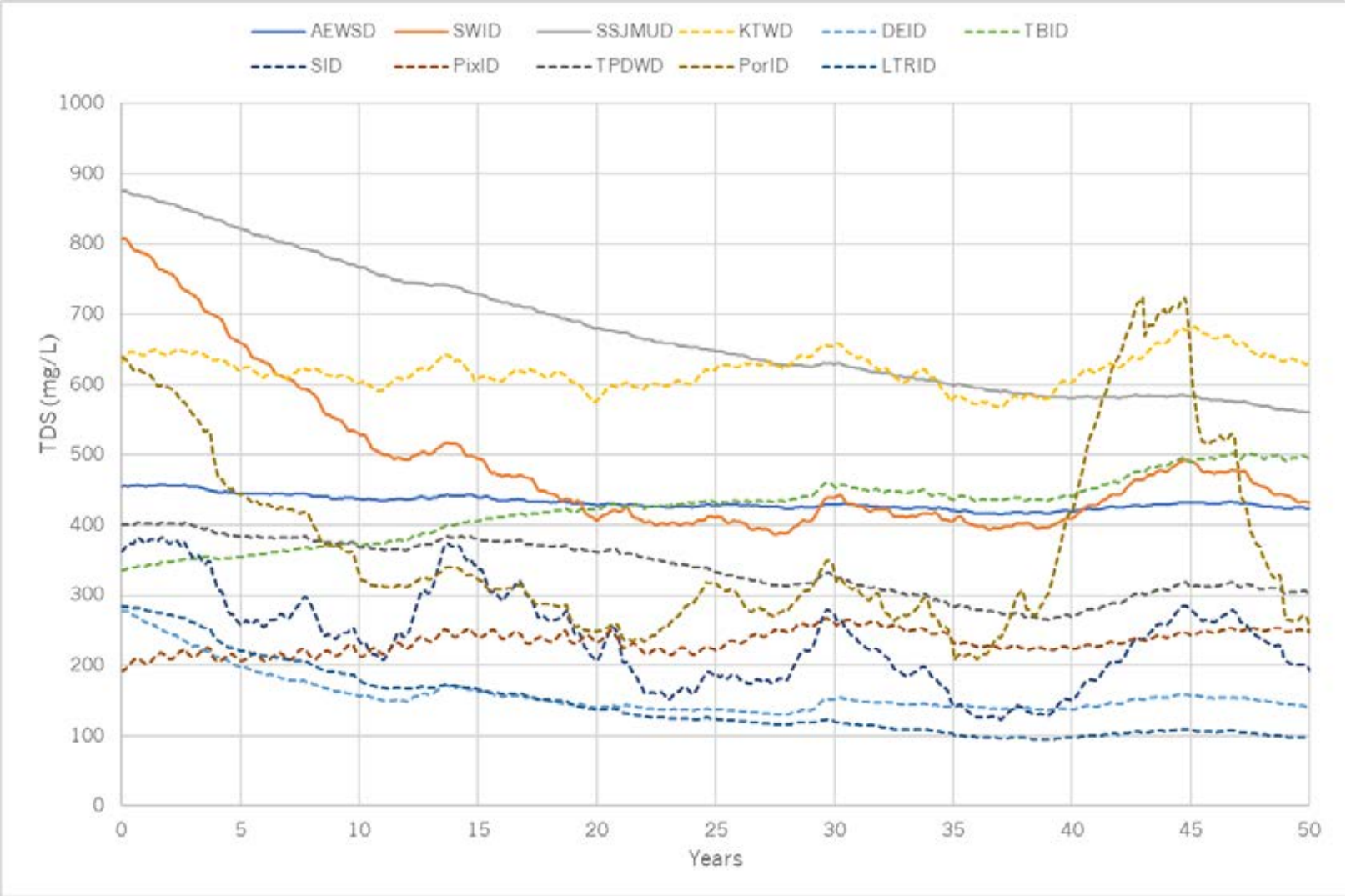
TBID does receive surface water deliveries under the Existing Conditions but still experiences an increase in simulated ending TDS concentration. Based on the assumptions applied in the simulation, TBID pumps 30% of its total groundwater from the upper aquifer. This pumping percentage from the upper aquifer is higher than most of the other Friant Contractors. Furthermore, over the 50-year simulation period, TBID experiences a decline in upper aquifer volume while mass does not decrease proportionally, thus resulting in an increase in TDS concentration.

Table 4-14. Summary of Simulated Concentration of Total Dissolved Solids in Groundwater with Associated Rates of Change and Significance Thresholds under Existing Conditions

Friant Contractor	Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Average Annual Rate of Change (mg/L)	Simulated Maximum 5-Year Average Annual Rate of Change[1] (mg/L/yr)	Significance Threshold (mg/L/yr)
AEWSD	454	423	-0.62	2.43	3.20
SWID	807	432	-7.49	**16.77**	3.84
SSJMUD	875	560	-6.30	0.57	3.84
KTWD	632	631	-0.02	**15.96**	3.84
DEID	277	141	-2.72	**4.20**	3.84
TBID	335	491	3.12	**10.83**	3.84
Saucelito ID	363	192	-3.42	**26.49**	3.84
Pixley ID	193	247	1.07	**8.29**	3.84
TPDWD	400	299	-2.02	**9.54**	3.84
Porterville ID	638	246	-7.85	**85.49**	3.84
LTRID	284	96	-3.76	2.42	3.84

Notes: Bolded numbers indicate exceedance of threshold.
1.Maximum 5-year average annual rate of change calculated on a monthly timestep as the cumulative change in concentration relative to 5 years prior, divided by 5 years to produce an annual average rate.

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
mg/L = milligrams per liter
mg/L/yr = milligrams per liter per year
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TDS = total dissolved solids, TPDWD = Tea Pot Dome Water District

Figure 4-27. Simulated Changes in Relative Concentration of Total Dissolved Solids in Groundwater under Existing Conditions

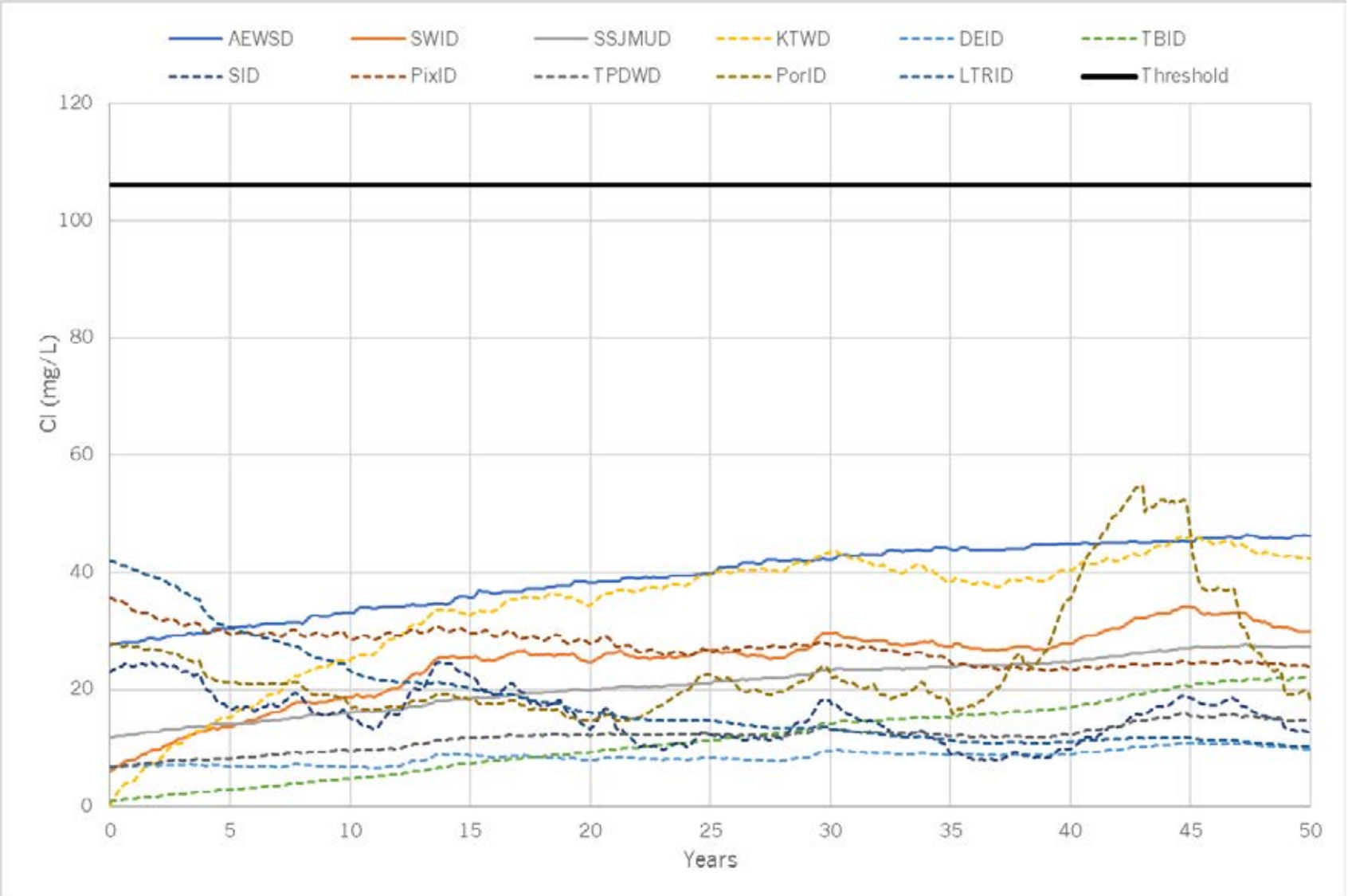
Chloride

Simulated results of monthly concentration of chloride in groundwater for the Friant Contractors did not exceed the threshold for chloride under Existing Conditions, see Figure 4-28. The results for simulated ending concentrations of chloride in the upper aquifer under the Existing Conditions for the Friant Contractors summarized in Table 4-15. Saucelito ID, Pixley ID, Porterville ID, and LTRID saw decreases in their simulated ending concentrations of chloride in the upper aquifer, whereas the other Friant Contractors saw increases. Increases in simulated ending concentrations were seen for the Friant Contractors where the starting concentration of chloride was higher in the lower aquifer as compared to the upper aquifer (see Table 4-14). Conversely, for the Friant Contractors where the lower aquifer had a lower starting concentration of chloride compared to the upper aquifer, the simulated ending concentrations of chloride in the upper aquifer decreased. The concentration of chloride in both aquifers is important as the majority of pumping for the Friant Contractors occurs from the lower aquifer. Thus, a higher concentration in the lower aquifer would lead to more mass being transported to the land surface resulting in higher concentration recharge water entering the upper aquifer leading to an increase in concentration over time. Although the simulated ending concentration and maximum concentration of chloride in the upper aquifer increased for seven Friant Contractors relative to starting concentrations, chloride concentrations did not surpass the significance threshold of 106 mg/L for chloride for any of the Friant Contractors in the study area over the 50-year simulation period.

Table 4-15. Summary of Simulated Concentrations of Chloride in Groundwater with Associated Significance Thresholds under Existing Conditions

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Maximum Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	27.6	46.2	46.3	106
SWID	5.9	29.8	34.2	106
SSJMUD	11.8	27.3	27.6	106
KTWD	0.2	42.3	46.2	106
DEID	6.5	9.8	10.9	106
TBID	0.9	21.7	22.1	106
Saucelito ID	23.0	12.3	24.7	106
Pixley ID	35.4	23.8	35.4	106
TPDWD	6.7	14.3	16.0	106
Porterville ID	27.7	18.1	54.7	106
LTRID	41.9	10.2	41.9	106

Key:
AEWSD = Arvin-Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
mg/L = milligrams per liter
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, Cl = chloride, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-28. Simulated Changes in Relative Concentration of Chloride in Groundwater under Existing Conditions

Boron

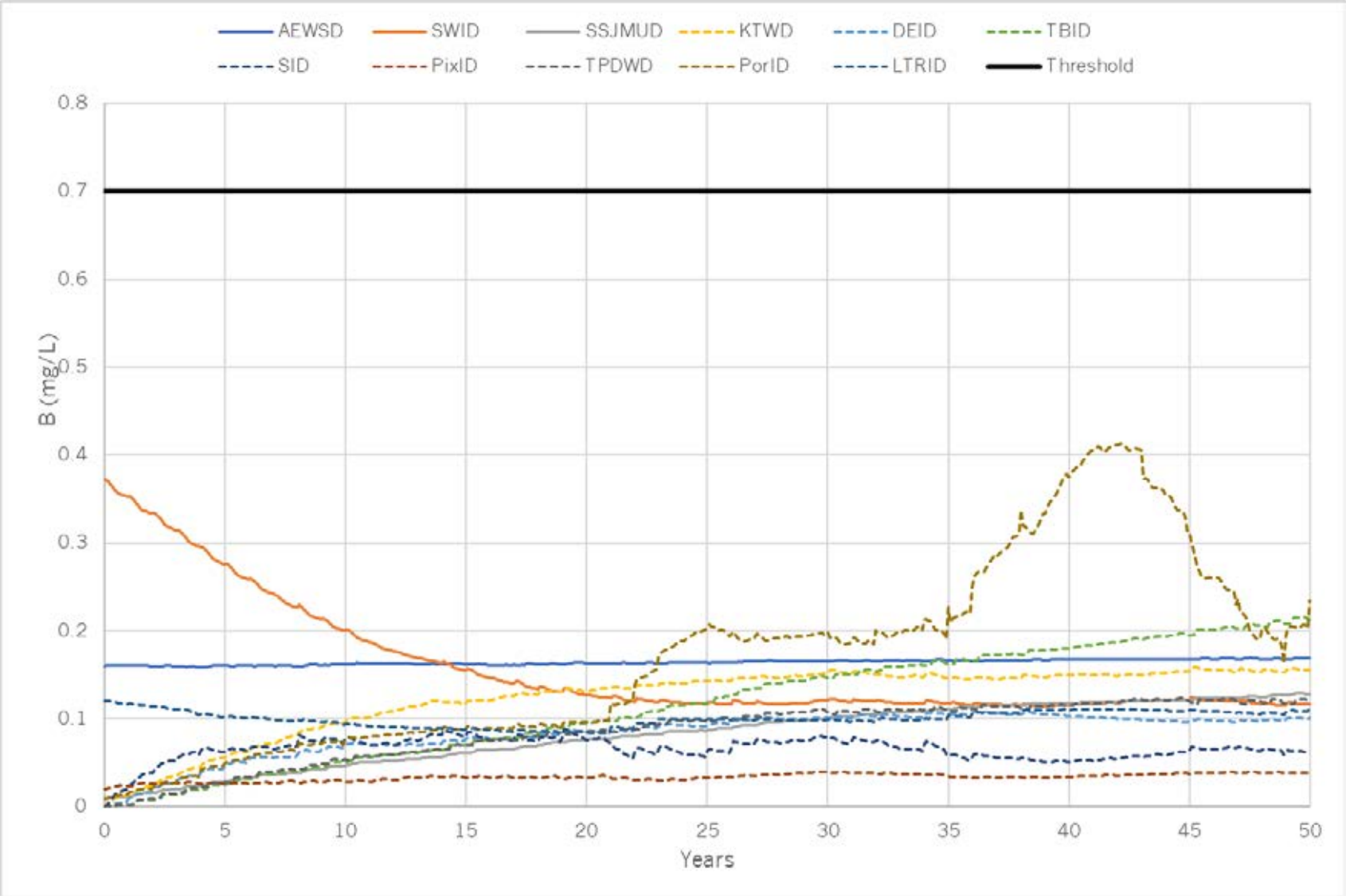
Under Existing Conditions, simulated results for monthly concentration of boron in groundwater for the Friant Contractors did not exceed the specified significance threshold during the 50-year simulation period. Table 4-16 provides results for simulated ending and maximum concentrations of boron in the upper aquifer for the Friant Contractors under Existing Conditions. Simulated changes in relative concentration of boron in groundwater under the Existing Conditions are shown in Figure 4-29. Most Friant Contractors show a simulated increase in boron concentration over the 50-year simulation period. Factors affecting the simulated increases in boron concentrations for some Friant Contractors under the Existing Conditions relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting boron concentrations in upper versus lower aquifer for simulations). The Friant Contractors that experienced a simulated increase in boron concentrations in the upper aquifer all started with higher concentrations of boron in the lower aquifer compared to the upper aquifer. Although the starting concentrations for boron were low in both aquifers, the difference in concentration between aquifers affected the simulated ending concentrations.

SWID and LTRID were the two Friant Contractors that experienced a decrease in upper aquifer concentration compared to the starting concentration. While SWID has the highest starting concentration of boron in its upper aquifer, the concentration of boron in the lower aquifer is substantially lower (see Table 4-16). Because simulated groundwater pumping for SWID is primarily from the lower aquifer, an improvement in the boron concentration within SWID's upper aquifer was observed in simulations. Minor changes in boron concentrations in groundwater for LTRID were likely attributed to having the same starting concentration of boron in the upper aquifer and lower aquifer, a condition unique to LTRID compared to other Friant Contractors evaluated.

Table 4-16. Summary of Simulated Concentrations of Boron in Groundwater with Associated Significance Thresholds under Existing Conditions

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Maximum Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	0.16	0.17	0.17	0.7
SWID	0.37	0.12	0.37	0.7
SSJMUD	0.01	0.13	0.13	0.7
KTWD	0.00	0.16	0.16	0.7
DEID	0.00	0.10	0.11	0.7
TBID	0.00	0.21	0.22	0.7
Saucelito ID	0.00	0.06	0.09	0.7
Pixley ID	0.02	0.04	0.04	0.7
TPDWD	0.00	0.12	0.12	0.7
Porterville ID	0.01	0.23	0.41	0.7
LTRID	0.12	0.11	0.12	0.7

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
mg/L = milligrams per liter
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, B = boron, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-29. Simulated Changes in Relative Concentration of Boron in Groundwater under Existing Conditions

Nitrate

Nitrate is a critical and unique groundwater quality constituent in the study area. Elevated levels of nitrate can be detrimental to drinking water supplies but also serve as a supply of nitrate for crops. As described in Chapter 4.1.1.2, nitrate uptake was modelled differently compared to the other constituents. Plant uptake for nitrate was set to 80% to account for the utilization of nitrate by crops while noting common understanding that the nitrogen demand by crops largely exceeds mass irrigation input annually. Groundwater quality analysis performed to assess impacts of Project alternatives focused on changes in concentrations of key constituents, specifically, nitrate, in applied water and did not consider site-specific, on-farm application of fertilizers (e.g., nitrate) and/or soil amendments.

Simulated results for ending and maximum concentrations of nitrate in the upper aquifer for the Friant Contractors under Existing Conditions are provided in Table 4-17 below. Figure 4-30 shows the simulated changes in relative concentration of nitrate in groundwater under the Existing Conditions. Starting concentrations of nitrate in groundwater for several Friant Contractors were well above the 10 mg/L threshold. Under Existing Conditions, the Friant Contractors, except for KTWD, experience a decline in nitrate concentrations over the 50-year simulation period.

In the case of KTWD, several factors outlined in the water budget components and assumptions (see Chapter 4.2.1.1 Water Budget Components and the Assumptions stated in Chapter 4.1.1.3 Development of the Groundwater Model) led to simulated increases in nitrate concentration in the upper aquifer. For the upper aquifer at KTWD, simulation results suggest a net outflow of water over the simulation period, and the aquifer is assumed to have a small saturated thickness (28 ft; see Table 4-2), and a higher nitrate concentration in the lower aquifer (where the majority of the pumping happens) compared to the upper aquifer. These combined factors lead to an increase in the overall nitrate concentrations in KTWD's upper aquifer over the simulation period. However, even though the simulated ending concentration is higher than KTWD's starting concentration, the ending concentration does not exceed the significance threshold of 10 mg/L at any point during the simulation.

The only Friant Contractor with simulated nitrate concentration that exceeds the significance threshold of 10 mg/L during the simulation period is TBID. TBID had a starting nitrate concentration of 27.3 mg/L for the upper aquifer. Although the concentration of nitrate decreased over the simulation period to 12.9 mg/L, nitrate concentrations for TBID were still above the significance criteria. Nitrate concentrations in the upper aquifer for Porterville ID also exceeded the 10 mg/L threshold during the simulation period. The exceedances for Porterville ID can be attributed to Dry water years modeled in the latter portion of the simulation period which led to decreased surface water supplies and thus increases in groundwater pumping amounts.

Factors affecting simulated changes in nitrate concentrations across the Friant Contractors relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting nitrate concentrations in upper versus lower aquifer for simulations).

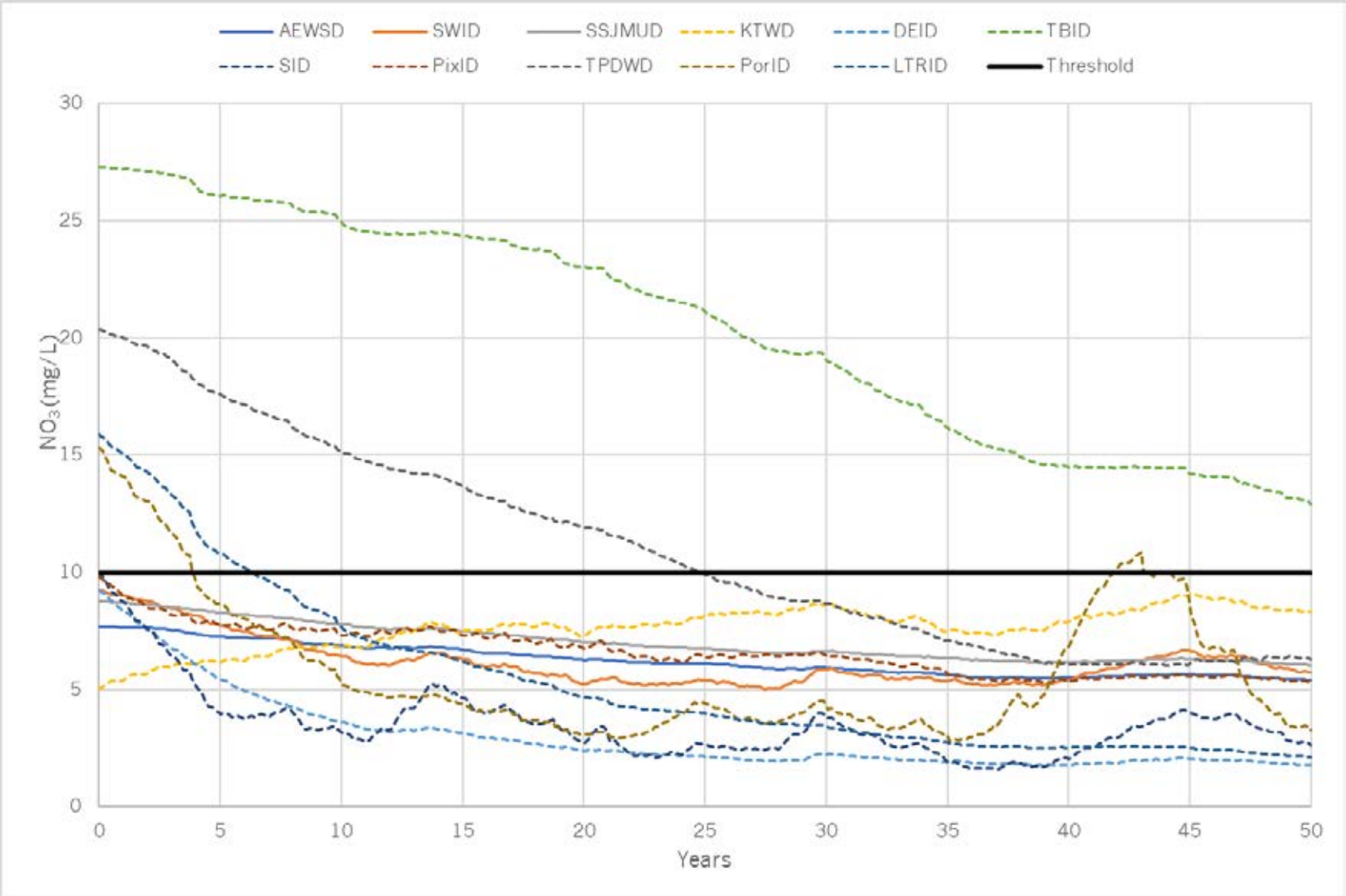
As stated previously, groundwater quality analysis performed to assess impacts of Project alternatives focused on changes in concentrations of key constituents, specifically, nitrate, in applied water and did not consider site-specific, on-farm application of fertilizers (e.g., nitrate) and/or soil amendments. Potential adverse effects on nitrate concentrations in groundwater under the Existing Conditions scenario (whether due to Project operations or on-farm practices) could be reduced through implementation of the CV-SALTS Nitrate Control Program.

Table 4-17. Summary of Simulated Concentrations for Nitrate in Groundwater with Associated Significance Thresholds under Existing Conditions

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Maximum Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	7.7	5.4	7.7	10
SWID	9.2	5.7	9.2	10
SSJMUD	8.8	6.0	8.8	10
KTWD	5.1	8.3	9.1	10
DEID	9.2	1.8	9.2	10
TBID	**27.3**	**12.9**	**27.3**	10
Saucelito ID	**10.0**	2.6	**10.0**	10
Pixley ID	9.8	5.3	9.8	10
TPDWD	**20.4**	6.3	**20.4**	10
Porterville ID	**15.3**	3.3	**15.3**	10
LTRID	**15.9**	2.1	**15.9**	10

Notes:
Bolded numbers indicate exceedance of threshold.

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
mg/L = milligrams per liter
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, NO_3 = nitrate as nitrogen, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-30. Simulated Changes in Relative Concentration of Nitrate in Groundwater under Existing Conditions

4.2.2 No Project Alternative

Below subsections provide results of groundwater quality analysis for operations under the No Project Alternative.

4.2.2.1 Groundwater Budget Components

As described in Chapter 4.2.1.1, several groundwater budget parameters were assumed constant and did not change between the Existing Conditions, No Project Alternative, and three Project alternatives. There are differences in applied surface water supply volumes and surface water quality conditions that are representative of assumptions applied in the Distribution Model. As it applies to the groundwater budget, changes in applied surface water supply affects total groundwater pumping to meet Friant Contractors demands and thus long-term water quality trends. Total simulated groundwater pumping under the No Project Alternative over the 50-year simulation period is shown in Table 4-12. The relative changes in groundwater pumping under the No Project Alternative compared to the Existing Conditions and the three Project alternatives under both the Existing Conditions and No Project Alternative are shown in Table 4-18.

Table 4-18. Relative Changes in Total Groundwater Pumping Over Simulation Period for all Alternatives

Friant Contractor	Relative Change in Simulated Groundwater Pumping for Alternatives Compared to Existing Conditions and Future Conditions (acre-feet)[1]				
	No Project Alternative[2]	Low Flow Alternative and Seasonal Alternative		High Flow Alternative	
		Under Existing Conditions	Under Future Conditions	Under Existing Conditions	Under Future Conditions
AEWSD	247,600	-150,900	-98,500	-301,300	-236,100
SWID	127,700	-209,700	-183,500	-463,800	-370,000
SSJMUD	174,100	-347,700	-293,000	-732,400	-624,700
KTWD	306,000	-123,800	-370,700	-217,200	-473,700
DEID	216,800	-212,500	-209,400	-415,900	-467,500
TBID	20,400	-57,500	-43,700	-117,300	-101,000
Saucelito ID	88,900	-73,900	-52,700	-164,800	-110,100
Pixley ID	-425,600	0	-557,600	0	-645,600
TPDWD	7,100	-22,200	-14,600	-46,000	-30,800
Porterville ID	66,200	-53,800	-34,400	-121,900	-73,500
LTRID	-108,700	-188,300	-492,500	-435,200	-710,300

1. Relative to simulated total groundwater pumping for upper and lower aquifers. Values are rounded to nearest 100 acre-feet.
2. No Project Alternative shown relative to Existing Conditions.

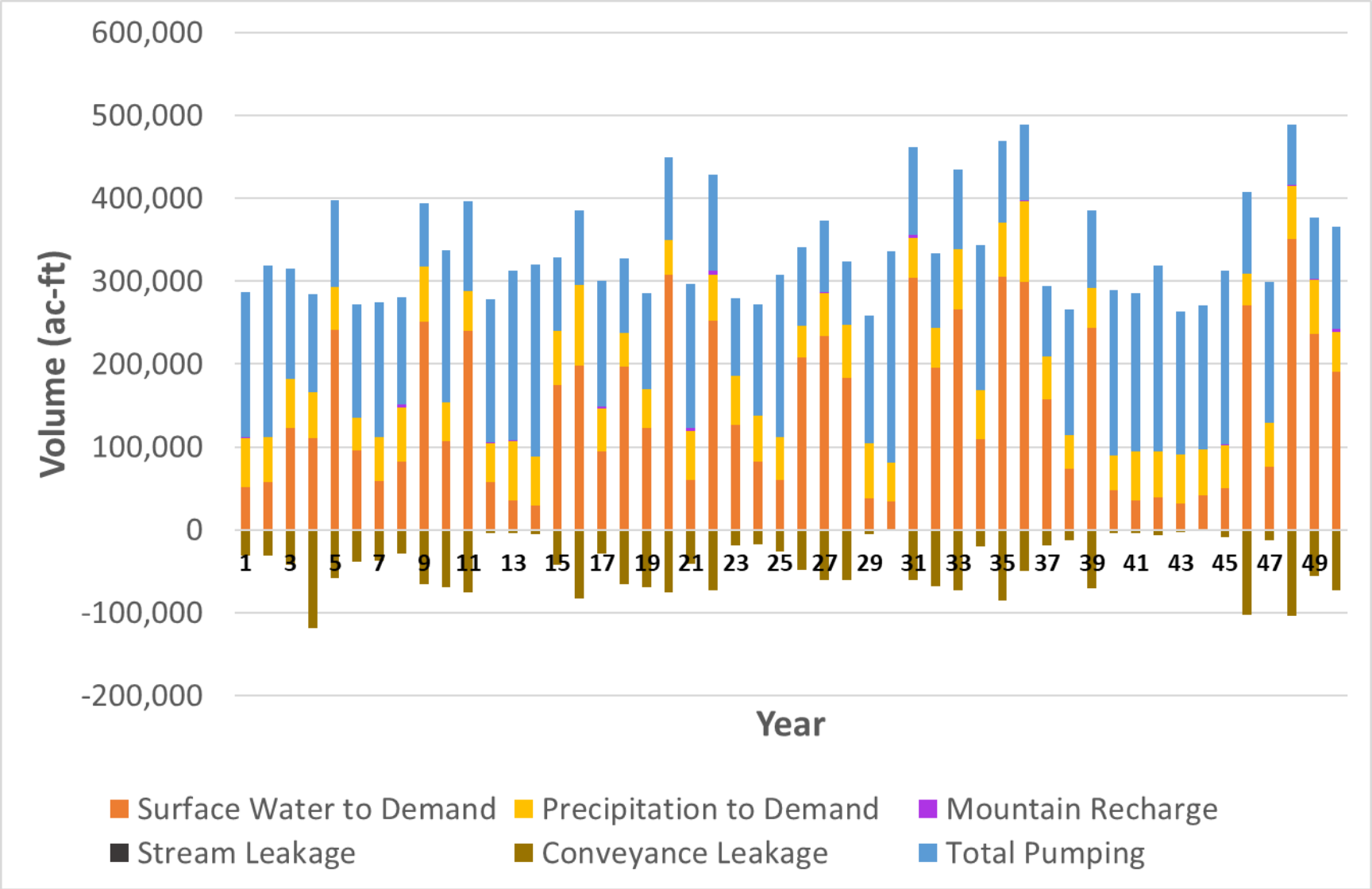
Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District

Figure 4-31 to Figure 4-52 depict the various water budget components of the groundwater model for each of the Friant Contractors within the study area under the No Project Alternative. The water budget component graphs show the inflows and outflows for the land surface and the upper aquifer separately. The volumes shown apply to the upper aquifer and are expressed in acre-feet.

For each Friant Contractor, a land surface water budget and upper aquifer water budget is shown. The land surface water budget summarizes the changes in the following parameters over the simulation period: surface water to demand, precipitation to demand, mountain recharge, stream leakage, conveyance leakage, and total pumping. The surface water to demand and total pumping are the two components that vary between the No Project Alternative and three Project alternatives. Variation in the surface water deliveries between the baseline and Project alternatives, as described in Chapter 3, over the simulation period effects groundwater pumping volumes. During periods when surface water deliveries increase, groundwater pumping to meet water demands decreases to meet water demands. All other land surface water budget components are considered the same between the No Project Alternative and three Project alternatives.

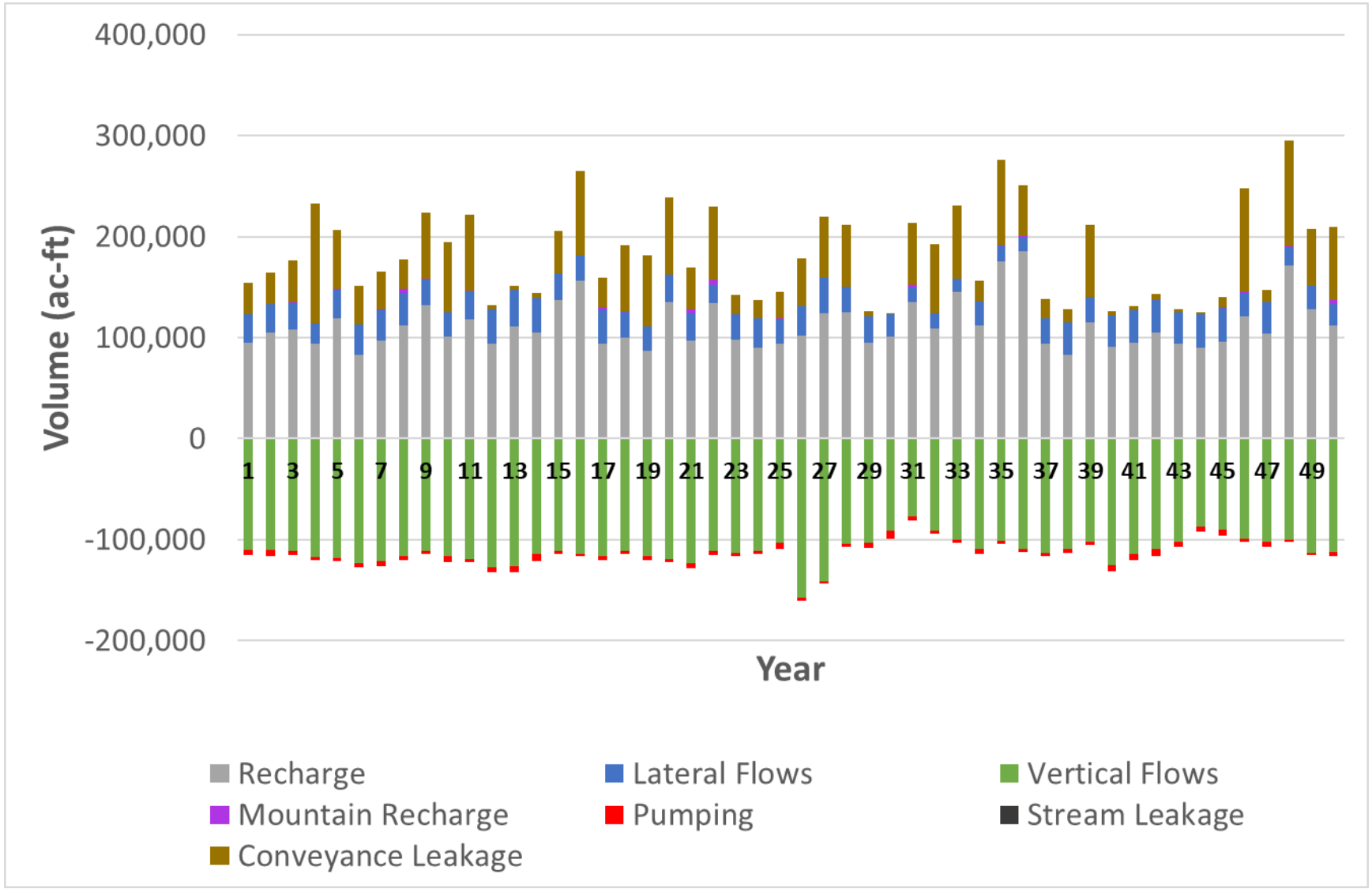
The upper aquifer water budget summarizes the changes in the following parameters over the simulation period: recharge, lateral flows, vertical flows, mountain recharge, pumping, stream leakage, and conveyance leakage. The recharge and pumping are the two components that vary between the No Project Alternative and three Project alternatives. Variation in the surface water deliveries between the baseline and Project alternatives, as described in Chapter 3, over the simulation period effects groundwater pumping volumes and recharge volumes. During periods when surface water deliveries increase, groundwater pumping to meet water demands decreases to meet water demands and recharge in the upper aquifer increases. All other upper aquifer water budget components are considered the same between the No Project Alternative and three Project alternatives. The inflow and outflow components for both the land surface and the upper aquifer are the same as those described under the Existing Conditions (Chapter 4.2.1.1). Although the water budget components are the same between the Existing Conditions and No Project Alternative, the differences in amounts for each component between the two conditions are related to future changes in operational and regulatory environment in the Friant Division and are independent of implementation of the proposed project.

In the No Project Alternative, AEWSD, SSJMUD, DEID, Saucelito ID, Pixley ID, and LTRID experience a net inflow of water over the simulation period. SWID, KTWD, TBID, TPDWD, and Porterville ID experienced a net outflow of water. While Pixley ID received no surface water deliveries under the Existing Conditions, Pixley ID does receive surface water deliveries under the No Project Alternative, thus decreasing total groundwater pumping.



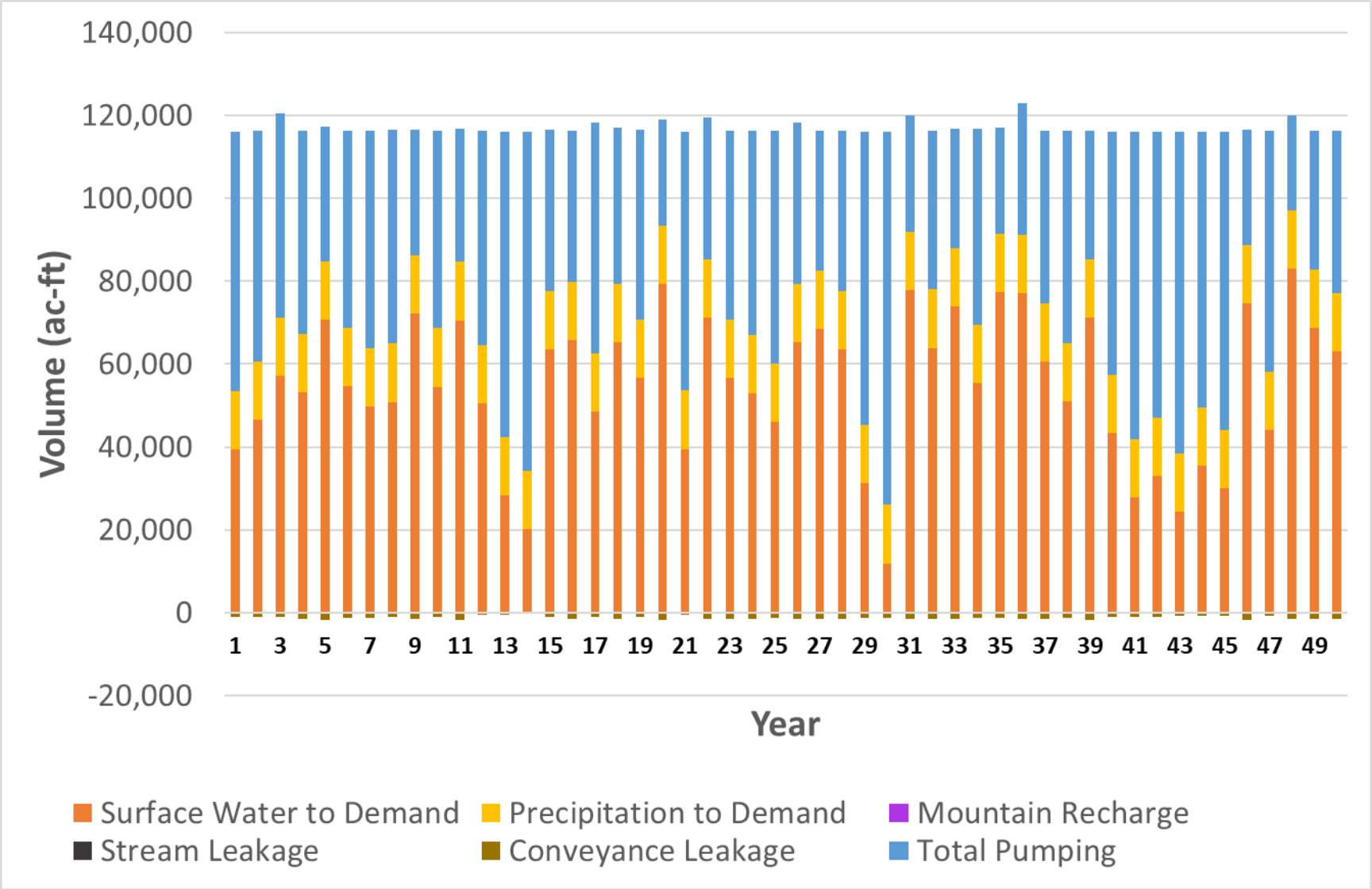
Key: ac-ft = acre-feet

Figure 4-31. Arvin Edison Water Storage District Land Surface Water Budget Components Aggregated by Year Under No Project Alternative



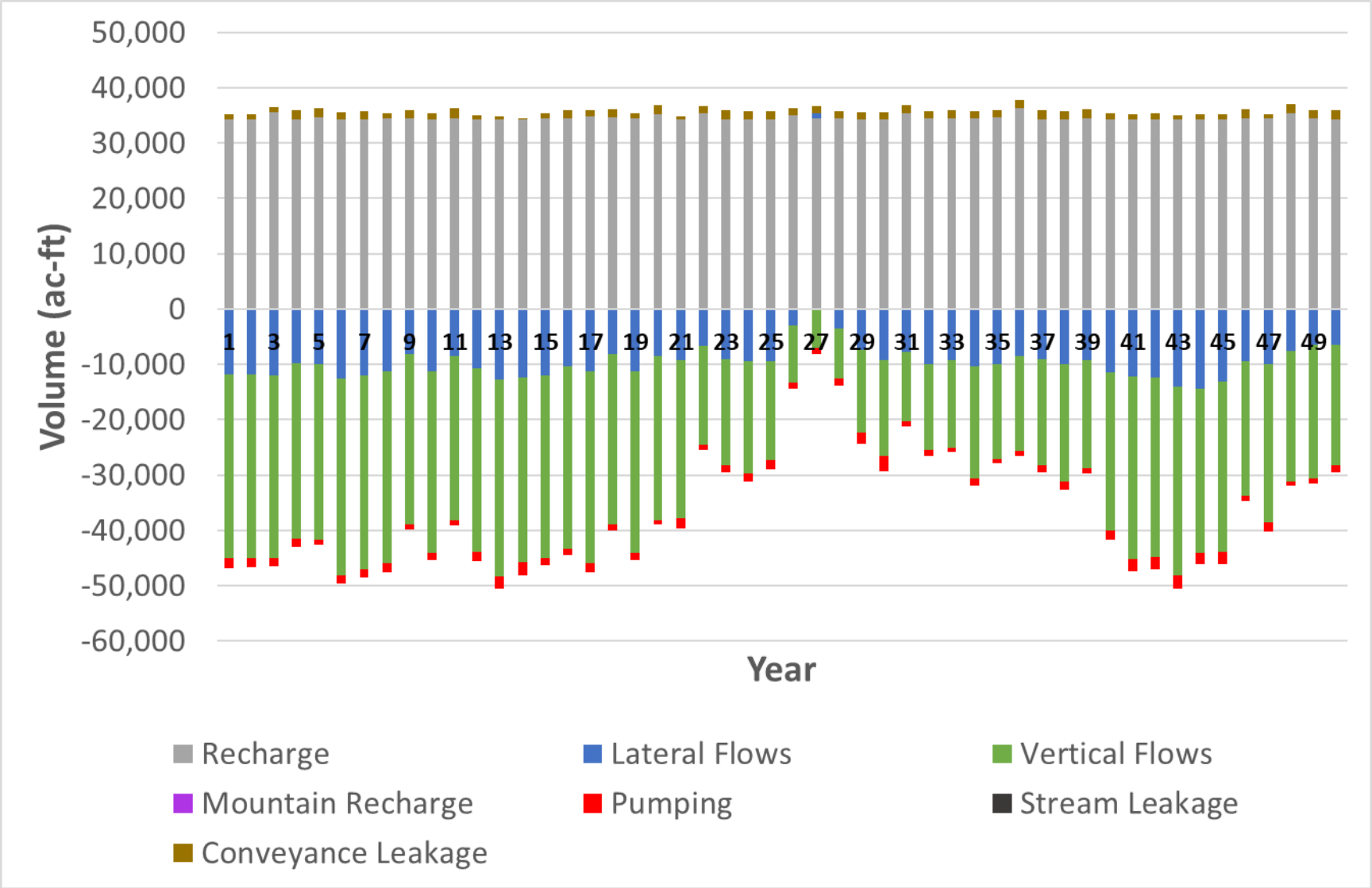
Key: ac-ft = acre-feet

Figure 4-32. Arvin Edison Water Storage District Upper Aquifer Water Budget Components Aggregated by Year Under No Project Alternative



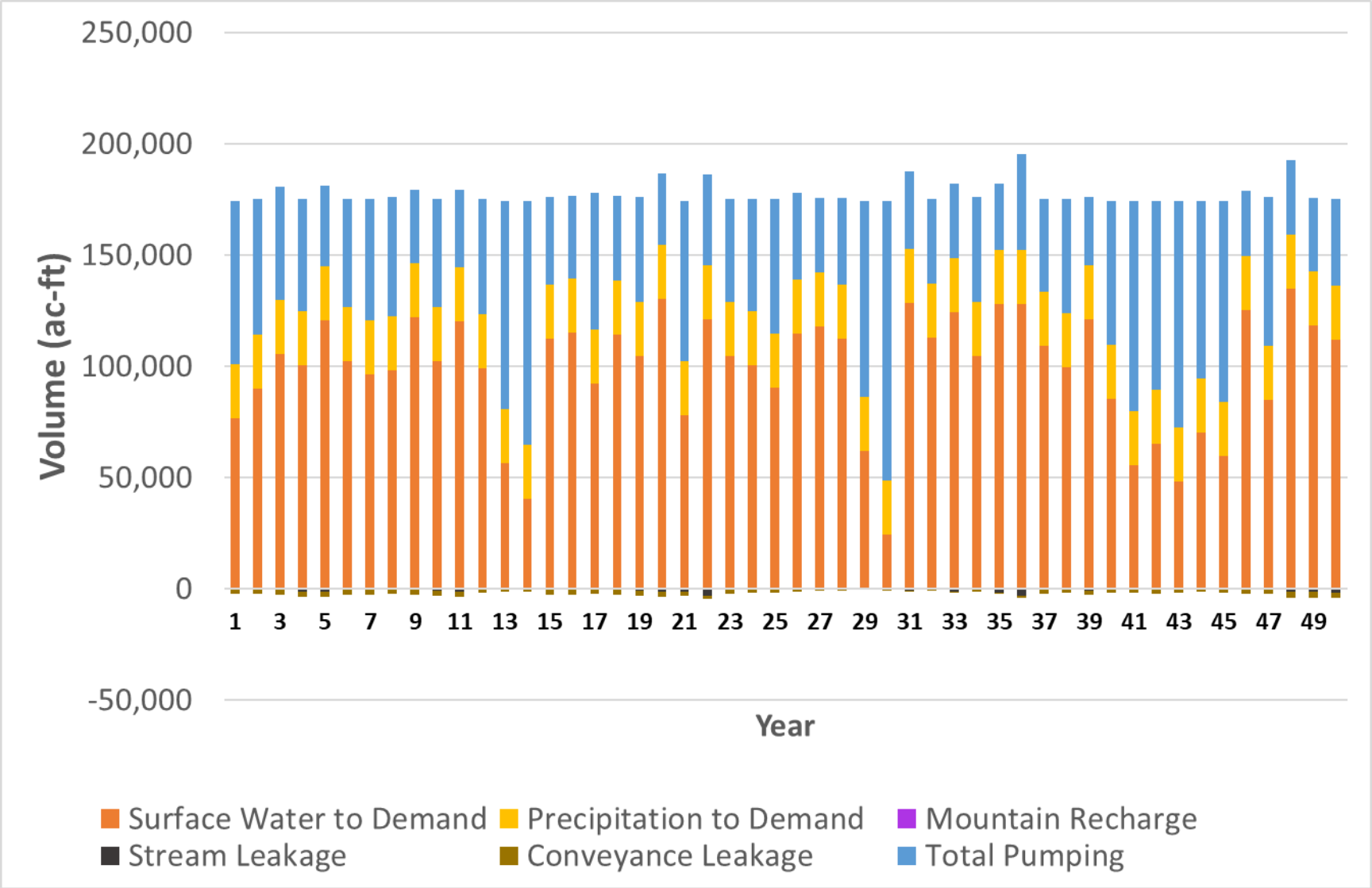
Key: ac-ft = acre-feet

Figure 4-33. Shafter-Wasco Irrigation District Land Surface Water Budget Components Aggregated by Year Under No Project Alternative



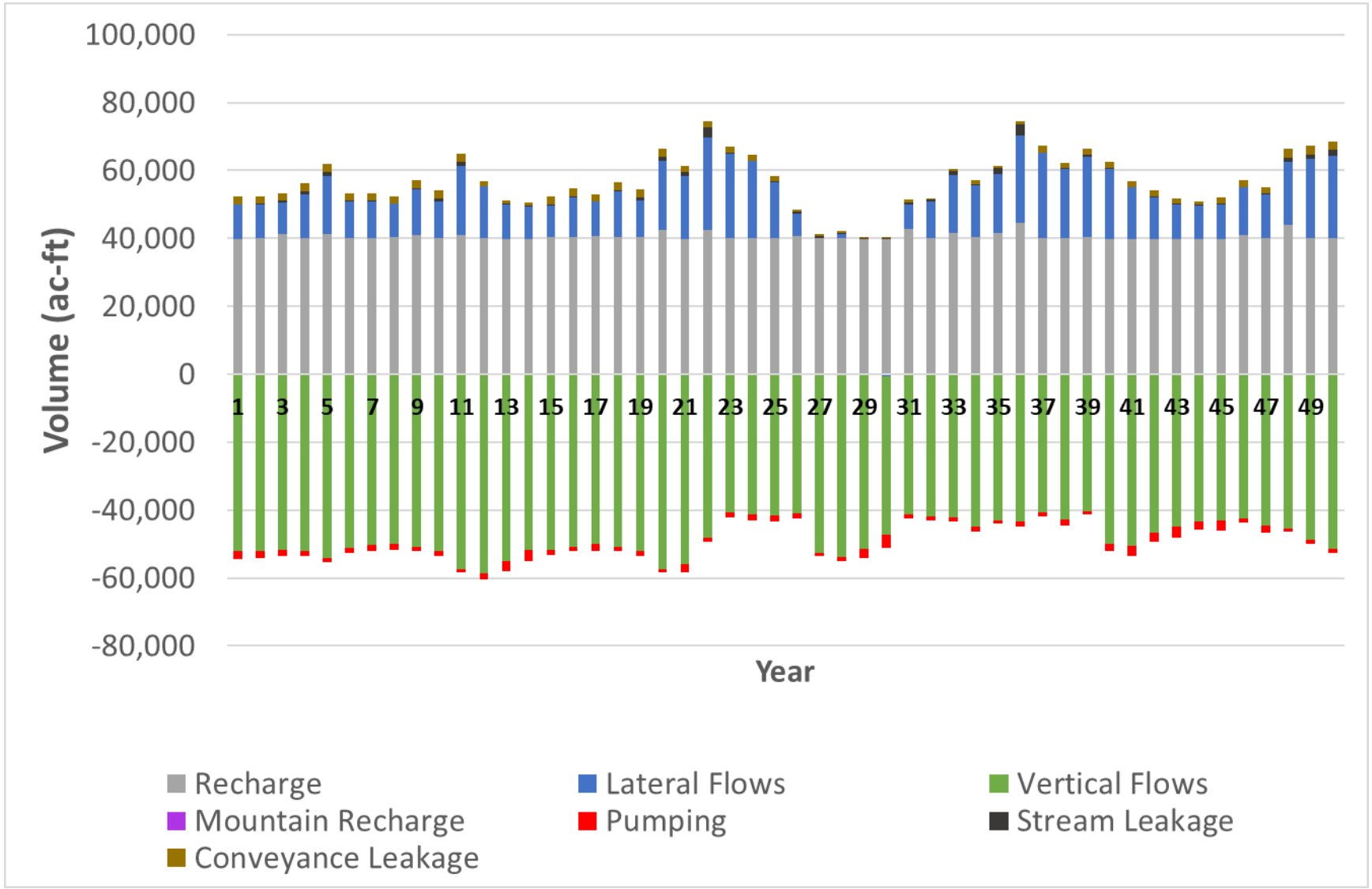
Key: ac-ft = acre-feet

Figure 4-34. Shafter-Wasco Irrigation District Upper Aquifer Water Budget Components Aggregated by Year Under No Project Alternative



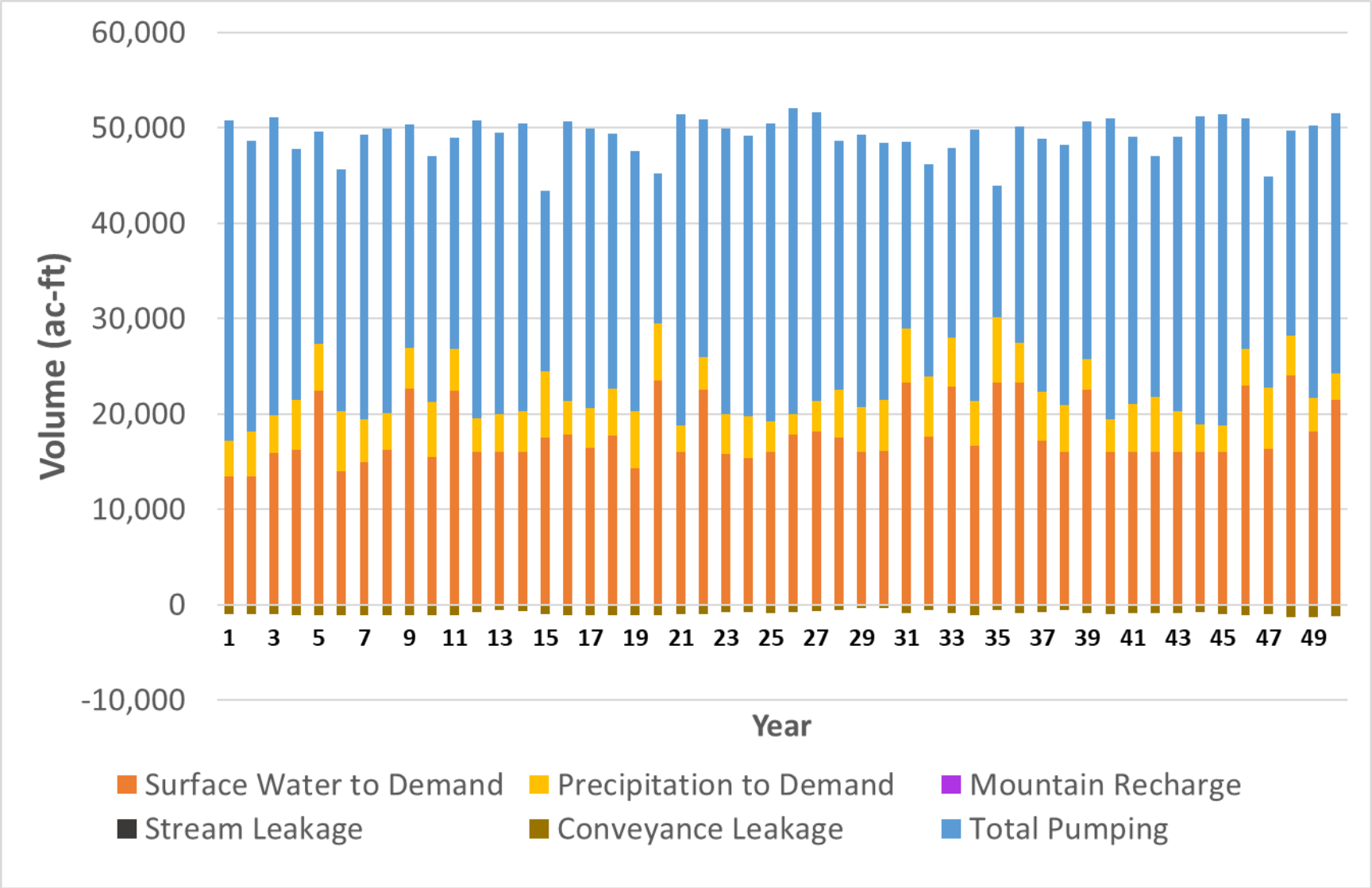
Key: ac-ft = acre-feet

Figure 4-35. Southern San Joaquin Municipal Utility District Land Surface Water Budget Components Aggregated by Year Under No Project Alternative



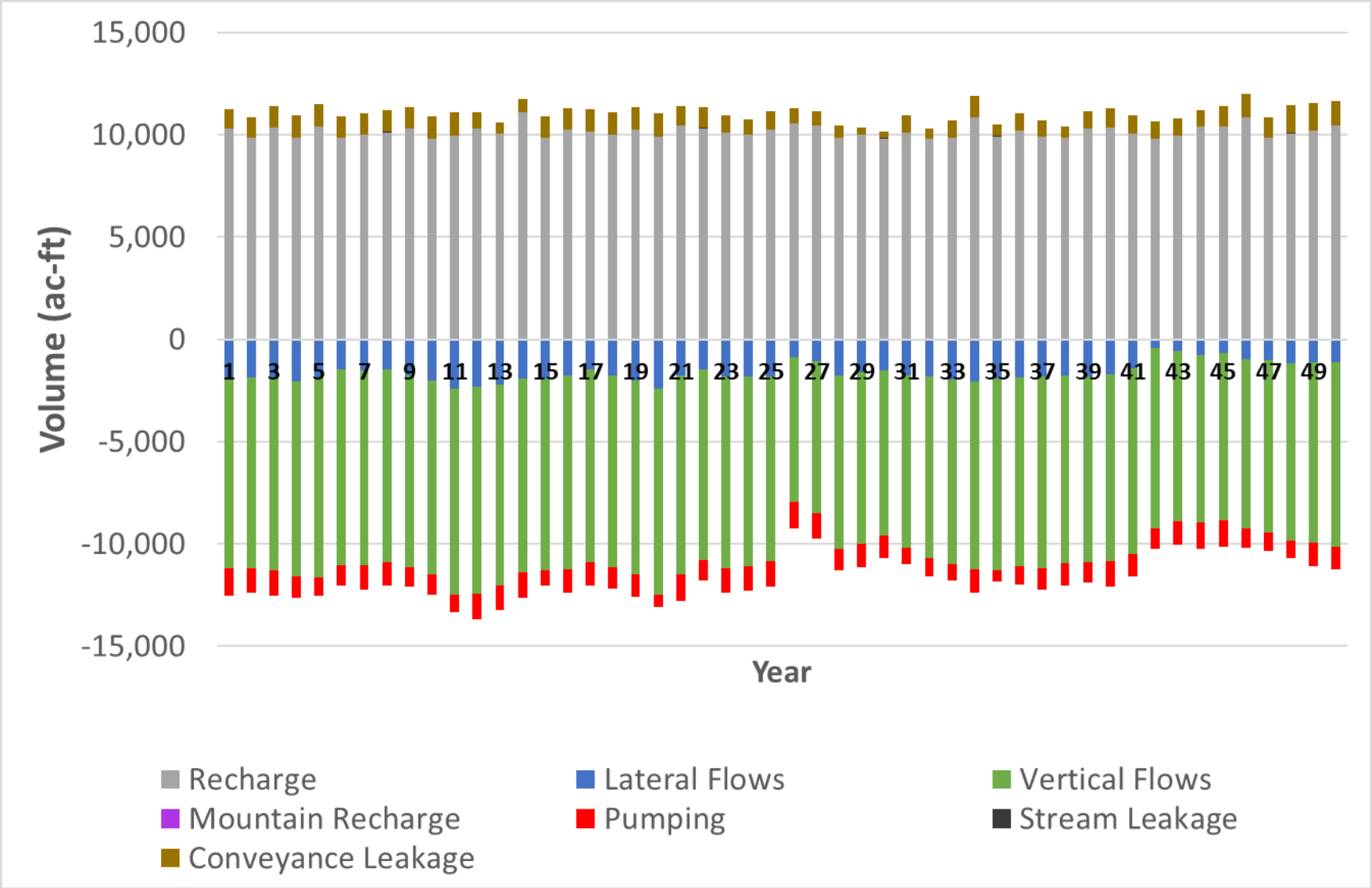
Key: ac-ft = acre-feet

Figure 4-36. Southern San Joaquin Municipal Utility District Upper Aquifer Water Budget Components Aggregated by Year Under No Project Alternative



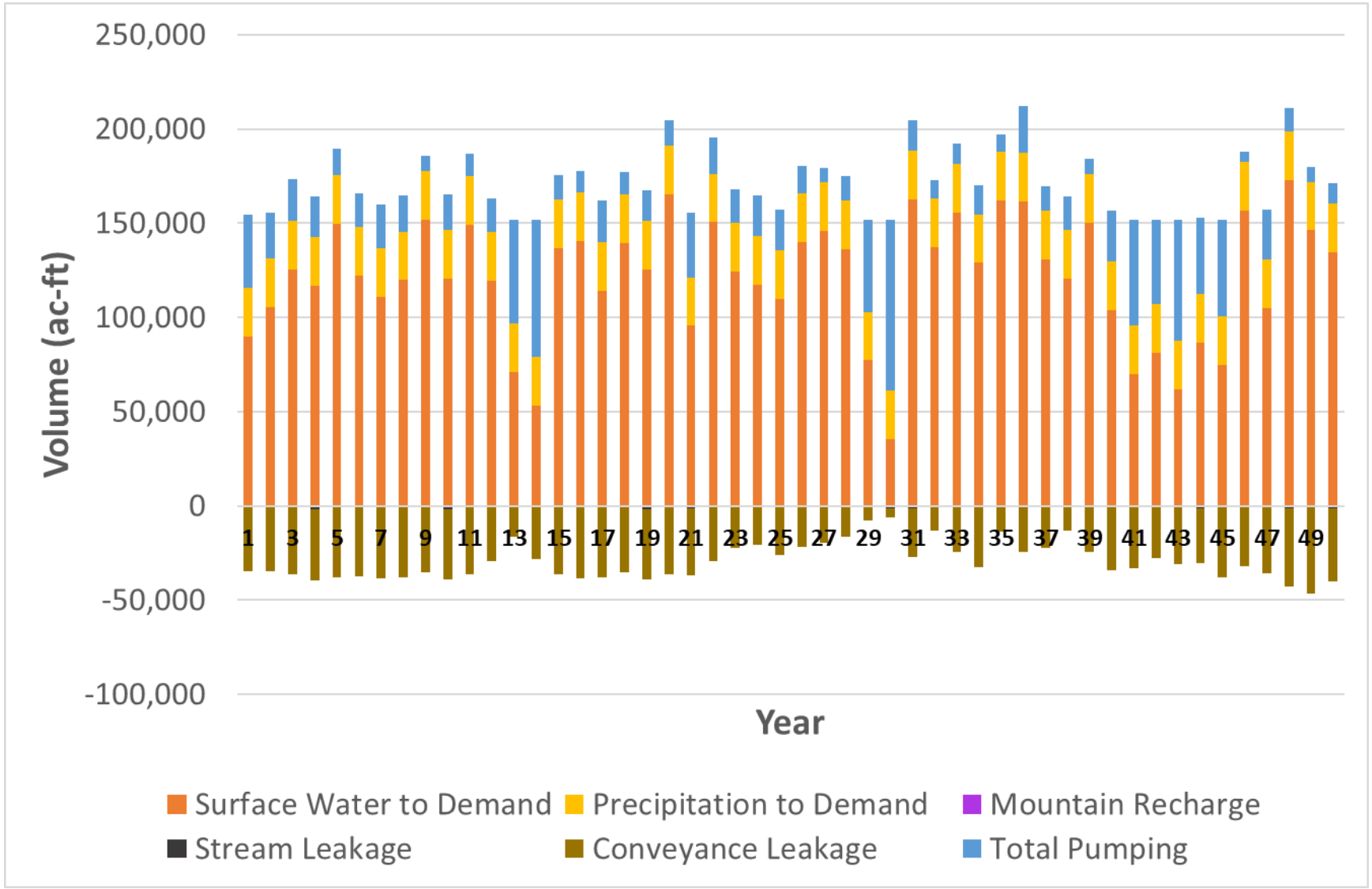
Key: ac-ft = acre-feet

Figure 4-37. Kern-Tulare Water District Land Surface Water Budget Components Aggregated by Year Under No Project Alternative



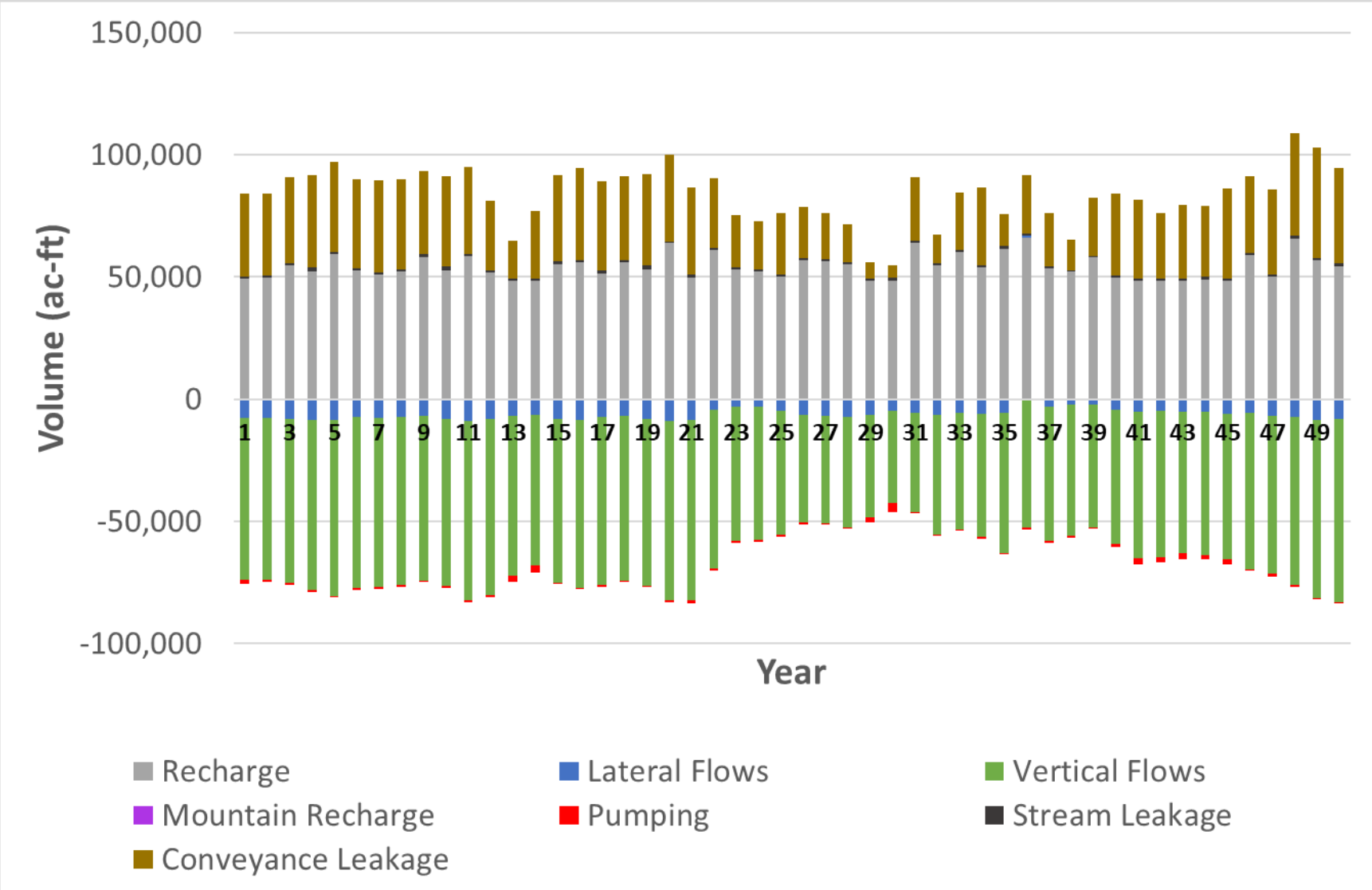
Key: ac-ft = acre-feet

Figure 4-38. Kern-Tulare Water District Upper Aquifer Water Budget Components Aggregated by Year Under No Project Alternative



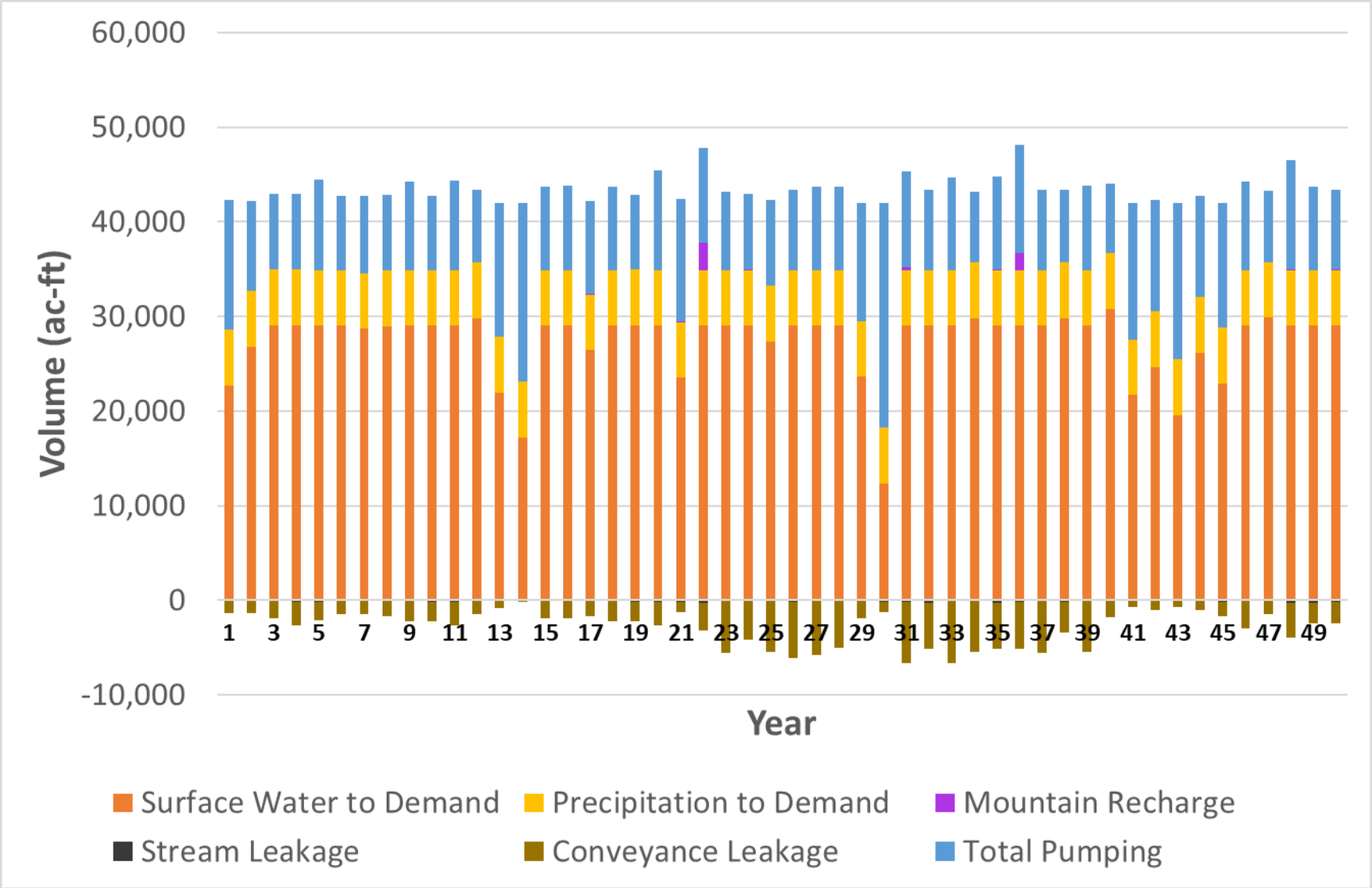
Key: ac-ft = acre-feet

Figure 4-39. Delano-Earlimart Irrigation District Land Surface Water Budget Components Aggregated by Year Under No Project Alternative



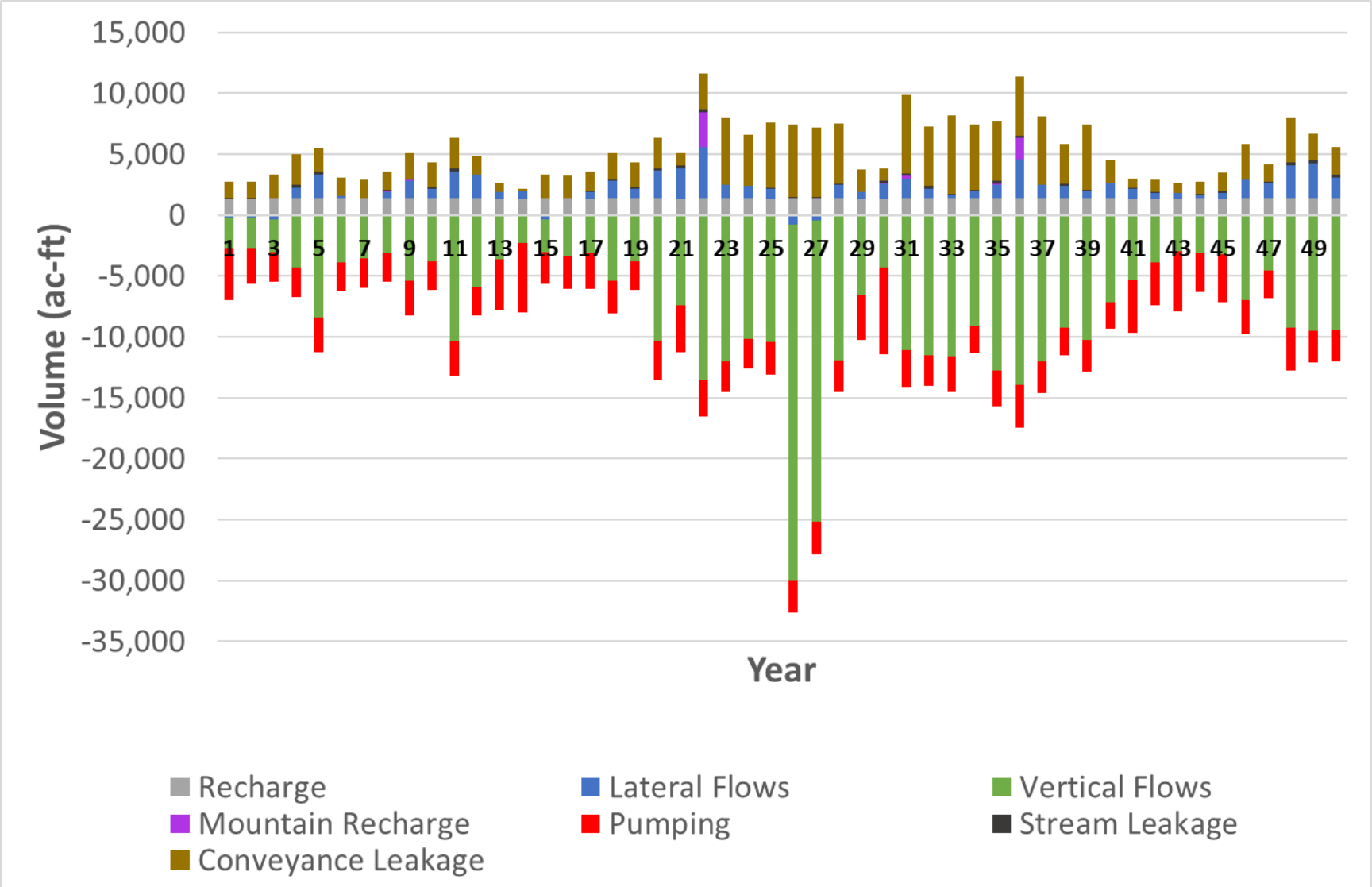
Key: ac-ft = acre-feet

Figure 4-40. Delano-Earlimart Irrigation District Upper Aquifer Water Budget Components Aggregated by Year Under No Project Alternative



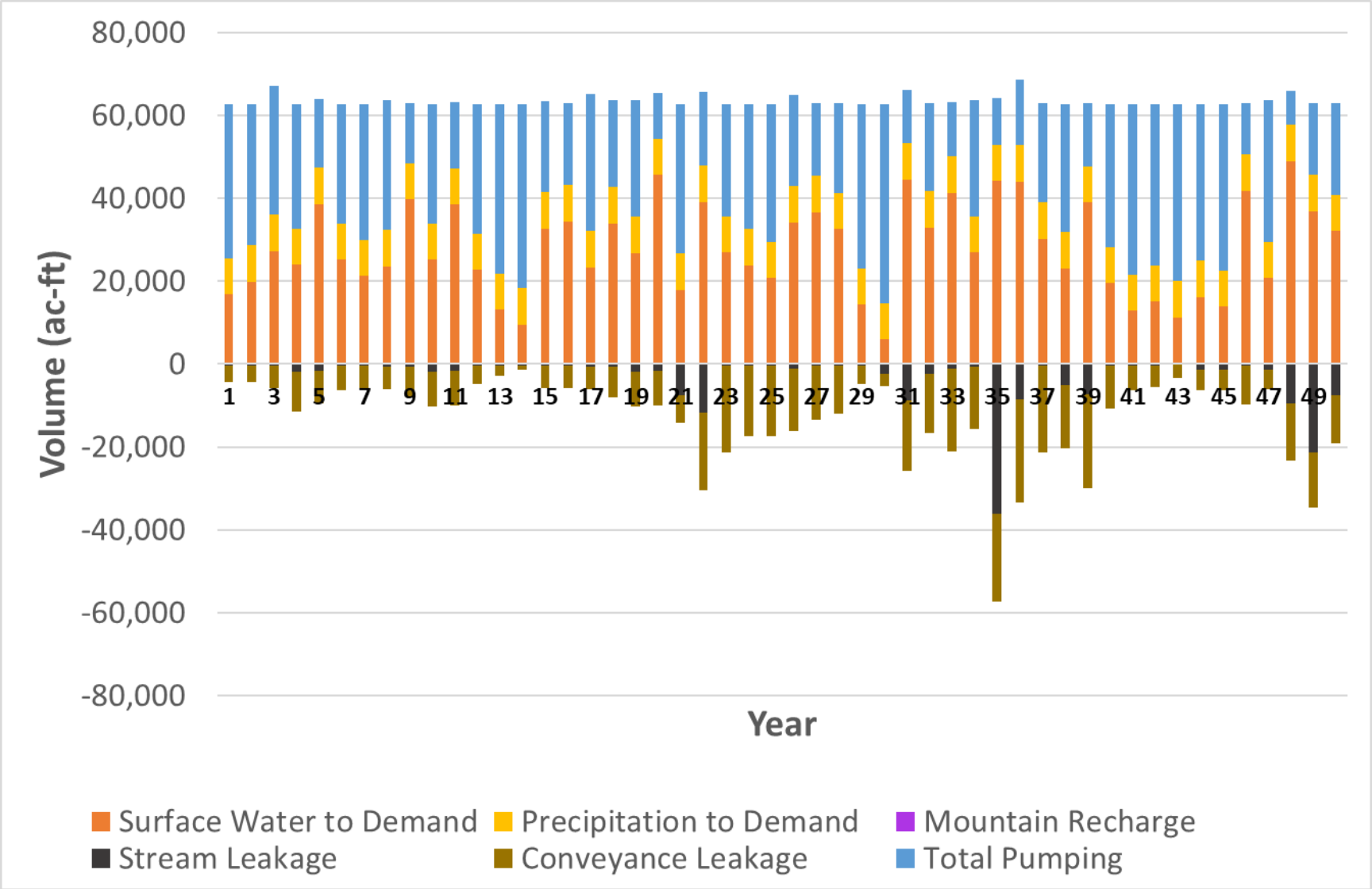
Key: ac-ft = acre-feet

Figure 4-41. Terra Bella Irrigation District Land Surface Water Budget Components Aggregated by Year Under No Project Alternative



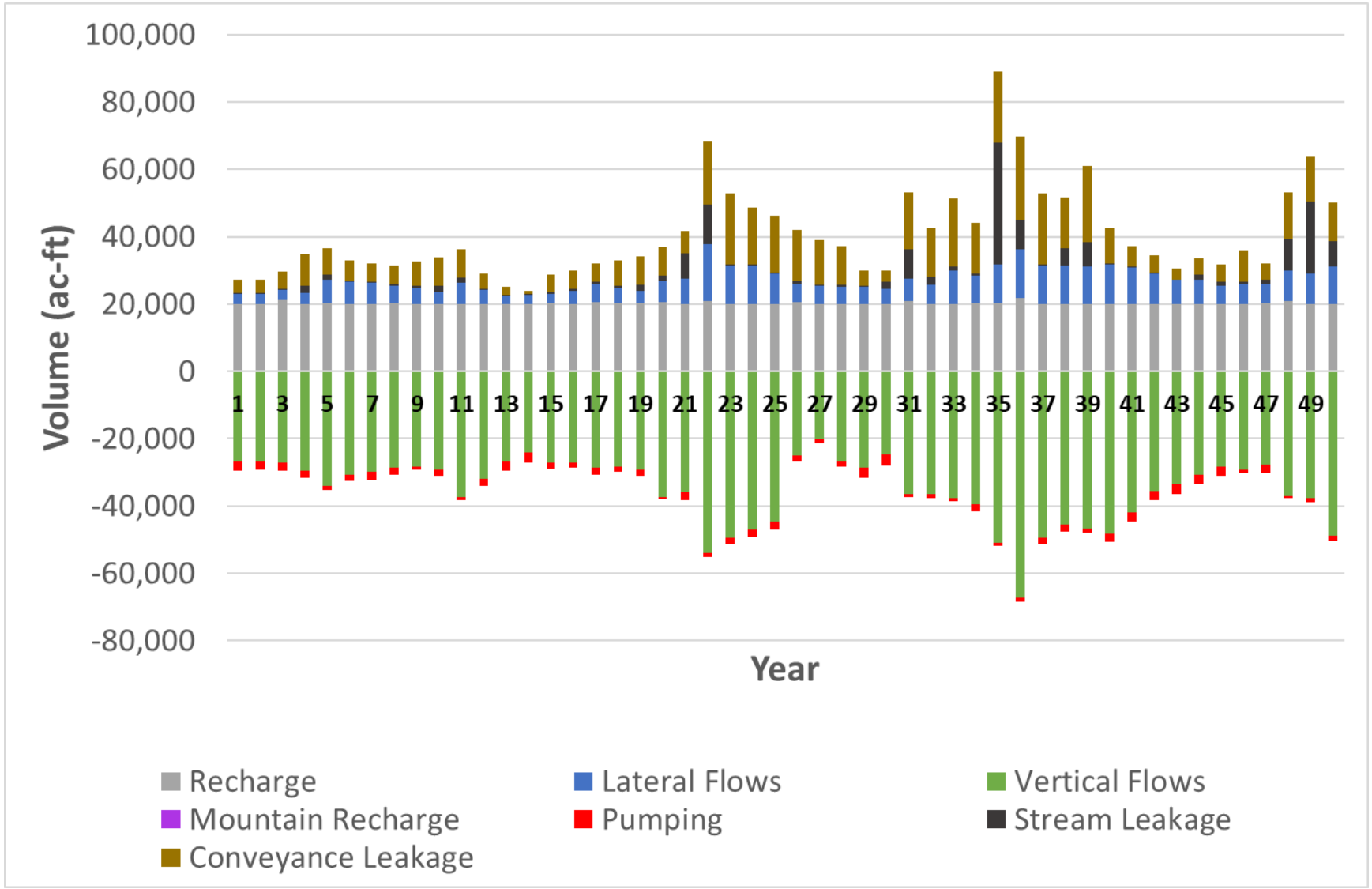
Key: ac-ft = acre-feet

Figure 4-42. Terra Bella Irrigation District Upper Aquifer Water Budget Components Aggregated by Year Under No Project Alternative



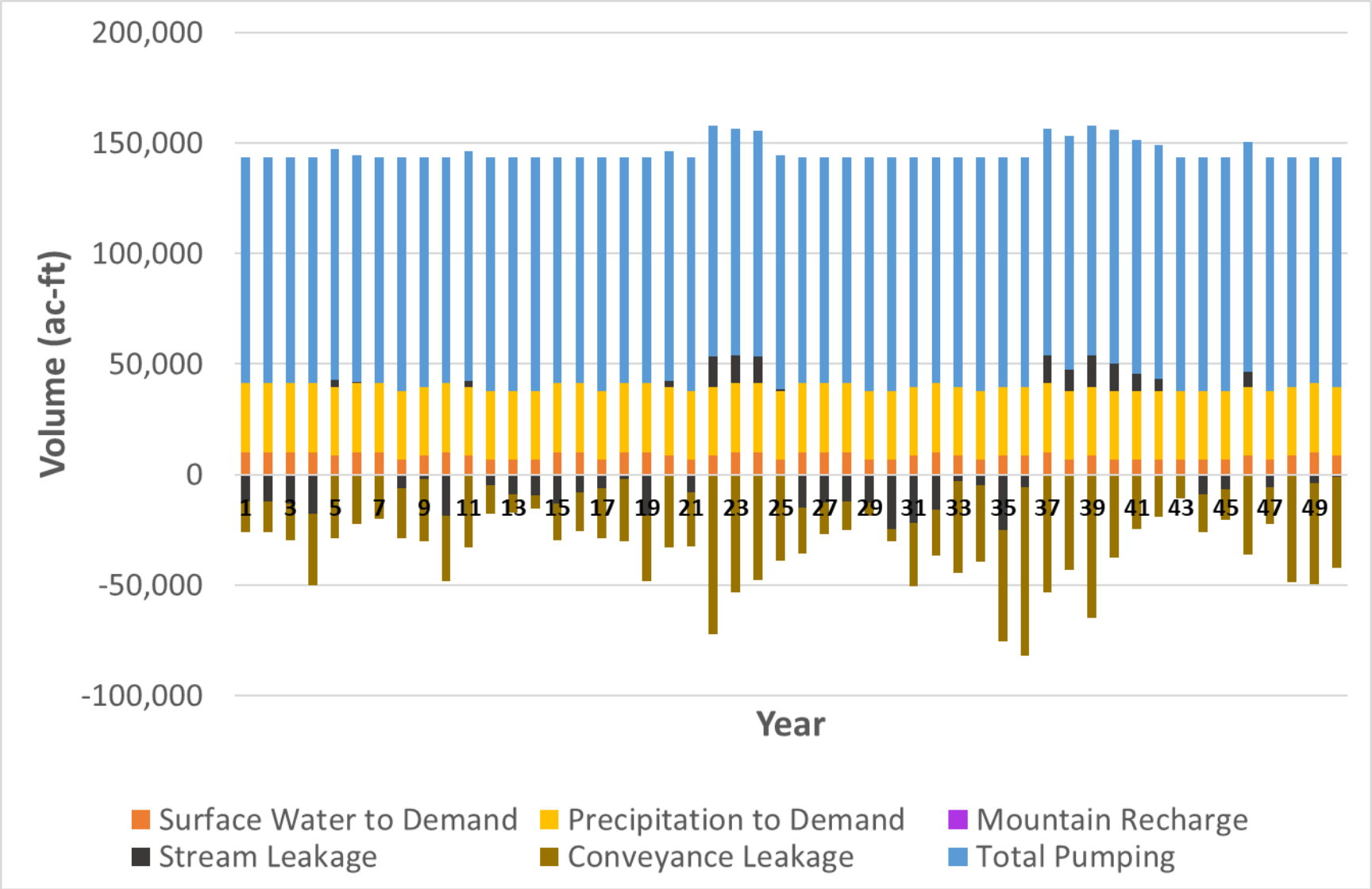
Key: ac-ft = acre-feet

Figure 4-43. Saucelito Irrigation District Land Surface Water Budget Components Aggregated by Year Under No Project Alternative



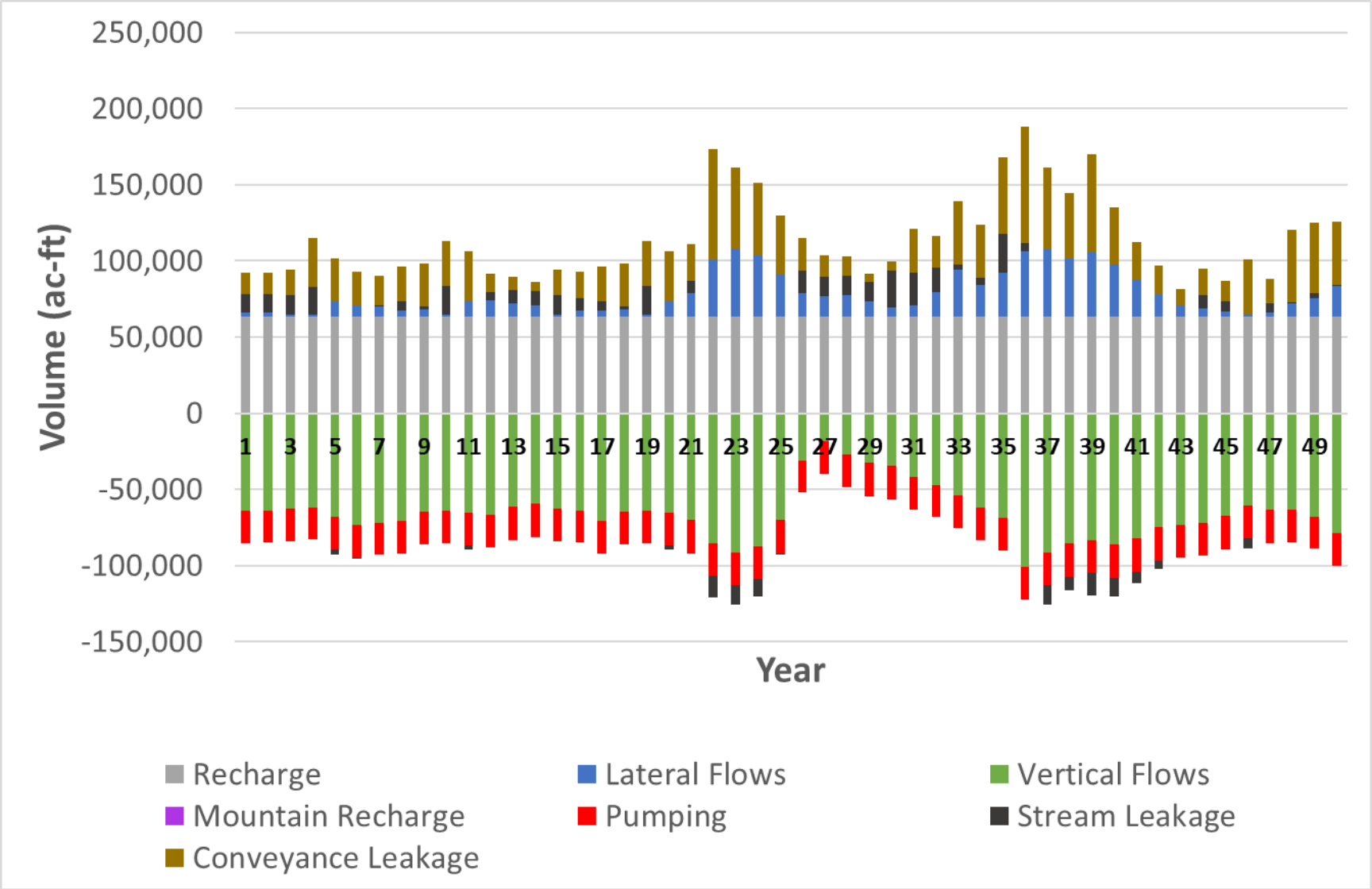
Key: ac-ft = acre-feet

Figure 4-44. Saucelito Irrigation District Upper Aquifer Water Budget Components Aggregated by Year Under No Project Alternative



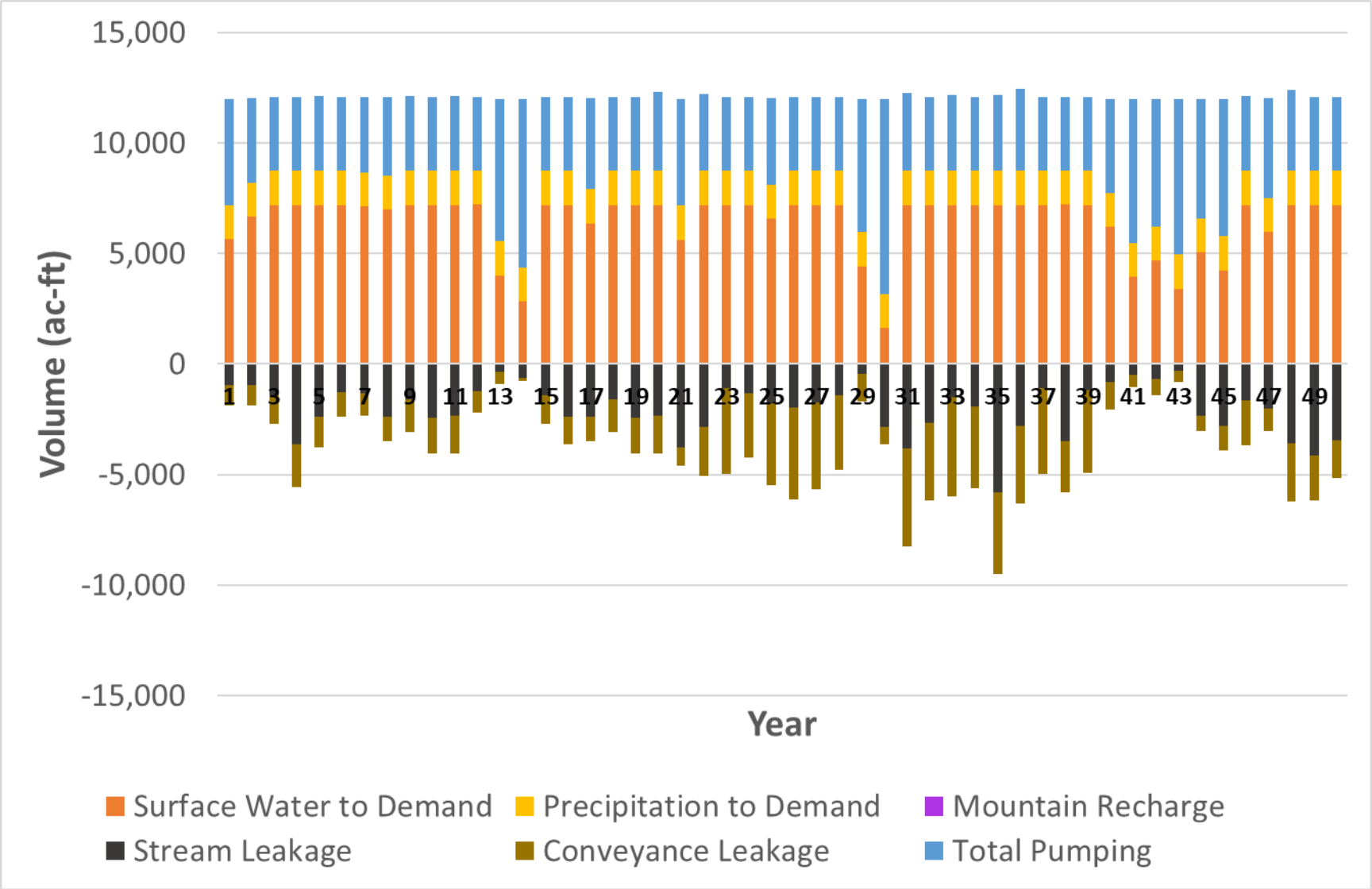
Key: ac-ft = acre-feet

Figure 4-45. Pixley Irrigation District Land Surface Water Budget Components Aggregated by Year Under No Project Alternative



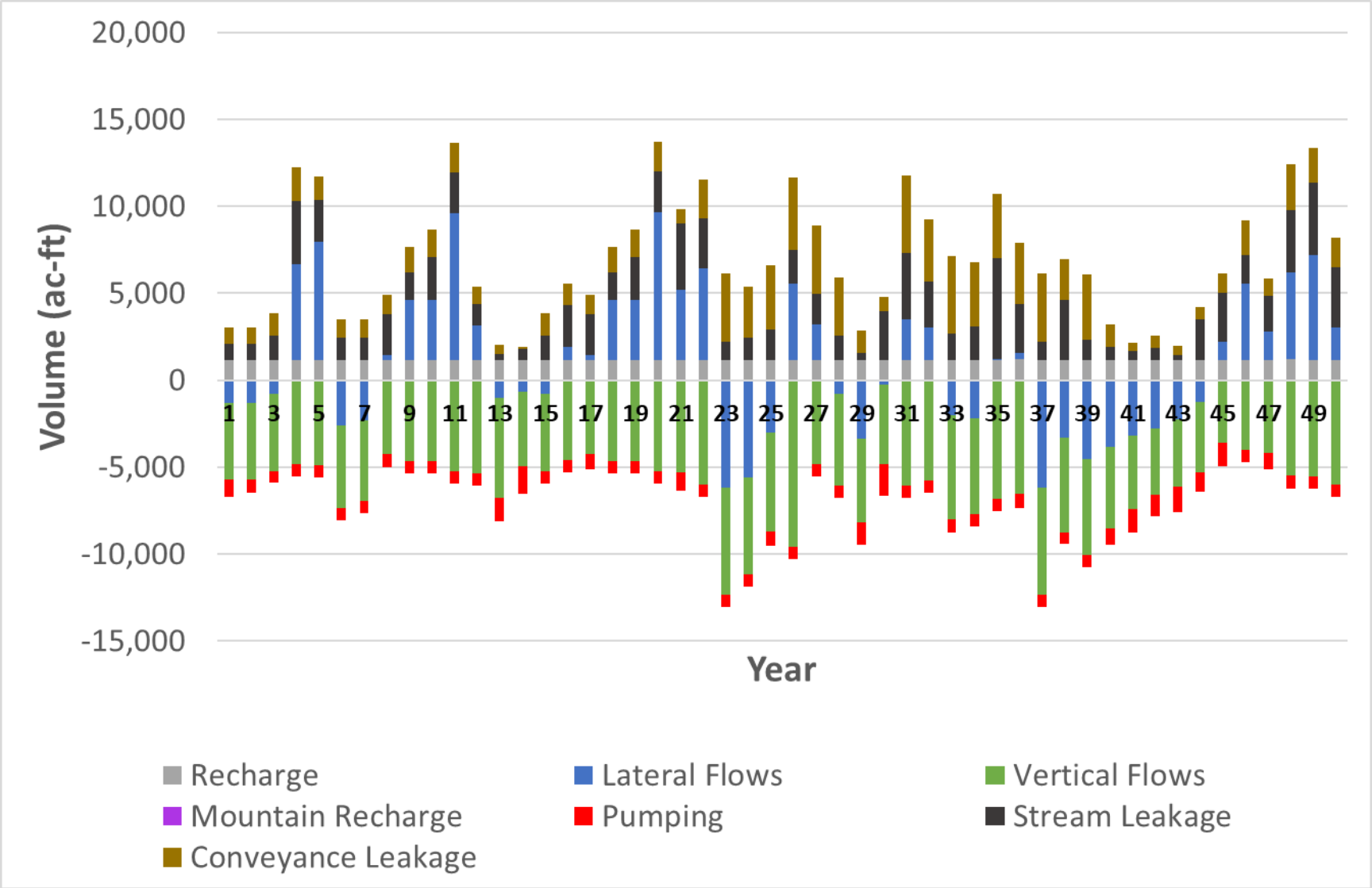
Key: ac-ft = acre-feet

Figure 4-46. Pixley Irrigation District Upper Aquifer Water Budget Components Aggregated by Year Under No Project Alternative



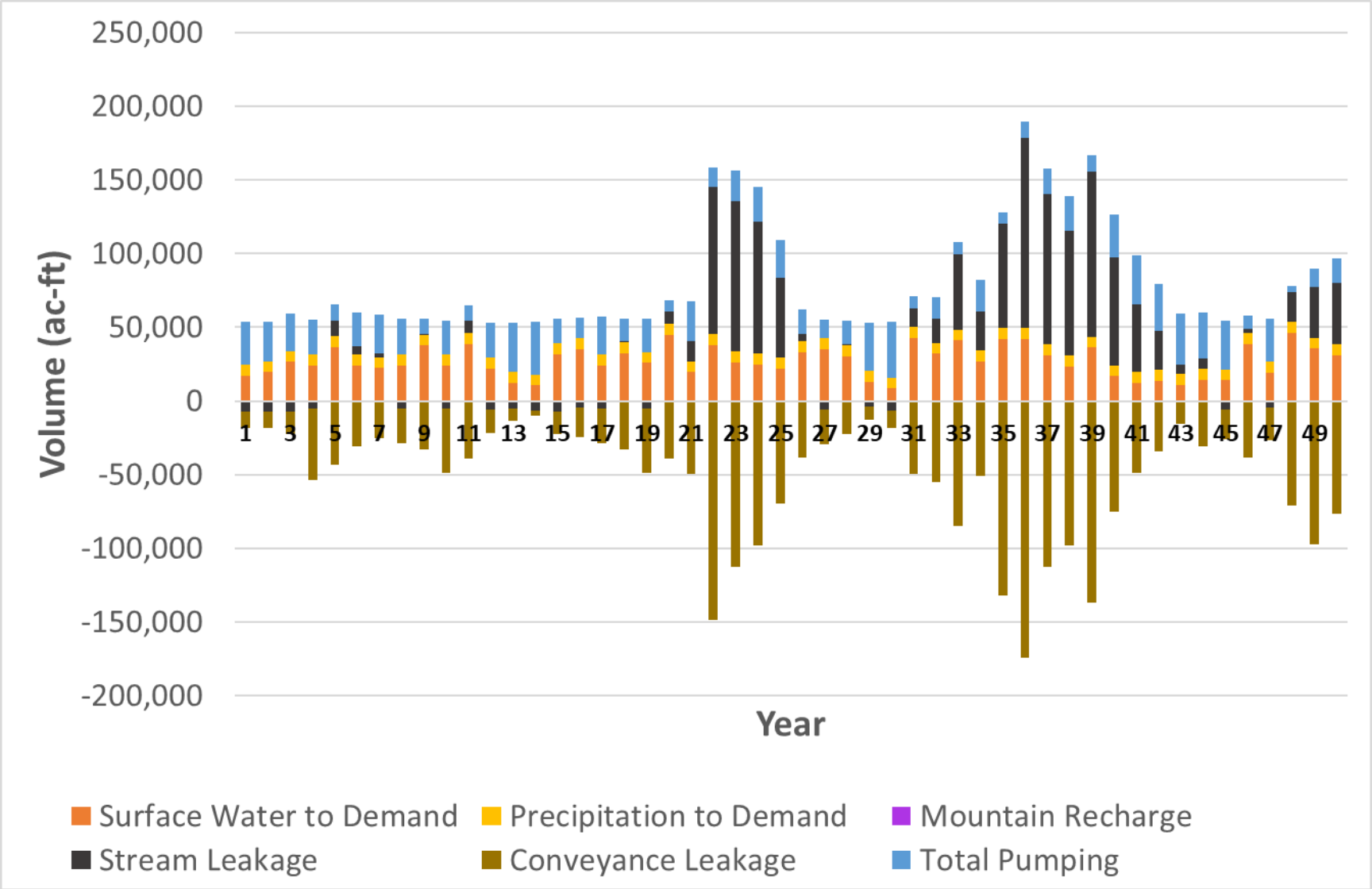
Key: ac-ft = acre-feet

Figure 4-47. Tea Pot Dome Water District Land Surface Water Budget Components Aggregated by Year Under No Project Alternative



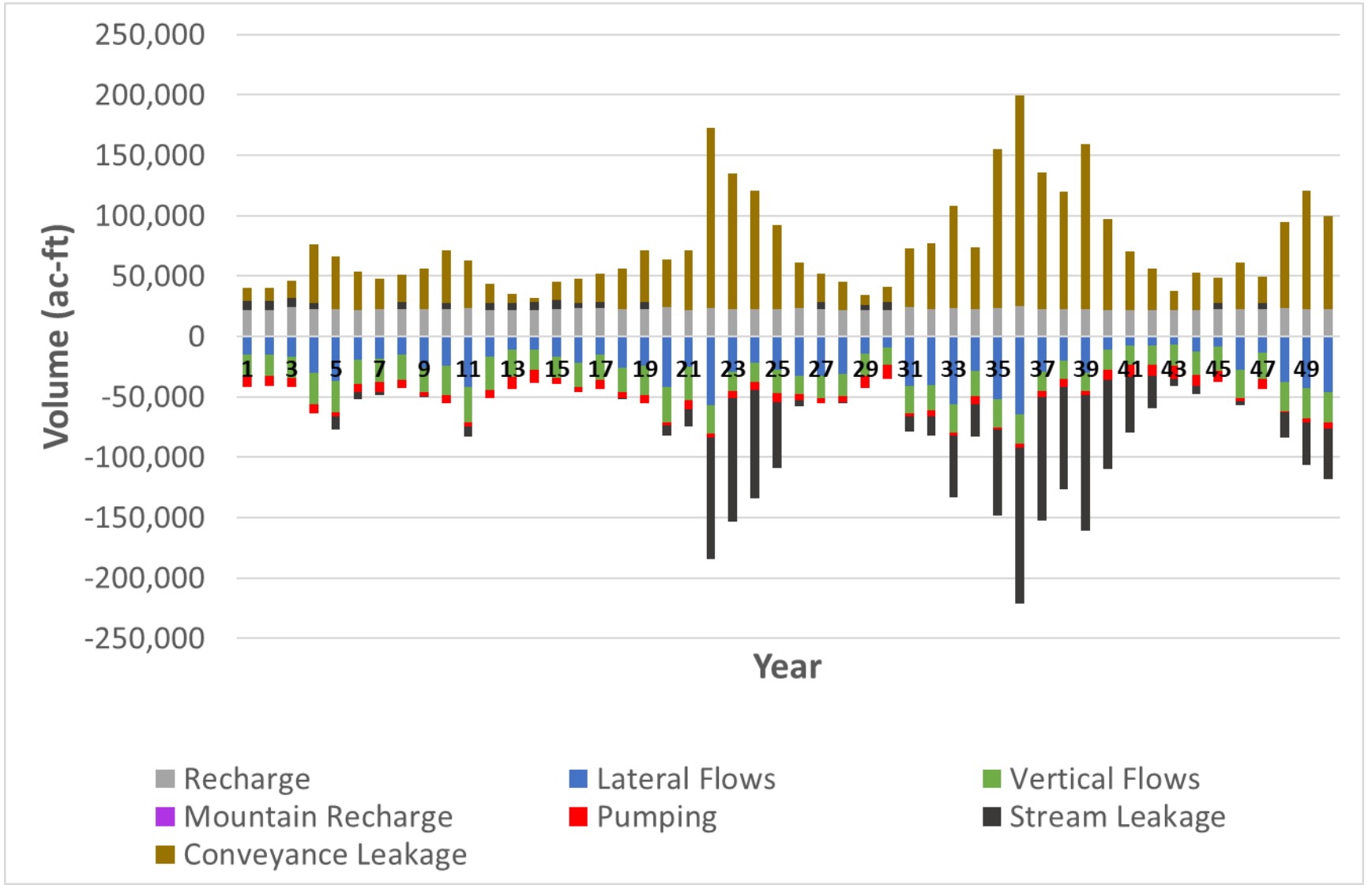
Key: ac-ft = acre-feet

Figure 4-48. Tea Pot Dome Water District Upper Aquifer Water Budget Components Aggregated by Year Under No Project Alternative



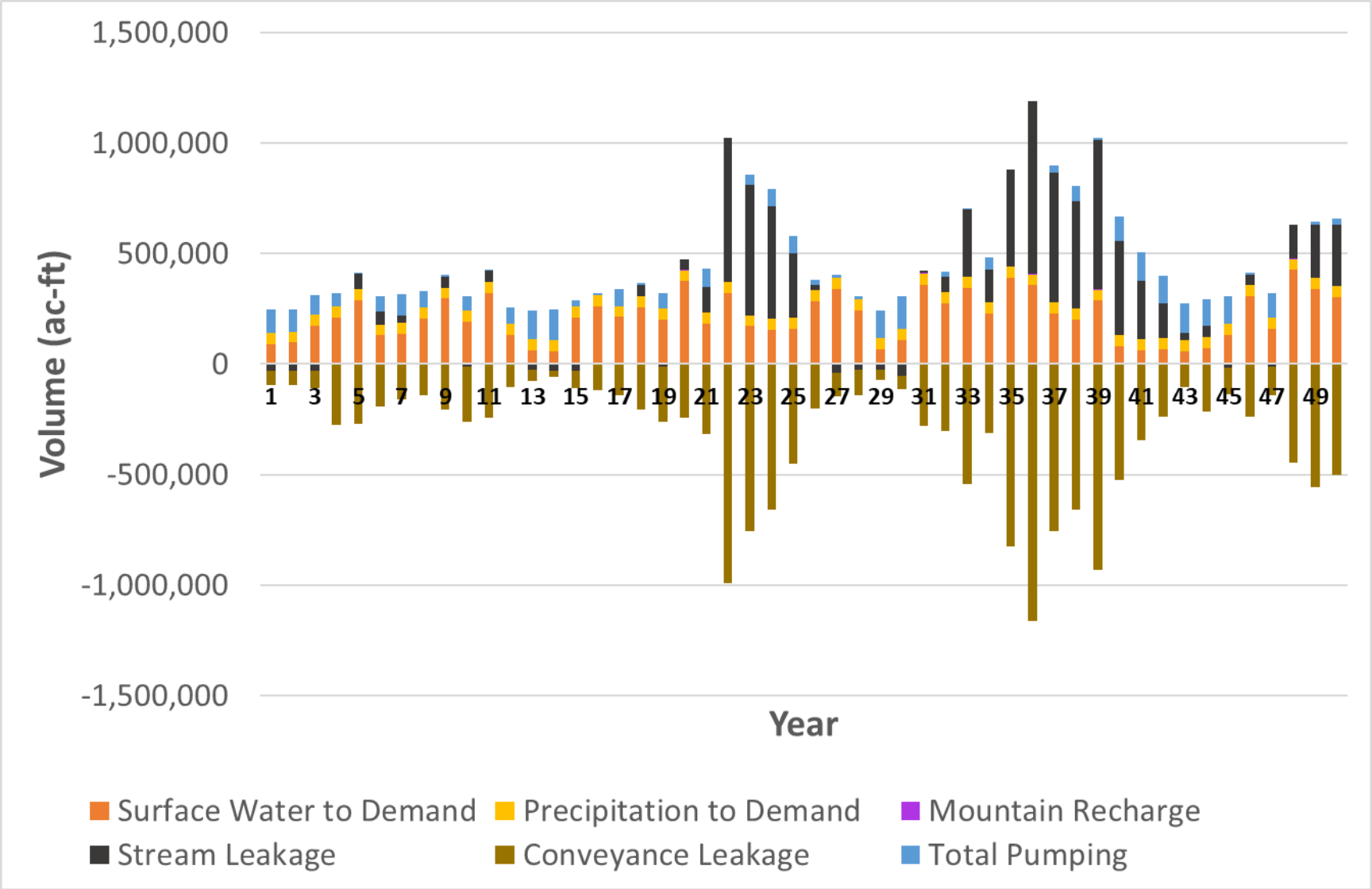
Key: ac-ft = acre-feet

Figure 4-49. Porterville Irrigation District Land Surface Water Budget Components Aggregated by Year Under No Project Alternative



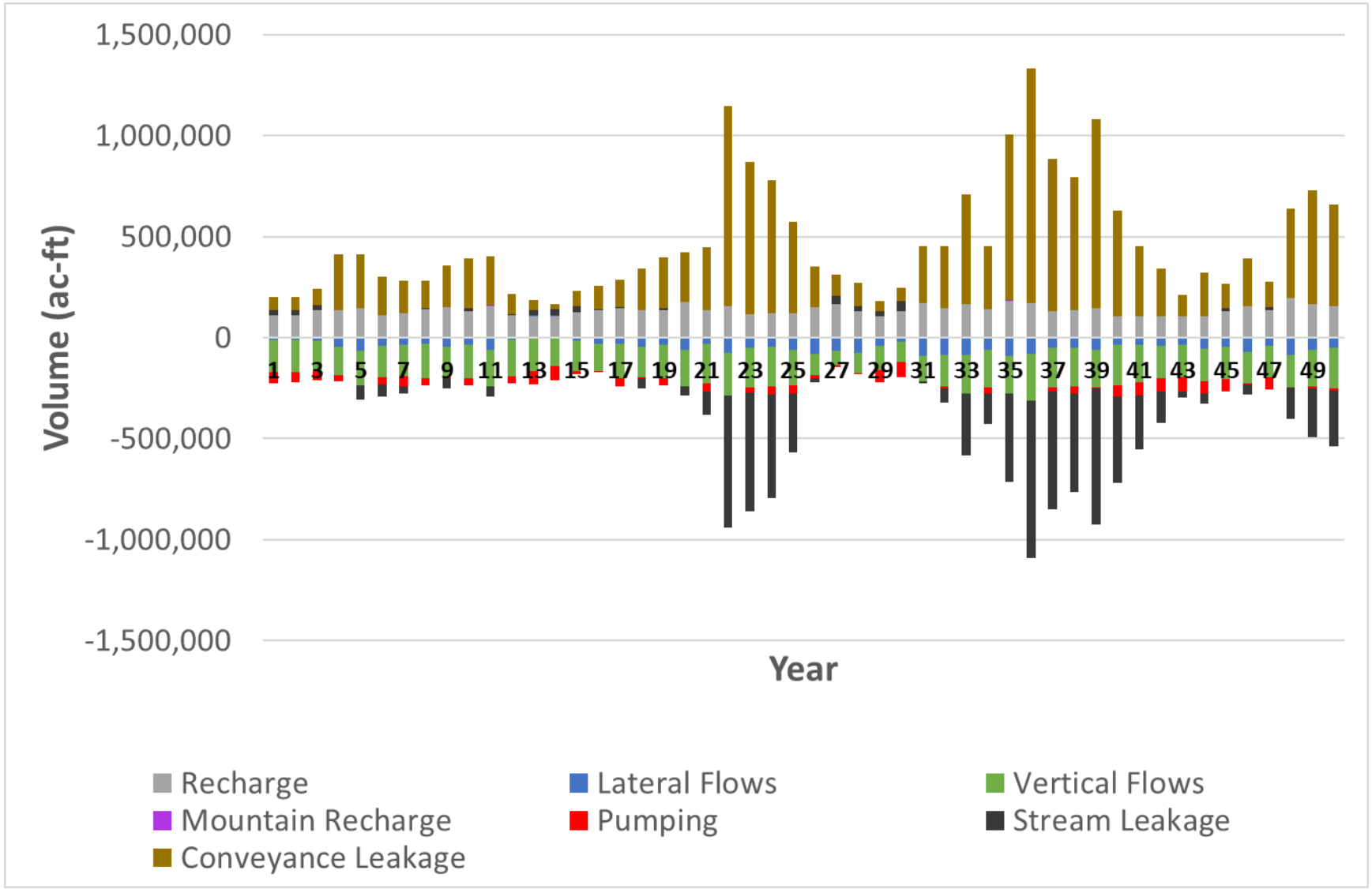
Key: ac-ft = acre-feet

Figure 4-50. Porterville Irrigation District Upper Aquifer Water Budget Components Aggregated by Year Under No Project Alternative



Key: ac-ft = acre-feet

Figure 4-51. Lower Tule River Irrigation District Land Surface Water Budget Components Aggregated by Year Under No Project Alternative



Key: ac-ft = acre-feet

Figure 4-52. Lower Tule River Irrigation District Upper Aquifer Water Budget Components Aggregated by Year Under No Project Alternative

4.2.2.2 Groundwater Quality Constituents

Results from the groundwater model simulations for groundwater quality analysis under the No Project Alternative are presented in Table 4-19 to Table 4-22. As described previously, changes in concentrations for four key constituents that affect the suitability of groundwater for beneficial uses (FWA, 2023) were evaluated using modeling tools: salinity measured as TDS, chloride, boron, and nitrate.

Results of the groundwater quality analysis are compared against specific significance criteria developed to determine the significance of potential impacts in relation to groundwater quality. The significance criteria applied include those developed in accordance with Appendix G of the State CEQA Guidelines; criteria based on factual or scientific information; criteria based on regulatory standards of local, State, and federal agencies; and criteria developed by FWA.

Below sections provide results for analysis of groundwater quality conditions for TDS, chloride, boron, and nitrate under the No Project Alternative. The starting concentrations for groundwater quality constituents under the No Project Alternative are the same as those utilized under the Existing Conditions.

Total Dissolved Solids

Simulated changes in relative concentration of TDS in groundwater on a monthly timestep are shown in Figure 4-53. Table 4-19 summarizes the simulated ending concentrations, annual rates of change, and simulated maximum 5-year annual rates of change for the Friant Contractors. Although none of the annual rates of change exceed the significance threshold, the simulated maximum 5-year annual rate of change for 8 of the 11 Friant Contractors in the study area exceeds the significance threshold. These results are similar to results for the Existing Conditions. As explained under the Existing Conditions, the simulated maximum 5-year annual rate of change represents Dry water years coupled with times of more outflow from the Friant Contractors, thus resulting in increasing concentrations of TDS.

The impact of dry water years on constituent concentrations is most evident in Porterville ID. This district experiences a series of dry years from year 40 to year 45. These dry years also coincide with a sharp increase in constituent concentration. This increase is the result of reduced surface water supplies and an increased reliance on groundwater pumping. TDS concentrations decrease after year 45 once surface water supplies increase. This increase in concentration is observed across all constituents in all scenarios due to the presence of dry years in each scenario.

Factors affecting the simulated TDS concentrations under the No Project Alternative relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers, and assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting TDS concentrations for simulations).

KTWD, TBID and Pixley ID. KTWD, TBID and Pixley ID show increases in their ending concentrations compared to the observed starting concentration under the No Project Alternative. Pixley ID experiences increases to the simulated ending concentration due to high levels of groundwater pumping. Although Pixley ID receives surface water deliveries under the No Project Alternative, a substantial amount of pumping still occurs, resulting in increasing TDS concentrations.

In the case of TBID, higher TDS concentrations were seen due to a higher pumping proportion from the upper aquifer compared to other Friant Contractors and a decline in upper aquifer volume over the simulation period. Under the Existing Conditions, KTWD experienced a decrease in TDS concentrations. However, in the No Project Alternative, KTWD received reduced amounts of surface water supplies. These reduced surface water deliveries resulted in higher groundwater pumping to meet water demands and led to simulated increase in TDS concentrations in the upper aquifer.

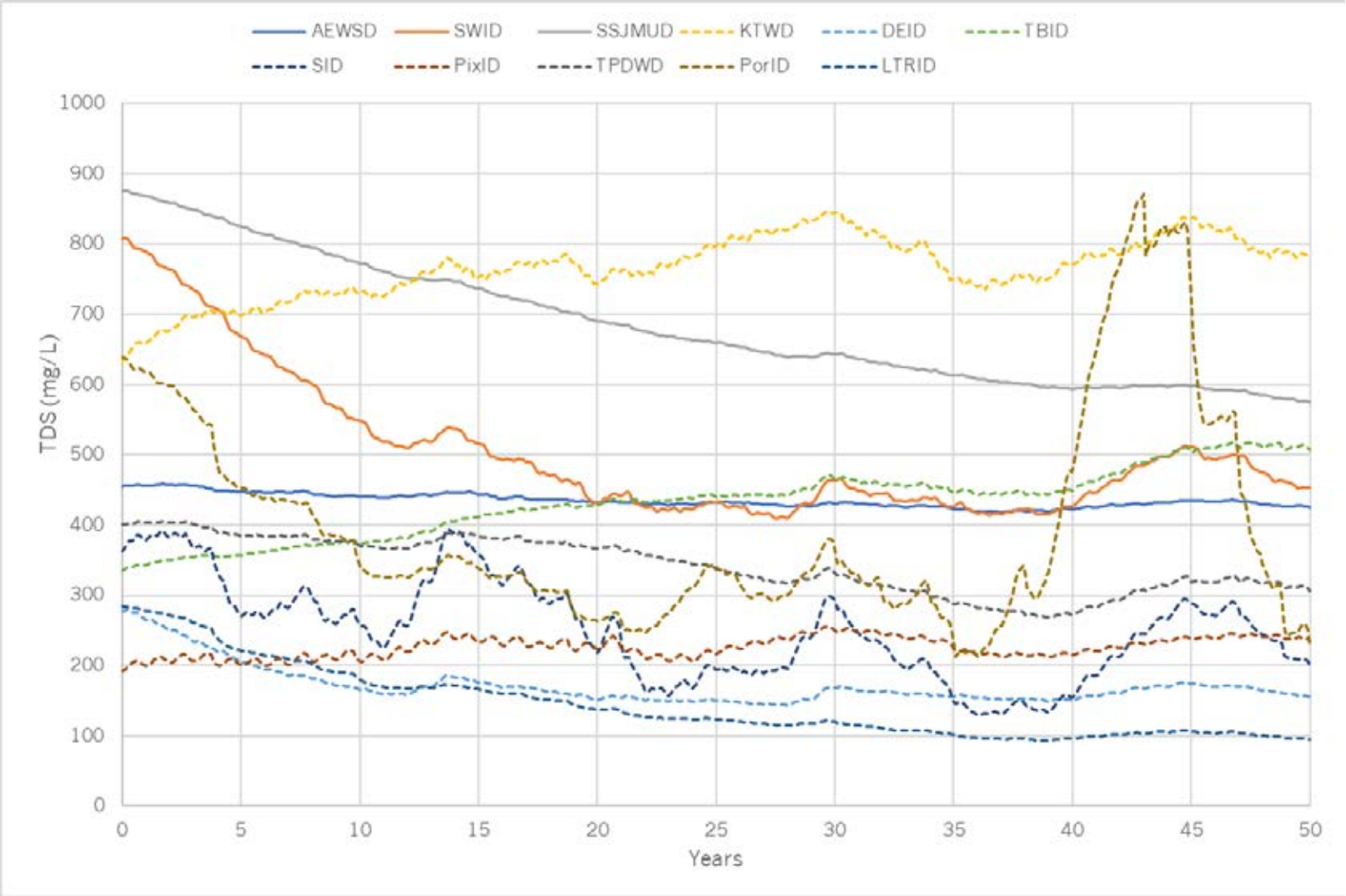
Table 4-19. Summary of Simulated Concentration of Total Dissolved Solids in Groundwater with Associated Rates of Change and Significance Thresholds under No Project Alternative

Friant Contractor	Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Average Annual Rate of Change (mg/L)	Simulated Maximum 5-Year Average Annual Rate of Change[1] (mg/L/yr)	Significance Threshold (mg/L/yr)
AEWSD	454	425	-0.58	2.44	3.20
SWID	807	452	-7.10	**17.23**	3.84
SSJMUD	875	575	-6.00	0.86	3.84
KTWD	632	785	3.06	**13.62**	3.84
DEID	277	156	-2.42	**4.80**	3.84
TBID	335	506	3.42	**12.10**	3.84
Saucelito ID	363	200	-3.26	**27.34**	3.84
Pixley ID	193	236	0.86	**7.84**	3.84
TPDWD	400	306	-1.88	**10.48**	3.84
Porterville ID	638	229	-8.18	**108.20**	3.84
LTRID	284	95	-3.78	2.38	3.84

Notes: Bolded numbers indicate exceedance of threshold.

1. Maximum 5-year average annual rate of change calculated on a monthly timestep as the cumulative change in concentration relative to 5 years prior, divided by 5 years to produce an annual average rate.

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
mg/L = milligrams per liter
mg/L/yr = milligrams per liter per year
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TDS = total dissolved solids, TPDWD = Tea Pot Dome Water District

Figure 4-53. Simulated Changes in Relative Concentration of Total Dissolved Solids in Groundwater under No Project Alternative

Chloride

Simulated changes in relative concentration of chloride in groundwater on a monthly timestep are shown in Figure 4-54. Results for simulated ending concentrations and simulated maximum concentrations of chloride in the upper aquifer for the Friant Contractors are summarized in Table 4-20. Simulated results of monthly concentration of chloride in groundwater for the Friant Contractors did not exceed the threshold for chloride.

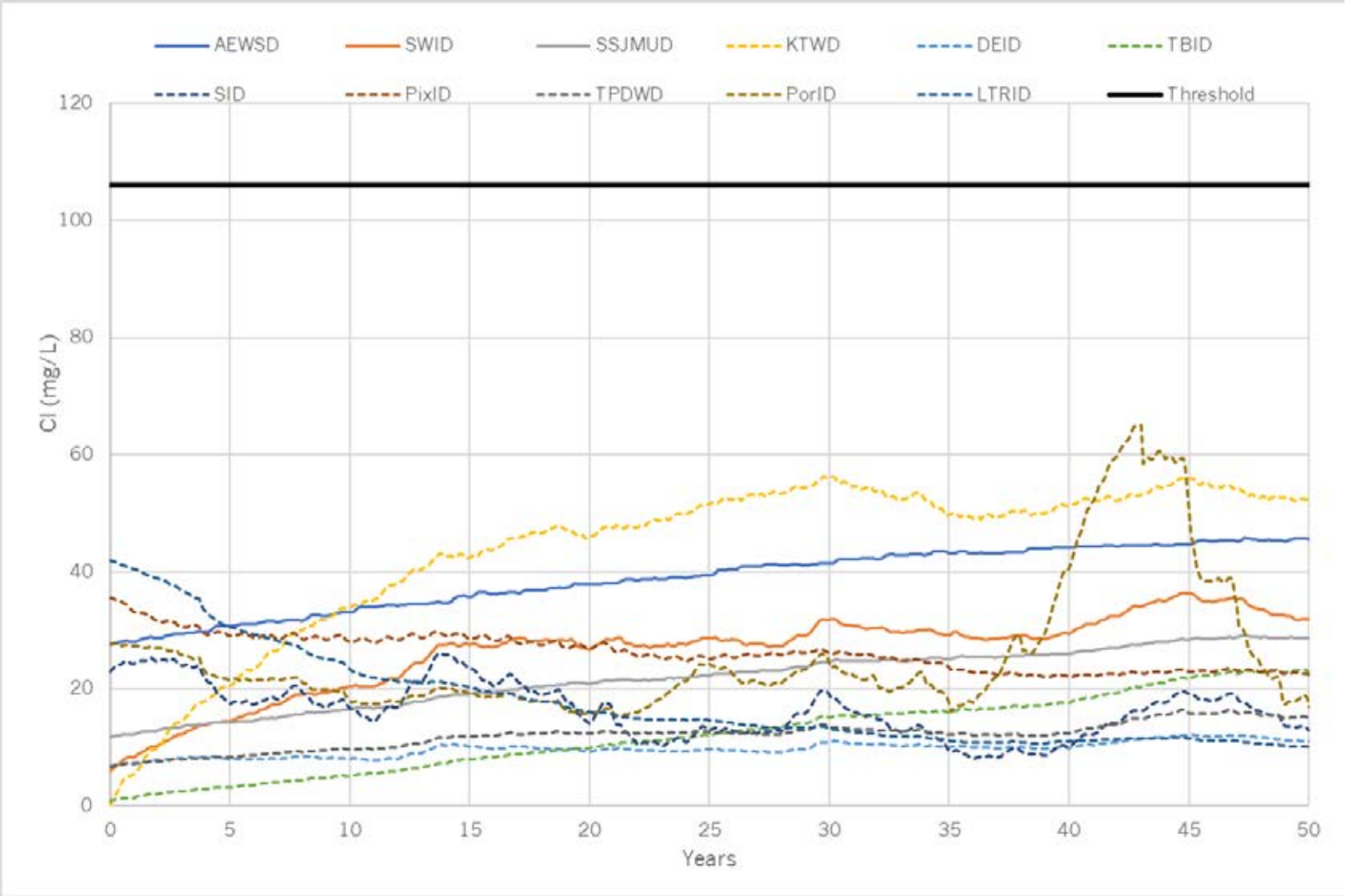
Although groundwater concentrations of chloride under the No Project Alternative would be higher than concentrations under Existing Conditions for some Friant Contractors, simulated chloride concentrations would remain below the specified significance threshold. Saucelito ID, Pixley ID, Porterville ID, and LTRID saw decreases in their simulated ending concentrations whereas other Friant Contractors saw increases. These results are akin to those observed under the Existing Conditions.

Increases in simulated ending concentrations are seen for the Friant Contractors where the starting concentration of chloride is higher in the lower aquifer compared to the upper aquifer. Conversely, for Friant Contractors where the lower aquifer has a lower starting concentration of chloride compared to the upper aquifer, a decrease is seen in the simulated ending concentrations.

Table 4-20. Summary of Simulated Concentrations of Chloride in Groundwater with Associated Significance Thresholds under No Project Alternative

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Maximum Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	27.6	45.6	45.8	106
SWID	5.9	31.9	36.4	106
SSJMUD	11.8	28.7	29.1	106
KTWD	0.2	52.4	56.2	106
DEID	6.5	11.0	12.2	106
TBID	0.9	22.9	23.3	106
Saucelito ID	23.0	12.8	26.1	106
Pixley ID	35.4	22.4	35.4	106
TPDWD	6.7	14.7	16.5	106
Porterville ID	27.7	16.9	65.0	106
LTRID	41.9	10.0	41.9	106

Key:
AEWSD = Arvin-Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
mg/L = milligrams per liter,
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District,
PDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, Cl = chloride, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-54. Simulated Changes in Relative Concentration of Chloride in Groundwater under No Project Alternative

Boron

Table 4-21 provides results for simulated ending and maximum concentrations of boron in the upper aquifer for the Friant Contractors under the No Project Alternative. Simulated changes in relative concentration of boron in groundwater under the No Project Alternative are shown in Figure 4-55. Simulated results for monthly concentration of boron in groundwater for the Friant Contractors did not exceed the specified significance threshold during the 50-year simulation period.

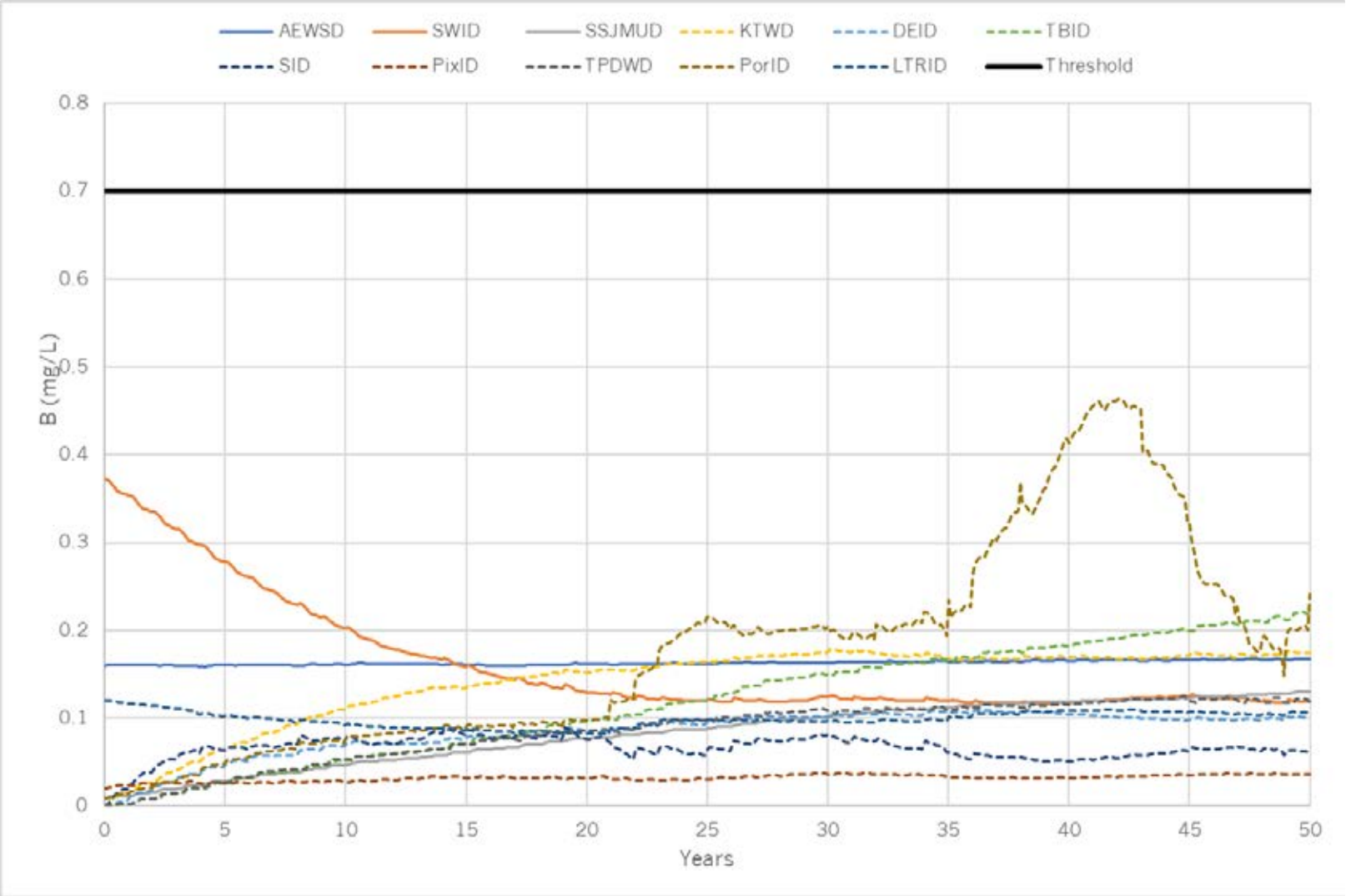
Most Friant Contractors show a simulated increase in boron concentration over the 50-year simulation period. Factors affecting the simulated increases in boron concentrations for some Friant Contractors under the No Project Alternative relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting boron concentrations in upper versus lower aquifer for simulations). The nine Friant Contractors in the study area that experienced a simulated increase in boron concentrations in the upper aquifer all started with higher concentrations of boron in the lower aquifer compared to the upper aquifer. Although the starting concentrations for boron were low in both aquifers, the difference in concentration between aquifers affected the simulated ending concentrations.

Simulated boron concentrations in the upper aquifer decreased for SWID and LTRID under the No Project Alternative compared to the starting concentration. While SWID has the highest starting concentration of boron in its upper aquifer, the concentration of boron in the lower aquifer is substantially lower (see Table 4-8). Because simulated groundwater pumping for SWID is primarily from the lower aquifer, an improvement in the boron concentration within SWID's upper aquifer was observed in simulations. Minor changes in boron concentrations in groundwater for LTRID were likely attributed having the same starting concentration of boron in the upper aquifer and lower aquifer, a condition unique to LTRID compared to other Friant Contractors evaluated. An additional factor affecting the simulated decreases in boron concentrations in the upper aquifer for SWID and LTRID was the increase in surface water deliveries with lower boron concentrations for some Friant Contractors under No Project Alternative, which contributes to groundwater recharge, compared to boron concentrations in groundwater.

Table 4-21. Summary of Simulated Concentrations of Boron in Groundwater with Associated Significance Thresholds under No Project Alternative

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Maximum Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	0.16	0.17	0.17	0.7
SWID	0.37	0.12	0.37	0.7
SSJMUD	0.01	0.13	0.13	0.7
KTWD	0.00	0.17	0.18	0.7
DEID	0.00	0.10	0.11	0.7
TBID	0.00	0.22	0.22	0.7
Saucelito ID	0.00	0.06	0.09	0.7
Pixley ID	0.02	0.04	0.04	0.7
TPDWD	0.00	0.12	0.12	0.7
Porterville ID	0.01	0.24	0.46	0.7
LTRID	0.12	0.11	0.12	0.7

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
mg/L = milligrams per liter
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, B = boron, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-55. Simulated Changes in Relative Concentration of Boron in Groundwater under No Project Alternative

Nitrate

Table 4-22 provides results for simulated ending and maximum concentrations of nitrate in the upper aquifer for Friant Contractors under the No Project Alternative. Simulated changes in relative concentration of nitrate in groundwater under the No Project Alternative are shown in Figure 4-56. Under the No Project Alternative, nitrate concentrations decreased during the simulation period for all Friant Contractors except KTWD, similar to conditions simulated under Existing Conditions. Same as the simulated conditions for other Project alternatives, starting concentrations of nitrate in groundwater for several Friant Contractors were well above the 10 mg/L threshold.

Factors likely attributing to the simulated increase in nitrate concentrations for KTWD are similar to those described for Existing Conditions. For KTWD, simulation results suggest a net outflow of water from the upper aquifer over the simulation period, and the aquifer is assumed to have a small, saturated thickness (28 feet; see Table 4-2). KTWD has a higher nitrate concentration in the lower aquifer (where the majority of the pumping happens) compared to the upper aquifer.

In addition to these factors, under the No Project Alternative, surface water deliveries to KTWD are reduced compared to Existing Conditions. This reduction in surface water deliveries led to additional groundwater pumping to meet water demands in simulations, and an increase in nitrate concentration in the upper aquifer. Over the simulation period, nitrate concentrations in the upper aquifer for KTWD exceeded the significance threshold of 10 mg/L for nitrate in groundwater.

Simulated nitrate concentrations in groundwater for Porterville ID increased to slightly above the threshold over the simulation period, specifically during a hydrologically dry period (when additional groundwater pumping is needed to meet irrigation demands due to decreased surface water supplies), but concentrations were below the threshold during other periods. Additionally, simulated nitrate concentrations in groundwater for TBID remained above the significance threshold for the entire simulation period. TBID had a starting nitrate concentration of 27.3 mg/L for the upper aquifer. Although the concentration of nitrate decreased over the simulation period to 13.0 mg/L, nitrate concentrations for TBID were still above the significance criteria.

Factors affecting simulated changes in nitrate concentrations across the Friant Contractors under the No Project Alternative (and other Project alternatives) relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting nitrate concentrations in upper versus lower aquifer for simulations).

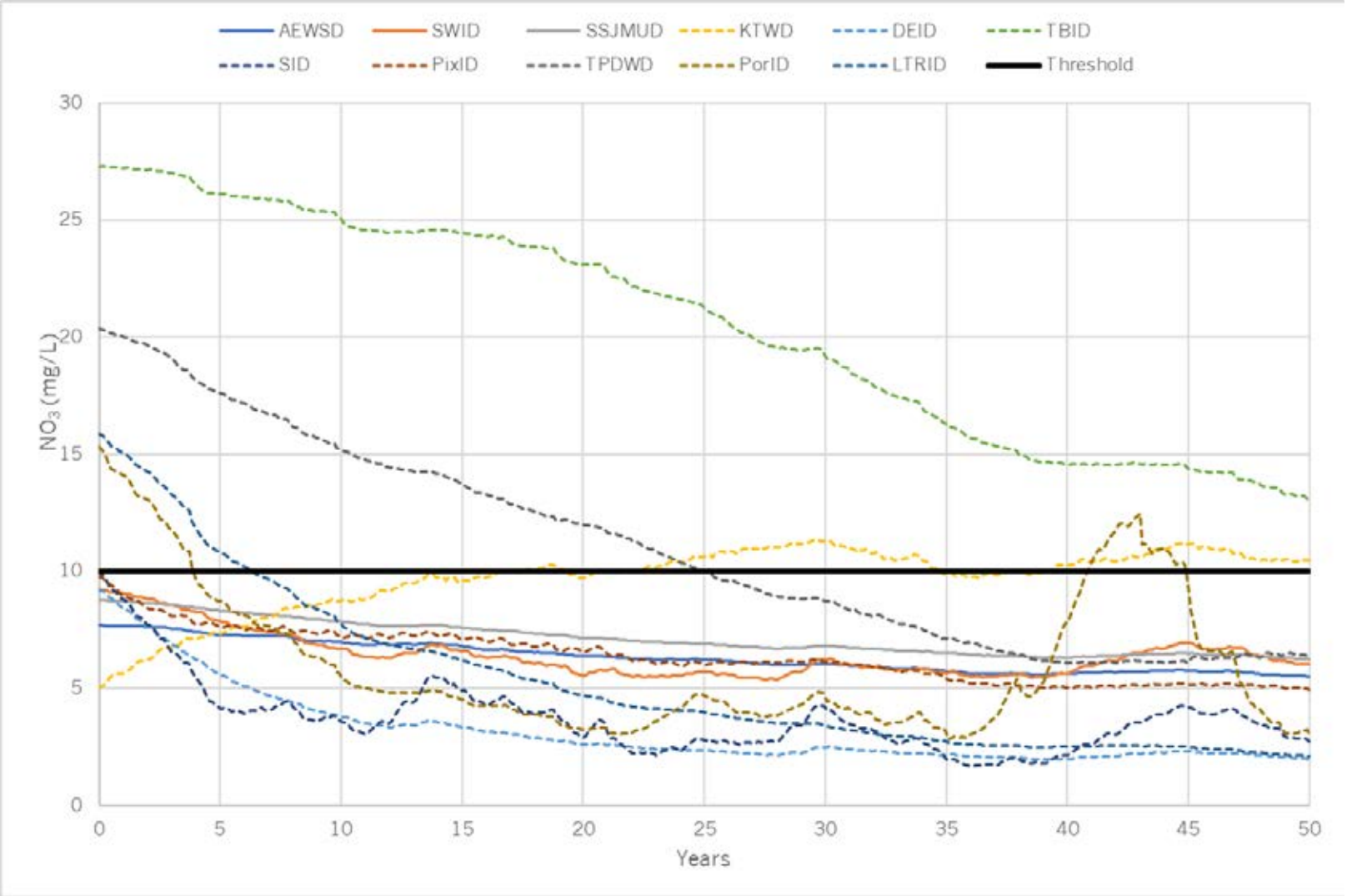
As stated previously, groundwater quality analysis performed to assess impacts of Project alternatives focused on changes in concentrations of key constituents, specifically, nitrate, in applied water and did not consider site-specific, on-farm application of fertilizers (e.g., nitrate) and/or soil amendments. Potential adverse effects on nitrate concentrations in groundwater under the No Project Alternative (whether due to Project operations or on-farm practices) could be reduced through implementation of the CV-SALTS Nitrate Control Program (see section E.3.1.1 in Appendix E for a description).

Table 4-22. Summary of Simulated Concentrations for Nitrate in Groundwater with Associated Significance Thresholds under No Project Alternative

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Maximum Simulated Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	7.7	5.5	7.7	10
SWID	9.2	6.0	9.2	10
SSJMUD	8.8	6.3	8.8	10
KTWD	5.1	**10.5**	**11.4**	10
DEID	9.2	2.0	9.2	10
TBID	**27.3**	**13.0**	**27.3**	10
Saucelito ID	**10.0**	2.7	**10.0**	10
Pixley ID	9.8	4.9	9.8	10
TPDWD	**20.4**	6.4	**20.4**	10
Porterville ID	**15.3**	3.0	**15.3**	10
LTRID	**15.9**	2.1	**15.9**	10

Notes: Bolded numbers indicate exceedance of threshold.

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
mg/L = milligrams per liter
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, NO_3 = nitrate as nitrogen, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-56. Simulated Changes in Relative Concentration of Nitrate in Groundwater under No Project Alternative

4.2.3 Low Flow Alternative and Seasonal Alternative

The sections below describe results of groundwater analyses performed for the Low Flow Alternative and Seasonal Alternative under both Existing Conditions and No Project Alternative. The differences between the Existing Conditions and No Project Alternative are related to future changes in operational and regulatory environment in the Friant Division and are independent of implementation of the proposed project.

4.2.3.1 Existing Conditions

Groundwater Budget Components

The changes in applied surface water supply affects total groundwater pumping to meet Friant Contractors demands and thus long-term water quality trends.

As described in Chapter 4.2.1.1, several groundwater budget parameters were assumed constant and did not change between the Existing Conditions, No Project Alternative, and the three Project alternatives. Figure 4-5 to Figure 4-26 depict the various water budget components of the groundwater model for each of the Friant Contractors in the study area under the Existing Condition. Several components of the land surface water budget and the upper aquifer water budget remain the same between the Existing Condition and the Low Flow Alternative and Seasonal Alternative under Existing Conditions. For the land surface water budget, the surface water to demand and total pumping are the two components that change between the Existing Condition and the Low Flow Alternative and Seasonal Alternative under Existing Conditions. For the upper aquifer water budget, the recharge and pumping are the two components that vary between the Existing Condition and the Low Flow Alternative and Seasonal Alternative under Existing Conditions. All other components of the land surface water budget and upper aquifer water budget are constant between the Existing Condition and the Low Flow Alternative and Seasonal Alternative under Existing Conditions. As such water budgets for the Low Flow and Seasonal Alternative under Existing Conditions are not shown again here.

Project operations under the Low Flow Alternative and Seasonal Alternative under Existing Conditions would result in an increase in available surface water supplies and decrease in groundwater pumping within most of the study area. The simulated increase in total surface water deliveries observed under the Low Flow Alternative and Seasonal Alternative under Existing Conditions and relative changes in water quality conditions for water budget components by Project reach are described in Chapter 3.2.3.1. Total simulated groundwater pumping under the Low Flow Alternative and Seasonal Alternative under Existing Conditions over the 50-year simulation period is shown in Table 4-12. The relative changes in groundwater pumping for the Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to the Existing Conditions are shown in Table 4-18. Simulated groundwater pumping under the Low Flow Alternative and Seasonal Alternative under Existing Conditions decreases compared to the Existing Conditions, due to additional surface water deliveries to the Friant Contractors to meet their water demands.

Groundwater Quality Constituents

Results from the Groundwater Model for the Low Flow Alternative and Seasonal Alternative under Existing Conditions are presented in Table 4-23 through Table 4-26. The simulated starting concentrations in the upper aquifer are the same as those utilized in the Existing Conditions. For each constituent, the rationale behind concentrations increases is summarized in bullet points as these concepts have been explained in more detail under the Existing Conditions and No Project Alternative sections.

Total Dissolved Solids

Simulated TDS concentrations and annual rates of change in TDS concentrations in groundwater vary widely across Friant Contractors. TDS concentrations generally decreased during the simulation period for many Friant Contractors. For 10 of the 11 Friant Contractors in the study area, the simulated average annual rate of change in TDS concentrations in groundwater is lower than the specified significance threshold under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. However, the simulated maximum 5-year average annual rate of change in TDS concentration in groundwater would be higher than the specified significance threshold for 8 of the 11 Friant Contractors in the study area. Some of these Friant Contractors where simulated maximum 5-year average annual rate of change in TDS concentration was higher than the specified significance threshold demonstrated a general decrease in TDS concentrations over the simulation period. See Table 4-23 for a summary of simulated starting and ending concentration for TDS with associated rates of change and significance thresholds for the Low Flow Alternative and Seasonal Alternative under Existing Conditions. Figure 4-57 provides simulated changes in relative concentration of TDS in groundwater for the Friant Contractors under the Low Flow Alternative and Seasonal Alternative under Existing Conditions.

Factors affecting the simulated TDS concentrations under the Low Flow Alternative and Seasonal Alternative under Existing Conditions are similar to those described for the No Project Alternative and relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers, and assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting TDS concentrations for simulations).

Additionally, for AEWSD, simulated increases in TDS concentrations in groundwater are attributed to higher TDS concentrations in surface water deliveries, which contributes to groundwater recharge, under the Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to the Existing Conditions; however, simulated TDS concentrations in groundwater for AEWSD under the Low Flow Alternative and Seasonal Alternative under Existing Conditions were lower than the specified significance threshold.

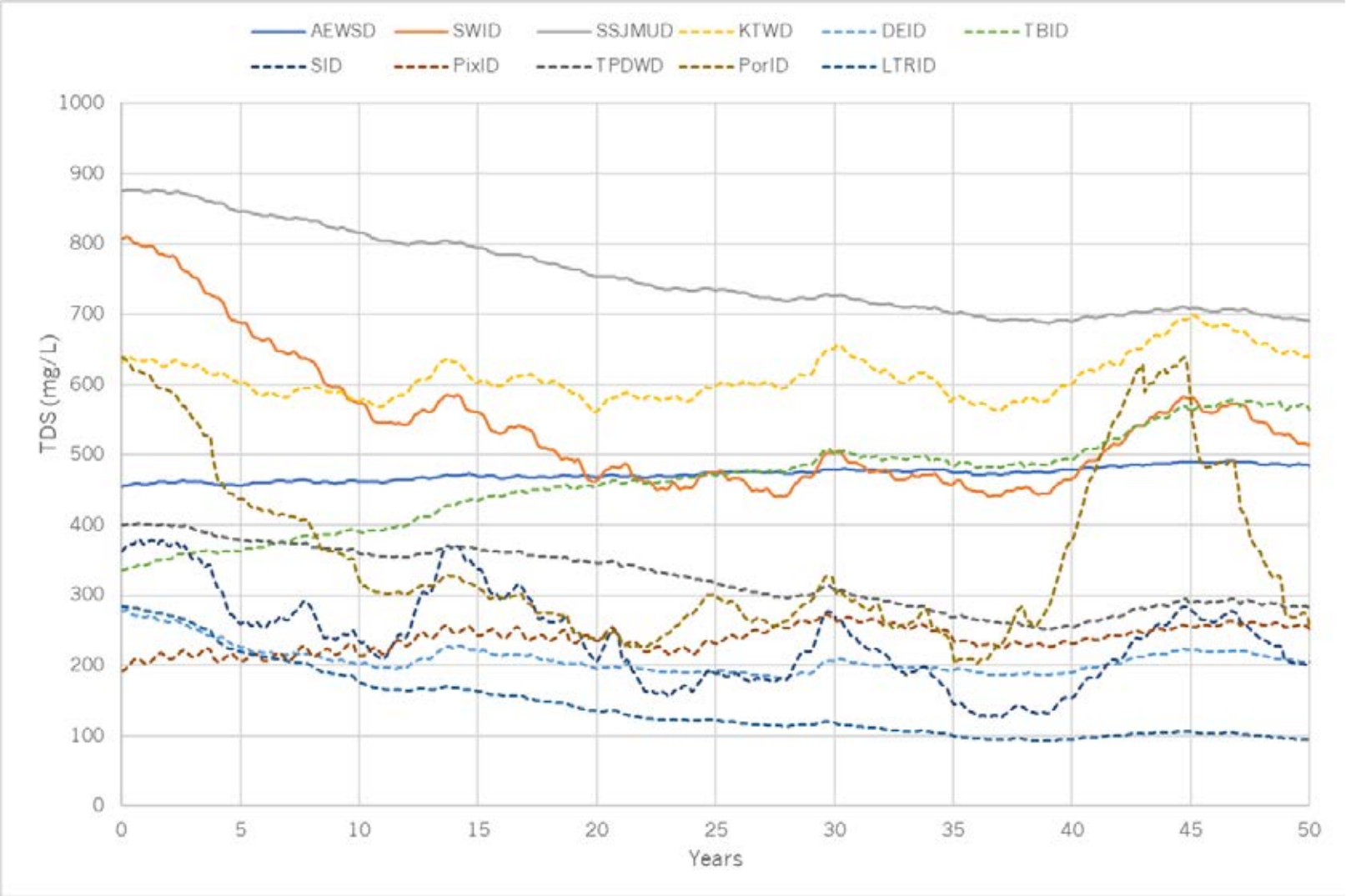
As previously described, consecutive dry years resulted in a sharp increase in constituent concentration for Porterville ID in years 40-45. This increase is the result of reduced surface water supplies and an increased reliance on groundwater pumping. TDS concentrations decrease after year 45 once surface water supplies increase. This increase in concentration is observed across all constituents in all scenarios due to the presence of dry years in each scenario.

Table 4-23. Summary of Simulated Concentration of Total Dissolved Solids in Groundwater with Associated Rates of Change and Significance Thresholds for Low Flow Alternative and Seasonal Alternative under Existing Conditions

Friant Contractor	Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Average Annual Rate of Change (mg/L)	Simulated Maximum 5-Year Average Annual Rate of Change[1] (mg/L/yr)	Significance Threshold (mg/L/yr)
AEWSD	454	485	0.61	2.44	3.20
SWID	807	515	-5.85	**23.46**	3.84
SSJMUD	875	690	-3.70	3.71	3.84
KTWD	632	642	0.20	**19.48**	3.84
DEID	277	206	-1.43	**6.89**	3.84
TBID	335	564	**4.58**	**14.97**	3.84
Saucelito ID	363	195	-3.36	**26.09**	3.84
Pixley ID	193	253	1.19	**9.02**	3.84
TPDWD	400	279	-2.42	**7.75**	3.84
Porterville ID	638	252	-7.72	**70.28**	3.84
LTRID	284	94	-3.80	2.30	3.84

Notes: Bolded numbers indicate exceedance of threshold.
1.Maximum 5-year average annual rate of change calculated on a monthly timestep as the cumulative change in concentration relative to 5 years prior, divided by 5 years to produce an annual average rate.

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
mg/L = milligrams per liter
mg/L/yr = milligrams per liter per year
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TDS = total dissolved solids, TPDWD = Tea Pot Dome Water District

Figure 4-57. Simulated Changes in Relative Concentration of Total Dissolved Solids in Groundwater for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Chloride

Results for simulated ending and maximum concentrations of chloride in the upper aquifer for the Friant Contractors for the Low Flow Alternative and Seasonal Alternative under Existing Conditions are summarized in Table 4-24. Figure 4-58 shows simulated changes in relative concentration of chloride in groundwater for the Low Flow Alternative and Seasonal Alternative under Existing Conditions. Although the simulated ending and/or maximum concentrations of chloride in groundwater for the Low Flow Alternative and Seasonal Alternative under Existing Conditions would be higher than the starting concentrations for some Friant Contractors, simulated chloride concentrations in groundwater for the Friant Contractors would remain below the significance threshold of 106 mg/L for chloride.

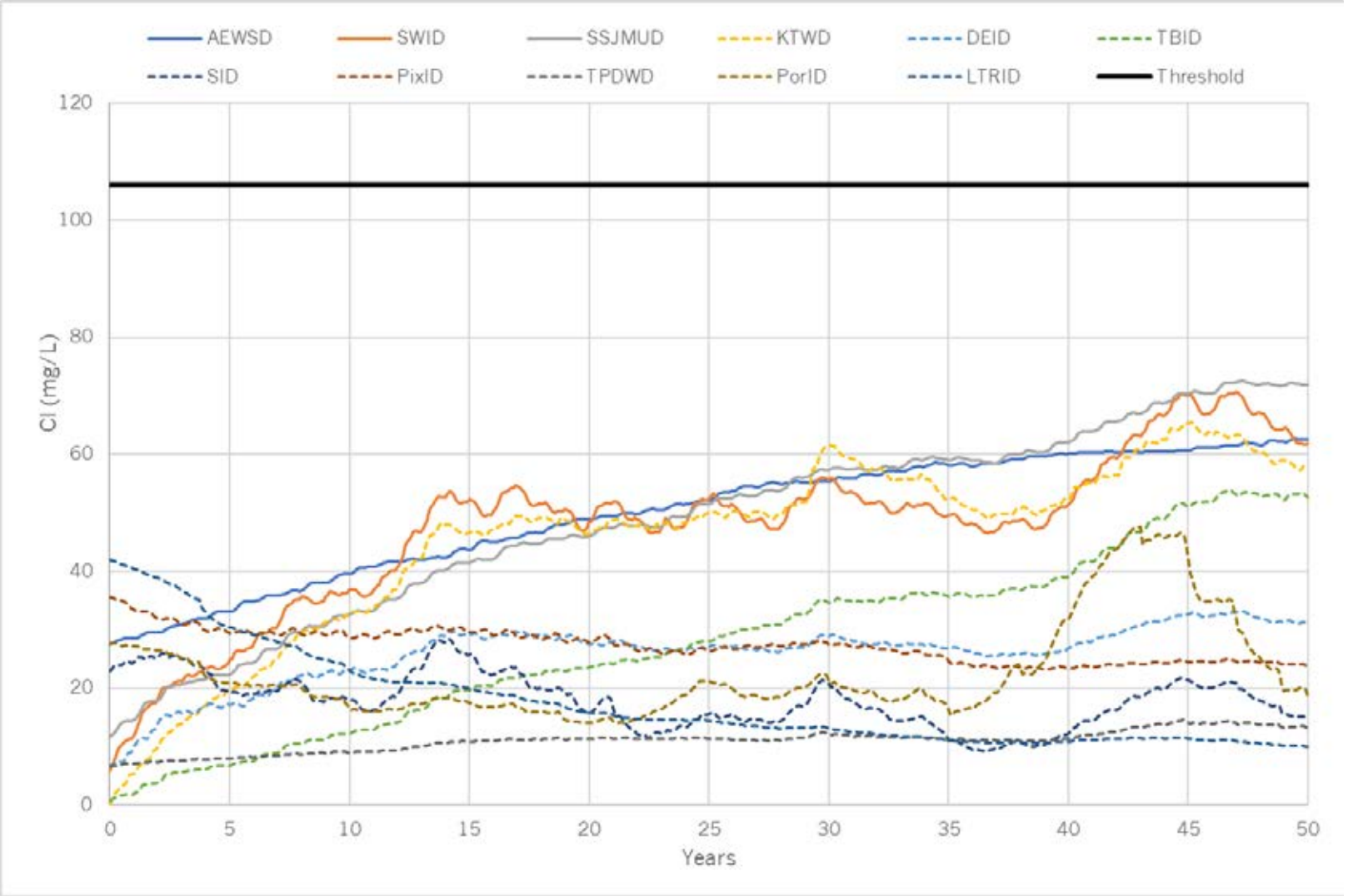
Saucelito ID, Pixley ID, Porterville ID, and LTRID saw decreases in their simulated ending concentrations whereas other Friant Contractors saw increases. Increases in simulated ending concentrations are seen for Friant Contractors where the starting concentration of chloride is higher in the lower aquifer compared to the upper aquifer. Conversely, for Friant Contractors where the lower aquifer has a lower starting concentration of chloride compared to the upper aquifer, a decrease is seen in the simulated ending concentrations.

Factors affecting the simulated chloride concentrations under the Low Flow Alternative and Seasonal Alternative under Existing Conditions are similar to those described for TDS. These factors relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting chloride concentrations in upper versus lower aquifer for simulations); and higher chloride concentrations in surface water deliveries under the Low Flow Alternative and Seasonal Alternative under Existing Conditions, which contributes to groundwater recharge.

Table 4-24. Summary of Simulated Concentrations of Chloride in Groundwater with Associated Significance Thresholds for Low Flow Alternative and Seasonal Alternative under Existing Conditions

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Maximum Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	27.6	62.4	62.6	106
SWID	5.9	61.8	70.6	106
SSJMUD	11.8	71.8	72.6	106
KTWD	0.2	58.0	65.5	106
DEID	6.5	31.3	33.2	106
TBID	0.9	52.6	53.8	106
Saucelito ID	23.0	14.7	28.4	106
Pixley ID	35.4	23.8	35.4	106
TPDWD	6.7	13.1	14.5	106
Porterville ID	27.7	18.6	47.6	106
LTRID	41.9	10.0	41.9	106

Key:
AEWSD = Arvin-Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
mg/L = milligrams per liter
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, Cl = chloride, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-58. Simulated Changes in Relative Concentration of Chloride in Groundwater for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Boron

Simulated results for ending and maximum concentrations of boron in the upper aquifer for the Friant Contractors under the Low Flow Alternative and Seasonal Alternative under Existing Conditions are provided in Table 4-25 below. Figure 4-59 shows the simulated changes in relative concentration of boron in groundwater under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. Simulated results for monthly concentration of boron in groundwater for the Friant Contractors did not exceed the specified significance threshold during the 50-year simulation period.

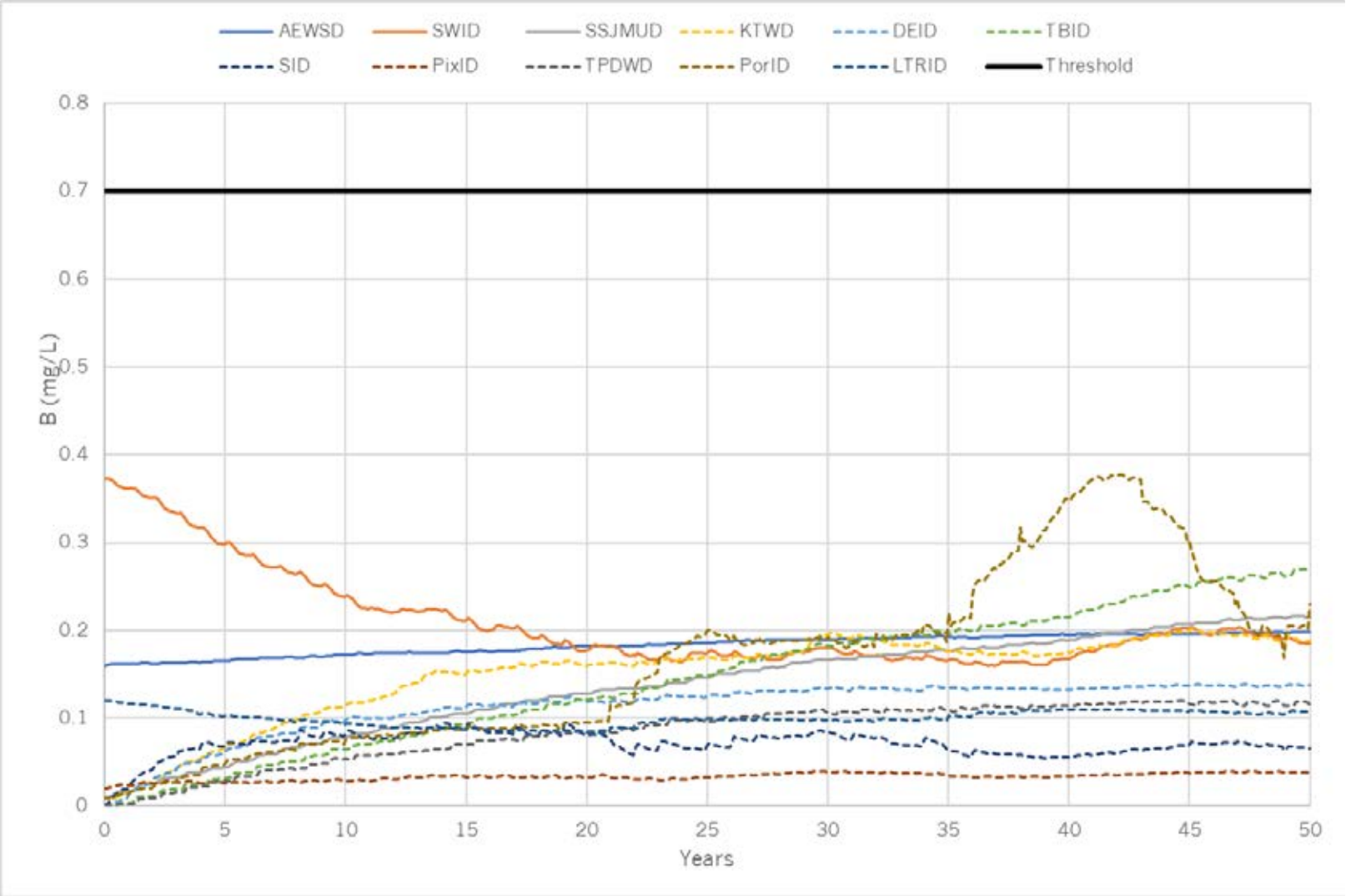
Like conditions described under the No Project Alternative, most Friant Contractors show a simulated increase in boron concentration over the 50-year simulation period. Factors affecting the simulated increase in boron concentrations under the Low Flow Alternative and Seasonal Alternative under Existing Conditions are the same as those described for the No Project Alternative. The factors relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting boron concentrations in upper versus lower aquifer for simulations). The nine Friant Contractors that experienced a simulated increase in boron concentrations in the upper aquifer all started with higher concentrations of boron in the lower aquifer compared to the upper aquifer.

Simulated boron concentrations in the upper aquifer decreased for SWID and LTRID under the Low Flow Alternative and Seasonal Alternative under Existing Conditions compared to the starting concentration. While SWID has the highest starting concentration of boron in its upper aquifer, the concentration of boron in the lower aquifer is substantially lower (see Table 4-8). Because simulated groundwater pumping for SWID is primarily from the lower aquifer, an improvement in the boron concentration within SWID's upper aquifer was observed in simulations. Minor changes in boron concentrations in groundwater for LTRID were likely attributed having the same starting concentration of boron in the upper aquifer and lower aquifer, a condition unique to LTRID compared to Friant Contractors evaluated. An additional factor affecting the simulated decreases in boron concentrations in the upper aquifer for SWID and LTRID was the increase in surface water deliveries with lower boron concentrations for some Friant Contractors under the Low Flow Alternative and Seasonal Alternative under Existing Conditions, which contributes to groundwater recharge, compared to boron concentrations in groundwater.

Table 4-25. Summary of Simulated Concentrations of Boron in Groundwater with Associated Significance Thresholds for Low Flow Alternative and Seasonal Alternative under Existing Conditions.

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Maximum Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	0.16	0.20	0.20	0.7
SWID	0.37	0.19	0.37	0.7
SSJMUD	0.01	0.22	0.22	0.7
KTWD	0.00	0.19	0.20	0.7
DEID	0.00	0.14	0.14	0.7
TBID	0.00	0.27	0.27	0.7
Saucelito ID	0.00	0.07	0.09	0.7
Pixley ID	0.02	0.04	0.04	0.7
TPDWD	0.00	0.12	0.12	0.7
Porterville ID	0.01	0.23	0.38	0.7
LTRID	0.12	0.11	0.12	0.7

Key:
AEWSD = Arvin-Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
mg/L = milligrams per liter
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, B = boron, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-59. Simulated Changes in Relative Concentration of Boron in Groundwater for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

Nitrate

Table 4-26 provides results for simulated ending and maximum concentrations of nitrate in the upper aquifer for the Friant Contractors under the Low Flow Alternative and Seasonal Alternative under Existing Conditions. Simulated changes in relative concentration of nitrate in groundwater are shown in Figure 4-60. Nitrate concentrations decreased during the simulation period for Friant Contractors except KTWD, similar to conditions simulated under Existing Conditions and No Project Alternative. Same as the simulated conditions for other scenarios, starting concentrations of nitrate in groundwater for several Friant Contractors were well above the 10 mg/L threshold.

Factors likely attributing to the simulated increase in nitrate concentrations for KTWD are similar to those described for Existing Conditions and No Project Alternative. For KTWD, simulation results suggest a net outflow of water from the upper aquifer over the simulation period, and the aquifer is assumed to have a small, saturated thickness (28 feet; see Table 4-2). KTWD has a higher nitrate concentration in the lower aquifer (where the majority of the pumping happens) compared to the upper aquifer. Although simulated nitrate concentrations in the upper aquifer for KTWD increased during the simulation period, concentrations did not exceed the significance threshold of 10 mg/L for nitrate in groundwater.

Simulated nitrate concentrations in groundwater for Porterville ID increased to slightly above the threshold over the simulation period, specifically during a hydrologically dry period (when additional groundwater pumping is needed to meet irrigation demands due to decreased surface water supplies), but concentrations were below the threshold during other periods. Additionally, simulated nitrate concentrations in groundwater for TBID remained above the significance threshold for the entire simulation period. TBID had a starting nitrate concentration of 27.3 mg/L for the upper aquifer. Although the concentration of nitrate decreased over the simulation period to 13.0 mg/L, nitrate concentrations for TBID were still above the significance criteria.

Factors affecting simulated changes in nitrate concentrations across the Friant Contractors under the Low Flow Alternative and Seasonal Alternative under Existing Conditions relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting nitrate concentrations in upper versus lower aquifer for simulations).

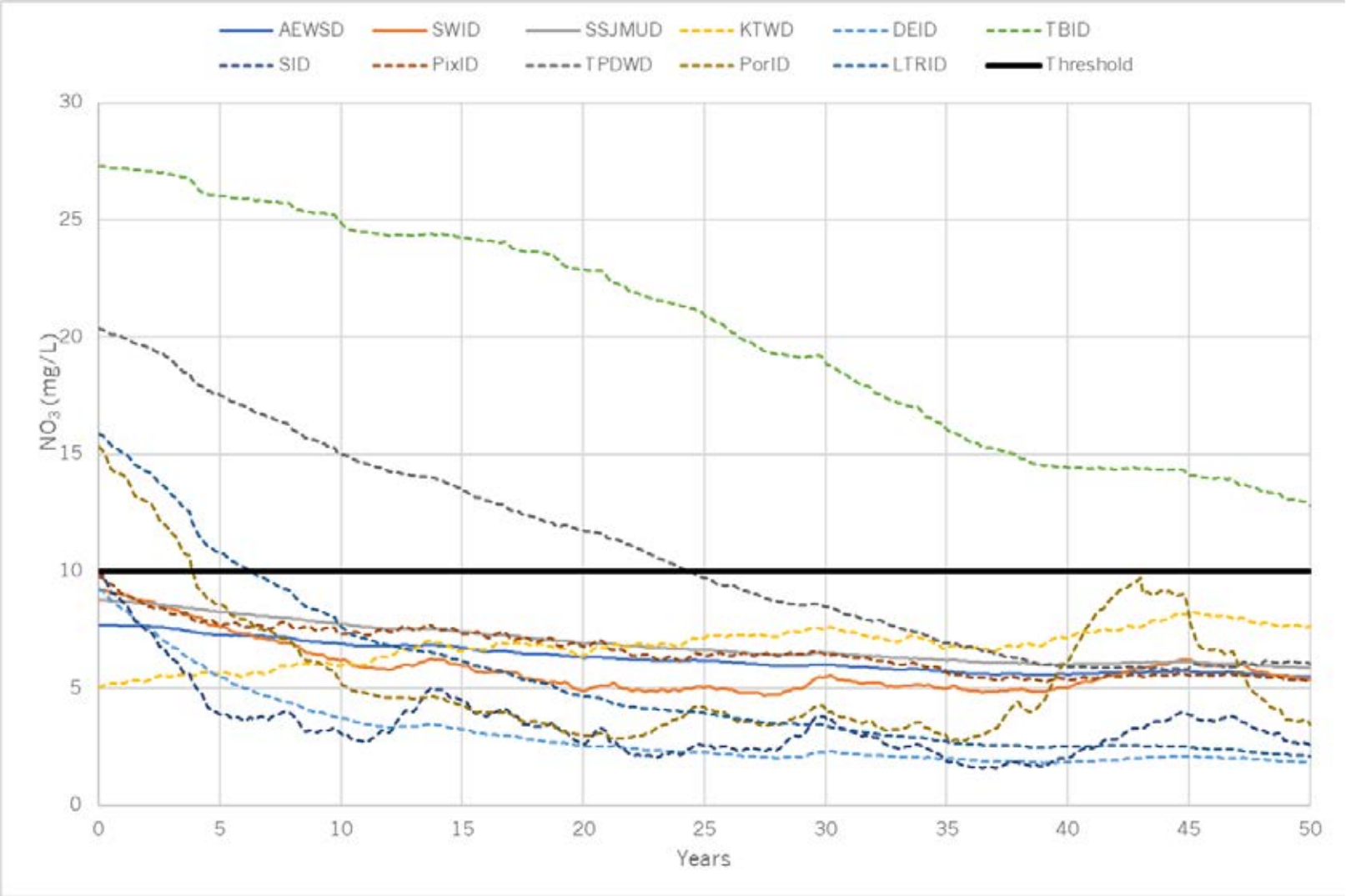
As stated previously, groundwater quality analysis performed to assess impacts of Project alternatives focused on changes in concentrations of key constituents, specifically, nitrate, in applied water and did not consider site-specific, on-farm application of fertilizers (e.g., nitrate) and/or soil amendments. Potential adverse effects on nitrate concentrations in groundwater under the Low Flow Alternative and Seasonal Alternative under Existing Conditions (whether due to Project operations or on-farm practices) could be reduced through implementation of the CV-SALTS Nitrate Control Program (see section E.3.1.1 in Appendix E for a description).

Table 4-26. Summary of Simulated Concentrations for Nitrate in Groundwater with Associated Significance Thresholds for Low Flow Alternative and Seasonal Alternative under Existing Conditions

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Maximum Simulated Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	7.7	5.5	7.7	10
SWID	9.2	5.4	9.2	10
SSJMUD	8.8	5.9	8.8	10
KTWD	5.1	7.7	8.3	10
DEID	9.2	1.8	9.2	10
TBID	**27.3**	**12.8**	**27.3**	10
Saucelito ID	**10.0**	2.6	**10.0**	10
Pixley ID	9.8	5.3	9.8	10
TPDWD	**20.4**	6.0	**20.4**	10
Porterville ID	**15.3**	3.4	**15.3**	10
LTRID	**15.9**	2.1	**15.9**	10

Notes: Bolded numbers indicate exceedance of threshold.

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
mg/L = milligrams per liter
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, NO_3 = nitrate as nitrogen, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-60. Simulated Changes in Relative Concentration of Nitrate in Groundwater for the Low Flow Alternative and Seasonal Alternative under Existing Conditions

4.2.3.2 Future Conditions

Groundwater Budget Components

The changes in applied surface water supply affects total groundwater pumping to meet Friant Contractors demands and thus long-term water quality trends.

As described in Chapter 4.2.1.1, several groundwater budget parameters were assumed constant and did not change between the Existing Conditions, No Project Alternative, and three Project alternatives. Figure 4-31 to Figure 4-52 depict the various water budget components of the groundwater model for each of the Friant Contractors in the study area under the No Project Alternative. Several components of the land surface water budget and the upper aquifer water budget remain the same between the No Project Alternative and the Low Flow Alternative and Seasonal Alternative under Future Conditions. For the land surface water budget, the surface water to demand and total pumping are the two components that change between the No Project Alternative and the Low Flow Alternative and Seasonal Alternative under Future Conditions. For the upper aquifer water budget, the recharge and pumping are the two components that vary between the No Project Alternative and the Low Flow Alternative and Seasonal Alternative under Future Conditions. All other components of the land surface water budget and upper aquifer water budget are constant between the No Project Alternative and the Low Flow Alternative and Seasonal Alternative under Future Conditions. As such water budgets for the Low Flow and Seasonal Alternative under Future Conditions are not shown again here.

Total simulated groundwater pumping under the Low Flow Alternative and Seasonal Alternative under Future Conditions over the 50-year simulation period is shown in Table 4-12. The relative changes in groundwater pumping for the Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative are shown in Table 4-18.

Increases in total surface water deliveries simulated under the Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the No Project Alternative and relative changes in water quality are summarized by reach as described in Chapter 3.2.3.2. On average, modeled surface water quality for Reach A shows higher concentrations for all constituents except nitrate. Reach B and Reach C show a deterioration in water quality for all constituents compared to the No Project Alternative. In contrast, water quality in Reach D improves or remains the same compared to the No Project Alternative. Thus, any differences between the No Project Alternative compared to the Low Flow Alternative and Seasonal Alternative under Future Conditions can be attributed to changes in surface water supply and quality. Changes in supply amounts directly impact pumping and therefore mass flux. Similarly, changes in surface water quality directly impacts mass flux into the upper aquifer.

Groundwater Quality Constituents

Results from the Groundwater Model for the Low Flow Alternative and Seasonal Alternative under Future Conditions are presented in Table 4-27 through Table 4-30. These results show simulated ending concentrations for TDS, nitrate, boron, and chloride and are representative of potential long-term groundwater trends under the Low Flow Alternative and Seasonal Alternative under Future Conditions proposed operations.

Total Dissolved Solids

Similar to the Low Flow Alternative and Seasonal Alternative under Existing Conditions, simulated TDS concentrations and annual rates of change in TDS concentrations in groundwater vary widely across Friant Contractors for the Low Flow Alternative and Seasonal Alternative under Future Conditions. TDS concentrations generally decreased during the simulation period for many Friant Contractors. For 10 of the 11 Friant Contractors in the study area, the simulated average annual rate of change in TDS concentrations in groundwater under the Low Flow Alternative and Seasonal Alternative under Future Conditions is lower than the specified significance threshold. However, the simulated maximum 5-year average annual rate of change in TDS concentration in groundwater would be higher than the specified significance threshold for 8 of the 11 Friant Contractors in the study area. Some of these Friant Contractors where simulated maximum 5-year average annual rate of change in TDS concentration was higher than the specified significance threshold demonstrated a general decrease in TDS concentrations over the simulation period. See Table 4-27 for a summary of simulated starting and ending concentration for TDS with associated rates of change and significance thresholds for the Low Flow Alternative and Seasonal Alternative under Future Conditions. Figure 4-61 provides simulated changes in relative concentration of TDS in groundwater for the Friant Contractors under the Low Flow Alternative and Seasonal Alternative under Future Conditions.

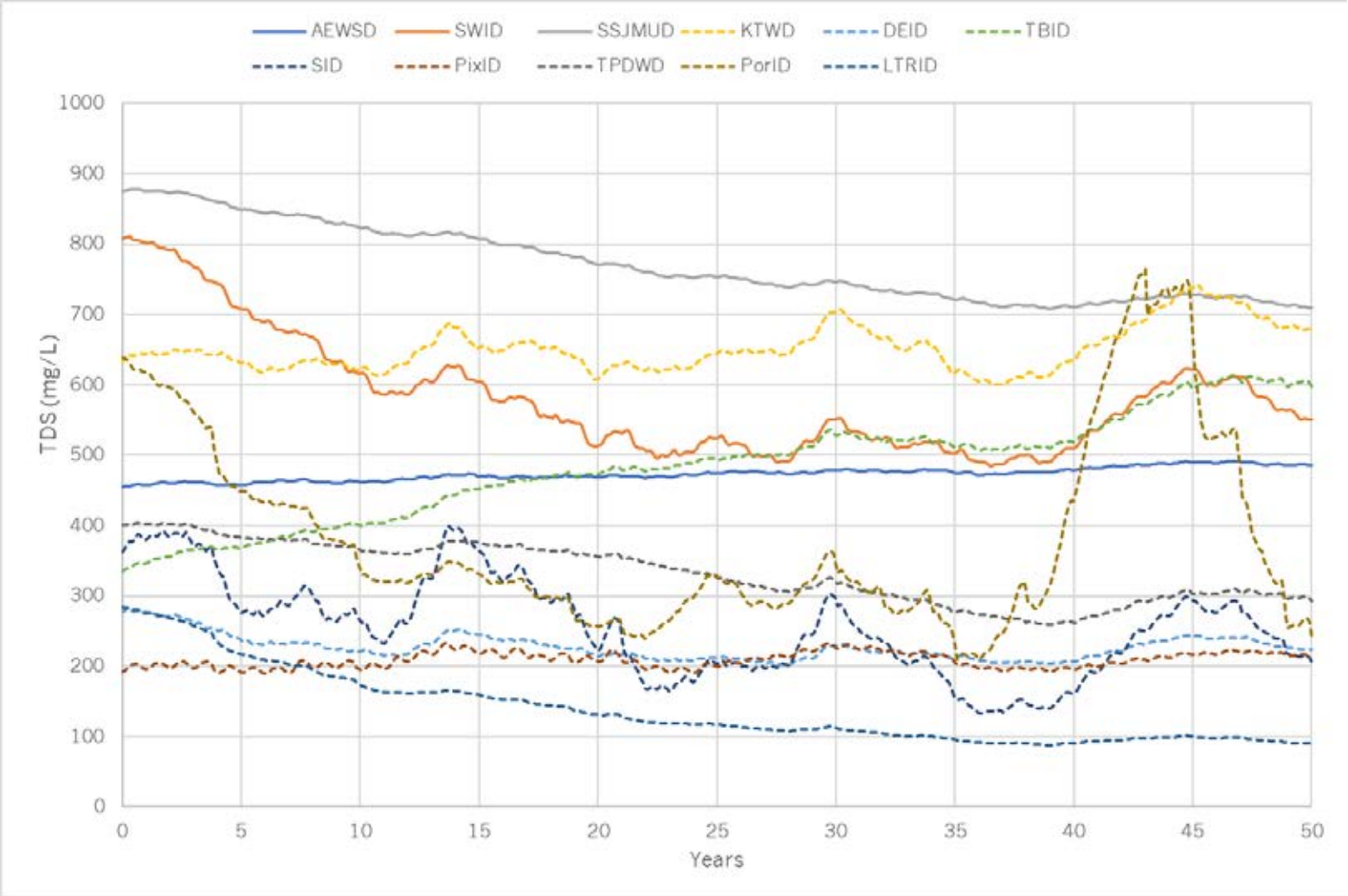
Factors affecting the simulated TDS concentrations under the Low Flow Alternative and Seasonal Alternative under Future Conditions are similar to those described for the Low Flow Alternative and Seasonal Alternative under Existing Conditions. These factors relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting TDS concentrations for simulations); consecutive dry years resulting in more pumping; and higher TDS concentrations in surface water deliveries under the Low Flow Alternative and Seasonal Alternative under Future Conditions, which contributes to groundwater recharge.

Table 4-27. Summary of Simulated Concentration of Total Dissolved Solids in Groundwater with Associated Rates of Change and Significance Thresholds for Low Flow Alternative and Seasonal Alternative under Existing Conditions

Friant Contractor	Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Average Annual Rate of Change (mg/L)	Simulated Maximum 5-Year Average Annual Rate of Change[1]* (mg/L/yr)	Significance Threshold (mg/L/yr)
AEWSD	454	485	0.62	2.43	3.20
SWID	807	551	-5.12	**22.83**	3.84
SSJMUD	875	709	-3.32	3.55	3.84
KTWD	632	681	0.97	**21.06**	3.84
DEID	277	224	-1.07	**7.44**	3.84
TBID	335	598	**5.26**	**16.62**	3.84
Saucelito ID	363	206	-3.15	**27.21**	3.84
Pixley ID	193	213	0.40	**6.28**	3.84
TPDWD	400	292	-2.15	**9.11**	3.84
Porterville ID	638	241	-7.94	**90.78**	3.84
LTRID	284	89	-3.90	2.16	3.84

Notes: Bolded numbers indicate exceedance of threshold.
1. Maximum 5-year average annual rate of change calculated on a monthly timestep as the cumulative change in concentration relative to 5 years prior, divided by 5 years to produce an annual average rate.

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
mg/L = milligrams per liter
mg/L/yr = milligrams per liter per year
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TDS = total dissolved solids, TPDWD = Tea Pot Dome Water District

Figure 4-61. Simulated Changes in Relative Concentration of Total Dissolved Solids in Groundwater for the for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Chloride

Results for simulated ending and maximum concentrations of chloride in the upper aquifer for the Friant Contractors under the Low Flow Alternative and Seasonal Alternative under Future Conditions are summarized in Table 4-28. Figure 4-62 shows simulated changes in relative concentration of chloride in groundwater under the Low Flow Alternative and Seasonal Alternative under Future Conditions. Although the simulated ending and/or maximum concentrations of chloride in groundwater under the Low Flow Alternative and Seasonal Alternative under Future Conditions would be higher than the starting concentrations for some Friant Contractors, simulated chloride concentrations in groundwater for the Friant Contractors would remain below the significance threshold of 106 mg/L for chloride.

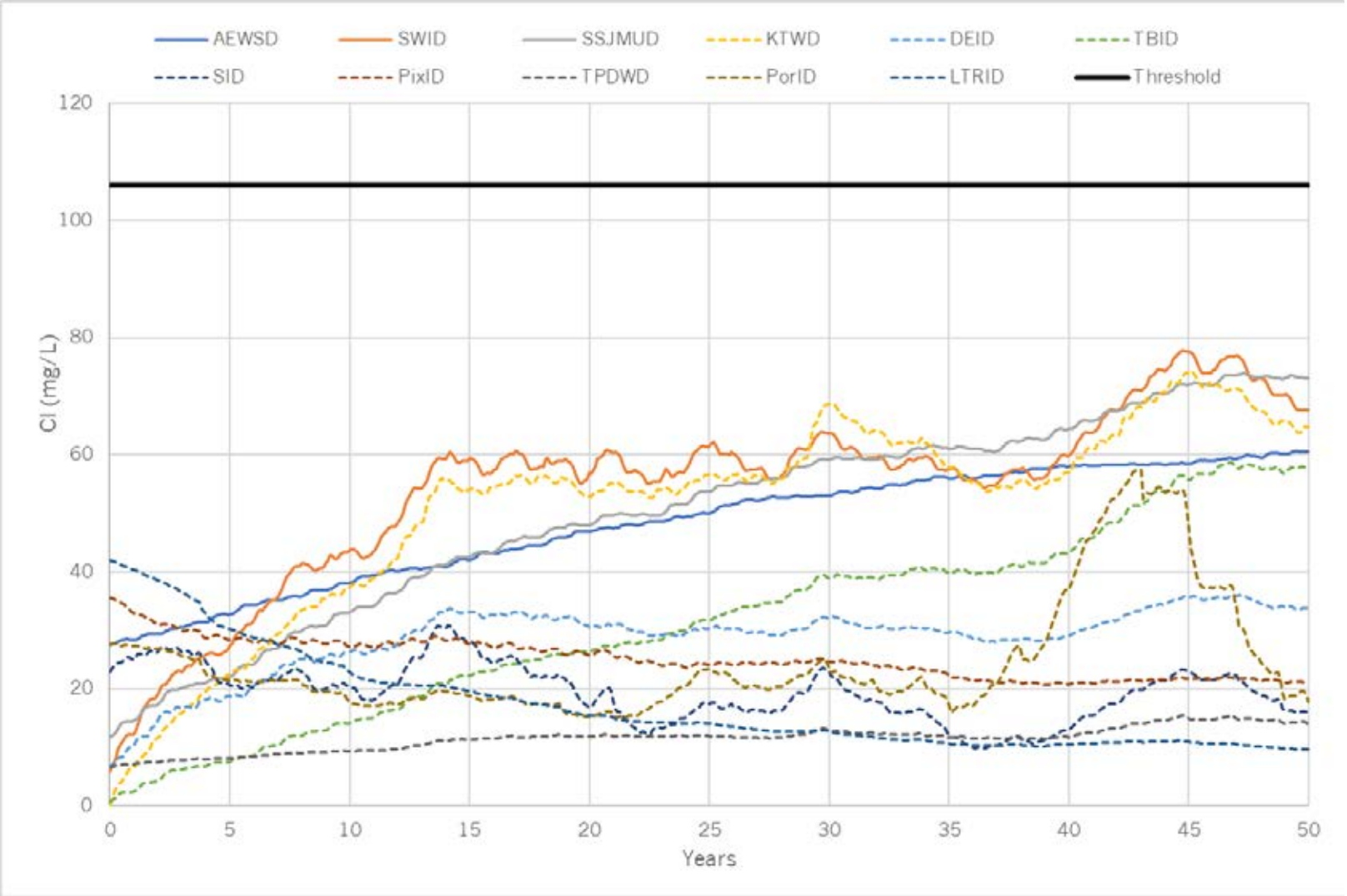
Saucelito ID, Pixley ID, Porterville ID, and LTRID saw decreases in their simulated ending concentrations whereas other Friant Contractors saw increases. Increases in simulated ending concentrations are seen for Friant Contractors where the starting concentration of chloride is higher in the lower aquifer compared to the upper aquifer. Conversely, Friant Contractors where the lower aquifer has a lower starting concentration of chloride compared to the upper aquifer, a decrease is seen in the simulated ending concentrations.

Factors affecting the simulated chloride concentrations under the Low Flow Alternative and Seasonal Alternative under Future Conditions are similar to those described for TDS. These factors relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting chloride concentrations in upper versus lower aquifer for simulations); and higher chloride concentrations in surface water deliveries under the Low Flow Alternative and Seasonal Alternative under Future Conditions, which contributes to groundwater recharge.

Table 4-28. Summary of Simulated Concentrations of Chloride in Groundwater with Associated Significance Thresholds for Low Flow Alternative and Seasonal Alternative under Future Conditions

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Maximum Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	27.6	60.4	60.6	106
SWID	5.9	67.7	77.8	106
SSJMUD	11.8	73.1	73.9	106
KTWD	0.2	64.7	74.2	106
DEID	6.5	33.9	36.1	106
TBID	0.9	57.3	58.6	106
Saucelito ID	23.0	15.6	30.8	106
Pixley ID	35.4	20.9	35.4	106
TPDWD	6.7	13.9	15.4	106
Porterville ID	27.7	17.8	57.5	106
LTRID	41.9	9.6	41.9	106

Key:
AEWSD = Arvin-Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
mg/L = milligrams per liter
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, Cl = chloride, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-62. Simulated Changes in Relative Concentration of Chloride in Groundwater for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Boron

Simulated results for ending and maximum concentrations of boron in the upper aquifer for the Friant Contractors under the Low Flow Alternative and Seasonal Alternative under Future Conditions are provided in Table 4-29 below. Figure 4-63 shows the simulated changes in relative concentration of boron in groundwater under Low Flow Alternative and Seasonal Alternative under Future Conditions. Simulated results for monthly concentration of boron in groundwater for the Friant Contractors did not exceed the specified significance threshold during the 50-year simulation period.

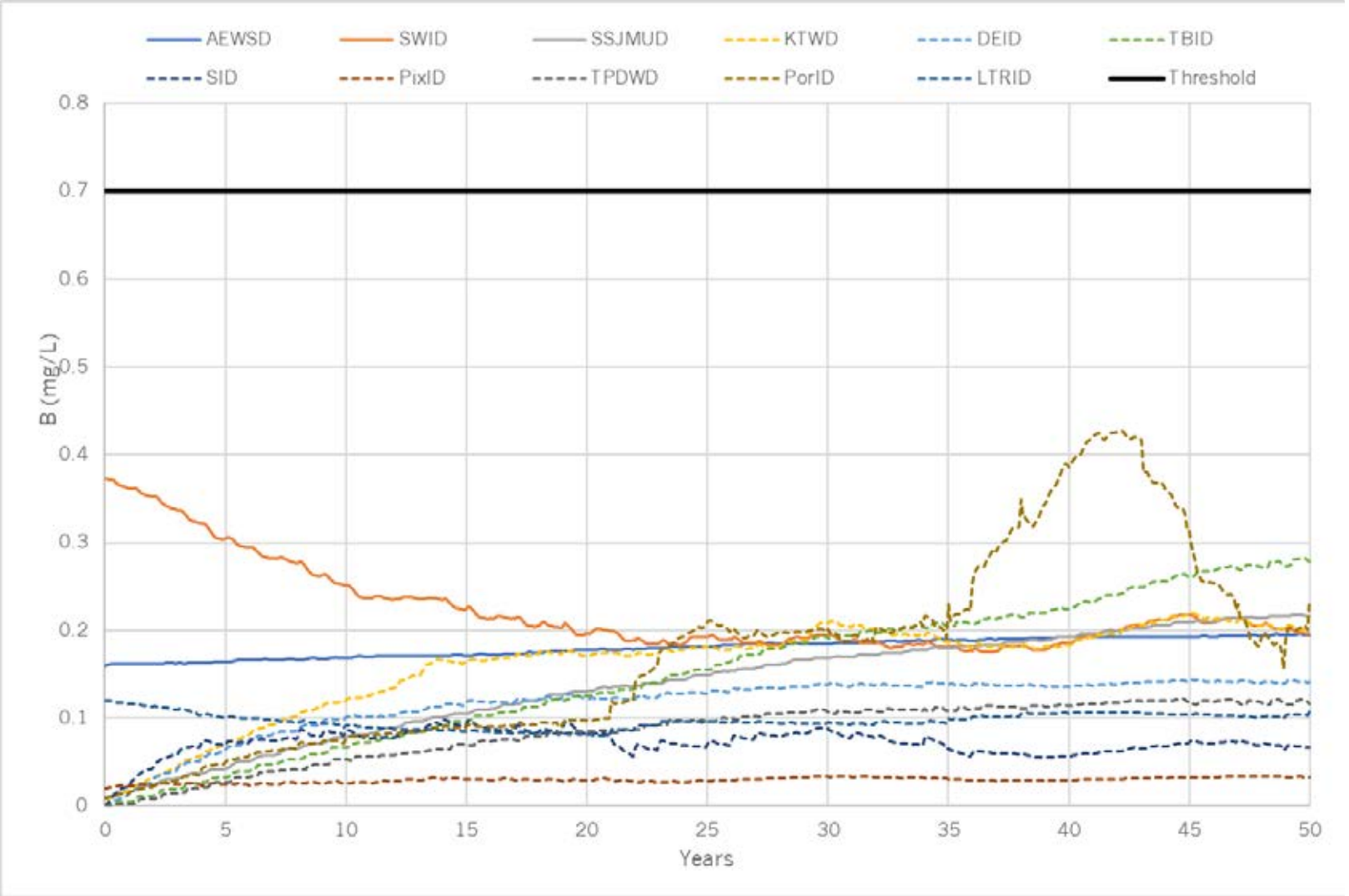
Like conditions described under the No Project Alternative, most Friant Contractors show a simulated increase in boron concentration over the 50-year simulation period. Factors affecting the simulated increase in boron concentrations under the Low Flow Alternative and Seasonal Alternative under Future Conditions are the same as those described for the No Project Alternative. The factors relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting boron concentrations in upper versus lower aquifer for simulations). The nine Friant Contractors in the study area that experienced a simulated increase in boron concentrations in the upper aquifer all started with higher concentrations of boron in the lower aquifer compared to the upper aquifer.

Simulated boron concentrations in the upper aquifer decreased for SWID and LTRID under the Low Flow Alternative and Seasonal Alternative under Future Conditions compared to the starting concentration. While SWID has the highest starting concentration of boron in its upper aquifer, the concentration of boron in the lower aquifer is substantially lower (see Table 4-8). Because simulated groundwater pumping for SWID is primarily from the lower aquifer, an improvement in the boron concentration within SWID's upper aquifer was observed. Minor changes in boron concentrations in groundwater for LTRID were likely attributed having the same starting concentration of boron in the upper aquifer and lower aquifer, a condition unique to LTRID compared to other Friant Contractors evaluated. An additional factor affecting the simulated decreases in boron concentrations in the upper aquifer for SWID and LTRID was the increase in surface water deliveries with lower boron concentrations for some Friant Contractors under the Low Flow Alternative and Seasonal Alternative under Future Conditions, which contributes to groundwater recharge, compared to boron concentrations in groundwater.

Table 4-29. Summary of Simulated Concentrations of Boron in Groundwater with Associated Significance Thresholds for Low Flow Alternative and Seasonal Alternative under Future Conditions

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Maximum Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	0.16	0.19	0.20	0.7
SWID	0.37	0.20	0.37	0.7
SSJMUD	0.01	0.22	0.22	0.7
KTWD	0.00	0.20	0.22	0.7
DEID	0.00	0.14	0.14	0.7
TBID	0.00	0.28	0.28	0.7
Saucelito ID	0.00	0.07	0.10	0.7
Pixley ID	0.02	0.03	0.03	0.7
TPDWD	0.00	0.12	0.12	0.7
Porterville ID	0.01	0.24	0.43	0.7
LTRID	0.12	0.11	0.12	0.7

Key:
AEWSD = Arvin-Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
mg/L = milligrams per liter
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, B = boron, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-63. Simulated Changes in Relative Concentration of Boron in Groundwater for the Low Flow Alternative and Seasonal Alternative under Future Conditions

Nitrate

Simulated ending and maximum concentrations of nitrate in the upper aquifer for the Friant Contractors under the Low Flow Alternative and Seasonal Alternative under Future Conditions are provided in Table 4-30. Figure 4-64 shows the simulated changes in relative concentration of nitrate in groundwater across the Friant Contractors. Nitrate concentrations decreased during the simulation period for the Friant Contractors except KTWD, similar to conditions simulated under the No Project Alternative. Same as the simulated conditions for other scenarios, starting concentrations of nitrate in groundwater for several Friant Contractors were well above the 10 mg/L threshold.

Factors likely attributing to the simulated increase in nitrate concentrations for KTWD are the same as described for the Low Flow Alternative and Seasonal Alternative under Existing Conditions. For KTWD, simulation results suggest a net outflow of water from the upper aquifer over the simulation period, and the aquifer is assumed to have a small, saturated thickness (28 feet; see Table 4-2). KTWD has a higher nitrate concentration in the lower aquifer (where the majority of the pumping happens) compared to the upper aquifer. Although simulated nitrate concentrations in the upper aquifer for KTWD increased during the simulation period, concentrations did not exceed the significance threshold of 10 mg/L for nitrate in groundwater.

Simulated nitrate concentrations in groundwater for Porterville ID increased to slightly above the threshold over the simulation period, specifically during a hydrologically dry period (when additional groundwater pumping is needed to meet irrigation demands due to decreased surface water supplies), but concentrations were below the threshold during other periods. Additionally, simulated nitrate concentrations in groundwater for TBID remained above the significance threshold for the entire simulation period. TBID had a starting nitrate concentration of 27.3 mg/L for the upper aquifer. Although the concentration of nitrate decreased over the simulation period to 13.0 mg/L, nitrate concentrations for TBID were still above the significance criteria.

Factors affecting simulated changes in nitrate concentrations across the Friant Contractors under the Low Flow Alternative and Seasonal Alternative under Future Conditions relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting nitrate concentrations in upper versus lower aquifer for simulations).

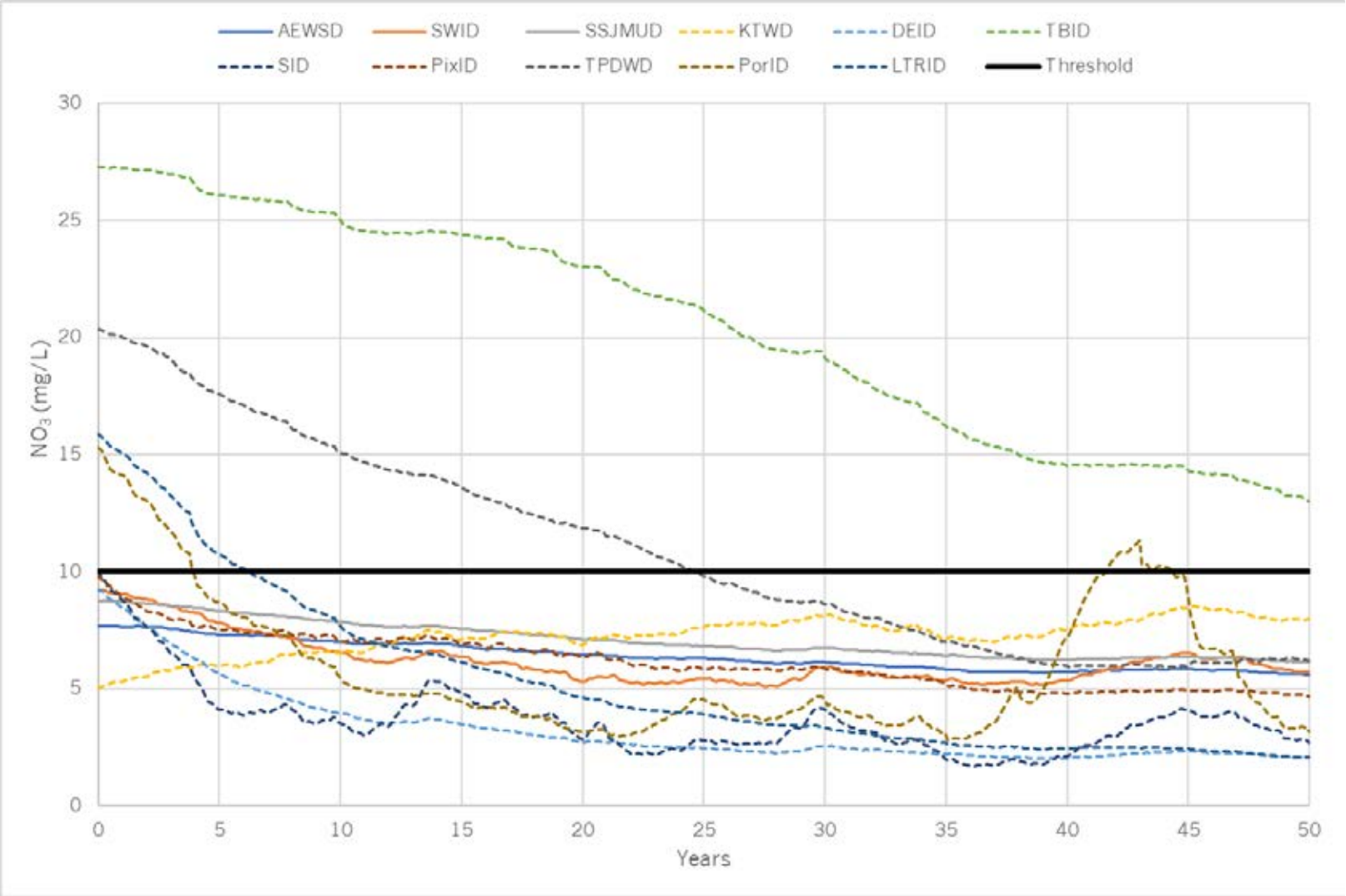
As stated previously, groundwater quality analysis performed to assess impacts of Project alternatives focused on changes in concentrations of key constituents, specifically, nitrate, in applied water and did not consider site-specific, on-farm application of fertilizers (e.g., nitrate) and/or soil amendments. Potential adverse effects on nitrate concentrations in groundwater under the Low Flow Alternative and Seasonal Alternative under Future Conditions (whether due to Project operations or on-farm practices) could be reduced through implementation of the CV-SALTS Nitrate Control Program.

Table 4-30. Summary of Simulated Concentrations for Nitrate in Groundwater with Associated Significance Thresholds for Low Flow Alternative and Seasonal Alternative under Future Conditions

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Maximum Simulated Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	7.7	5.6	7.7	10
SWID	9.2	5.7	9.2	10
SSJMUD	8.8	6.1	8.8	10
KTWD	5.1	8.0	8.5	10
DEID	9.2	2.1	9.2	10
TBID	**27.3**	**13.0**	**27.3**	10
Saucelito ID	**10.0**	2.7	**10.0**	10
Pixley ID	9.8	4.7	9.8	10
TPDWD	**20.4**	6.2	**20.4**	10
Porterville ID	**15.3**	3.2	**15.3**	10
LTRID	**15.9**	2.1	**15.9**	10

Notes: Bolded numbers indicate exceedance of threshold.

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
mg/L = milligrams per liter
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, NO_3 = nitrate as nitrogen, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-64. Simulated Changes in Relative Concentration of Nitrate in Groundwater under for the Low Flow Alternative and Seasonal Alternative under Future Conditions

4.2.4 High Flow Alternative

The sections below describe results of groundwater analyses performed for the High Flow Alternative under both Existing Conditions and No Project Alternative. The differences between the Existing Conditions and No Project Alternative are related to future changes in operational and regulatory environment in the Friant Division and are independent of implementation of the proposed project.

4.2.4.1 Existing Conditions

Groundwater Budget Components

The changes in applied surface water supply affects total groundwater pumping to meet Friant Contractors demands and thus long-term water quality trends.

As described in Chapter 4.2.1.1, several groundwater budget parameters were assumed constant and did not change between the Existing Conditions, No Project Alternative, and three Project alternatives. Figure 4-5 to Figure 4-26 depict the various water budget components of the groundwater model for each of the Friant Contractors in the study area under the Existing Condition. Several components of the land surface water budget and the upper aquifer water budget remain the same between the Existing Condition and the High Flow Alternative under Existing Conditions. For the land surface water budget, the surface water to demand and total pumping are the two components that change between the Existing Condition and the High Flow Alternative under Existing Conditions. For the upper aquifer water budget, the recharge and pumping are the two components that vary between the Existing Condition and the High Flow Alternative under Existing Conditions. All other components of the land surface water budget and upper aquifer water budget are constant between the Existing Condition and the High Flow Alternative under Existing Conditions. As such water budgets for the High Flow Alternative under Existing Conditions are not shown again here.

Chapter 3.2.4.1. summarizes surface water deliveries in the High Flow Alternative under Existing Conditions. These deliveries are larger in quantity compared to both the Existing Conditions and the Low Flow Alternative and Seasonal Alternative under Existing Conditions. Pixley ID receives negligible amounts of surface water deliveries in the High Flow Alternative under Existing Conditions. These delivery amounts are similar to those received by Pixley ID in the Existing Conditions and the Low Flow Alternative and Seasonal Alternative under Existing Conditions. Thus, Pixley ID has no change in its net inflow or outflow in the High Flow Alternative under Existing Conditions compared to the Low Flow Alternative and Seasonal Alternative under Existing Conditions. Total simulated groundwater pumping under the High Flow Alternative under Existing Conditions over the 50-year simulation period is shown in Table 4-12. The relative changes in groundwater pumping for the High Flow Alternative under Existing Conditions compared to the Existing Conditions are shown in Table 4-18. Simulated groundwater pumping under the High Flow Alternative under Existing Conditions decreases compared to the Existing Conditions, likely due to additional surface water deliveries to the Friant Contractors to meet their water demands.

Relative changes in water quality are summarized in Chapter 3.2.4.1. In Reach A, TDS, boron, and chloride see increases in concentration in the High Flow Alternative under Existing Conditions relative to the Existing Conditions. However, water quality improves for nitrate for eight out of the twelve months on average. On average, Reach D experiences an improvement or no change in water quality in the High Flow Alternative under Existing Conditions relative to the Existing Conditions for all constituents. Reaches B and C show increases in average concentrations for all constituents in all months in the High Flow Alternative under Existing Conditions relative to the Existing Conditions. Thus, any differences between the Existing Conditions and the High Flow Alternative under Existing Conditions can be attributed to changes in surface water supply and quality. Changes in supply amounts directly impact pumping and therefore mass flux. Similarly, changes in surface water quality directly impacts mass flux into the upper aquifer.

Groundwater Quality Constituents

Results from the Groundwater Model for the High Flow Alternative under Existing Conditions are presented in Table 4-31 to Table 4-34. These results reflect ending concentrations for TDS, nitrate, boron, and chloride in the Low Flow Alternative and Seasonal Alternative under Existing Conditions.

Total Dissolved Solids

Similar to the Low Flow Alternative and Seasonal Alternative under Existing Conditions, simulated TDS concentrations and annual rates of change in TDS concentrations in groundwater vary widely across Friant Contractors for the High Flow Alternative under Existing Conditions. TDS concentrations generally decreased during the simulation period for many Friant Contractors. For 10 of the 11 Friant Contractors in the study area, the simulated average annual rate of change in TDS concentrations in groundwater is lower than the specified significance threshold. However, the simulated maximum 5-year average annual rate of change in TDS concentration in groundwater would be higher than the specified significance threshold for 8 of the 11 Friant Contractors evaluated in the study area. Some of these Friant Contractors where simulated maximum 5-year average annual rate of change in TDS concentration was higher than the specified significance threshold demonstrated a general decrease in TDS concentrations over the simulation period. See Table 4-31 for a summary of simulated starting and ending concentration for TDS with associated rates of change and significance thresholds for High Flow Alternative under Existing Conditions. Figure 4-65 provides simulated changes in relative concentration of TDS in groundwater for the Friant Contractors under the High Flow Alternative under Existing Conditions.

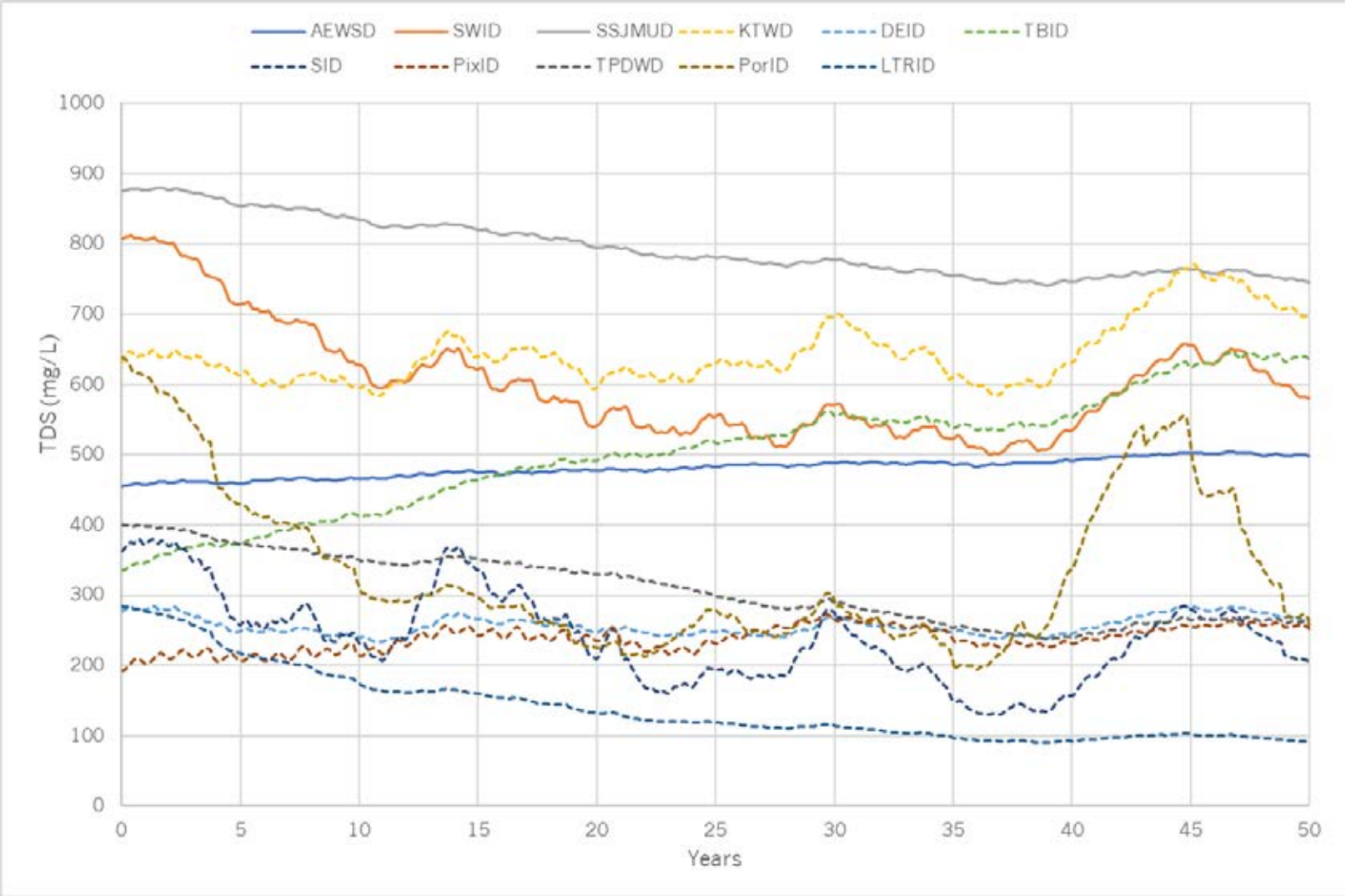
Factors affecting the simulated TDS concentrations under High Flow Alternative under Existing Conditions are similar to those described for the Low Flow Alternative and Seasonal Alternative under Existing Conditions. These factors relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting TDS concentrations for simulations); consecutive dry years resulting in more pumping; and higher TDS concentrations in surface water deliveries under High Flow Alternative under Existing Conditions, which contributes to groundwater recharge.

Table 4-31. Summary of Simulated Concentrations for Total Dissolved Solids with Associated Rates of Change and Significance Thresholds High Flow Alternative under Existing Conditions

Friant Contractor	Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Average Annual Rate of Change (mg/L)	Simulated Maximum 5-Year Average Annual Rate of Change[1]* (mg/L/yr)	Significance Threshold (mg/L/yr)
AEWSD	454	498	0.9	2.4	3.20
SWID	807	581	-4.5	**25.6**	3.84
SSJMUD	875	745	-2.6	3.8	3.84
KTWD	632	698	1.3	**27.7**	3.84
DEID	277	265	-0.2	**7.7**	3.84
TBID	335	632	**5.9**	**15.5**	3.84
Saucelito ID	363	201	-3.2	**26.1**	3.84
Pixley ID	193	253	1.2	**9.0**	3.84
TPDWD	400	258	-2.8	**5.7**	3.84
Porterville ID	638	253	-7.7	**57.8**	3.84
LTRID	284	91	-3.9	2.1	3.84

Notes: Bolded numbers indicate exceedance of threshold.
1. Maximum 5-year average annual rate of change calculated on a monthly timestep as the cumulative change in concentration relative to 5 years prior, divided by 5 years to produce an annual average rate.

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
mg/L = milligrams per liter
mg/L/yr = milligrams per liter per year
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TDS = total dissolved solids, TPDWD = Tea Pot Dome Water District

Figure 4-65. Simulated Changes in Relative Concentration of Total Dissolved Solids in Groundwater for the High Flow Alternative under Existing Conditions

Chloride

Table 4-32 provides results for simulated ending and maximum concentrations of chloride in the upper aquifer for the Friant Contractors under the High Flow Alternative under Existing Conditions. Simulated changes in relative concentration of chloride in groundwater under the High Flow Alternative under Existing Conditions are shown in Figure 4-66. Although the simulated ending and/or maximum concentrations of chloride in groundwater under the High Flow Alternative under Existing Conditions would be higher than the starting concentrations for some Friant Contractors, simulated chloride concentrations in groundwater for the Friant Contractors evaluated would remain below the significance threshold of 106 mg/L for chloride.

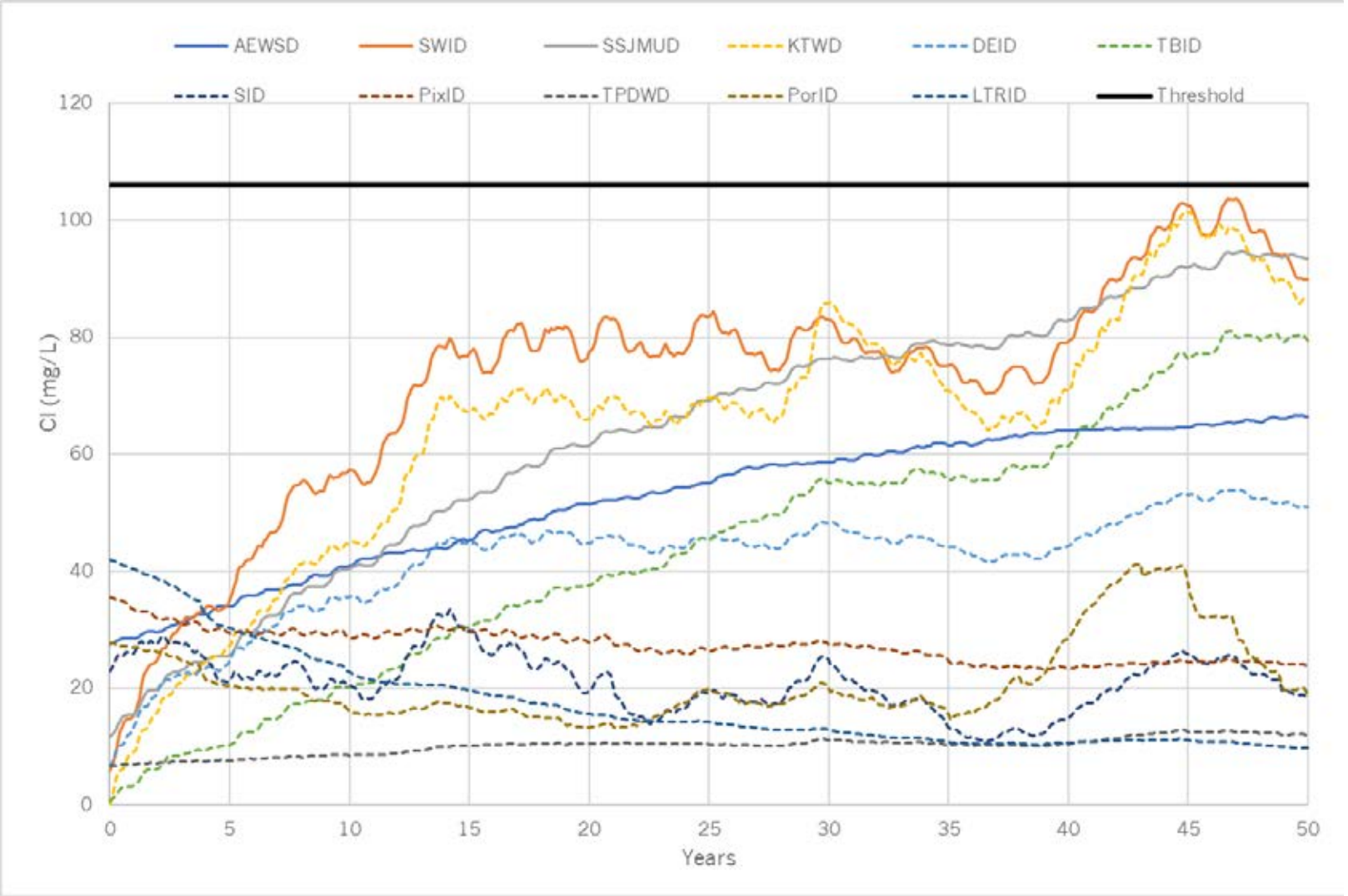
Saucelito ID, Pixley ID, Porterville ID, and LTRID saw decreases in their simulated ending concentrations whereas other Friant Contractors saw increases. Increases in simulated ending concentrations are seen for Friant Contractors where the starting concentration of chloride is higher in the lower aquifer compared to the upper aquifer. Conversely, for Friant Contractors where the lower aquifer has a lower starting concentration of chloride compared to the upper aquifer, a decrease is seen in the simulated ending concentrations.

Factors affecting the simulated chloride concentrations under High Flow Alternative under Existing Conditions are similar to those described for TDS. These factors relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting chloride concentrations in upper versus lower aquifer for simulations); and higher chloride concentrations in surface water deliveries under High Flow Alternative under Existing Conditions, which contributes to groundwater recharge.

Table 4-32. Summary of Simulated Concentrations of Chloride in Groundwater with Associated Significance Thresholds for High Flow Alternative under Existing Conditions

Friant Contractors	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Maximum Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	27.6	66.4	66.6	106
SWID	5.9	89.8	103.7	106
SSJMUD	11.8	93.5	94.7	106
KTWD	0.2	86.4	101.4	106
DEID	6.5	51.0	53.9	106
TBID	0.9	79.4	81.1	106
Saucelito ID	23.0	18.2	33.4	106
Pixley ID	35.4	23.8	35.4	106
TPDWD	6.7	11.9	12.9	106
Porterville ID	27.7	18.8	41.2	106
LTRID	41.9	9.8	41.9	106

Key:
AEWSD = Arvin-Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
mg/L = milligrams per liter
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, Cl = chloride, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-66. Simulated Changes in Relative Concentration of Chloride in Groundwater for the High Flow Alternative under Existing Conditions

Boron

Table 4-33 provides results for simulated ending and maximum concentrations of boron in the upper aquifer for Friant Contractors under the High Flow Alternative under Existing Conditions. The simulated changes in relative concentration of boron in groundwater under the High Flow Alternative under Existing Conditions are shown in Figure 4-67. Simulated results for monthly concentration of boron in groundwater for the Friant Contractors did not exceed the specified significance threshold during the 50-year simulation period.

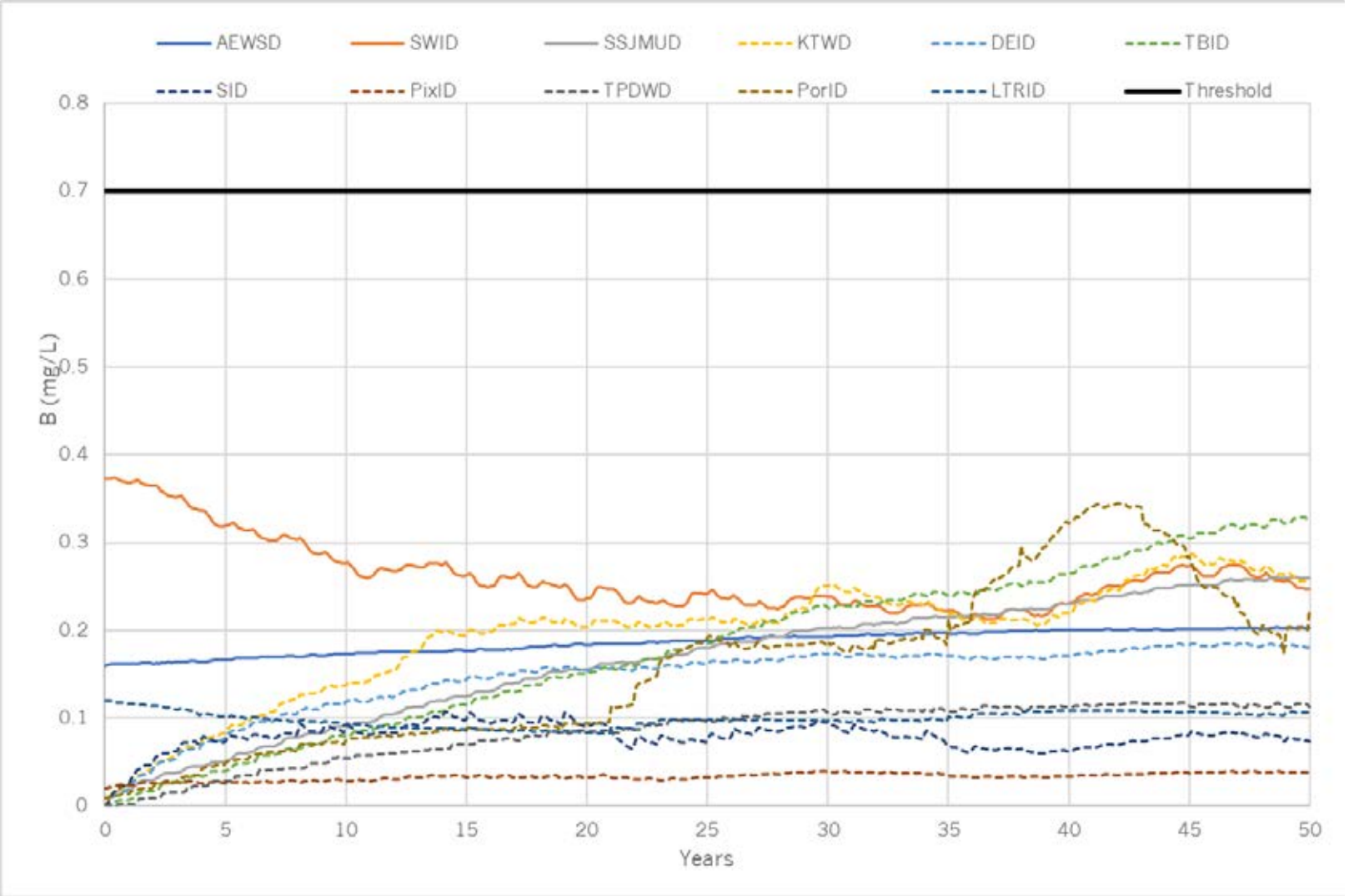
Like conditions described under the Existing Conditions, most Friant Contractors show a simulated increase in boron concentration over the 50-year simulation period. Factors affecting the simulated increase in boron concentrations under the High Flow Alternative under Existing Conditions are the same as those described for the Existing Conditions. The factors relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting boron concentrations in upper versus lower aquifer for simulations). The Friant Contractors that experienced a simulated increase in boron concentrations in the upper aquifer all started with higher concentrations of boron in the lower aquifer compared to the upper aquifer. Although the starting concentrations for boron were low in both aquifers, the difference in concentration between aquifers affected the simulated ending concentrations.

Simulated boron concentrations in the upper aquifer decreased for SWID and LTRID under the High Flow Alternative under Existing Conditions compared to the starting concentration. While SWID has the highest starting concentration of boron in its upper aquifer, the concentration of boron in the lower aquifer is substantially lower (see Table 4-33). Because simulated groundwater pumping for SWID is primarily from the lower aquifer, an improvement in the boron concentration within SWID's upper aquifer was observed in simulations. Minor changes in boron concentrations in groundwater for LTRID were likely attributed having the same starting concentration of boron in the upper aquifer and lower aquifer, a condition unique to LTRID compared to other Friant Contractors. An additional factor affecting the simulated decreases in boron concentrations in the upper aquifer for SWID and LTRID was the increase in surface water deliveries with lower boron concentrations for some Friant Contractors under the High Flow Alternative under Existing Conditions, which contributes to groundwater recharge, compared to boron concentrations in groundwater.

Table 4-33. Summary of Simulated Concentrations of Boron in Groundwater with Associated Significance Thresholds for the High Flow Alternative under Existing Conditions

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Maximum Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	0.16	0.20	0.20	0.7
SWID	0.37	0.25	0.37	0.7
SSJMUD	0.01	0.26	0.26	0.7
KTWD	0.00	0.25	0.29	0.7
DEID	0.00	0.18	0.19	0.7
TBID	0.00	0.32	0.33	0.7
Saucelito ID	0.00	0.07	0.11	0.7
Pixley ID	0.02	0.04	0.04	0.7
TPDWD	0.00	0.11	0.12	0.7
Porterville ID	0.01	0.22	0.34	0.7
LTRID	0.12	0.11	0.12	0.7

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
mg/L = milligrams per liter
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, B = boron, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-67. Simulated Changes in Relative Concentration of Boron in Groundwater for the High Flow Alternative under Existing Conditions

Nitrate

Simulated ending and maximum concentrations of nitrate in the upper aquifer for the Friant Contractors under the High Flow Alternative under Existing Conditions are provided in Table 4-34. Figure 4-68 shows the simulated changes in relative concentration of nitrate in groundwater across the Friant Contractors. Nitrate concentrations decreased during the simulation period for Friant Contractors except KTWD, similar to conditions simulated under the other Project alternatives. Same as the simulated conditions for other Project alternatives, starting concentrations of nitrate in groundwater for several Friant Contractors were well above the 10 mg/L threshold.

Factors likely attributing to the simulated increase in nitrate concentrations for KTWD are the same as described for the Existing Conditions. For KTWD, simulation results suggest a net outflow of water from the upper aquifer over the simulation period, and the aquifer is assumed to have a small, saturated thickness (28 feet; see Table 4-2). KTWD has a higher nitrate concentration in the lower aquifer (where the majority of the pumping happens) compared to the upper aquifer. Although simulated nitrate concentrations in the upper aquifer for KTWD increased during the simulation period, concentrations did not exceed the significance threshold of 10 mg/L for nitrate in groundwater.

Simulated nitrate concentrations in groundwater for Porterville ID increased to slightly above the threshold over the simulation period, specifically during a hydrologically dry period (when additional groundwater pumping is needed to meet irrigation demands due to decreased surface water supplies), but concentrations were below the threshold during other periods. Additionally, simulated nitrate concentrations in groundwater for TBID remained above the significance threshold for the entire simulation period. TBID had a starting nitrate concentration of 27.3 mg/L for the upper aquifer. Although the concentration of nitrate decreased over the simulation period to 12.7 mg/L, nitrate concentrations for TBID were still above the significance criteria.

Factors affecting simulated changes in nitrate concentrations across the Friant Contractors under the High Flow Alternative under Existing Conditions relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting nitrate concentrations in upper versus lower aquifer for simulations).

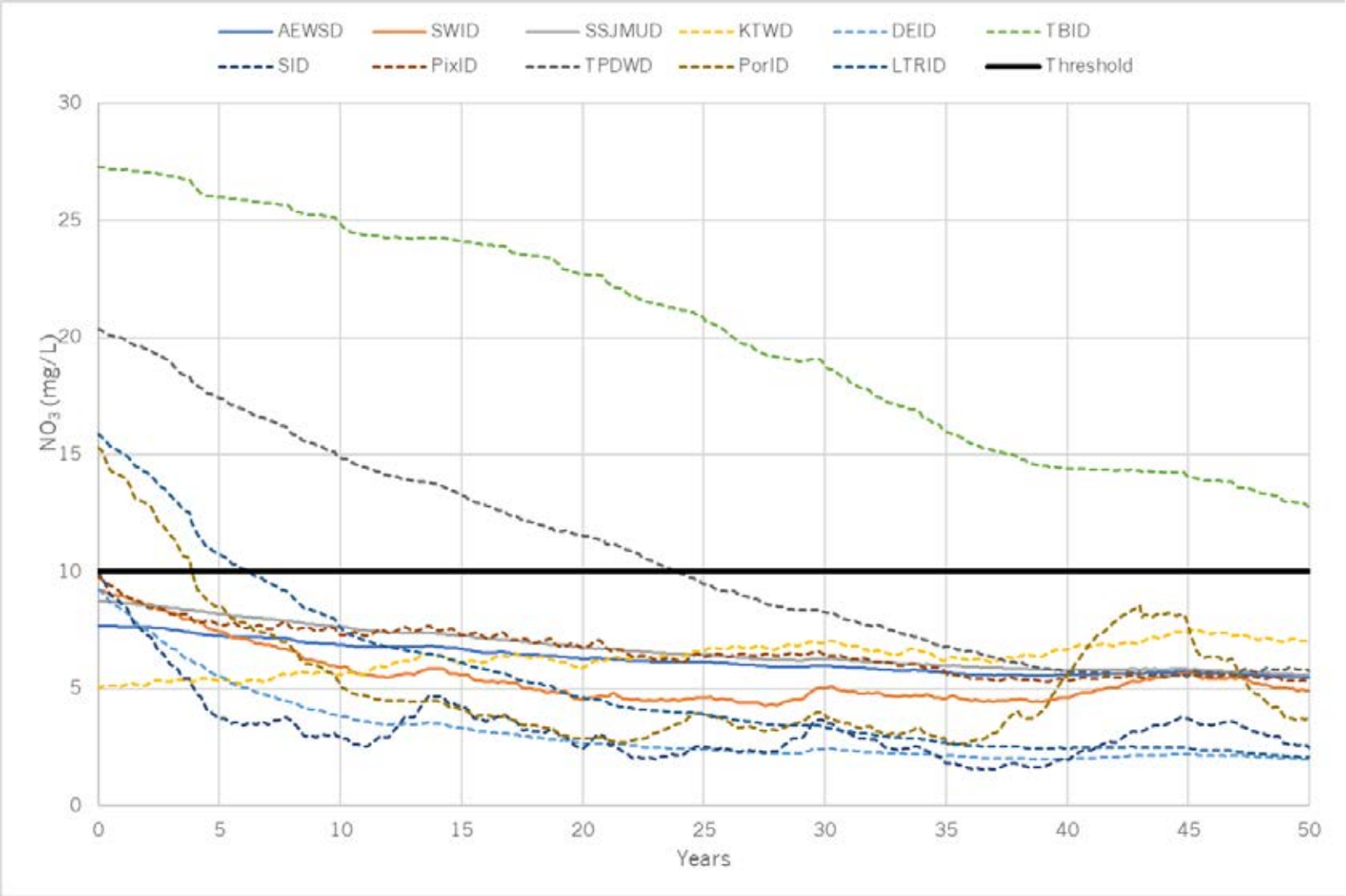
As stated previously, groundwater quality analysis performed to assess impacts of Project alternatives focused on changes in concentrations of key constituents, specifically, nitrate, in applied water and did not consider site-specific, on-farm application of fertilizers (e.g., nitrate) and/or soil amendments. Potential adverse effects on nitrate concentrations in groundwater under the High Flow Alternative under Existing Conditions (whether due to Project operations or on-farm practices) could be reduced through implementation of the CV-SALTS Nitrate Control Program (see section E.3.1.1 in Appendix E for a description).

Table 4-34. Summary of Simulated Concentrations for Nitrate in Groundwater with Associated Significance Thresholds for High Flow Alternative under Existing Conditions

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Maximum Simulated Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	7.7	5.5	7.7	10
SWID	9.2	4.9	9.2	10
SSJMUD	8.8	5.6	8.8	10
KTWD	5.1	7.1	7.5	10
DEID	9.2	2.0	9.2	10
TBID	**27.3**	**12.7**	**27.3**	10
Saucelito ID	**10.0**	2.5	**10.0**	10
Pixley ID	9.8	5.3	9.8	10
TPDWD	**20.4**	5.8	**20.4**	10
Porterville ID	**15.3**	3.6	**15.3**	10
LTRID	**15.9**	2.1	**15.9**	10

Notes: Bolded numbers indicate exceedance of threshold.

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
mg/L = milligrams per liter
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, NO_3 = nitrate as nitrogen, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-68. Simulated Changes in Relative Concentration of Nitrate in Groundwater for the High Flow Alternative under Existing Conditions

4.2.4.2 Future Conditions

Groundwater Budget Components

The changes in applied surface water supply affects total groundwater pumping to meet Friant Contractors demands and thus long-term water quality trends.

As described in Chapter 4.2.1.1, several groundwater budget parameters were assumed constant and did not change between the Existing Conditions, No Project Alternative, and three Project alternatives. Figure 4-31 to Figure 4-52 depict the various water budget components of the groundwater model for each of the Friant Contractors in the study area under the No Project Alternative. Several components of the land surface water budget and the upper aquifer water budget remain the same between the No Project Alternative and the High Flow Alternative under Future Conditions. For the land surface water budget, the surface water to demand and total pumping are the two components that change between the No Project Alternative and the High Flow Alternative under Future Conditions. For the upper aquifer water budget, the recharge and pumping are the two components that vary between the No Project Alternative and the High Flow Alternative under Future Conditions. All other components of the land surface water budget and upper aquifer water budget are constant between the No Project Alternative and the High Flow Alternative under Future Conditions. As such water budgets for the High Flow Alternative under Future Conditions are not shown again here.

Total simulated groundwater pumping under the High Flow Alternative under Future Conditions over the 50-year simulation period is shown in Table 4-12. The relative changes in groundwater pumping for the High Flow Alternative under Future Conditions compared to the No Project Alternative are shown in Table 4-18.

Chapter 3.2.4.2. summarizes surface water deliveries in the High Flow Alternative under Future Conditions. Surface water deliveries increase in High Flow Alternative under Future Conditions compared to the No Project Alternative. Surface water deliveries are also linked to changes in surface water quality in Chapter 3.2.4.2. Months that have larger increases in surface water deliveries have a greater deterioration in water quality. Water quality also deteriorates more from north to south. Thus, any differences between the No Project Alternative and the High Flow Alternative under Future Conditions can be attributed to changes in surface water supply and quality. Changes in supply amounts directly impact pumping and therefore mass flux. Similarly, changes in surface water quality directly impacts mass flux into the upper aquifer.

Groundwater Quality Constituents

Results from the groundwater model for the High Flow Alternative under Future Conditions are presented in Table 4-35 to Table 4-38. These results reflect ending concentrations for TDS, nitrate, boron, and chloride and are representative of potential long-term groundwater trends under High Flow Alternative under Future Conditions proposed operations.

Total Dissolved Solids

Similar to High Flow Alternative under Existing Conditions, simulated TDS concentrations and annual rates of change in TDS concentrations in groundwater vary widely across districts for the High Flow Alternative under Future Conditions. TDS concentrations generally decreased during the simulation period for many Friant Contractors. For 10 of the 11 Friant Contractors in the study area, the simulated average annual rate of change in TDS concentrations in groundwater under High Flow Alternative under Future Conditions is lower than the specified significance threshold. However, the simulated maximum 5-year average annual rate of change in TDS concentration in groundwater would be higher than the specified significance threshold for 8 of the 11 Friant Contractors in the study area. Some of these Friant Contractors where simulated maximum 5-year average annual rate of change in TDS concentration was higher than the specified significance threshold demonstrated a general decrease in TDS concentrations over the simulation period. See Table 4-35 for a summary of simulated starting and ending concentration for TDS with associated rates of change and significance thresholds for High Flow Alternative under Future Conditions. Figure 4-69 provides simulated changes in relative concentration of TDS in groundwater for the Friant Contractors under the High Flow Alternative under Future Conditions.

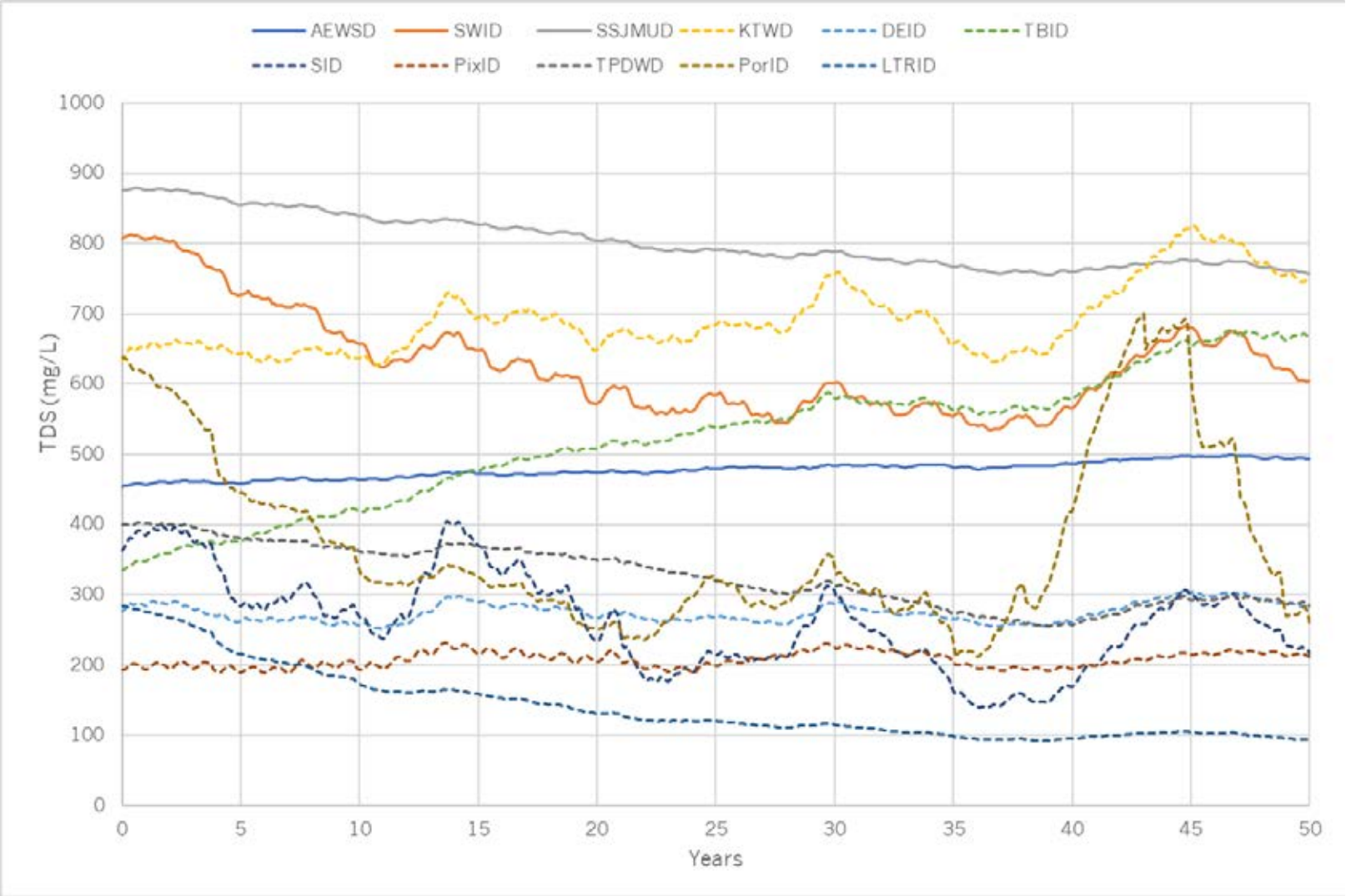
Factors affecting the simulated TDS concentrations under High Flow Alternative under Future Conditions are similar to those described for the Low Flow Alternative and Seasonal Alternative under Future Conditions. These factors relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting TDS concentrations for simulations); consecutive dry years resulting in more pumping; and higher TDS concentrations in surface water deliveries under High Flow Alternative under Future Conditions, which contributes to groundwater recharge.

Table 4-35. Summary of Simulated Concentrations for Total Dissolved Solids in Groundwater with Associated Rates of Change and Significance Thresholds for High Flow Alternative under Future Conditions

Friant Contractor	Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Average Annual Rate of Change (mg/L)	Simulated Maximum 5-Year Average Annual Rate of Change[1]* (mg/L/yr)	Significance Threshold (mg/L/yr)
AEWSD	454	493	0.8	2.4	3.20
SWID	807	604	-4.1	**24.1**	3.84
SSJMUD	875	757	-2.4	3.5	3.84
KTWD	632	747	2.3	**29.7**	3.84
DEID	277	284	0.1	**8.4**	3.84
TBID	335	663	**6.6**	**16.6**	3.84
Saucelito ID	363	216	-2.9	**27.1**	3.84
Pixley ID	193	212	0.4	**6.0**	3.84
TPDWD	400	284	-2.3	**7.8**	3.84
Porterville ID	638	257	-7.6	**78.7**	3.84
LTRID	284	94	-3.8	2.3	3.84

Notes: Bolded numbers indicate exceedance of threshold
1. Maximum 5-year average annual rate of change calculated on a monthly timestep as the cumulative change in concentration relative to 5 years prior, divided by 5 years to produce an annual average rate.

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
LTRID = Lower Tule River Irrigation District
mg/L = milligrams per liter
mg/L/yr = milligrams per liter per year
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TDS = total dissolved solids, TPDWD = Tea Pot Dome Water District

Figure 4-69. Simulated Changes in Relative Concentration of Total Dissolved Solids in Groundwater for the High Flow Alternative under Future Conditions

Chloride

Table 4-36 provides results for simulated ending and maximum concentrations of chloride in the upper aquifer for Friant Contractors under the High Flow Alternative under Future Conditions. Simulated changes in relative concentration of chloride in groundwater under the High Flow Alternative under Future Conditions are shown in Figure 4-70. Although the simulated ending and/or maximum concentrations of chloride in groundwater under the High Flow Alternative under Future Conditions would be higher than the starting concentrations for some Friant Contractors, simulated chloride concentrations in groundwater for the Friant Contractors, except KTWD, would remain below the significance threshold of 106 mg/L for chloride.

Saucelito ID, Pixley ID, Porterville ID, and LTRID saw decreases in their simulated ending concentrations whereas other Friant Contractors saw increases. Increases in simulated ending concentrations are seen for Friant Contractors where the starting concentration of chloride is higher in the lower aquifer compared to the upper aquifer. Conversely, Friant Contractors where the lower aquifer has a lower starting concentration of chloride compared to the upper aquifer, a decrease is seen in the simulated ending concentrations.

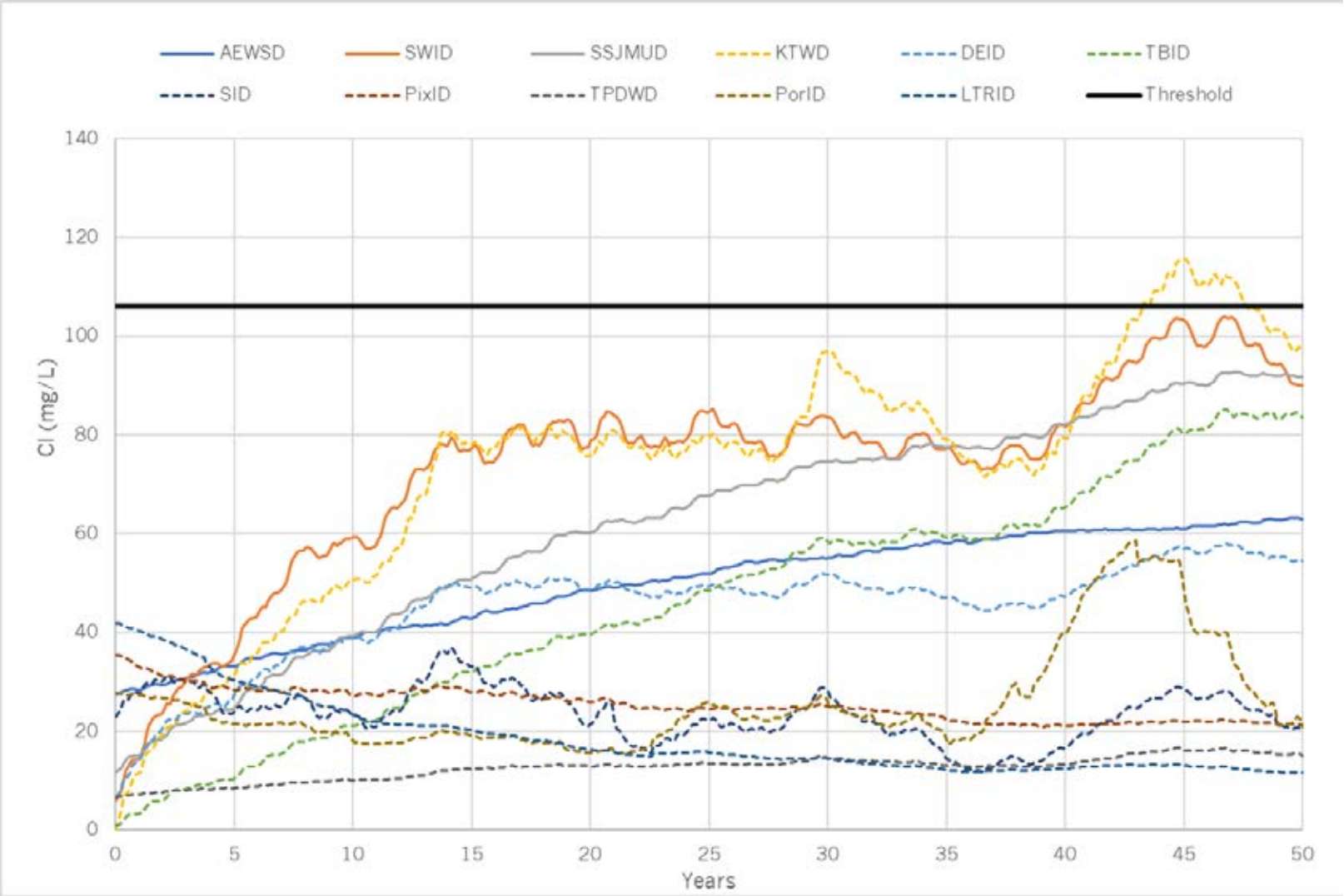
Factors affecting the simulated chloride concentrations under High Flow Alternative under Future Conditions are similar to those described for TDS. These factors relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting chloride concentrations in upper versus lower aquifer for simulations); and higher chloride concentrations in surface water deliveries under High Flow Alternative under Future Conditions, which contributes to groundwater recharge.

Table 4-36. Summary of Simulated Concentrations of Chloride in Groundwater with Associated Significance Thresholds for High Flow Alternative under Future Conditions

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Maximum Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	27.6	63.0	63.2	106
SWID	5.9	90.1	103.9	106
SSJMUD	11.8	91.7	92.8	106
KTWD	0.2	97.5	**115.6**	106
DEID	6.5	54.5	57.9	106
TBID	0.9	83.5	85.2	106
Saucelito ID	23.0	19.9	37.0	106
Pixley ID	35.4	21.2	35.4	106
TPDWD	6.7	15.1	16.6	106
Porterville ID	27.7	20.9	58.5	106
LTRID	41.9	11.6	41.9	106

Notes: Bolded numbers indicate exceedance of threshold.

Key:
AEWSD = Arvin-Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
mg/L = milligrams per liter
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, Cl = chloride, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-70. Simulated Changes in Relative Concentration of Chloride in Groundwater for the High Flow Alternative under Future Conditions

Boron

Simulated results for ending and maximum concentrations of boron in the upper aquifer for Friant Contractors under the High Flow Alternative under Future Conditions are provided in Table 4-37 below. Figure 4-71 shows the simulated changes in relative concentration of boron in groundwater under the High Flow Alternative under Future Conditions. Simulated results for monthly concentration of boron in groundwater for the Friant Contractors did not exceed the specified significance threshold during the 50-year simulation period.

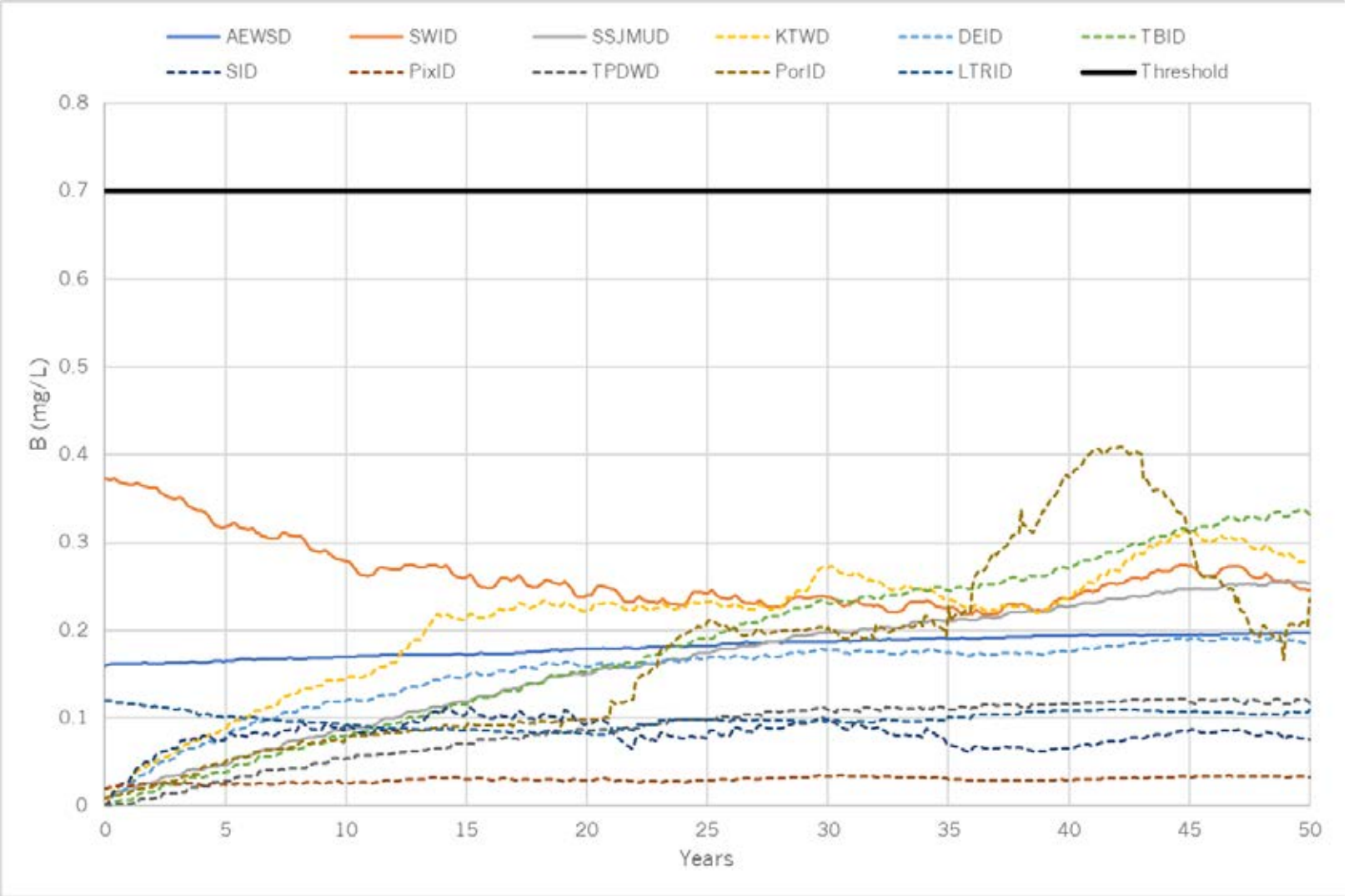
Like conditions described under the No Project Alternative, most Friant Contractors show a simulated increase in boron concentration over the 50-year simulation period. Factors affecting the simulated increase in boron concentrations under High Flow Alternative under Future Conditions are the same as those described for the No Project Alternative. The factors relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting boron concentrations in upper versus lower aquifer for simulations). The nine Friant Contractors that experienced a simulated increase in boron concentrations in the upper aquifer all started with higher concentrations of boron in the lower aquifer compared to the upper aquifer.

Simulated boron concentrations in the upper aquifer decreased for SWID and LTRID under the High Flow Alternative under Future Conditions compared to the starting concentration. While SWID has the highest starting concentration of boron in its upper aquifer, the concentration of boron in the lower aquifer is substantially lower (see Table 4-37). Because simulated groundwater pumping for SWID is primarily from the lower aquifer, an improvement in the boron concentration within SWID's upper aquifer was observed in simulations. Minor changes in boron concentrations in groundwater for LTRID were likely attributed having the same starting concentration of boron in the upper aquifer and lower aquifer, a condition unique to LTRID compared to other Friant Contractors evaluated. An additional factor affecting the simulated decreases in boron concentrations in the upper aquifer for SWID and LTRID was the increase in surface water deliveries with lower boron concentrations for some districts under High Flow Alternative under Future Conditions, which contributes to groundwater recharge, compared to boron concentrations in groundwater.

Table 4-37. Summary of Simulated Concentrations of Boron in Groundwater with Associated Significance Thresholds for High Flow Alternative under Future Conditions

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Simulated Maximum Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	0.16	0.20	0.20	0.7
SWID	0.37	0.25	0.37	0.7
SSJMUD	0.01	0.25	0.26	0.7
KTWD	0.00	0.28	0.31	0.7
DEID	0.00	0.19	0.19	0.7
TBID	0.00	0.33	0.34	0.7
Saucelito ID	0.00	0.08	0.11	0.7
Pixley ID	0.02	0.03	0.03	0.7
TPDWD	0.00	0.12	0.12	0.7
Porterville ID	0.01	0.24	0.41	0.7
LTRID	0.12	0.11	0.12	0.7

Key:
AEWSD = Arvin-Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
mg/L = milligrams per liter
LTRID = Lower Tule River Irrigation District
SSJMUD = Southern San Joaquin Municipal Utility District
SWID = Shafter-Wasco Irrigation District
TBID = Terra Bella Irrigation District
TPDWD = Tea Pot Dome Water District



Key: AEWSD = Arvin Edison Water Storage District, B = boron, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-71. Simulated Changes in Relative Concentration of Boron in Groundwater for the High Flow Alternative under Future Conditions

Nitrate

Table 4-38 summarizes simulated ending and maximum concentrations of nitrate in the upper aquifer for Friant Contractors under the High Flow Alternative under Future Conditions. Simulated changes in relative concentration of nitrate in groundwater across the Friant Contractors are shown in Figure 4-72. Nitrate concentrations decreased during the simulation period for the Friant Contractors, except KTWD, similar to conditions simulated for other scenarios. Same as the simulated conditions for other scenarios, starting concentrations of nitrate in groundwater for several Friant Contractors were well above the 10 mg/L threshold.

Factors likely attributing to the simulated increase in nitrate concentrations for KTWD are the same as described for the High Flow Alternative under Existing Conditions. For KTWD, simulation results suggest a net outflow of water from the upper aquifer over the simulation period, and the aquifer is assumed to have a small, saturated thickness (28 feet; see Table 4-2). KTWD has a higher nitrate concentration in the lower aquifer (where the majority of the pumping happens) compared to the upper aquifer. Although simulated nitrate concentrations in the upper aquifer for KTWD increased during the simulation period, concentrations did not exceed the significance threshold of 10 mg/L for nitrate in groundwater.

Simulated nitrate concentrations in groundwater for Porterville ID increased to slightly above the threshold over the simulation period, specifically during a hydrologically dry period (when additional groundwater pumping is needed to meet irrigation demands due to decreased surface water supplies), but concentrations were below the threshold during other periods. Additionally, simulated nitrate concentrations in groundwater for TBID remained above the significance threshold for the entire simulation period. TBID had a starting nitrate concentration of 27.3 mg/L for the upper aquifer. Although the concentration of nitrate decreased over the simulation period to 12.9 mg/L, nitrate concentrations for TBID were still above the significance criteria.

Factors affecting simulated changes in nitrate concentrations across the Friant Contractors under the High Flow Alternative under Future Conditions relate to anticipated levels of groundwater pumping and proportions of groundwater pumping from upper versus lower aquifers; assumptions about upper aquifer characteristics (e.g., saturated thickness of upper aquifer) and groundwater quality conditions (e.g., starting nitrate concentrations in upper versus lower aquifer for simulations).

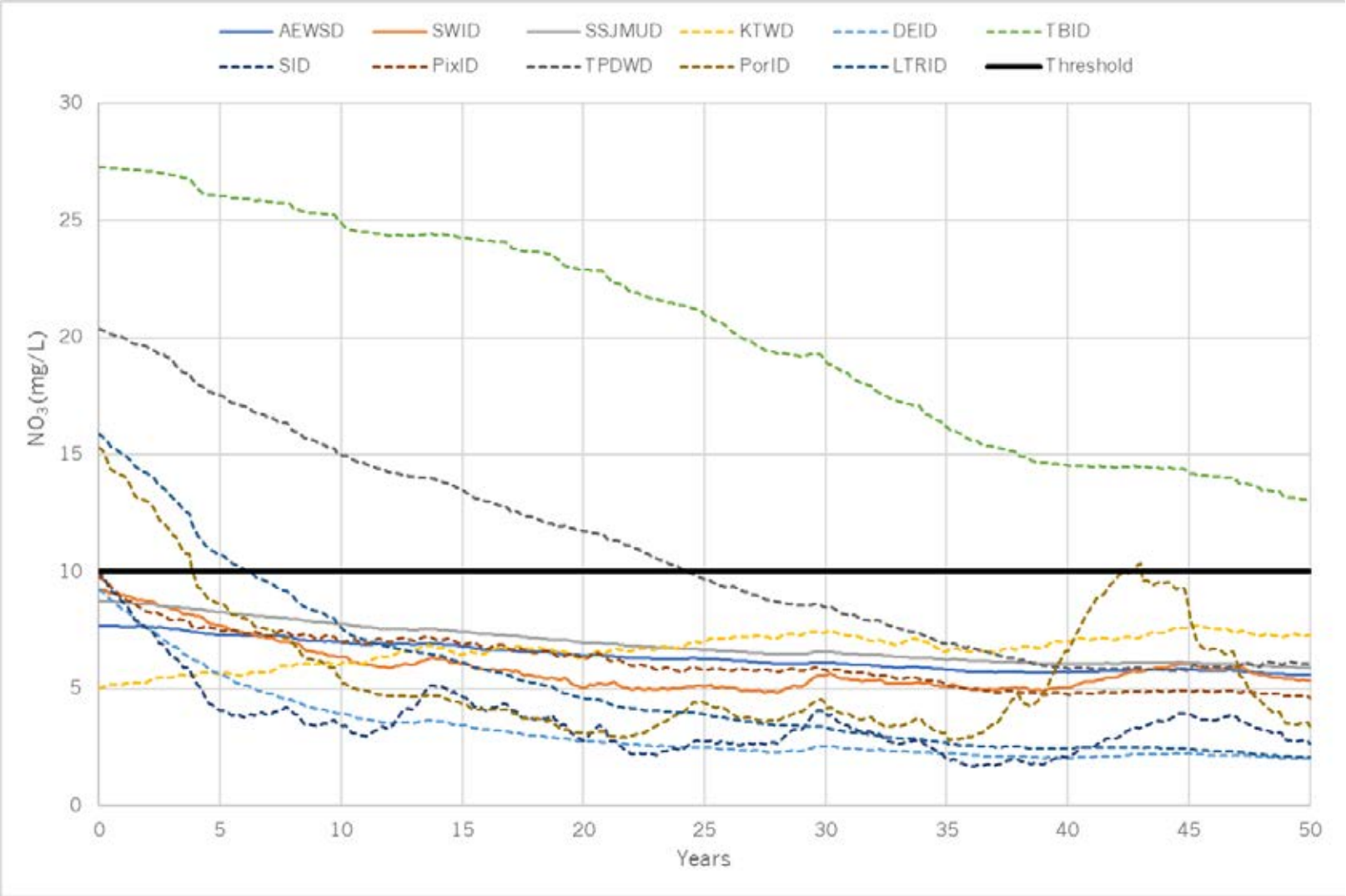
As stated previously, groundwater quality analysis performed to assess impacts of Project alternatives focused on changes in concentrations of key constituents, specifically, nitrate, in applied water and did not consider site-specific, on-farm application of fertilizers (e.g., nitrate) and/or soil amendments. Potential adverse effects on nitrate concentrations in groundwater under the High Flow Alternative under Future Conditions (whether due to Project operations or on-farm practices) could be reduced through implementation of the CV-SALTS Nitrate Control Program (see section E.3.1.1 in Appendix E for a description).

Table 4-38. Summary of Simulated Concentrations for Nitrate in Groundwater with Associated Significance Thresholds for High Flow Alternative under Future Conditions

Friant Contractor	Simulated Starting Concentration (mg/L)	Simulated Ending Concentration (mg/L)	Maximum Simulated Concentration (mg/L)	Significance Threshold (mg/L)
AEWSD	7.7	5.6	7.7	10
SWID	9.2	5.4	9.2	10
SSJMUD	8.8	5.9	8.8	10
KTWD	5.1	7.3	7.7	10
DEID	9.2	2.0	9.2	10
TBID	**27.3**	**12.9**	**27.3**	10
Saucelito ID	**10.0**	2.7	**10.0**	10
Pixley ID	9.8	4.6	9.8	10
TPDWD	**20.4**	6.0	**20.4**	10
Porterville ID	**15.3**	3.4	**15.3**	10
LTRID	**15.9**	2.1	**15.9**	10

Notes: Bolded numbers indicate exceedance of threshold.

Key:
AEWSD = Arvin Edison Water Storage District
DEID = Delano-Earlimart Irrigation District
ID = Irrigation District
KTWD = Kern Tulare Water District
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Key: AEWSD = Arvin Edison Water Storage District, DEID = Delano-Earlimart Irrigation District, KTWD = Kern Tulare Water District, LTRID = Lower Tule River Irrigation District, mg/L = milligrams per liter, NO_3 = nitrate as nitrogen, PixID = Pixley Irrigation District, PorID = Porterville Irrigation District, SID = Saucelito Irrigation District, SSJMUD = Southern San Joaquin Municipal Utility District, SWID = Shafter-Wasco Irrigation District, TBID = Terra Bella Irrigation District, TPDWD = Tea Pot Dome Water District

Figure 4-72. Simulated Changes in Relative Concentration of Nitrate in Groundwater for the High Flow Alternative under Future Conditions

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