EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

Eastern San Joaquin Groundwater Subbasin

GROUNDWATER SUSTAINABILITY PLAN

November 2019; revised June 2022

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Eastern San Joaquin Groundwater Subbasin

Groundwater Sustainability Plan

Prepared by:

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

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11/5/2019

November 2019; Revised June 2022

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EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

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Acronyms

µg/L	micrograms per liter
µmhos/cm	micromhos per centimeter
1,2,3-TCP	1,2,3-Trichloropropane
AB	Assembly Bill
ACS	American Community Survey
AEM	airborne electromagnetic survey
AF	acre-feet
AF/day	acre-feet per day
AF/year	acre-feet per year
AMI	Advanced Metering Infrastructure
AWMP	Agricultural Water Management Plan
AWMPs	Agricultural Water Management Plans
B.P.	before present
Bay-Delta Plan	Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary
bgs	below ground surface
BMP	best management practice
BTEX	benzene, toluene, ethylbenzene, and xylenes
Cal Water	California Water Service Company Stockton District
California State Parks	California Department of Parks and Recreation
CALSIMETAW	California Simulation of Evapotranspiration of Applied Water
CASGEM	California Statewide Groundwater Elevation Monitoring
CC	climate change
CCR	California Code of Regulations
CCWD	Calaveras County Water District
CDEC	California Data Exchange Center
CDFW	California Department of Fish and Wildlife
CDP	census designated place
CDPH	California Department of Public Health
CDPR	California Department of Pesticide Regulation
CDWA	Central Delta Water Agency
CEDEN	California Environmental Data Exchange Network
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CGPF	CalSim II Generated Perturbation Factors
CGPS	continuously operating Global Positioning System
CNRA	California Natural Resources Agency
CSJWCD	Central San Joaquin Water Conservation District
CVFPB	Central Valley Flood Protection Board
CVRWQCB	Central Valley Regional Water Quality Control Board
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
CWSRF	Clean Water State Revolving Fund
DAC	Disadvantaged Community
DACs	Disadvantaged Communities
DBCP	1,2-dibromo-3-chloropropane
DDW	Division of Drinking Water
Delta	Sacramento-San Joaquin River Delta
DER	Department of Environmental Resources
DFW	Department of Fish and Wildlife
DMS	Data Management System

DOGGR	Division of Oil, Gas, and Geothermal Resources
DPR	Department of Pesticide Regulation
DTSC	Department of Toxic Substances Control
DWR	Department of Water Resources
Eastside GSA	Eastside San Joaquin GSA
EBMUD	East Bay Municipal Utility District
EC	electrical conductivity
EDB	ethylene dibromide
EPA	Environmental Protection Agency
ERTs	Encoder Receiver Transmitters
ESJ	Eastern San Joaquin
ESJGWA	Eastern San Joaquin Groundwater Authority
ESJGWA Board	Eastern San Joaquin Groundwater Authority Board of Directors
ESJWRM	Eastern San Joaquin Water Resources Model
ETo	evapotranspiration
EWMPs	efficient water management practices
ft. bgs	feet below ground surface
GAMA	Groundwater Ambient Monitoring and Assessment
GBA	Groundwater Basin Authority
GCM	global climate model
GDE	Groundwater Dependent Ecosystem
GDEs	Groundwater-Dependent Ecosystems
GICIMA	Groundwater Information Center Interactive Mapping Application
GIS	Geographic Information System
GMP	Groundwater Management Plan
gpm	gallons per minute
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HCM	Hydrogeologic Conceptual Model
ICU Program	Integrated Conjunctive Use Program
ILRP	Irrigated Lands Regulatory Program
InSAR	Interferometric Synthetic Aperture Radar
IRWM	Integrated Regional Water Management
IRWMP	Integrated Regional Water Management Plan
IWFM	Integrated Water Flow Model
JPA	Joint Powers Agreement
LCSD	Lockeford Community Services District
LCWD	Linden County Water District
LLNL	Lawrence Livermore National Laboratory
LOCA	local analogs
MAC	Mokelumne-Amador-Calaveras
MAF	million acre-feet
MAR	managed aquifer recharge
MCL	maximum contaminant level
mg/L	milligrams per liter
MGD	million gallons per day
MHI	median household income
MOA	memorandum of agreement
MokeWISE	Mokelumne Watershed Interregional Sustainability Evaluation
MSL	mean sea level
MtBE	methyl tertiary-butyl ether

MUD	Municipal Utilities Department
MWH	Montgomery Watson Harza
NAD 83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
NCCAG	Natural Communities Commonly Associated with Groundwater
NDWA	North Delta Water Agency
NEPA	National Environmental Policy Act
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NSJWCD	North San Joaquin Water Conservation District
NWIS	National Water Information System
OES	San Joaquin County Office of Emergency Services
OID	Oakdale Irrigation District
OSWCR	Online System for Well Completion Reports
PCE	perchloroethylene
PDA	Protest Dismissal Agreement
PMAs	Projects and Management Actions
pdf	portable document format
PFOA	perfluorooctantoic acid
PFOS	perfluorooctanesulfonic acid
PMAs	Projects and Management Actions
PG&E	Pacific Gas and Electric Company
PRISM	Precipitation-Elevation Regressions on Independent Slopes Model
PS	persistent scatter
RCP	representative climate pathways
RD	Reclamation District
RL	Reporting Limit
RWQCB	Regional Water Quality Control Board
SAGBI	Soil Agricultural Groundwater Banking Index
SB	Senate Bill
SCWSP	South County Water Supply Program
SDACs	Severely Disadvantaged Communities
SDWA	South Delta Water Agency
SEWD	Stockton East Water District
SGM	Sustainable Groundwater Management
SGMA	the Sustainable Groundwater Management Act
SJC	San Joaquin County
SJCFCWCD	San Joaquin County Flood Control and Water Conservation District
SJV	San Joaquin Valley
SMCL	secondary maximum contaminant levels
SNMP	Salt and Nutrient Management Plan
SRA	State Recreation Area
SS	specific storage
SSJ GSA	South San Joaquin GSA
SSJ	South San Joaquin
SSJID	South San Joaquin Irrigation District
SVRA	State Vehicular Recreation Area
SWRCB	State Water Resources Control Board
SWTF	Surface Water Treatment Facility
SY	specific yield

TCE	trichloroethene
TDS	total dissolved solids
TNC	The Nature Conservancy
TSS	Technical Support Services
UNAVCO	University NAVSTAR Consortium
USACE	U.S. Army Corps of Engineers
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	United States Fish & Wildlife Service
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
UWMP	Urban Water Management Plan
UWMPs	Urban Water Management Plans
VIC	Variable Infiltration Capacity
VOC	volatile organic compound
Water Code	California Water Code
WDL	Water Data Library
WDR	waste discharge requirement
WID	Woodbridge Irrigation District
Workgroup	Groundwater Sustainability Workgroup
WPCF	Water Pollution Control Facility
WRFP	Water Recycling Funding Program
WRIMS	Water Resource Integrated Modeling System

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EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

EXECUTIVE SUMMARY

ES-1. INTRODUCTION

Critical Dates for the Eastern San Joaquin Subbasin

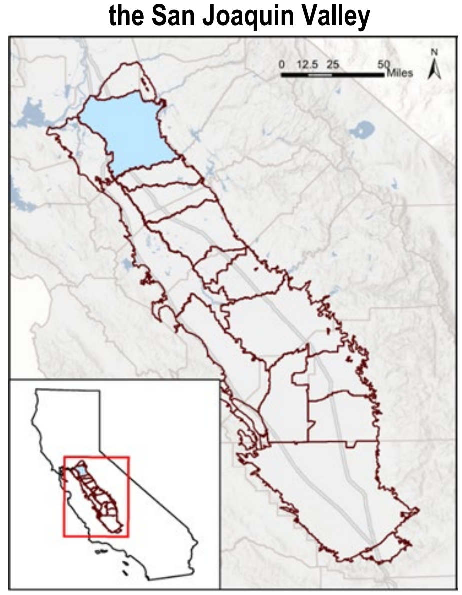
- 2020 By January 31: Submit GSP to DWR
- 2025 Evaluate GSP and update if warranted
- 2030 Evaluate GSP and update if warranted
- 2035 Evaluate GSP and update if warranted
- 2040 Achieve sustainability for the Subbasin

In 2014, the California legislature enacted the Sustainable Groundwater Management Act (SGMA) in response to continued overdraft of California's groundwater resources. The Eastern San Joaquin Groundwater Subbasin (Eastern San Joaquin Subbasin, or Subbasin) is one of 21 basins and subbasins identified by the California Department of Water Resources (DWR) as being in a state of critical overdraft. SGMA requires preparation of a Groundwater Sustainability Plan (GSP) to address measures necessary to attain sustainable conditions in the Subbasin. Within the framework of SGMA, sustainability is generally defined as long-term reliability of the groundwater supply and the absence of undesirable results.

The Eastern San Joaquin Groundwater Authority (ESJGWA) was formed in 2017 in response to SGMA. A Joint Exercise of Powers Agreement establishes the ESJGWA, which is composed of 16 Groundwater Sustainability Agencies (GSAs): Central Delta Water Agency (CDWA), Central San Joaquin Water Conservation District (CSJWCD), City of Lodi, City of Manteca, City of Stockton, Eastside San Joaquin GSA (Eastside GSA) (composed of Calaveras County Water District [CCWD], Stanislaus County, and Rock Creek Water District), Linden County Water District (LCWD), Lockeford Community Services District (LCSD), North San Joaquin Water Conservation District (NSJWCD), Oakdale Irrigation District (OID), San Joaquin County No. 1, San Joaquin County No. 2 (with participation from California Water Service Company Stockton District [Cal Water]), South Delta Water Agency (SDWA), South San Joaquin GSA (composed of South San Joaquin Irrigation District [SSJID] including Woodward Reservoir, City of Ripon, and City of Escalon), Stockton East Water District (SEWD), and Woodbridge Irrigation District (WID). The ESJGWA is governed by a 16-member Board of Directors (ESJGWA Board), with one representative from each GSA. The Board is guided by an Advisory Committee, also with one representative from each GSA, that is tasked with making recommendations to the ESJGWA Board on technical and substantive matters.

SGMA requires development of a GSP that achieves groundwater sustainability in the Subbasin by 2040. The GSP outlines the need to reduce overdraft conditions and has identified 23 projects for potential development that either replace groundwater use (offset) or supplement groundwater supplies (recharge) to meet current and future water demands. Although current analysis indicates that groundwater pumping offsets and/or recharge on the order of 37,000 acre-feet per year (AF/year) may be required to achieve sustainability, additional efforts are needed to confirm the level of pumping offsets and/or recharge required to achieve sustainability. These efforts include collecting additional data and a review of the Subbasin groundwater model, along with other efforts as outlined in the GSP.

Figure ES-1: GSP Plan Area within the San Joaquin Valley



A Public Draft GSP was prepared and made available for public review and comment on July 10, 2019 for a period of 45 days ending on August 25, 2019. The ESJGWA received numerous comments from the public, reviewed and prepared responses to comments, and revised the Draft GSP. This Final GSP includes those edits and revisions. Comment letters and responses are included as appendices to the GSP.

On November 18, 2021, the ESJGWA received a Consultation Initiation Letter (Letter) from DWR. The Letter identified two potential deficiencies in the Subbasin GSPs which may preclude DWR's approval, as well as potential corrective actions to address each potential deficiency. The Letter initiated consultation between DWR, the Plan Manager, the ESJGWA, and the Subbasin's GSAs. In response to DWR's comments, this GSP was revised in June 2022. DWR comments have also been addressed in a series of four technical memoranda appended to this revised GSP and referenced throughout the document.

ES-2. PLAN AREA

The ESJGWA's jurisdictional area is defined by the boundaries of the Eastern San Joaquin Subbasin in DWR's 2003 Bulletin 118 as updated in 2016 and 2018. The Subbasin underlies the San Joaquin Valley, as shown in Figure ES-1.

ES-3. OUTREACH EFFORTS

A stakeholder engagement strategy was developed to enable the interests of beneficial users of groundwater in the Subbasin to be considered. The strategy incorporated monthly Groundwater Sustainability Workgroup (Workgroup) meetings, monthly Advisory Committee meetings, monthly ESJGWA Board meetings, approximately quarterly informational open house events, outreach presentations to community groups, and information distribution to property owners and residents in the Subbasin. Figure ES-2 shows attendees at one of the informational open house events conducted during development of the GSP.

Figure ES-2 - Informational Open House Events

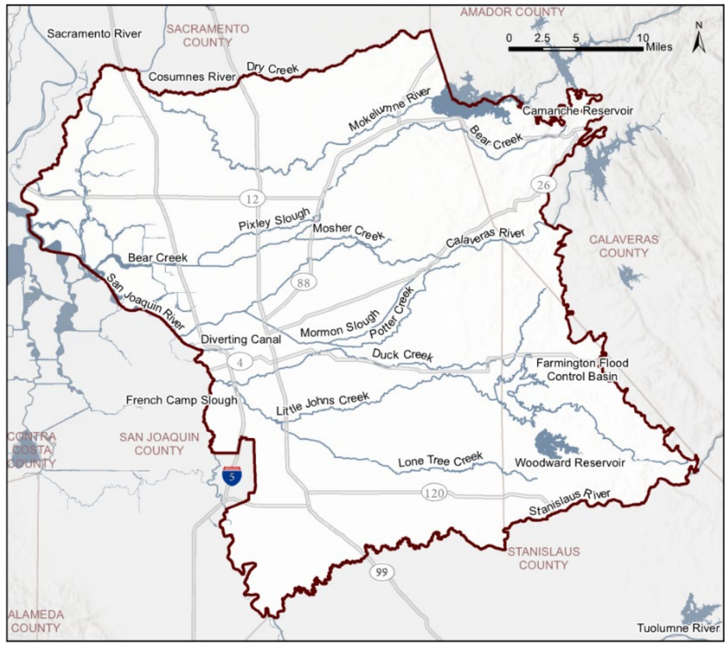
Public Meeting Type	Number of Meetings
ESJGWA Board Meetings	25
Advisory Committee Meetings	17
Groundwater Sustainability Workgroup Meetings	13
Informational Open House Events	4
Outreach Presentations to Community Groups	10

The Workgroup was established to encourage active involvement from diverse social, cultural, and economic elements of the population in the Subbasin. The 23 Workgroup members represent large and small landowners and growers from different geographic locations in the Subbasin, long-time residents, representatives from non-governmental organizations, disadvantaged community policy advocates, and outreach coordinators. Spanish translation was provided at informational open house events, creating an opportunity for local Spanish-speaking individuals to engage in the GSP development process. Input from the Workgroup was presented to the ESJGWA Board and has also been incorporated into the GSP.

ES-4. BASIN SETTING

The Subbasin is located to the west of the Sacramento-San Joaquin River Delta (Delta) and is bounded by the Sierra Nevada foothills to the east, the San Joaquin River to the west, Dry Creek to the north, and Stanislaus River to the south. In the eastern portion of the Subbasin, groundwater flows from east to west and generally mirrors the eastward sloping topography of the geologic formations. In the western portion of the Subbasin, groundwater flows eastward toward areas with relatively lower groundwater elevation. Surface water generally flows from east to west, with the major river systems traversing the Subbasin being the Calaveras, Mokelumne, and Stanislaus rivers. Multiple smaller streams flow into the San Joaquin River, which flows from south to north. The location of the Subbasin is shown in Figure ES-3.

Figure ES-3: Basin Setting

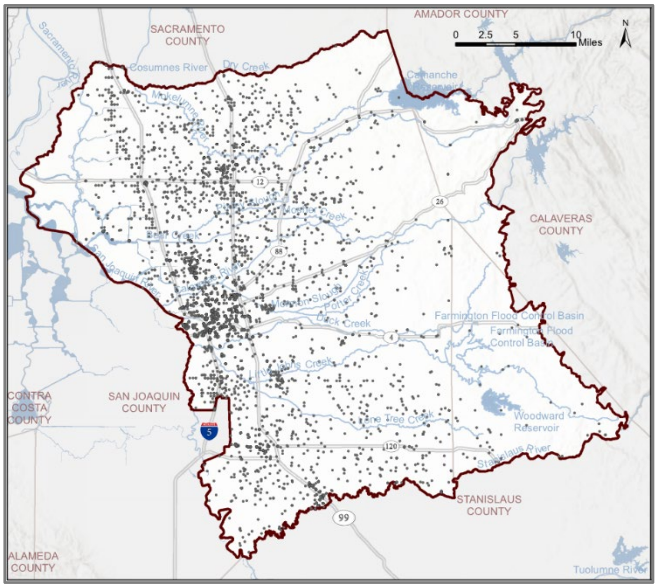


ES-5. EXISTING GROUNDWATER CONDITIONS

Groundwater levels in some portions of the Subbasin have been declining for many years, while groundwater levels in other areas of the Subbasin have remained stable or increased in recent years. The change in groundwater levels varies across the Subbasin, with the greatest declines occurring in the central portion of the Subbasin. The western and southern portions of the Subbasin have experienced less change in groundwater levels, in part due to the minimal groundwater pumping in the Delta area to the west and the import of surface water for agricultural and urban uses.

Groundwater quality in the Subbasin varies by location. Areas along the western margin have historically had higher levels of salinity. Salinity may be naturally occurring or the result of human activity. Sources of salinity in the Subbasin include Delta sediments, deep saline groundwater, and irrigation return water. Total dissolved solids (TDS), which is a measure of all inorganic and organic substances present in a liquid in molecular, ionized, or colloidal suspended form, is commonly used to measure salinity. The Groundwater Ambient Monitoring and Assessment (GAMA) Program includes numerous water quality monitoring sites in the Subbasin compiled from different sources, shown in Figure ES-4. Maximum TDS concentrations across the Subbasin have been reported as high as 2,500 milligrams per liter (mg/L) along portions of the Subbasin's western boundary. For drinking water, California has three secondary maximum contaminant level (SMCL) standards for TDS, all based on aesthetic considerations such as taste and odor, not public health concerns. These are 500 mg/L (recommended limit), 1,000 mg/L (upper limit), and 1,500 mg/L (short-term limit). TDS concentrations decrease significantly to the east, to typically less than 500 mg/L (the recommended limit for aesthetic considerations). Elevated concentrations of other constituents, such as nitrate, arsenic, and point-source contaminants, are generally localized and not widespread and are

Figure ES-4: GAMA Water Quality Sampling Locations



generally related to natural sources or land use activities. The GSP establishes ongoing monitoring of salinity, arsenic, nitrate, and a number of other common water quality constituents to fill data gaps and identify potential trends of concern.

While the total volume of groundwater in storage in the Subbasin has declined over time, groundwater storage reduction has not historically been an area of concern in the Subbasin, as there are large volumes of fresh water stored in the aquifer. The total fresh groundwater in storage was estimated at over 50 million-acre-feet (MAF) in 2015. The amount of groundwater in storage has decreased by approximately .01 percent per year between 1995 and 2015. As such, it is highly unlikely the Subbasin will experience conditions under which the volume of stored groundwater poses a concern, although the depth to access that groundwater does pose a concern.

Land subsidence has not historically been an area of concern in the Subbasin, and there are no records of land subsidence caused by groundwater pumping in the Subbasin.

Seawater intrusion is not present in the Subbasin. While the Delta ecosystem evolved with a natural salinity cycle that brought brackish tidal water in from the San Francisco Bay, current management practices endeavor to maintain freshwater flows through a combination of hydraulic and physical barriers and alterations to existing channels.

Surface waters can be hydraulically interconnected with the groundwater system, where the stream baseflow is either derived from the aquifer (gaining stream) or recharged to the aquifer (losing stream). If the water table beneath the stream lowers as a result of groundwater pumping, the stream may disconnect entirely from the underlying aquifer. Major river systems in the Subbasin are highly managed to meet instream flow requirements for fisheries, water quality standards, and water rights of users downstream.

ES-6. SUSTAINABLE MANAGEMENT CRITERIA

SGMA introduces several terms to measure sustainability, including:

Sustainability Indicators – Sustainability indicators refer to any of the effects caused by groundwater conditions occurring throughout the Subbasin that, when significant and unreasonable, cause undesirable results. The six sustainability indicators identified by DWR are the following:

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon
- Significant and unreasonable reduction of groundwater storage
- Significant and unreasonable seawater intrusion
- Significant and unreasonable degraded water quality
- Significant and unreasonable land subsidence that substantially interferes with surface land uses
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water

Sustainability Goal – This goal is the culmination of conditions resulting in a sustainable condition (absence of undesirable results) within 20 years.

Undesirable Results – Undesirable results are the significant and unreasonable occurrence of conditions that adversely affect groundwater use in the Subbasin, including reduction in the long-term viability of domestic, agricultural, municipal, or environmental uses of the Subbasin's groundwater. Categories of undesirable results are defined through the sustainability indicators.

Minimum Thresholds – Minimum thresholds are numeric values for each sustainability indicator and are used to define when undesirable results occur. Undesirable results occur if minimum thresholds are exceeded in an established percentage of sites in the Subbasin's representative monitoring network.

Measurable Objectives – Measurable objectives are a specific set of quantifiable goals for the maintenance or improvement of groundwater conditions.

The method prescribed by SGMA to measure undesirable results involves setting minimum thresholds and measurable objectives for a series of representative wells. Representative wells are identified to provide a basis for measuring groundwater conditions throughout a basin or subbasin without having to measure each well, which would be cost prohibitive. In the Eastern San Joaquin Subbasin, representative wells were selected based on history of recorded groundwater levels and potential to effectively represent the groundwater conditions.

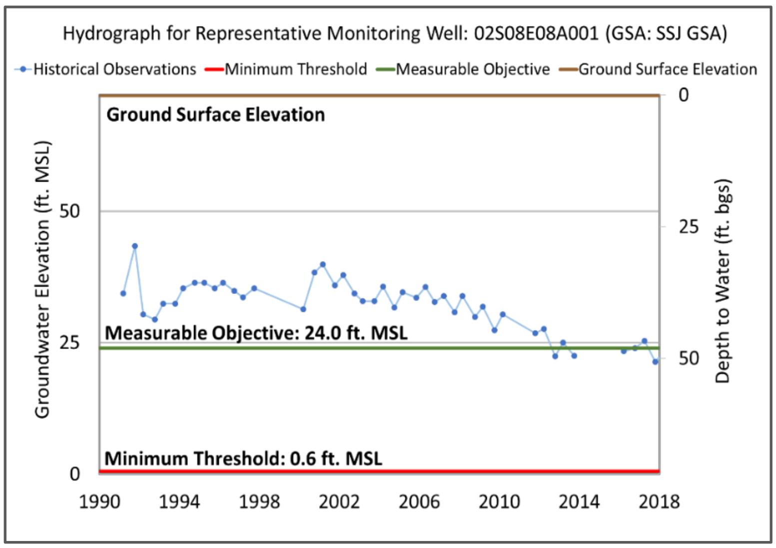
Revisions to Sustainable Management Criteria –This revised GSP reflects changes made to the sustainable management criteria in response to the potential corrective actions recommended by DWR. In their Consultation Initiation Letter, DWR identified the following two deficiencies:

> **Potential Deficiency 1** – The GSP lacks sufficient justification for determining that undesirable results for chronic lowering of groundwater levels, subsidence, and depletion of interconnected surface waters can only occur in consecutive non-dry water year types. The GSP also lacks sufficient explanation for its minimum thresholds and undesirable results for chronic lowering of groundwater levels.
>
> **Potential Deficiency 2** - The GSP does not provide enough information to support the use of the chronic lowering of groundwater level sustainable management criteria and representative monitoring network as a proxy for land subsidence.

Revisions made to sustainable management crieria, as well as additional explanations as to how the Subbasin sustainability indicators and sustainable management criteria were determined, are described in Chapter 3: Sustainable Management Criteria.

A total of 20 representative wells were identified for measurement of groundwater levels in the Subbasin, and 10 representative wells were identified for groundwater quality monitoring. The GSP uses groundwater quality data as the basis for evaluating conditions for seawater intrusion and uses groundwater level data as the basis for evaluating conditions for groundwater storage, depletions of interconnected surface water, and land subsidence. As such, these representative wells provide the basis for measuring the six sustainability indicators across the Subbasin.

Figure ES-5: Sample Relationship Between Minimum Threshold and Measurable Objective



Minimum thresholds and measurable objectives were developed for each of the representative wells. Figure ES-5 shows a typical relationship of the minimum thresholds, measurable objectives, and historical groundwater level data for a sample groundwater level representative monitoring well.

Minimum thresholds for groundwater levels were developed with reference to historical drought low conditions and domestic well depths. Specifically, minimum thresholds were established based on the deeper of the historical drought low plus a buffer of the historical fluctuation *or* the 10th percentile domestic well depth, whichever is shallower – establishing levels that are protective of 90 percent of domestic wells. In municipalities with ordinances requiring the use of City water (water provided by the City's municipal wells), the 10th percentile municipal well depth is used in place of the 10th percentile domestic well depth criteria.

Measurable objectives were established based on the historical drought low and provide a buffer above the minimum threshold. A table summarizing minimum thresholds and measurable objectives is included in the GSP. Graphs showing the minimum threshold and measurable objective for each of the representative wells are contained in an appendix to the GSP.

Minimum thresholds for water quality were defined by considering two primary beneficial uses at risk of undesirable results related to salinity: drinking water and agriculture uses. Minimum thresholds are 1,000 mg/L for each representative monitoring well, consistent with the upper limit SMCL for TDS. Crop tolerances in the Subbasin range by crop type from 900 mg/L TDS for almonds up to 4,000 mg/L TDS for wheat, assuming a 90 percent yield.

The minimum threshold for seawater intrusion is a 2,000 mg/L chloride isocontour line established near the western edge of the Subbasin, between sentinel monitoring locations. 2,000 mg/L chloride is approximately 10 percent of seawater chloride concentrations (19,500 mg/L) and was developed as a minimum threshold based on consideration of existing management practices in other areas of the state.

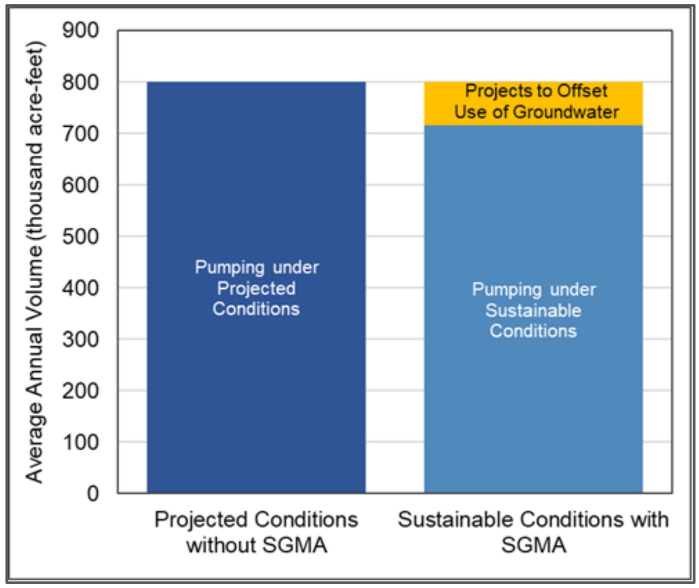
For depletions of interconnected surface water, the minimum thresholds and measurable objectives for groundwater levels are used. There is significant correlation between groundwater levels and depletions, and the groundwater levels minimum thresholds are found to be protective of depletions.

Similarly, the minimum thresholds and measurable objectives for groundwater levels are used for the land subsidence and groundwater storage sustainability indicators, as both are strongly linked to groundwater levels. The groundwater levels minimum thresholds are found to be protective of land subsidence and groundwater storage.

ES-7. WATER BUDGETS

The Eastern San Joaquin Subbasin has been in an overdraft condition for many years. Overdraft occurs when the amount of groundwater extracted exceeds the long-term average groundwater recharged.

Figure ES-6: Subbasin-Wide Total Groundwater Pumping and Offsets Required to Achieve Sustainability



The groundwater evaluations conducted as a part of GSP development have provided estimates of the historical, current, and projected groundwater budget conditions. The current analysis was prepared using the best available information and through development of a new groundwater modeling tool, the Eastern San Joaquin Water Resources Model (ESJWRM). It is anticipated that as additional information becomes available, the model can be updated, and more refined estimates of annual pumping and overdraft can be developed.

Following the submittal of the Eastern San Joaquin Subbasin GSP in January 2020, the ESJWRM was revised to correct data relating to historical surface water deliveries and to include additional data for Water Year (WY) 2016 through WY 2020. The ESJWRM simulation period was extended to simulate Water Years 1995 through 2020 and the model recalibrated for the extended period. As a result of the model update, both the historical and projected water budgets were revised in 2021 to reflect the new data sets used in the model. Additionally, refinements and enhancements were made to the historical data for the updated historical ESJWRM requiring an update to the projected conditions baseline ESJWRM. The updated version of the Projected Conditions Baseline (PCBL) used the extended dataset and calibration results, along with updated data sources and assumptions for projected conditions, representing approximately water year 2040 conditions.

Based on these analyses, at projected groundwater pumping levels, the long-term groundwater pumping offset and/or recharge required for the Subbasin to achieve sustainability is approximately 16,000 AF/year. Groundwater levels are expected to continue to decline based on projections of current land and water uses. Projects that offset groundwater pumping and/or increase recharge will help the Subbasin reach sustainability, as illustrated in Figure ES-6.

The projected Subbasin water budget was also evaluated under climate change conditions, which simulate higher demand requiring increased groundwater pumping despite more precipitation and streamflows. The updated version of the Projected Conditions Baseline with Climate Change (PCBL-CC) largely used the same perturbation factors (2070 Central Tendency climate change conditions) as the original simulation, but the updated PCBL-CC extended the simulation time period by two years. The overdraft modeled under climate change conditions is simulated to increase above projected conditions without climate change, requiring long-term groundwater pumping offset and/or recharge required for the Subbasin to achieve sustainability of approximately 38,000 AF/year.

Finally, as part of the revisions to this GSP to address DWR-identified deficiencies, projects and management actions (PMAs) likely to be implemented over the next five years were simulated in the projected water budget, both with and without climate change. The projected water budget with PMAs demonstrated that with implementation of the identified subset of projects, the Subbasin could achieve and maintain sustainability. However, when climate change impacts are added to the scenario, the Subbasin remains in overdraft conditions, indicating that additional PMAs will be required in the future to address climate change impacts on the groundwater basin.

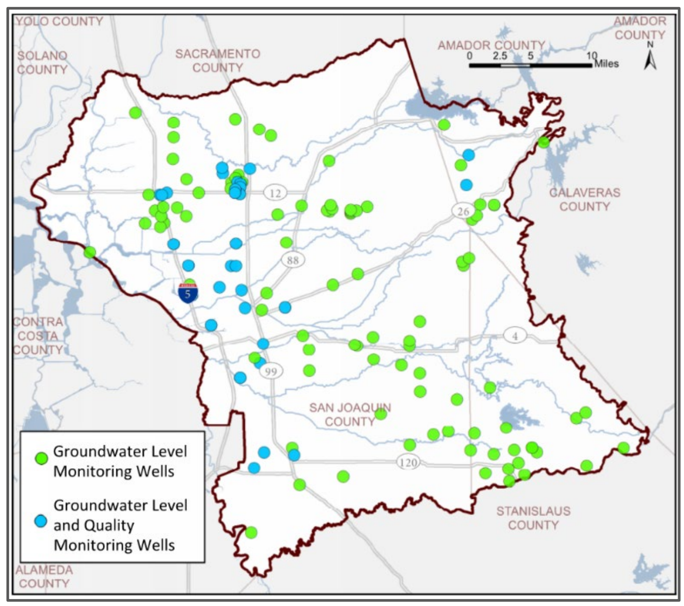
ES-8. MONITORING NETWORKS

The GSP outlines the monitoring networks for the six sustainability indicators. The objective of these monitoring networks is to monitor conditions across the Subbasin and to detect trends toward undesirable results. Specifically, the monitoring network was developed to do the following:

- Monitor impacts to the beneficial uses or users of groundwater
- Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds
- Demonstrate progress toward achieving measurable objectives described in the GSP

There are four monitoring networks in the Eastern San Joaquin Subbasin: a representative network for water levels, a broad network for water levels, a representative network for water quality, and a broad network for water quality. Representative networks are used to determine compliance with the minimum thresholds, while the broad networks collect data for informational purposes to identify trends and fill data gaps. The two monitoring networks for water quality will additionally be used to develop a chloride isocontour to monitor for potential seawater intrusion and water levels data will inform depletions of interconnected surface water.

Figure ES-7: Groundwater Monitoring Wells



The monitoring networks were designed by evaluating data from the DWR's California Statewide Groundwater Elevation Monitoring (CASGEM) Program, the United States Geological Survey (USGS), and participating GSAs. The monitoring network consists largely of wells that are already being used for monitoring in the Subbasin. Additional wells are being added, including two new deep, multi-completion monitoring wells awarded under DWR's Technical Support Services (TSS) program. Figure ES-7 shows the location of existing groundwater monitoring wells in both the representative and broad monitoring networks.

Wells in the monitoring networks will be measured on a semi-annual schedule. Historical measurements have been entered into the Subbasin Data Management System (DMS), and future data will also be stored in the DMS.

A summary of the wells in the monitoring networks is shown in the table below.

Summary of Monitoring Network Wells	
Representative Networks	**Well Count**
Groundwater Level	20
Groundwater Quality	10
Broad Networks	
CASGEM (Groundwater Levels)	76
Nested or Clustered Wells (Groundwater Levels & Quality)	16
Agency Wells (Groundwater Levels & Quality)	5

ES-9. DATA MANAGEMENT SYSTEM

The Eastern San Joaquin DMS was built on a flexible, open software platform that uses familiar Google maps and charting tools for analysis and visualization. The DMS serves as a data-sharing portal that enables use of the same data and tools for visualization and analysis. These tools support sustainable groundwater management and create transparent reporting about collected data and analysis results.

The DMS is web-based; the public can easily access this portal using common web browsers such as Google Chrome, Firefox, and Microsoft Edge. The DMS is currently populated with available historical data. Future data will also be entered into the system as it is collected.

The DMS portal provides easy access and the ability to query information stored in the system. Groundwater data can be plotted for any of the available data points, providing a pictorial view of historical and current data.

The DMS can be accessed at this link using the Guest Login: https://opti.woodardcurran.com/esj/

Figure ES-8: Opti DMS Screenshot

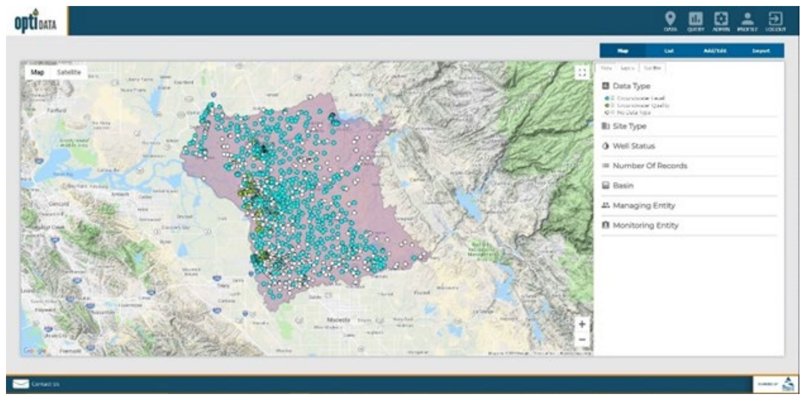
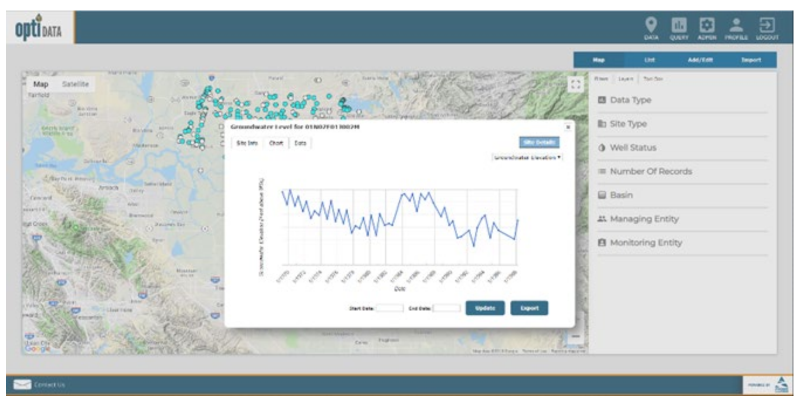


Figure ES-9: Typical DMS Data Display



ES-10. PROJECTS AND MANAGEMENT ACTIONS

Achieving sustainability in the Subbasin requires implementation of projects and management actions. The Subbasin will achieve sustainability by implementing water supply projects that either replace groundwater use or supplement groundwater supplies to attain the current estimated pumping offset and/or recharge need of 16,000 AF/year. It should be noted that this number will be reevaluated in the future after additional data are collected and analyzed. In addition, three projects have been identified that support demand conservation activities, including water use efficiency upgrades. Currently, no pumping restrictions have been proposed for the Subbasin; however, GSAs maintain the flexibility to implement such demand-side management actions in the future if need is determined.

Although the ESJGWA does not have direct authority to require GSAs to implement projects, the ESJGWA will coordinate analysis of GSA-level demands and will compile annual or biannual reports to evaluate progress. If projects do not progress, or if monitoring efforts demonstrate that the projects are not effective in achieving stated recharge and/or offset targets, the GWA will convene a working group to evaluate supply-side and demand-side management actions such as the implementation of groundwater pumping curtailments, land fallowing, etc.

Projects to increase water supply availability in the Subbasin were identified by individual GSAs. The initial set of projects was reviewed with the ESJGWA Board, Advisory Committee, and Workgroup. A final list of 23 potential projects are included in the GSP, representing a variety of project types including direct and in-lieu[1] recharge, intra-basin water transfers, demand conservation, water recycling, and stormwater reuse. Projects are classified into three categories based on project status: Planned, Potential, and Longer-term/Conceptual. Planned projects are anticipated to be completed and implemented prior to 2040. Near-term Planned projects are anticipated to provide enough water to meet the required groundwater pumping offset and/or recharge needed to reach sustainability without climate change; however, additional projects will be required in the future to address climate change impacts. Potential projects provide a menu of options for additional water supply projects that can be implemented in the Subbasin. These projects require further analysis and permitting to determine feasibility and cost effectiveness. Longer-term/Conceptual projects are in the early conceptual planning stages and would require significant additional work to move forward. Additionally, a study has been proposed by NSJWCD to evaluate reaches of the Mokelumne River downstream of Camanche Reservoir to support model refinement and validation and to inform SGMA basin accounting. These projects are summarized below.

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1 In-lieu recharge refers to the use of surface water or recycled water supplies for applications where groundwater is currently used. This “in-lieu” use reduces groundwater pumping and allows groundwater to remain in the aquifer.

Project Description	Project Type	Project Proponent	Estimated Demand Reduction (AF/year)
Planned Projects:			
Lake Grupe In-lieu Recharge	In-lieu Recharge	Stockton East Water District	10,000
SEWD Surface Water Implementation Expansion	In-lieu Recharge	Stockton East Water District	19,000
City of Manteca Advanced Metering Infrastructure	Conservation	City of Manteca	272
City of Lodi Surface Water Facility Expansion & Delivery Pipeline	In-lieu Recharge	City of Lodi	4,750
White Slough Water Pollution Control Facility Expansion	Recycling/In-lieu Recharge	City of Lodi	115
CSJWCD Capital Improvement Program	In-lieu Recharge	Central San Joaquin Water Conservation District	5,000
NSJWCD South System Modernization	In-lieu Recharge	North San Joaquin Water Conservation District	4,500
Long-term Water Transfer to SEWD and CSJWCD	Transfers/In-lieu Recharge	South San Joaquin GSA	45,000
Potential Projects			
BNSF Railway Company Intermodal Facility Recharge Pond	Direct Recharge	Central San Joaquin Water Conservation District	1,000
City of Stockton Advanced Metering Infrastructure	Conservation	City of Stockton	2,000
South System Groundwater Banking with EBMUD	In-lieu Recharge	North San Joaquin Water Conservation District	4,000
NSJWCD North System Modernization/Lakso Recharge	In-Lieu Recharge/Direct Recharge	North San Joaquin Water Conservation District	2,600
Manassero Recharge Project	Direct Recharge	North San Joaquin Water Conservation District	8,000
Tecklenburg Recharge Project	Direct Recharge	North San Joaquin Water Conservation District	8,000
City of Escalon Wastewater Reuse	Recycling/In-lieu Recharge/Transfers	South San Joaquin GSA	672
City of Ripon Surface Water Supply	In-lieu Recharge	South San Joaquin GSA	6,000
City of Escalon Connection to Nick DeGroot Water Treatment Plant	In-lieu Recharge	South San Joaquin GSA	2,015
Longer-term/Conceptual Projects			
Farmington Dam Repurpose Project	Direct Recharge	Stockton East Water District	30,000
Recycled Water Transfer to Agriculture	Recycling/Transfers/ In-lieu Recharge	City of Manteca	5,193
Mobilizing Recharge Opportunities	Direct Recharge	San Joaquin County	Not determined
NSJWCD Winery Recycled Water	Recycling/In-Lieu Recharge/Direct Recharge	North San Joaquin Water Conservation District	750
Pressurization of SSJID Facilities	Conservation	South San Joaquin GSA	30,000
SSJID Storm Water Reuse	Stormwater/In-lieu Recharge/Direct Recharge	South San Joaquin GSA	1,100

As previously noted, DWR's Consultation Initiation Letter requested additional detail on how projects and management actions, in conjunction with the proposed chronic lowering of groundwater levels sustainable management criteria, will help the subbasin achieve sustainability and avoid significant and unreasonable impacts. As part of the process to respond to DWR, the ESJGWA worked with each GSA individually to update GSP project descriptions with new information that has become available in the past two years since the GSP was first adopted in 2020. These revised projects were then divided into two categories: Category A projects (projects that are likely to advance in the next five years and have existing water rights or agreements) and Category B projects (projects that are not anticipated to advance in the next five years, but could be leveraged in the future, particularly if Category A projects do not fully achieve stated recharge and/or offset targets). Category A projects were simulated in the projected water budget to evaluate their effectiveness on achieving Subbasin sustainability. Category B projects may be elevated to a Category A project should feasibility studies demonstrate a viable project, if water rights or contracts are firmly identified, if partnerships are formed, and if economic evaluation demonstrate that the projects are cost effective, and remain part of the overall adaptive management strategy that the Subbasin is utilizing in GSP implementation to achieve and maintain Subbasin sustainability.

Category A Projects

Project	Submitting GSA	Project Type	Water Source	Baseline Water Year Type	Annual Volume (AFY)	Notes
1. Lake Grupe In-Lieu Recharge	Stockton East Water District	In-Lieu Recharge	The surface water source of this project is from SEWD's existing contract with the U.S. Bureau of Reclamation (USBR) for the New Hogan Reservoir. Surface water is diverted from the Calaveras River. This is an existing surface water right.	Drought	2,000	Range of 0-2,000 AFY in multiple dry years
				Dry	4,900	
				Normal	4,900	
				Wet	4,900	
2. SEWD Surface Water Implementation Expansion	Stockton East Water District	In Lieu Recharge	This project relies on water from New Hogan Reservoir (Calaveras River water) and New Melones Reservoir (Stanislaus River water). This is an existing surface water right. SEWD has long-term water supply contracts with USBR for both New Hogan Reservoir and New Melones Reservoir.	Drought	4,000	Range of 0-4,000 AFY in multiple drought years
				Dry	8,000	
				Normal	19,000	
				Wet	19,000	
3. West Groundwater Recharge Basin	Stockton East Water District	Direct Recharge	This project relies on water from New Hogan Reservoir (Calaveras River water) and New Melones Reservoir (Stanislaus River water). This is an existing surface water right. SEWD has long-term water supply contracts with USBR for both New Hogan Reservoir and New Melones Reservoir. In addition to Calaveras River and Stanislaus River water, stormwater runoff will also contribute to the volume of water available for recharge.	Drought	1,500	
				Dry	4,000	
				Normal	16,000	
				Wet	16,000	
4. CSJWCD Capital Improvement Program	Central San Joaquin Water Conservation District	In-Lieu Recharge	This project relies on water from New Melones Reservoir. This is an existing surface water right. CSJWCD has long-term water supply contracts with USBR for the New Melones Unit Central Valley Project.	Drought	0	
				Dry	12,000	
				Normal	24,000	
				Wet	24,000	

Project	Submitting GSA	Project Type	Water Source	Baseline Water Year Type	Annual Volume (AFY)	Notes
5. Long-Term Water Transfer to SEWD and CSJWCD	South San Joaquin GSA	Transfers/In-Lieu Recharge	This project relies on water from New Melones Reservoir (Stanislaus River water). This is an existing surface water right (pre-1914) held by Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID).	Drought	20,000	This project currently only covers the transfer of water from OID and SSJID to SEWD urban customers.
				Dry	5,000	
				Normal	0	
				Wet	0	
6. White Slough Pollution Control Facility Expansion	City of Lodi	Recycled Water/In-Lieu Recharge	Treated wastewater effluent from White Slough Water Pollution Control Facility.	Drought	3,729	
				Dry	3,729	
				Normal	3,729	
				Wet	3,729	
7. NSJWCD South System Modernization	North San Joaquin Water Conservation District	In-Lieu Recharge/Direct Recharge	This project relies on water from the Mokelumne River. This is an existing water right held by NSJWCD (Permit 10477).	Drought	0	
				Dry	0	
				Normal	4,800	
				Wet	6,000	
8. NSJWCD Tecklenburg Recharge Project	North San Joaquin Water Conservation District	Direct Recharge	This project relies on water from the Mokelumne River. This is an existing surface water right held by NSJWCD (Permit 10477).	Drought	0	
				Dry	1,000	
				Normal	4,800	
				Wet	6,000	
9. NSJWCD South System Groundwater Banking with EBMUD	North San Joaquin Water Conservation District	In-Lieu Recharge	This project relies on water from the Mokelumne River. This is an existing water right held by East Bay Municipal Utility District (EBMUD) (Permit 10478) as per Protest Dismissal Agreement from 11/25/2014.	Drought	0	
				Dry	1,500	
				Normal	6,400	80% of wet year supply
				Wet	8,000	
10. NSJWCD North System Modernization/Lakso Recharge	North San Joaquin Water Conservation District	In-Lieu Recharge/Direct Recharge	This project relies on water from the Mokelumne River. This is an existing surface water right held by NSJWCD (Permit 10477).	Drought	0	
				Dry	1,000	
				Normal	3,200	
				Wet	4,000	
11. Delta Water Treatment Plant Groundwater Recharge Improvements Project	City of Stockton	Direct Recharge	This project relies on raw water from the Delta Water Treatment Plant.	Drought	5,040	
				Dry	5,040	
				Normal	5,040	

Project	Submitting GSA	Project Type	Water Source	Baseline Water Year Type	Annual Volume (AFY)	Notes
Geotechnical Investigation				Wet	5,040	

Category B Projects

Project Name	Project Type	Submitting GSA	Current Status	Time-table (initiation and completion)	Annual Volume (AFY)
Perfecting Mokelumne River Water Right	In-lieu Recharge	San Joaquin County	Planning phase	2022-2025	20,000 to 50,000
City of Manteca Advanced Metering Infrastructure	Conservation	City of Manteca	Currently underway	2019-2021	272
City of Lodi Surface Water Facility Expansion & Delivery Pipeline	In-lieu Recharge	City of Lodi	Planning phase	2030-2033	4,750
BNSF Railway Company Intermodal Facility Recharge Pond	Direct Recharge	CSJWCD	Planning phase	2020-2023	1,000
City of Stockton Advanced Metering Infrastructure	Conservation	City of Stockton	Initial study completed in 2011	2020/25-2025/28	2,000
Manaserro Recharge Project	Direct Recharge	NSJWCD	Planning phase	2019-2022*	8,000
City of Escalon Wastewater Reuse	Recycling/ In-lieu Recharge/ Transfers	SSJ GSA	Planning phase	2020-2028	672
City of Ripon Surface Water Supply	In-lieu Recharge	SSJ GSA	Design complete; environmental permitting underway	2020-2024	6,000
City of Escalon Connection to Nick DeGroot Water Treatment Plant	In-lieu Recharge	SSJ GSA	Conceptual design phase; environmental review complete	2020-2023	2,015
Farmington Dam Repurpose Project	Direct Recharge	SEWD	Preplanning phase with reconnaissance study complete	2030-2050	30,000
Recycled Water Transfer to Agriculture	Recycling/Transfers/ In-lieu Recharge	City of Manteca	Planning phase with evaluation completed in Draft Reclaimed Water Facilities Master Plan	Not determined	5,193
Mobilizing Recharge Opportunities	Direct Recharge	San Joaquin County	Early conceptual planning phase	Not determined	Not determined
NSJWCD Winery Recycled Water	Recycling/ In-Lieu Recharge/ Direct Recharge	NSJWCD	Conceptual planning and discussion	2025-2027	750

Project Name	Project Type	Submitting GSA	Current Status	Time-table (initiation and completion)	Annual Volume (AFY)
Pressurization of SSJID Facilities	Conservation	SSJ GSA	Feasibility study complete	2019-2030	30,000
SSJID Storm Water Reuse	Storm Water/ In-lieu Recharge/ Direct Recharge	SSJ GSA	Planning phase	2027-2030	1,100

ES-11. GSP IMPLEMENTATION

The overdraft condition in the Subbasin requires projects to offset groundwater pumping and/or increase recharge. The exact amount of required offset/recharge will be reevaluated after additional data are collected and analyzed.

Projects will be administered by the GSA project proponents. GSAs may elect to implement projects individually or jointly with one or more GSAs or with the ESJGWA.

Implementing the GSP will require numerous management activities that will be undertaken by the ESJGWA, including the following:

- Monitoring and recording of groundwater levels and groundwater quality data
- Maintaining and updating the Subbasin DMS with newly collected data
- Annual monitoring of progress toward sustainability
- Annual reporting of Subbasin conditions to DWR as required by SGMA
- Refining Subbasin model and water budget planning estimates
- Evaluating the GSP once every 5 years and updating if warranted

The ESJGWA Board adopted a preliminary schedule for project implementation. Project implementation is scheduled to begin in 2020, with full implementation by 2040. This approach provides adequate time to put in place methods necessary to refine model estimates and verify project cost effectiveness.

Implementation of the eight identified Planned Projects will begin prior to 2030 and will continue through 2040. Evaluation and possible implementation of the nine Potential Projects and six Longer-term/Conceptual Projects will be based on long-term management or changing needs of the GSA or Subbasin. Further evaluation is necessary to determine technical, economic, and institutional feasibility.

ES-12. FUNDING

Implementation of the GSP requires funding sources. To the degree they become available, outside grants will be sought to assist in reducing cost of implementation to participating agencies, residents, and landowners of the Subbasin. However, there will be a need to collect funds to support implementation.

The areas associated with ESJGWA-wide management and GSP implementation will be borne by the ESJGWA through contributions from the member GSAs, under a cost-sharing arrangement to be developed following GSP adoption. These costs include:

- ESJGWA administration
- Groundwater level monitoring and reporting
- Groundwater quality monitoring and reporting

- Water use estimation
- Data management
- Stakeholder engagement
- Annual report preparation and submittal to DWR
- Developing and implementing a funding mechanism
- Grant applications
- GSP evaluation and updates, if warranted (every 5 years)

For budgetary purposes, the estimated initial cost of these activities is on the order of $600,000 to $1 million per year excluding projects and management actions costs and costs associated with the installation of new monitoring wells and grant writing. Additional one-time costs, such as model refinement, are estimated to be on the order of $315,000.

GSAs will individually fund implementation of projects in their respective areas. Options for GSA funding include fees based on groundwater pumping, acreage, or combinations of these, and pursuit of any available grant funds. The GSAs will evaluate options for securing the needed funding on an individual basis.

The estimated initial costs of projects range from on the order of $50,000 to $328 million, depending on the project. Annual project costs range from $3,000 to $9 million per year to provide funds for operations and maintenance.

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1. AGENCY INFORMATION, PLAN AREA, AND COMMUNICATION

1.1 INTRODUCTION AND AGENCY INFORMATION

1.1.1 Purpose of the Groundwater Sustainability Plan

The purpose of this Groundwater Sustainability Plan (GSP) is to meet the regulatory requirements set forth in the three-bill legislative package consisting of Assembly Bill (AB) 1739 (Dickinson), Senate Bill (SB) 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act (SGMA). SGMA defines sustainable groundwater management as "management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results", which are defined by SGMA as any of the following effects caused by groundwater conditions occurring throughout the basin (CA DWR, 2018):

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon
- Significant and unreasonable reduction of groundwater storage
- Significant and unreasonable seawater intrusion
- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies
- Significant and unreasonable land subsidence that substantially interferes with surface land uses
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water

The Eastern San Joaquin Groundwater Subbasin (Eastern San Joaquin Subbasin or Subbasin) has been identified by the Department of Water Resources (DWR) as critically overdrafted. The Eastern San Joaquin Groundwater Sustainability Plan (Eastern San Joaquin GSP, GSP, or the Plan) has been developed to meet SGMA regulatory requirements by the January 31, 2020 deadline for critically-overdrafted basins while reflecting local needs and preserving local control over water resources. The Eastern San Joaquin GSP provides a path to achieve and document sustainable groundwater management within 20 years following Plan adoption, promoting the long-term sustainability of locally-managed groundwater resources now and into the future.

While the Eastern San Joaquin GSP offers a new and significant approach to groundwater resource protection, it was developed within an existing framework of comprehensive planning efforts. Throughout the Eastern San Joaquin Region, several separate yet related planning efforts have occurred previously or are concurrently proceeding. The following figure (Figure 1-1) shows flagship reports from these efforts, which include integrated regional water management, urban water management, agricultural water management, watershed management, habitat conservation, and general planning. The Eastern San Joaquin GSP fits in with these prior planning efforts, building on existing local management and basin characterization. A description of prior planning efforts can be found in Section 1.2.2.7 of this document.

Figure 1-1: Interconnected Planning and Modeling Efforts for Water Resource Protection

1.1.2 Sustainability Goal

A sustainability goal is the culmination of conditions resulting in a sustainable condition (absence of undesirable results) within 20 years. The sustainability goal reflects this requirement and succinctly states the GSP's objectives and desired conditions of the Subbasin.

The sustainability goal description for the Eastern San Joaquin Subbasin is *to maintain an economically-viable groundwater resource for the beneficial use of the people of the Eastern San Joaquin Subbasin by operating the Subbasin within its sustainable yield or by modification of existing management to address future conditions. This goal will be achieved through the implementation of a mix of supply and demand type projects consistent with the GSP implementation plan* (see Chapter 6: Projects and Management Actions).

Additional discussion of the sustainability goal can be found in Chapter 3: Sustainable Management Criteria.

1.1.3 Contact Information

The San Joaquin County Department of Public Works Director has been designated as Plan Manager and record keeper. As Plan Manager, the Public Works Director is tasked with submitting a single, jointly-composed GSP to DWR on behalf of the entire Subbasin. Contact information for the submitting agency and Plan Manager is provided in Figure 1-2.

Figure 1-2: Plan Manager and Agency Contact Information

Agency Contact

Eastern San Joaquin Groundwater Authority
1810 E. Hazelton Avenue,
P.O. Box 1810
Stockton, CA 95201

info@esjgroundwater.org

www.esjgroundwater.org

Plan Administrator

Kris Balaji, PMP, P.E.
Director
San Joaquin County Department of Public Works
1810 E. Hazelton Ave.,
Stockton, CA 95201
(209) 468-3100

kbalaji@sjgov.org

1.1.4 Agency Information

The Eastern San Joaquin GSP was developed jointly by the Eastern San Joaquin Groundwater Authority (ESJGWA), which is a joint powers authority formed by the 16 groundwater sustainability agencies (GSAs) within the Eastern San Joaquin Subbasin. The ESJGWA includes the Central Delta Water Agency (CDWA), Central San Joaquin Water Conservation District (CSJWCD), City of Lodi, City of Manteca, City of Stockton, Eastside San Joaquin GSA (Eastside GSA) (composed of Calaveras County Water District [CCWD], Stanislaus County, and Rock Creek Water District), Linden County Water District (LCWD), Lockeford Community Services District (LCSD), North San Joaquin Water Conservation District (NSJWCD), Oakdale Irrigation District (OID), San Joaquin County No. 1, San Joaquin County No. 2, South Delta Water Agency (SDWA), South San Joaquin GSA (composed of South San Joaquin Irrigation District [SSJID] including Woodward Reservoir, City of Ripon, and City of Escalon), Stockton East Water District (SEWD), and Woodbridge Irrigation District (WID). Collectively, these 16 GSAs will be referred to as “GSAs”. Figure 1-3 below indicates the jurisdictional boundaries of the individual GSAs.

The GSAs represent a diverse range of water management organizations. The agencies include water agencies, irrigation districts, water conservation districts, and local governments at the city and county level. The GSAs will work through the ESJGWA to implement this GSP to cover the entire geographic extent encompassed by the boundaries of the Eastern San Joaquin Subbasin.

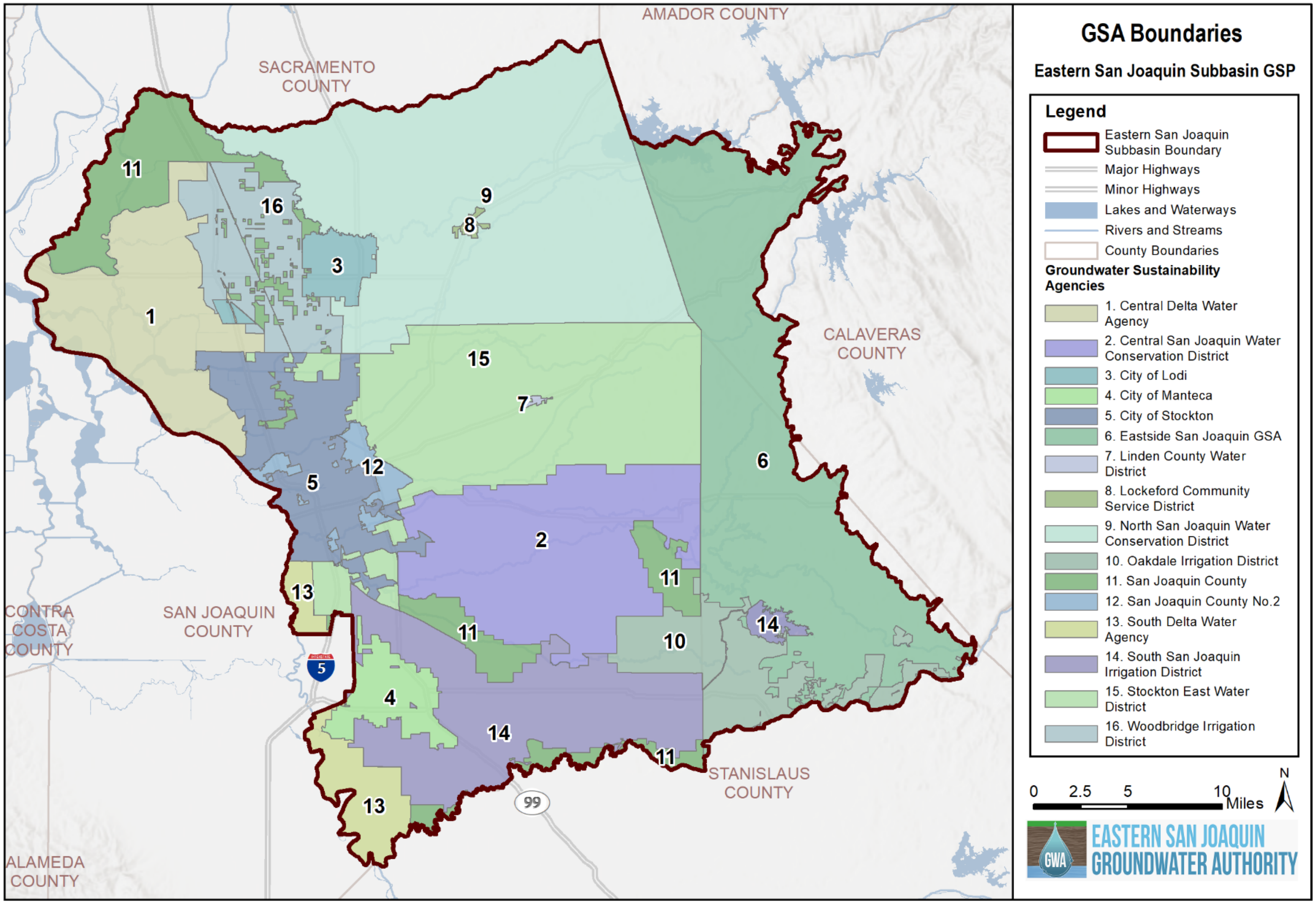
California Water Service Company Stockton District (Cal Water) has formed a partnership with San Joaquin County to participate in the process as part of the San Joaquin County No. 2 GSA, since its status as an investor-owned utility prohibited it from forming its own GSA under SGMA regulations until later amendments under SB 13 (Pavley). As a major purveyor of water in the Stockton region, Cal Water’s participation is considered essential to the development of a comprehensive plan for sustainable groundwater management in the Subbasin.

The portion of the City of Lathrop located east of the San Joaquin River was initially involved in the Eastern San Joaquin Subbasin GSP development process as a 17th GSA (City of Lathrop GSA) and was part of the ESJGWA. The City of Lathrop GSA voluntarily withdrew its status from the ESJGWA in March 2019 following DWR’s approval of their request for a basin boundary modification between the Eastern San Joaquin Subbasin and the neighboring Tracy Subbasin, which moved the City of Lathrop entirely within the Tracy Subbasin.

Additionally, WID voluntarily withdrew its status as a GSA and its membership in the ESJGWA in December 2018; WID reinstated its status as a GSA and its membership in the ESJGWA in October 2019.

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

Figure 1-3: Eastern San Joaquin Groundwater Sustainability Agencies



1.1.4.1 Eastern San Joaquin Groundwater Authority Joint Powers Agreement

The Joint Powers Agreement (JPA) provides the basis for forming the ESJGWA. The ESJGWA submitted an Initial Notification to jointly develop a GSP for the Eastern San Joaquin Subbasin on February 8, 2017. The agreement and bylaws are provided in Appendix 1-A.

The purpose of the ESJGWA is to act as the coordinating agency and cooperatively carry out the purposes of SGMA in the Eastern San Joaquin Subbasin. The ESJGWA is a public entity separate from the member organizations and holds the authority to coordinate and exercise the common powers of its members within the geographical area of the Eastern San Joaquin Subbasin consistent with the terms and conditions of the JPA.

Since its formation, the ESJGWA has employed a consensus-based approach in its goal to provide a dynamic, cost-effective, and collegial organization to achieve initial and ongoing SGMA compliance within the Subbasin. Collaboration among the ESJGWA member agencies has strengthened the potential for broad public support for groundwater management activities as well as the ability to leverage local, state, and federal funds (Eastern San Joaquin GWA, 2017b).

1.1.4.2 Organization and Management Structure of the GSAs

The governing body of the ESJGWA, the ESJGWA Board of Directors (ESJGWA Board), convenes every second Wednesday of the month at 11:00 a.m. to formulate the GSP by debating and finalizing key discussion points and decisions incorporated into the Plan. Each of the 16 GSAs has a voice on the ESJGWA Board and has appointed two representatives to serve: one Board member and one Alternate member to attend in the Board member's absence.

The ESJGWA Board is tasked with developing actions including, but not limited to, the following:

- Approving budget(s) and appropriate cost sharing for any project or program that requires funding from the ESJGWA
- Proposing guidance and options for obtaining grant funding
- Adopting rules, regulations, policies, and procedures related to the JPA
- Approving any contracts with consultants or subcontractors that would undertake work on behalf of the GSAs and/or relate to Basin-wide issues and, if applicable, recommend the funding that each GSA should contribute towards the costs of such contracts
- Reporting to the GSAs' respective governing boards
- Approving and implementing a GSP

The ESJGWA Board is guided by an Advisory Committee that is made up of one representative from each GSA and convenes every second Wednesday of the month at 9:00 a.m. The Advisory Committee is responsible for developing recommendations on technical and substantive Subbasin-wide matters. The Advisory Committee is tasked with developing actions including, but not limited to, the following:

- Recommending the action and/or approval of technical or policy elements for the development of a GSP, including groundwater conditions, thresholds, and projects and management actions
- Recommending the action and/or approval of a GSP

The ESJGWA Board is also informed by a Groundwater Sustainability Workgroup (Workgroup) which consists of 23 community representatives of agricultural communities, groundwater users, environmental groups, businesses, industry, and the community at large. The Workgroup is tasked with reviewing groundwater conditions, management issues and needs, and projects and management actions to improve sustainability in the Subbasin. The Workgroup meets approximately monthly in sessions that provide a forum for the exchange of information and feedback from members and their respective organizations. An application to join the Workgroup was disseminated in early 2018. 22 applications were received, and all applicants were approved based on their ability to represent the broad interests and geography of the region. An additional member was added with approval of the Workgroup members after attending the first meeting, totaling to 23 members. Additional information on the Workgroup can be found in Section 1.3.4.2.

Decisions of the ESJGWA Board are made by an affirmative majority of Board members, except in the following cases which require a two-thirds supermajority vote: approval or modification or amendment of the ESJGWA annual budget; decisions related to the levying of taxes, assessments, or property-related fees and charges; decisions related to the expenditure of funds by the ESJGWA beyond expenditures approved in the annual budget; adoption of rules, regulations, policies, bylaws, and procedures related to the function of the ESJGWA; decisions related to the establishment of the members' percentage obligations for payment of the ESJGWA's operating and administrative costs; approval of any contract over $250,000 or contracts for terms that exceed two years; decisions regarding the acquisition and the holding, use, sale, letting, and disposal of real and personal property including water rights, and the construction, maintenance, alteration, and operation of works or improvements; decisions related to the limitation or curtailment of groundwater pumping; and approval of a GSP. Each member of the ESJGWA Board has one vote. A process for dispute resolution and noncompliance, including internal resolution and mediation prior to judicial or administrative remedies, is set forth in the ESJGWA Bylaws in Appendix 1-A.

GSAs share in the general operating and administrative costs of the ESJGWA in accordance with percentages determined by the ESJGWA Board.

1.1.4.3 Description of Participating Agencies

A brief description of each of the GSAs that make up the ESJGWA is provided in the sections below.

Central Delta Water Agency – The Central Delta Water Agency (CDWA) service area encompasses a total of 52,000 acres in the northwestern portion of the Eastern San Joaquin Subbasin. The primary land use in this area is agriculture with crops such as vineyards, fruit and nut trees, row crops, and field crops. CDWA protects water supply within its service area (which extends outside of the Subbasin), assists landowners and reclamation districts with water issues, and represents landowners in flood control matters. CDWA does not own any facilities, and surface water from the Delta is the area's only utilized source of water, along with limited private groundwater pumping. Approximately 5,000 acres of the GSA overlap with the sphere of influence of the City of Stockton (Eastern San Joaquin County GBA, 2014).

Central San Joaquin Water Conservation District – The Central San Joaquin Water Conservation District (CSJWCD) was formed in 1959 under provisions of the California Water Conservation Act of 1931. The CSJWCD includes approximately 73,000 largely agricultural acres, of which 6,300 acres are within the sphere of influence of the City of Stockton. To mitigate declining groundwater levels, the CSJWCD contracted with the United States Bureau of Reclamation (USBR) for 80,000 acre-feet per year (AF/year) from New Melones Reservoir on the Stanislaus River. Irrigation facilities have been installed and operated by individual landowners through a surface water incentive program sponsored by the CSJWCD. At the regional level, CSJWCD has participated as a member agency of the Eastern Water Alliance and the Groundwater Basin Authority (GBA), two preceding efforts to the ESJGWA that focused on groundwater management (Eastern San Joaquin County GBA, 2014).

City of Lodi – The City of Lodi is located northeast of the City of Stockton along Highway 99. The City of Lodi relies on both groundwater and surface water to satisfy customer needs. In 2003, Lodi entered into a 40-year agreement with WID for up to 6,000 AF/year of Mokelumne River water. The City of Lodi built the Lodi Surface Water Treatment Plant and associated conveyance facilities necessary to deliver this supply, which were completed and operational at the end of 2012. The City of Lodi currently provides up to 3,000 AF/year of treated wastewater to agricultural land in the vicinity of the wastewater treatment plant, White Slough Water Pollution Control Facility. The GSA for the City of Lodi covers 9,000 acres and includes the White Slough Water Pollution Control Facility area (City of Lodi, 2015).

City of Manteca – The approximately 13,000 acres of the City of Manteca straddles Highway 99 south of the City of Stockton. Potable water supplies consist of a combination of groundwater and treated surface water from the South County Water Supply Program (SCWSP). Manteca currently receives up to 11,500 AF/year of treated surface water and ultimately can receive up to 18,500 AF/year in Phase II of the SCWSP. Up to 4,000 AF/year of reclaimed wastewater is applied to fodder crops on City-owned and leased lands (City of Manteca, 2015).

City of Stockton – The City of Stockton Municipal Utilities Department (MUD) service area generally encompasses portions of the City of Stockton north of the Calaveras River and south of the Cal Water service area. Water use measured in 2015 shows approximately 27 percent of the Stockton MUD's water deliveries come from groundwater, with 73 percent from treated surface water from SEWD and the Delta Water Supply Project. The Delta Water Supply Project came online in 2012 and utilizes surface water both from the San Joaquin River (City of Stockton water right) and Mokelumne River through a 40-year agreement with WID initiated in 2008 for up to 6,500 AF/year with more water as the City of Stockton grows. The City of Stockton GSA (approximately 39,000 acres) overlaps with the extent of the Cal Water service area (City of Stockton, 2015).

Eastside San Joaquin GSA – Eastside San Joaquin GSA (Eastside GSA) is a partnership between Calaveras County Water District, Stanislaus County, and Rock Creek Water District. The area covers over 126,000 acres, stretching into the western portion of Calaveras County and northern portion of Stanislaus County.

- <u>Calaveras County Water District</u> – The Calaveras County Water District (CCWD) serves a population of 20,700 people through 17,000 service connections and shares the same boundaries as Calaveras County. Supply for CCWD comes from reservoir releases on the Calaveras, Stanislaus, and Mokelumne Rivers for a total of approximately 6,000 AF/year for primarily agricultural and residential use. Though not a reliable source of supply in Calaveras County, groundwater does provide the sole supply for residential use in some areas. CCWD also relies heavily on recycled water to reduce potable water demand. Calaveras County had one of the fastest growing annual percent increase in populations in California between 2000 and 2010 (CCWD, 2015). For the portion of Calaveras County that falls within the Eastern San Joaquin Subbasin, the land is mostly unirrigated with the few crops irrigated by either riparian rights along the Calaveras River or private groundwater wells. The population is estimated to be small and served by private residential pumping.

- <u>Stanislaus County</u> – Stanislaus County has a total area of 973,000 acres and nine incorporated cities and extends beyond Eastern San Joaquin Subbasin. There are approximately 30 water suppliers that serve water to Stanislaus County for domestic, commercial, and agricultural uses. The majority of the county's population resides in incorporated cities due to urban development and steady population growth within city boundaries. These incorporated cities are outside of the Subbasin. The portions of Stanislaus County that fall within the Eastern San Joaquin Subbasin not already included in a GSA have partnered with the CCWD and Rock Creek Water District as the Eastside GSA. The land is mostly unirrigated, and water needs are met by private pumping.

- <u>Rock Creek Water District</u> – Rock Creek Water District was formed in 1941 and covers approximately 1,800 acres in northeastern Stanislaus County. Through the Salt Spring Valley Reservoir in Calaveras County, Rock Creek Water District delivers agricultural water for irrigation (Stanislaus LAFCO, 2018).

Linden County Water District – Linden County Water District (LCWD) provides water and wastewater services to the 300 acres of the unincorporated community of Linden, located approximately 12 miles northeast of the City of Stockton along State Route 26. LCWD lies entirely within the boundaries of the SEWD. Between 2000 and 2010, the population in Linden increased by 61 percent from approximately 1,100 to 1,800 residents. LCWD relies on groundwater to meet residential demands in Linden (SJC, 1992).

Lockeford Community Services District – Lockeford Community Services District (LCSD) was established in 1976 and superseded the San Joaquin County Water Works District No. 1 and Lockeford Sanitary District. LCSD provides water and wastewater services to approximately 3,200 residents (as of 2010) in the unincorporated urban community of Lockeford located 17 miles northeast of the City of Stockton on State Routes 12 and 88. LCSD lies within the boundaries of the NSJWCD; however, LCSD's jurisdiction area is its own GSA and is not part of the NSJWCD GSA. LCSD's GSA area is approximately 800 acres and encompasses primarily residential and agricultural land uses. LCSD anticipates that, as community build-out occurs, it may serve over 5,000 residents. Groundwater from the Eastern San Joaquin Subbasin is LCSD's only source of potable water (SJC, 2016a).

North San Joaquin Water Conservation District GSA – North San Joaquin Water Conservation District (NSJWCD), organized in 1948 under provisions of the Water Conservation District Act of 1931, includes approximately 149,000 acres east of the City of Lodi, including about 70,000 acres of irrigated agriculture. NSJWCD also includes approximately 4,740 acres within the Lodi city limits and the community of Lockeford. Pursuant to agreements between NSJWCD, Lockeford, and Lodi, the Lodi and Lockeford acreage is excluded from the NSJWCD GSA. NSJWCD straddles the Mokelumne River and has Dry Creek as its northern boundary. Prior to a basin boundary modification approved in 2016, NSJWCD was located in both the Cosumnes and the Eastern San Joaquin Subbasins. NSJWCD has a 20,000 AF Mokelumne River surface water right which is generally available in normal to wet years. NSJWCD provides surface water deliveries to irrigated acreage and conducts groundwater recharge, but much of the NSJWCD area relies on private groundwater pumping. At the regional level, NSJWCD has participated as a member agency of the Eastern Water Alliance and the GBA, two preceding efforts to the ESJGWA that focused on groundwater management (Eastern San Joaquin County GBA, 2014).

Oakdale Irrigation District – Oakdale Irrigation District (OID) comprises about 81,000 acres, primarily located in the northern portion of Stanislaus County, but with a small portion located within San Joaquin County. A little less than 40 percent of the District's area overlies the Eastern San Joaquin Subbasin (over 31,000 acres), and the remaining portion overlies the Modesto Subbasin. SSJID and OID jointly own facilities to provide water from the Stanislaus River for agricultural use (Eastern San Joaquin County GBA, 2014).

San Joaquin County – The San Joaquin County GSA consists of 51,000 acres of areas within the Eastern San Joaquin Subbasin not covered by the other GSAs. Overlapping agencies include North Delta Water Agency (NDWA), unincorporated county, riparian land along Stanislaus River, and areas in the City of Stockton served by the City of Stockton MUD. In collaboration with the Northeast San Joaquin County Groundwater Banking Authority, San Joaquin County led the development of the Eastern San Joaquin Groundwater Basin Groundwater Management Plan in 2004 to review, enhance, and coordinate existing groundwater management policies and programs in the region and to develop new policies and programs for the long-term sustainability of groundwater resources. San Joaquin County has also supported the development of studies and plans in the region, such as the Groundwater Basin Authority System Plan and San Joaquin County Water Management Plan.

- <u>North Delta Water Agency</u> – The NDWA was formed by a special act of the Legislature in 1973 to protect the water supply against seawater intrusion and to ensure a reliable water supply to meet current and future water needs. The NDWA service area now includes approximately 277,000 acres within the counties of Sacramento, San Joaquin, Solano, and Yolo. Most of the land is devoted to agriculture use and supplied with surface water from the Delta (NDWA, 2015). The reclamations districts within the NDWA and the Eastern San Joaquin Subbasin include Reclamation District (RD) 38 – Staten Island, RD 2086 – Canal Ranch, and RD 348 – New Hope Tract.

San Joaquin County No. 2 (Cal Water) – San Joaquin County No. 2 GSA includes approximately 7,000 acres of the unincorporated San Joaquin County portion of the Cal Water Service Area. Cal Water is an investor-owned public utility regulated by the California Public Utilities Commission; it is a signatory to the California Urban Water Conservation Council. Cal Water has approximately 42,000 connections in the greater Stockton area, primarily south of the Calaveras River. Cal Water utilizes surface water delivered from SEWD and groundwater pumped by Cal Water wells to meet customer demands. Cal Water's Stockton District was formed in 1927 with the purchase of the water system from Pacific Gas and Electric Company (PG&E).

South Delta Water Agency – The South Delta Water Agency (SDWA) was originally formed to address local water supply and water quality concerns in the south Delta area. The SDWA encompasses a total of approximately 150,000 acres within its boundaries, and almost 18,000 acres overlap with the southwestern portion of the Eastern San Joaquin Subbasin. The SDWA does not own any facilities or water rights. Instead, the SDWA protects property owners who have individual water rights. Surface water is the primary source of water used within the agency boundaries given that most of the groundwater is highly saline (Eastern San Joaquin County GBA, 2014).

South San Joaquin GSA – South San Joaquin GSA's 64,000 acres encompass most of the South San Joaquin Irrigation District (SSJID), including Woodward Reservoir and canals leading to SSJID; the City of Ripon; and the City of Escalon. The portion of SSJID within the incorporated City of Manteca is included in the City of Manteca GSA.

- South San Joaquin Irrigation District – SSJID was formed in 1909 under the Irrigation District Act and covers approximately 72,000 acres in the southeastern portion of San Joaquin County located within the Eastern San Joaquin Subbasin boundaries. The cities of Manteca, Ripon, and Escalon account for approximately 20,000 acres of the SSJID area. SSJID in 2005 began the delivery of up to 32,000 AF/year currently (and up to 43,000 AF/year in Phase II) of treated surface water from Woodward Reservoir to the cities of Manteca, Lathrop, and Tracy for the SCWSP, with Escalon to receive water in the future (Eastern San Joaquin County GBA, 2014).

- City of Ripon – The City of Ripon is located at the southern edge of San Joaquin County along Highway 99. The population in 2015 was approximately 14,700 people and is expected to grow to about 30,800 people by 2040. The city's potable water is provided by city groundwater wells and supplied over 4,000 acre-feet (AF) in 2015. Non-potable groundwater and surface water from SSJID are used for irrigation purposes and recharge (City of Ripon, 2015).

- City of Escalon – The City of Escalon is located within the San Joaquin County boundaries along State Route 120. Incorporated in 1957, the City of Escalon was home to approximately 7,400 residents in 2015. The City of Escalon has an allotment of 2,015 AF of treated water from the SSJID and the SCWSP; however, the city is not utilizing its allotment and currently relies solely on groundwater wells to serve the city's population as well as commercial customers. The City of Escalon is selling its allotment of treated water to the City of Tracy but intends to construct a pipeline to convey SSJID water to meet domestic and industrial needs in the City of Escalon (SSJID, 2015b).

Stockton East Water District – Stockton East Water District (SEWD) was formed in 1948, includes a total of 143,300 acres, overlaps with portions of WID, and includes the entire City of Stockton and the entire Cal Water service area. The SEWD GSA covers 101,000 acres of the district, with the remaining SEWD areas covered by the City of Stockton, San Joaquin County, and San Joaquin County No. 2 GSAs. SEWD is guaranteed 56.5 percent of New Hogan Reservoir's yield and is provided a total amount of 75,000 AF/year from New Melones Reservoir through agreements with USBR. SEWD delivers wholesale drinking water to the City of Stockton, Cal Water, San Joaquin County, and Woodbridge Irrigation District (WID) areas in the Stockton MUD (Eastern San Joaquin County GBA, 2014). At the regional level, SEWD has participated as a member agency of the Eastern Water Alliance and the GBA, two efforts preceding the current ESJGWA that focused on groundwater management (Eastern San Joaquin County GBA, 2014).

Woodbridge Irrigation District – WID, organized in 1924 under the California Irrigation District Act, encompasses a gross area of approximately 42,900 acres with over 29,000 acres covered by the WID GSA. WID is discontinuous, resulting in patches of non-district lands within its boundary, and overlaps with portions of NSJWCD, SEWD, and the City of Lodi. WID owns and operates the Woodbridge Diversion Dam, located on the Lower Mokelumne River northeast of the City of Lodi, as well as an extensive canal system serving approximately 13,000 acres west of Lodi and north of Stockton. Recent improvements made to the new Woodbridge Diversion Dam include state-of-the-art fish and diversion works which enable WID to keep Lodi Lake full year-round. At the regional level, WID has participated as a member agency in regional groundwater management efforts, including the GBA.

1.1.4.4 Legal Authority

Any local public agency that has water supply, water management, or land use responsibilities in a basin can decide to become a GSA under SGMA. A single local agency can become a GSA, or a combination of local agencies can decide to form a GSA by using either a JPA, a memorandum of agreement (MOA), or other legal agreement (CA DWR, 2016a).

In the Eastern San Joaquin Subbasin, the ESJGWA has legal authority to jointly prepare, adopt, and implement a GSP consistent with the terms of the JPA Agreement and the ESJGWA Bylaws (Eastern San Joaquin GWA, 2017a).

The ESJGWA's JPA calls out the following powers granted to GSAs by SGMA:

- Become a GSA individually or collectively;
- Approve any portion, section, or chapter of the GSP adopted by the ESJGWA;
- Act through GSAs to implement SGMA and the GSP; and
- Exercise the powers conferred to GSAs by SGMA.

Each GSA that is a member of the ESJGWA has its own legal authorities. For example, NSJWCD has the legal authorities granted to a GSA under the California Water Code (Water Code) as well as the legal authorities granted to a Water Conservation District pursuant to Water Code § 74000 et seq. The legal authorities of each GSA are listed in Appendix 1-B. Agency resolutions to become GSAs are provided in Appendix 1-C.

1.1.4.5 Estimated Costs and Approach to Meeting Costs

Implementation of the GSP requires funding sources. To the degree they become available, outside grants will be sought to assist in reducing cost of implementation to participating agencies, residents, and landowners of the Subbasin. However, there will be a need to collect funds to support implementation.

For budgetary purposes, the estimated initial cost of these activities is on the order of $600,000 to $1 million per year excluding projects and management actions costs and costs associated with the installation of new monitoring wells and grant writing. Additional one-time costs, such as model refinement, are estimated to be on the order of $315,000. The ESJGWA Board will evaluate options for securing the needed funding. Additional detail on GSP implementation costs and funding sources are detailed in Chapter 7: Plan Implementation.

1.1.5 GSP Organization

This GSP is organized according to DWR's "GSP Annotated Outline" for standardized reporting (CA DWR, 2016b). The Preparation Checklist for GSP Submittal in DWR formatting can be found in Appendix 1-D (CA DWR, 2016d).

1.2 PLAN AREA

1.2.1 Description of Plan Area

This section provides a detailed description of the Eastern San Joaquin Subbasin, including major streams and creeks, institutional entities, agricultural and urban land uses, locations of groundwater wells, and locations of state lands. The Plan Area document also describes existing surface water and groundwater monitoring programs, existing water management programs, and general plans in the Plan Area.

1.2.1.1 Summary of Jurisdictional Areas and Other Features

The Eastern San Joaquin Subbasin falls within the larger San Joaquin Valley Groundwater Basin (see Figure 1-4). Basin designations by DWR were first published in 1952 in Water Quality Investigations Report No. 3, *Ground Water Basins in California*, and subsequently updated in Bulletin 118 in 1975, 1980, and 2003. The San Joaquin River Hydrologic Region contains 11 distinct subbasins, where the Eastern San Joaquin Subbasin (Bulletin 118 Basin Number 5-022.01) is bordered to the north by the Cosumnes Subbasin (Bulletin 118 Basin Number 5-022.16), the South American Subbasin (Bulletin 118 Basin Number 5-021.65), and the Solano Subbasin (Bulletin 118 Basin Number 5-021.66); to the south by the Modesto Subbasin (Bulletin 118 Basin Number 5-022.02); and to the west by the Tracy Subbasin (Bulletin 118 Basin Number 5-022.15) and East Contra Costa Subbasin (Bulletin 118 Basin Number 5-022.19) (see Figure 1-5).

The Eastern San Joaquin Subbasin includes lands south of Dry Creek between the San Joaquin River on the west and the crystalline basement rock of the Sierra Nevada foothills on the east. The Eastern San Joaquin Subbasin boundary to the south stretches along the San Joaquin County line and continues along the Stanislaus River into Calaveras County to the east. Geologic units in the Eastern San Joaquin Subbasin consist of consolidated rocks and unconsolidated deposits (CA DWR, 2006).

No adjudicated areas or areas covered by an alternative to a GSP exist within the Eastern San Joaquin Subbasin.

Figure 1-4: Placement within the San Joaquin Valley Groundwater Basin

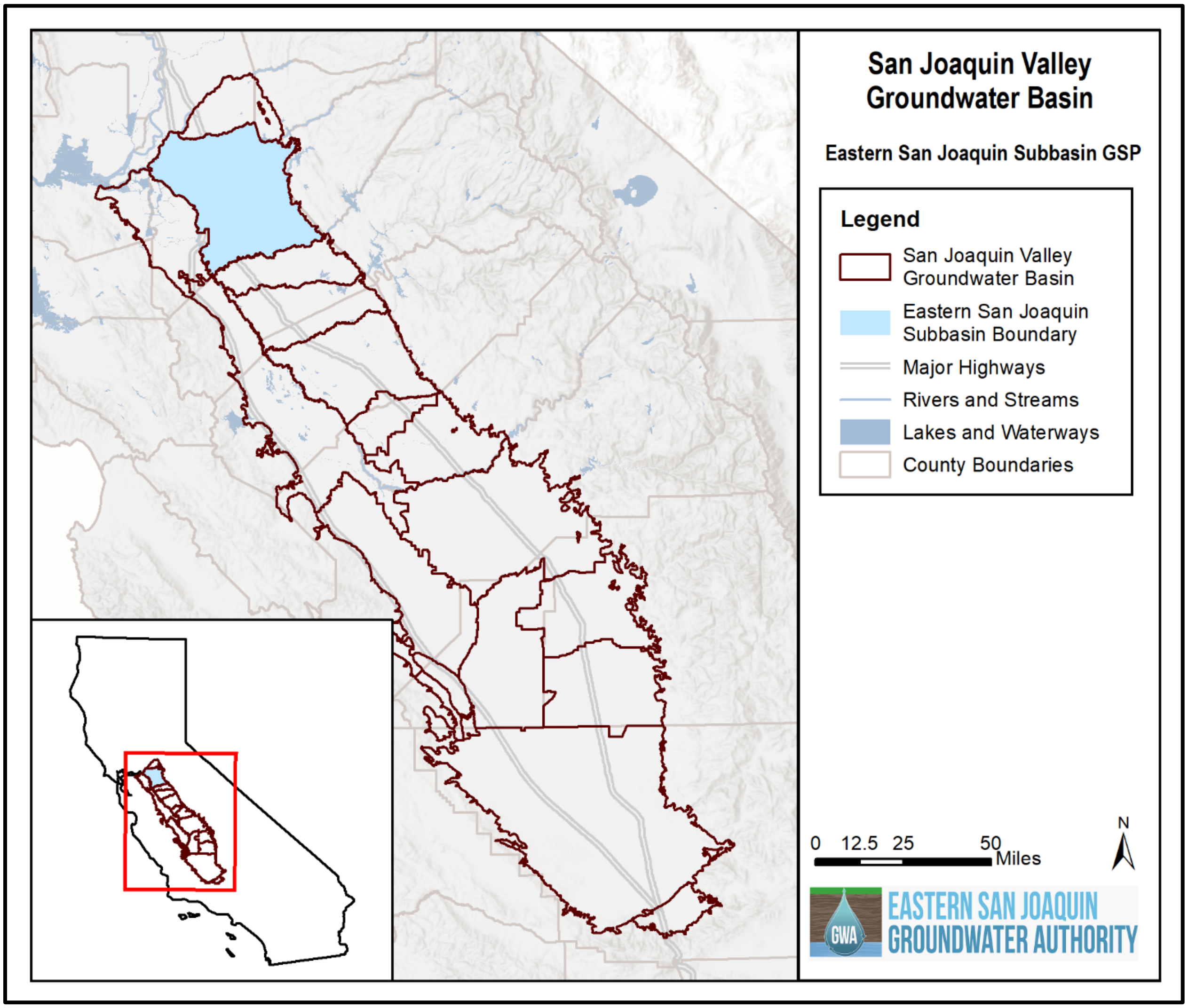
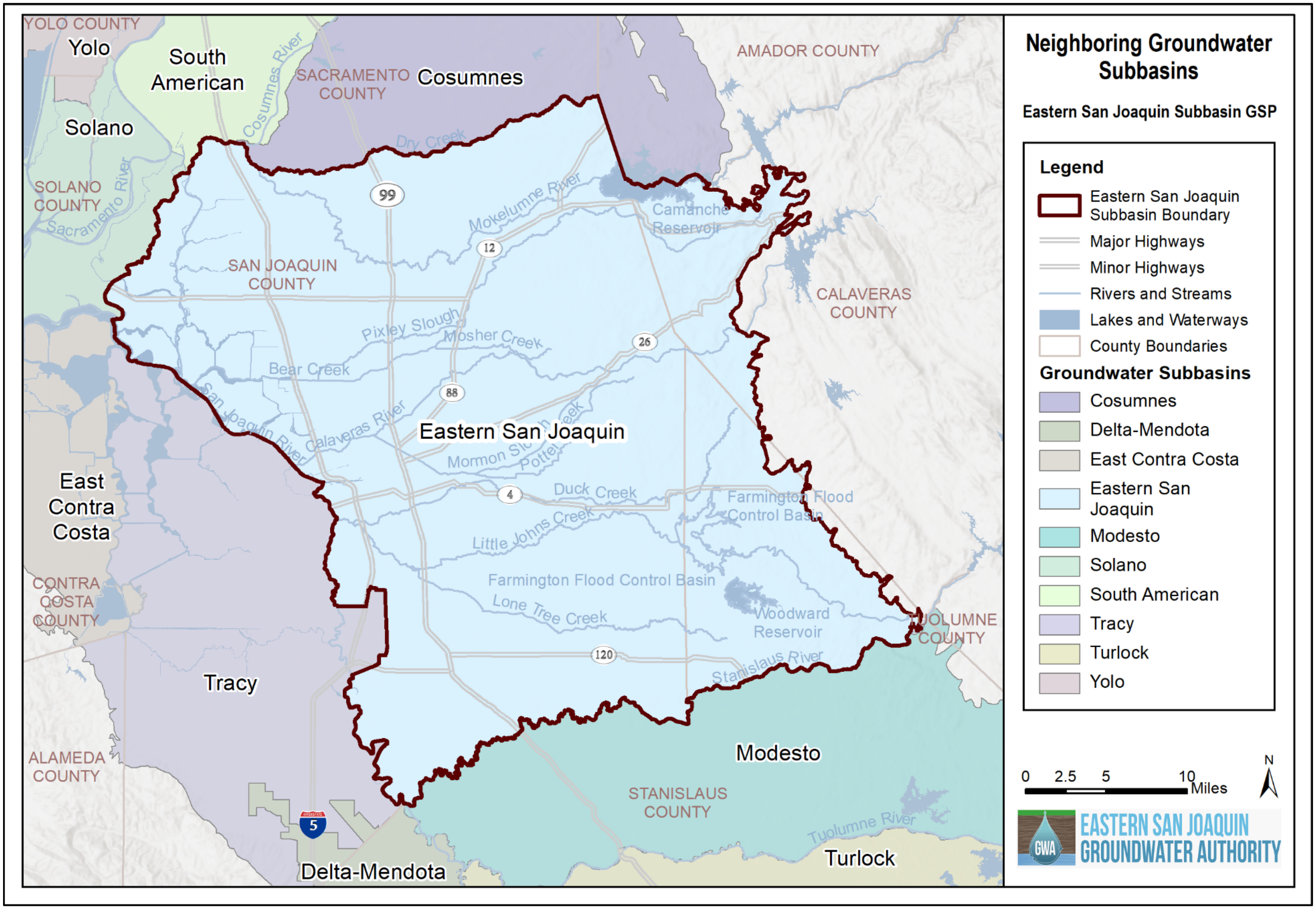


Figure 1-5: Neighboring Groundwater Subbasins



The Eastern San Joaquin Subbasin underlies areas of San Joaquin, Stanislaus, and Calaveras Counties. Figure 1-6 shows the location of these three counties within the State of California as well as the three other counties bordering the Eastern San Joaquin Subbasin: Sacramento, Amador, and Contra Costa.

Figure 1-6: Underlying and Surrounding Counties

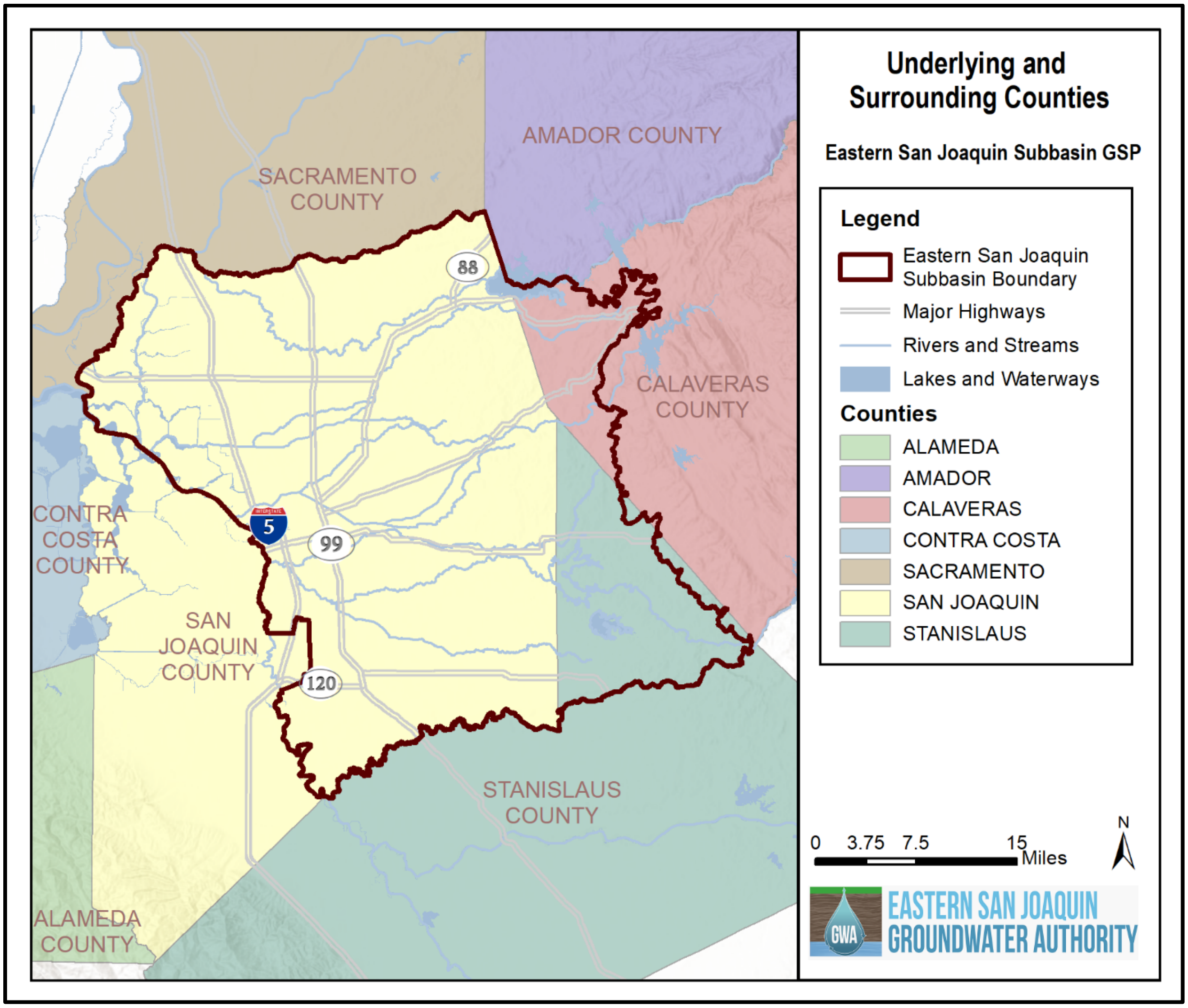


Figure 1-7 shows the Eastern San Joaquin Subbasin and the Subbasin's key geographic features. The Subbasin encompasses an area of about 1,195 square miles. There are eight entities within the region with land use jurisdiction: the County of San Joaquin, the County of Calaveras, the County of Stanislaus, the City of Stockton, the City of Lodi, the City of Manteca, the City of Escalon, and the City of Ripon. The cities of Lodi, Escalon, Manteca, and Ripon are contained entirely within the Subbasin, while western portions of San Joaquin County and the City of Stockton, and eastern portions of Calaveras and Stanislaus counties, lie in neighboring subbasins or outside of groundwater subbasins altogether. The Eastern San Joaquin Subbasin encompasses the following unincorporated communities: Acampo, Adela, Atlanta, August, Bear Creek, Burson, Clements, Collierville, Country Club, Dogtown, East Oakdale, Eugene, Farmington, French Camp, Garden Acres, Goodmans Corner, Jenny Lind, Kennedy, Knights Ferry, Lake Camanche Ranches, Lincoln Village, Linden, Lockeford, Milton, Morada, Mormon, Oak Grove, Peters, South Camanche Shore, Taft Mosswood, Terminous, Thornton, Valley Home, Valley Springs, Victor, Wallace, Waterloo, Woodbridge, and Youngstown.

Figure 1-7: City Boundaries

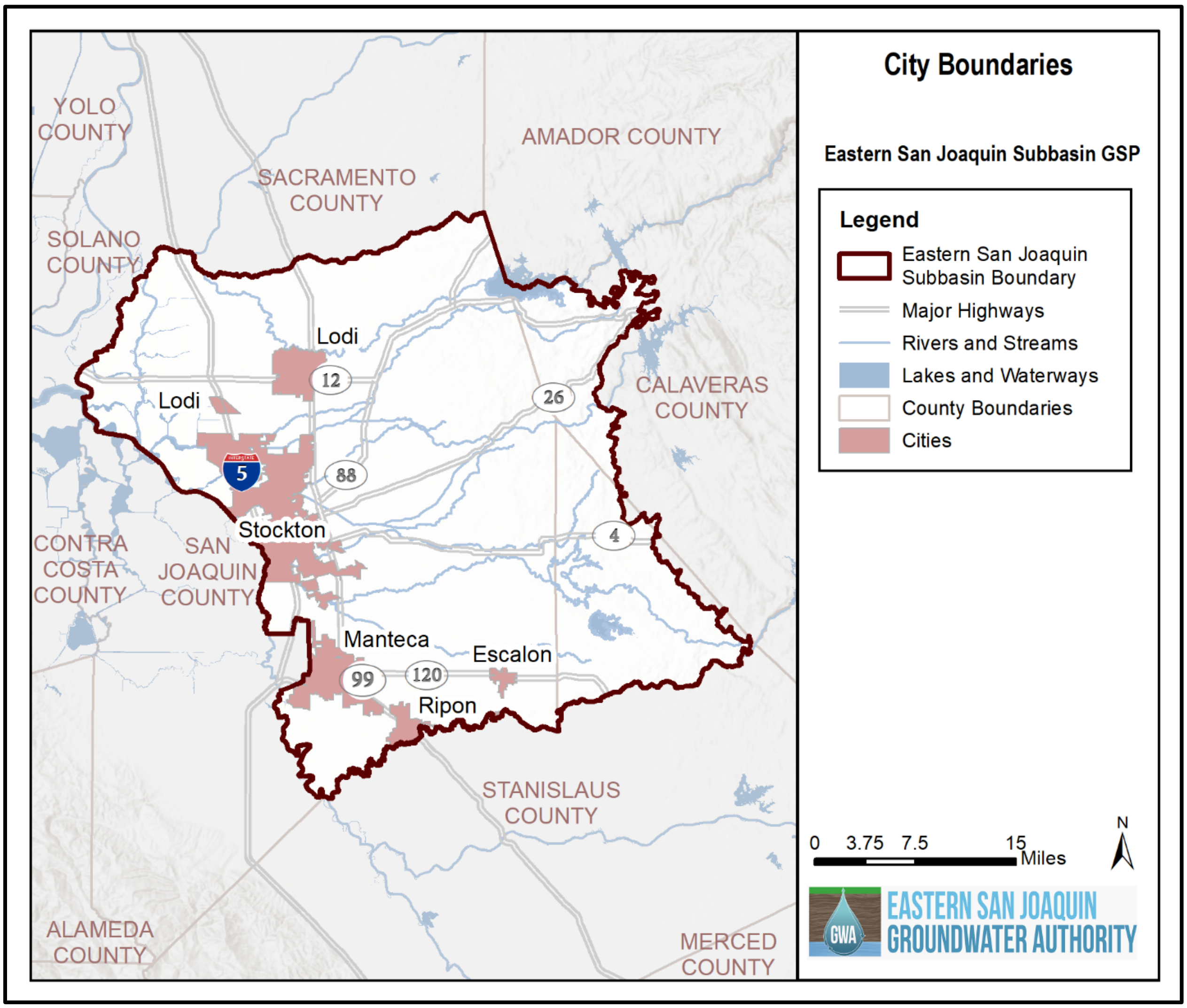


Figure 1-8 shows the spatial extent of Disadvantaged Communities (DACs) and Severely Disadvantaged Communities (SDACs) in the Eastern San Joaquin Subbasin. DWR defines DACs as census geographies (census tracts, census block groups, and census-designated places) with an annual median household income (MHI) that is less than 80 percent of the statewide annual MHI. SDACs are defined as census geographies with an MHI less than 60 percent of the statewide annual MHI. DWR uses the most recently available 5-year American Community Survey (ACS) dataset to identify these areas. For this GSP, the 2012-2016 ACS dataset was used, establishing statewide MHI as $63,783 (CA DWR, Mapping Tools).

Figure 1-8: Disadvantaged Communities (DACs)

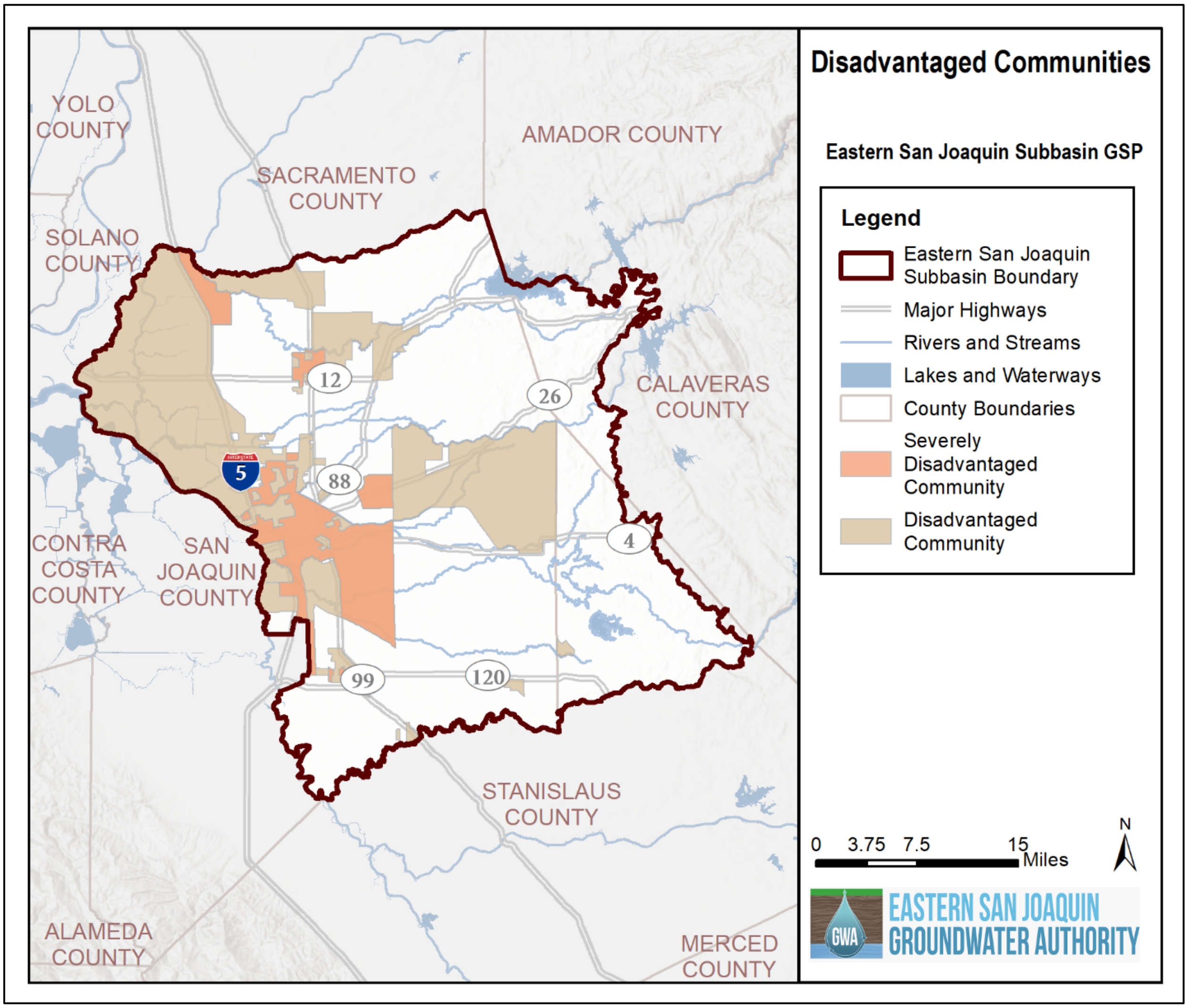
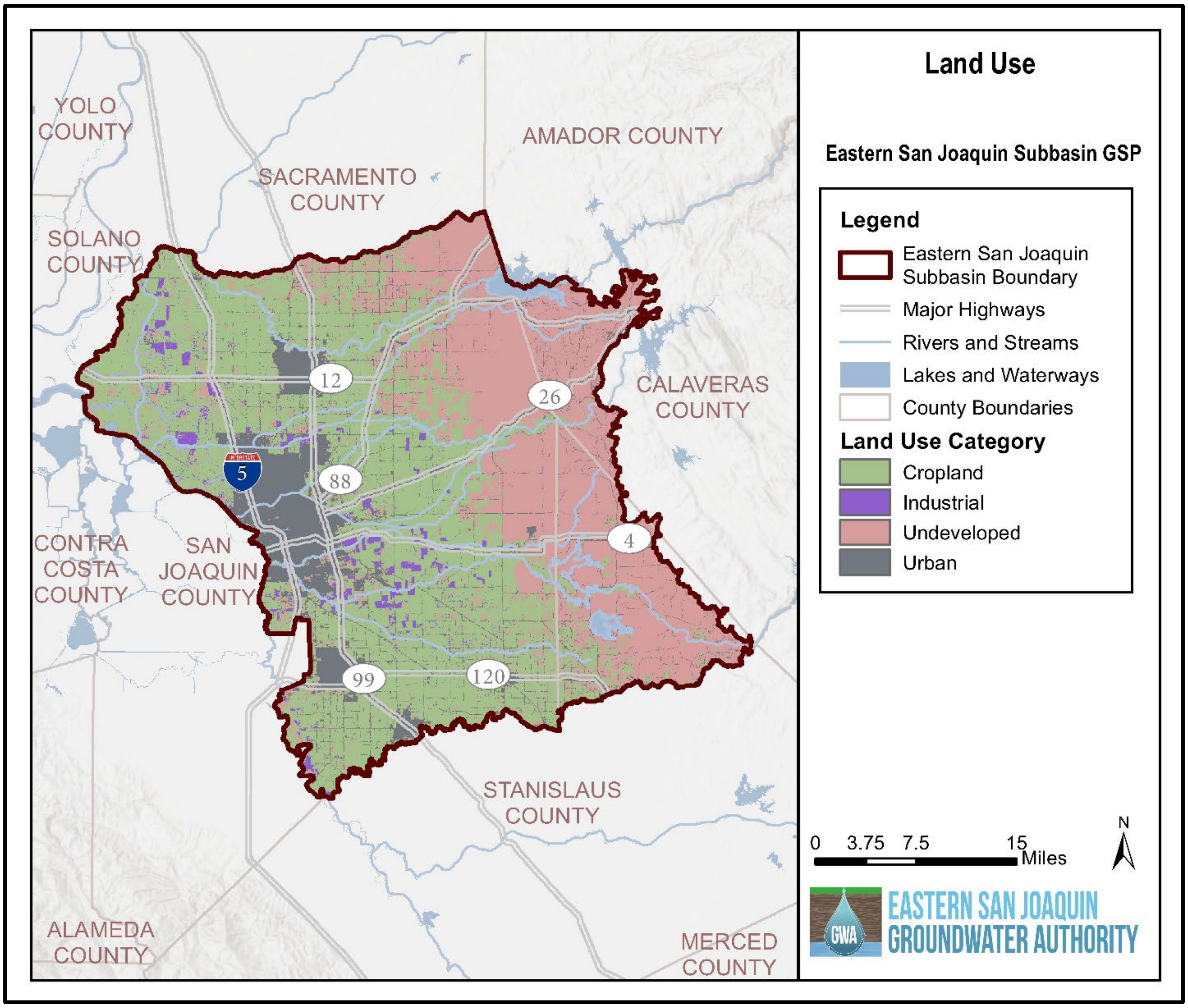


Figure 1-9 shows a map of land use in the Eastern San Joaquin Subbasin across four general categories: cropland, industrial, undeveloped, and urban. These categories were mapped based on categories provided by 2015 land use from the United States Department of Agriculture's (USDA) CropScape 2015 dataset.

Land use patterns in the Eastern San Joaquin Subbasin are dominated by agricultural uses, including nut and fruit trees, vineyards, row crops, grazing, and forage. Both agricultural and urban land use rely on a combination of surface water and groundwater, with some agricultural lands using recycled or reusing water. Land use is primarily controlled by local agencies. Land use patterns in the low foothills to the east are dominated by native vegetation and unirrigated pasture lands (USDA, 2015).

Figure 1-9: Land Use



Crop type varies by region, with fruit and nut trees and vine crops comprising the majority of agriculture in the Subbasin. Almond orchards dominate the southern portion of the Subbasin, cherry and walnut orchards dominate the central portion of the Subbasin, and vineyards dominate the northern portion (Figure 1-10). Irrigated crop acreage in the Subbasin are 37 percent fruit and nut trees, 24 percent vineyards, and 11 percent alfalfa and irrigated pasture, according to the 2015 CropScape dataset (USDA, 2015).

Figure 1-10: Land Use by Crop Type

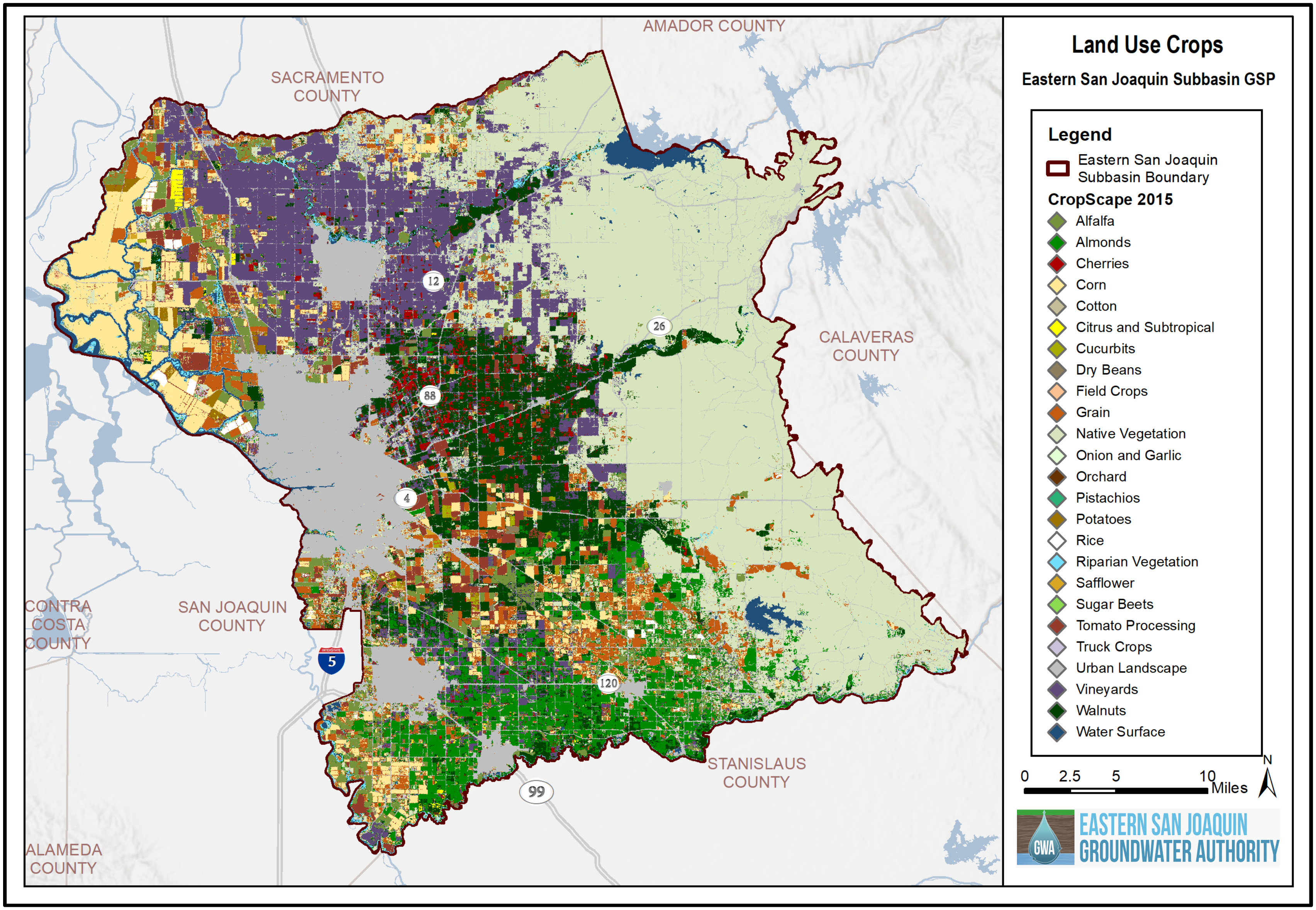


Figure 1-11 shows a map with boundaries of federal and state public lands within the region that includes the Eastern San Joaquin Subbasin. The United States Fish and Wildlife Service (USFWS) manages the San Joaquin River National Wildlife Refuge situated in Stanislaus County where the Tuolumne, Stanislaus, and San Joaquin rivers meet. Established in 1987 to provide habitat for migratory birds and endangered species, the refuge is 7,000 acres and is located just outside the southern boundary of the Subbasin (USFWS, 2012).

The California Department of Parks and Recreation (California State Parks, 2019) maintains the Caswell Memorial State Park located along the Stanislaus River near Ripon. The Caswell Memorial State Park protects a riparian oak woodland and is home to the riparian brush rabbit, an endangered species (California State Parks, 2019). This is the only state park within the Eastern San Joaquin Subbasin boundary. The Franks Tract State Recreation Area (SRA) and the Carnegie State Vehicular Recreation Area (SVRA) are also managed by California State Parks; however, both of these areas are located outside of the Subbasin boundary.

The California Department of Fish and Wildlife (CDFW) owns 880 acres of man-made ditches, canals, and marshes with both grassland and riparian habitat, recognized as the White Slough Wildlife Area. The property was designated by the Fish and Game Commission in 1980 and provides recreational opportunities such as fishing, hunting, and hiking (CDFW, 2019a). CDFW also maintains the 353-acre Woodbridge Ecological Reserve to protect primarily the sandhill crane population, but also other migratory waterfowl. The sandhill crane was listed as a threatened species in 1983. Woodbridge Ecological Reserve and the greater Stockton Delta wetlands make up the largest freshwater marsh in California (CDFW, 2019b). Lastly, Vernalis Ecological Reserve is also shown in Figure 1-11. It serves as a public access area owned by CDFW for hunting and wildlife viewing (CDFW, 2019c).

Figure 1-11: US Fish and Wildlife Service, California State Parks, and California Department of Fish and Wildlife Boundaries

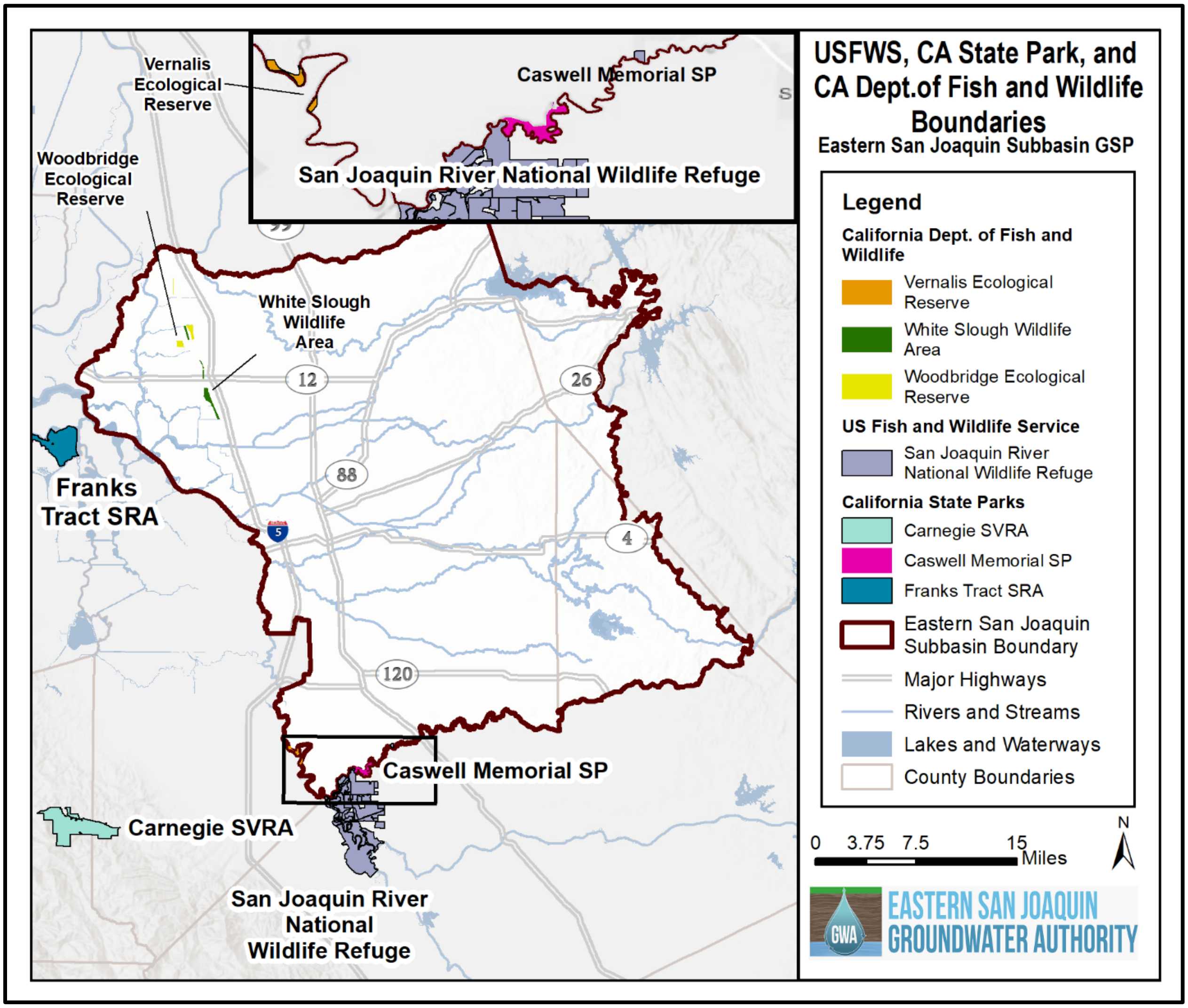


Figure 1-12 to Figure 1-14 shows the density of domestic, public, and production wells per square mile in the Eastern San Joaquin Subbasin, as classified by the DWR Online System for Well Completion Reports (OSWCR), which is discussed in Section 1.2.2.1. This includes approximately 1,000 unique wells collected primarily from DWR's Water Data Library (WDL), but also other state, regional, and local monitoring entities. Though there are overlaps and discrepancies in the designation of wells, domestic wells are largely private residential wells, public wells are municipal-operated wells, and production wells are for irrigation, municipal, public, and industrial purposes (CA DWR, 2019). Areas with few wells exist in the Subbasin, particularly in the northwestern corner of the Subbasin and to the east. Wells containing groundwater level data are described further in Section 1.2.2.1. Community water systems, defined by the State Water Resources Control Board (SWRCB) as wells serving 15 or more connections or more than 25 people per day, are identified in Appendix 1-F.

Figure 1-12: Density of Domestic Wells per Square Mile

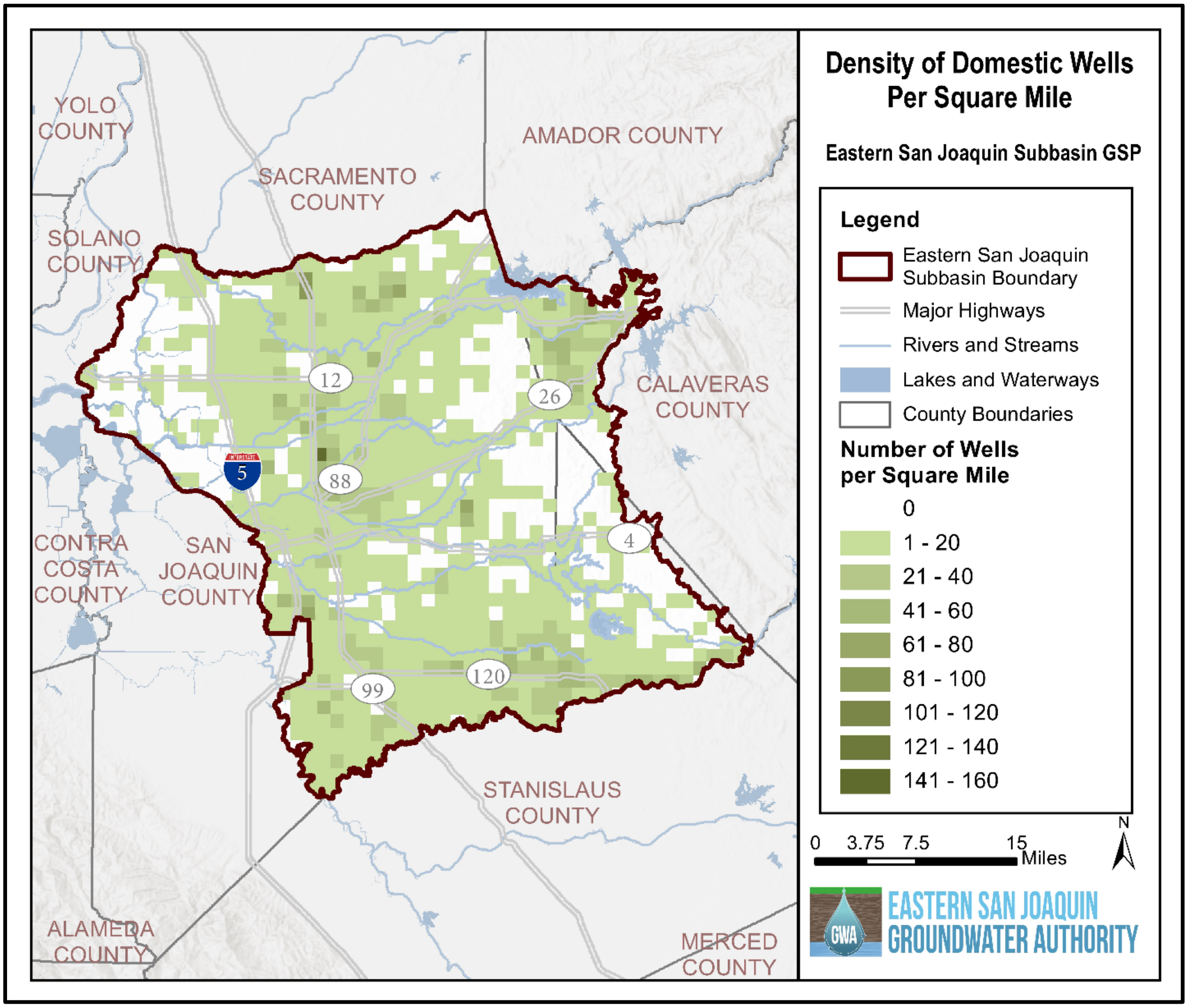


Figure 1-13: Density of Public Wells per Square Mile

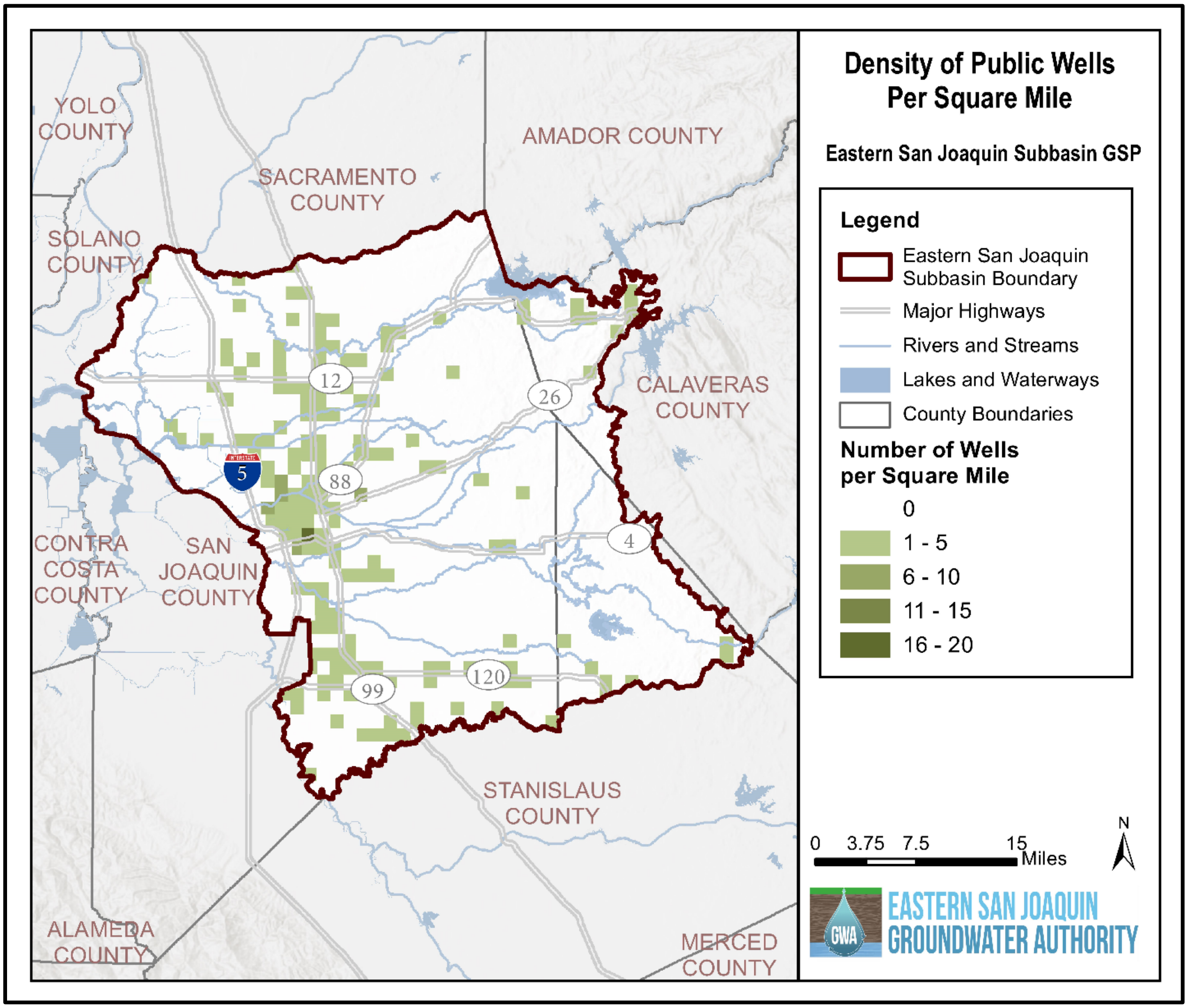
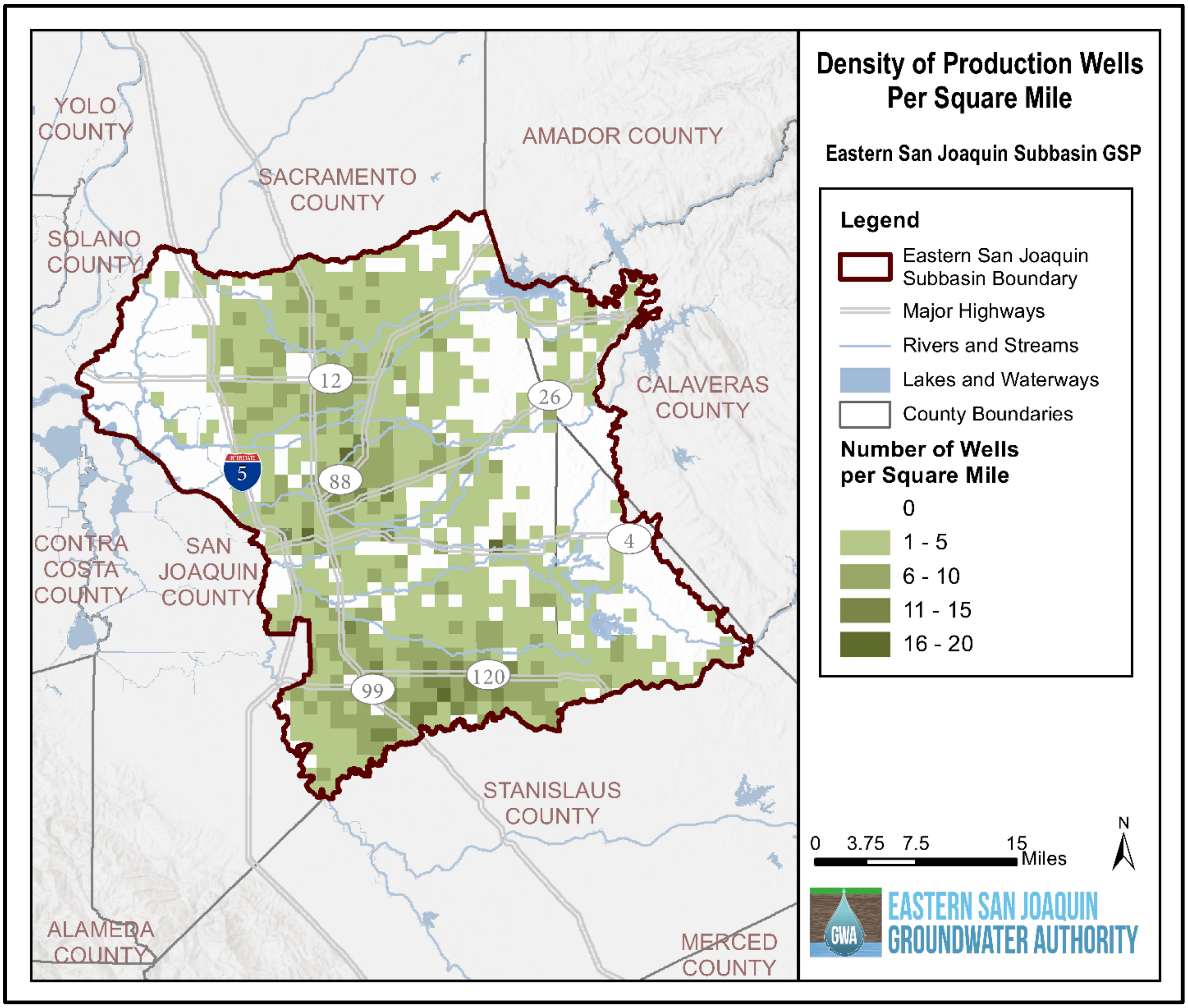


Figure 1-14: Density of Production Wells per Square Mile



1.2.2 Water Resources Monitoring and Management Programs

The existing monitoring and management landscape within the Eastern San Joaquin Subbasin is a patchwork of local, regional, state, and federal programs, each serving its own specific function. This patchwork provides valuable data that have supported past needs and will assist in meeting monitoring needs under SGMA. This patchwork of programs includes redundancies, inconsistent protocols, and inconsistent timing of monitoring that may be improved during SGMA implementation.

Existing monitoring within the Eastern San Joaquin Subbasin is extensive, complex, and performed for a variety of purposes by a variety of entities. During a review of existing groundwater monitoring data and programs, data were collected from the following agencies and programs. Programs and agencies are listed by the jurisdiction they operate across: statewide, regional, or local. The sections that follow describe in detail the programs most heavily relied upon in the development of the GSP and are organized by data type. Section 1.2.2.3 addresses the interconnection between databases.

Statewide Monitoring Programs (Agencies and Databases):

- California Data Exchange Center (CDEC)
- California Department of Pesticide Regulation (CDPR)
- California Environmental Data Exchange Network (CEDEN)
- California State Water Resources Control Board (SWRCB), Division of Drinking Water (DDW)
- Department of Water Resources (DWR):
  - California Statewide Groundwater Elevation Monitoring (CASGEM)
  - California Statewide Groundwater Elevation Monitoring Groundwater Information Center Interactive Mapping Application (GICIMA)
  - Online System for Well Completion Reports (OSWCR)
  - Water Data Library (WDL)
- Groundwater Ambient Monitoring and Assessment (GAMA) Program
- GeoTracker
- University NAVSTAR Consortium (UNAVCO)
- United States Bureau of Reclamation (USBR)
- United States Geological Survey (USGS)

Regional Monitoring Programs:

- Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS)
- California Department of Public Health (CDPH)
- Central Valley Regional Water Quality Control Board (CVRWQCB) Waste Discharge Requirement (WDR) dairy data, Dairy Cares
- USGS's National Water Information System (NWIS)
- Central Valley Dairy Representative Monitoring Program
- EnviroStor
- Groundwater Quality Trend Monitoring Program through SWRCB Irrigated Lands Regulatory Program (ILRP)
- San Joaquin River Restoration Program

Local Monitoring Agencies

- Cal Water
- Calaveras County Water District

- City of Lodi
- City of Manteca
- City of Stockton
- Linden County Water District
- Lockeford Community Services District
- North San Joaquin Water Conservation District
- Oakdale Irrigation District
- San Joaquin County
- South San Joaquin Irrigation District
- Stockton East Water District

A description of the monitoring programs that will be used in GSP implementation is provided in Chapter 4: Monitoring Networks.

1.2.2.1 Groundwater Level Monitoring and Data Sources

1.2.2.1.1 CASGEM

DWR maintains several groundwater level monitoring programs, tools, and resources covering California. The California Statewide Groundwater Elevation Monitoring (CASGEM) Program is DWR's primary resource for groundwater level data and has been used extensively in the development of this GSP. The CASGEM Program was authorized in 2009 by SB X7-6 to establish collaboration between local monitoring parties and DWR to collect and make public statewide groundwater elevation data. The program provides the framework for local agencies or other organizations to "assume responsibility for monitoring and reporting groundwater elevations in all or part of a basin or subbasin" (Water Code §10927). Three CASGEM monitoring entities exist in the Eastern San Joaquin Subbasin: CCWD, San Joaquin County Flood Control and Water Conservation District (SJCFCWCD), and Stanislaus County. These three agencies have completed separate CASGEM Monitoring Plans, which are included in the references section.

- **CCWD CASGEM Monitoring Plan:** CCWD adopted a CASGEM Monitoring Plan in November 2012, with the following objectives:
  - Collect semi-annual groundwater levels from a selected monitoring well network
  - Upload groundwater levels to the CASGEM website after data quality steps have been completed
  - Maintain and update the monitoring well network plan documents including additions and removals from the monitoring network

  These objectives are helpful to this planning effort, as they include regular monitoring of groundwater levels and data upload to CASGEM. The CCWD plan also includes a description of the CASGEM monitoring network and groundwater level measurements. The monitoring network includes two USGS nested monitoring wells equipped with pressure transducers, which continuously monitor groundwater levels. The monitoring network also includes seven other wells that are not USGS wells. These wells are not equipped with pressure transducers, and manual groundwater elevation measurements are taken at all wells twice a year. As stated in the CCWD CASGEM plan, the non-USGS wells are owned by private landowners, and additional wells may need to be added in the future if owners opt out of the monitoring network (CCWD, 2012). This monitoring network covers the portion of Calaveras County within the Eastern San Joaquin Subbasin.

- **SJCFCWCD CASGEM Monitoring Plan:** The SJCFCWCD CASGEM Monitoring Plan provides a description of the CASGEM monitoring network and groundwater conditions in San Joaquin County. This plan covers the portions of the Eastern San Joaquin and Tracy Subbasins within San Joaquin County. The SJCFCWCD has been taking semi-annual water level measurements since 1971 at wells owned by a variety of entities and by private individuals. A large portion of wells in the district's network are privately owned (SJCFCWCD, 2006). SJCFCWCD sent out consent forms to these private well owners to release well information to CASGEM; about 40 of these forms were signed and returned, and construction information for these wells was uploaded to CASGEM. This information includes attributes such as well depth, coordinates, reference point elevation, and depth of screened interval.
- **Stanislaus County CASGEM Monitoring Plan:** The Stanislaus County Department of Environmental Resources (DER) established a CASGEM monitoring plan in 2016 to cover the portion of Stanislaus County within the Eastern San Joaquin Subbasin, often referred to as the northern triangle. This plan details the groundwater level monitoring history, protocols, and network for the northern triangle portion of Stanislaus County. This area is rural and most of the development exists between the Stanislaus River and near the Woodward Reservoir. Wells selected for the CASGEM program are in the developed areas. 17 wells are included in this CASGEM plan to be measured semi-annually, consisting of one domestic and ten irrigation wells, plus six wells that are of unknown type. Well information such as depth and screened interval was uploaded to CASGEM for these wells (Stanislaus County DER, 2016).

1.2.2.1.2 San Joaquin County Flood Control and Water Conservation District

The SJCFCWCD publishes semi-annual groundwater reports covering groundwater conditions in San Joaquin County. These reports include tables, hydrographs, and maps on groundwater levels. Groundwater level results from each semi-annual report are compared with values from the previous period. Groundwater level data collected by the district include the data mentioned in the CASGEM section, above, and additional data that are not incorporated into CASGEM. The data are maintained by the SJCFCWCD.

1.2.2.1.3 Water Data Library

DWR's WDL contains measurements of groundwater elevations from water supply and monitoring wells monitored by numerous entities, such as DWR and local agencies. Groundwater level measurements available from the WDL are either continuously or periodically measured. Continuous measurements are provided by automatic water level measuring devices that take readings at wells; periodic measurements are manual recordings typically occurring at monthly or semi-annual time intervals. Measurements displayed through the WDL are taken through other programs, such as CASGEM. The WDL lists the organization responsible for collecting each water level measurement. The WDL water level measurements are available through the California Natural Resources Agency (CNRA) Open Data website as a bulk download, or through the WDL website on a per station basis.

1.2.2.1.4 USGS – National Water Information System

The NWIS is a USGS program comprising several water datasets, including groundwater level measurements, river flow, and river stage data. Like the WDL, NWIS contains continuous and periodic water measurements for recent and historical conditions. Within the Eastern San Joaquin Subbasin, there are only a few active NWIS sites and many inactive sites with historical records. For stream measurements, active sites are largely along major streams, such as the Mokelumne River, the Stanislaus River, and the San Joaquin River; along Delta waterways; or in the Sierra Nevada foothills, upstream of reservoirs.

1.2.2.1.5 Data Received Directly from GSAs

A number of the GSAs collect water level and water quality information within their GSAs of varying frequencies and detail. These data were provided as part of the Eastern San Joaquin Water Resources Model (ESJWRM) data collection effort and were compared with and included in groundwater level and water quality datasets analyzed for the preparation of this GSP.

The development of the ESJWRM took place in an open and transparent process. Coordination efforts took place through the Eastern San Joaquin County GBA, the organizational structure for agency coordination that proceeded SGMA regulations and the formation of the ESJGWA. Through this effort, many of the staff and consultants representing GSAs forming the ESJGWA, participated in a prior group through the GBA, which acted as a forum to review model input data and assumptions. The group facilitated major modeling decisions and provided input data, including groundwater pumping records, surface water delivery records, urban demand, and local water levels and quality data.

Local agencies with consistent representation in meetings related to the development of the ESJWRM included San Joaquin County, WID, City of Lodi, NSJWCD, LCSD, CCWD, City of Stockton, Cal Water, SEWD, City of Lathrop, City of Manteca, SSJID, City of Escalon, OID, and Stanislaus County. Other agencies contributed local data to information collection efforts later in the GSP development process.

Online System for Well Completion Reports – The OSWCR is a DWR program used to document and compile boring or well completion records throughout California. There are as many as 2 million domestic, irrigation, and monitoring water wells in California included in this dataset, including approximately 10,000 domestic wells located in the Eastern San Joaquin Subbasin. When a well is constructed, modified, or destroyed, drilling contractors are required to submit a Well Completion Report to DWR for upload to the interactive OSWCR web site. OSWCR is used as a data source for wells identified for monitoring. In this GSP, the OSWCR database was used to describe the Plan area and identify sustainable management criteria.

1.2.2.2 Groundwater Quality Monitoring and Data Sources

1.2.2.2.1 Groundwater Ambient Monitoring and Assessment Program

The GAMA Program is an extensive groundwater quality monitoring program that was established by the SWRCB in 2000. The program compiles groundwater quality data from several agencies including the DWR, USGS, Department of Pesticide Regulations (DPR), Lawrence Livermore National Laboratory (LLNL), and others. Agencies submit data from monitoring wells for 258 constituents including total dissolved solids (TDS), nitrates and nitrites, arsenic, and manganese. GAMA data for the Eastern San Joaquin Subbasin contains water quality results collected by the SWRCB-DDW (formerly DHS-DDW), DPR, DWR, LLNL, and USGS from the 1940s to present. Figure 2-3 in Chapter 2: Basin Setting shows the GAMA well locations throughout the Eastern San Joaquin Subbasin, roughly 6,800 monitoring points.

1.2.2.2.2 Water Data Library

DWR's WDL contains groundwater quality data in addition to the groundwater level records described previously. This information includes data from discrete groundwater quality samples collected by DWR and other cooperating entities. These water quality data list the entity responsible for taking the sample but do not specify what program the sample was taken under. The WDL water quality measurements are available through the CNRA Open Data website as a bulk download, or through the WDL website on a per-station basis. WDL water quality measurements in this GSP are utilized for basin characterization but are acquired from the other programs.

1.2.2.2.3 National Water Information System

The USGS NWIS contains groundwater quality data, in addition to the groundwater level measurements previously discussed. Groundwater quality results in NWIS relate to GAMA records, but there is no direct link between the two databases. Some NWIS sites have a State ID listed, which is a common identifier used for wells. This indicates these wells can be connected to other databases using the State ID information. However, differences in the format of the State ID between NWIS and other databases create challenges in cross referencing between databases. In this GSP, NWIS water quality measurements are utilized for basin characterization but are acquired from the other programs.

1.2.2.2.4 Division of Drinking Water

The SWRCB DDW monitors public water system wells for Title 22 requirements such as organic and inorganic compounds, metals, microbial, and radiological analytes. Data are available for active and inactive drinking water sources for water systems that serve the public – defined as wells serving 15 or more connections or more than 25 people per day. Data are electronically transferred from certified laboratories to DDW daily. Data generated from this program are used for regulatory compliance by water purveyors and become part of Consumer Confidence Reports (CCR) and GAMA.

1.2.2.2.5 GeoTracker

GeoTracker, operated by the SWRCB, contains records for sites that require cleanup, such as leaking underground storage tank sites, Department of Defense sites, and cleanup program sites. GeoTracker also contains records for various unregulated projects as well as permitted facilities including: ILRP, future CV-SALTS, oil and gas production, operating permitted underground storage tanks, and land disposal sites. GeoTracker receives records and data from SWRCB programs and other monitoring agencies.

1.2.2.2.6 Irrigated Lands Regulatory Program

The Irrigated Lands Regulatory Program (ILRP) is a program established by the CVRWQCB focused on monitoring and regulating the concentration of pesticides, toxicity, and nutrients (such as TDS and nitrates) in surface and groundwater. General orders under the ILRP require agricultural users in the Central Valley to prevent sediment, fertilizer, pesticides, manure, and other materials used in farming from leaving the field in irrigation or stormwater and entering surface waters or leaching below the root zone to groundwater. Agricultural users biannually sample and submit data for irrigation and domestic wells. As part of the ILRP, the San Joaquin County & Delta Water Quality Coalition members monitor drinking water wells on enrolled parcels for nitrates. This requirement began January 1, 2019, based on the February 7, 2018 revision of ILRP WDR (Order) for the Eastern San Joaquin River Watershed by the SWRCB. The ILRP program is in the process of developing a comprehensive monitoring network for future use to address the ILRP data objectives. The San Joaquin County & Delta Water Quality Coalition members also monitor domestic wells for nitrate in high vulnerability areas.

1.2.2.2.7 Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS)

The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) program was launched by the CVRWQCB in 2006 in an effort to develop sustainable salinity and nitrate management plans and solutions to the salinity problem in the Central Valley. CV-SALTS is a coalition of agricultural, business, and industry parties along with local, regional, and state governments which facilitate and fund efficient management systems of salinity, technical studies, and the 2017 Final Salt and Nitrate Management Plan (SNMP). The 2017 SNMP was developed based on a detailed water quality analysis conducted for salinity (represented by TDS) and nitrates using measurements from wells across multiple agencies from 2000-2016. Appendices to the SNMP and supporting documents contain summary information about these constituents by Subbasin, including Eastern San Joaquin. Basin Plan Amendments identify specific actions and recommendations for individual basins in the Central Valley. Efforts are underway to implement a salinity monitoring program and the CV-SALTS program will likely require monitoring and data submittal.

1.2.2.3 Interconnection of Databases

Several of the databases discussed above utilize the same water level or water quality data. These records often specify the monitoring entity responsible for the measurement. Although these data overlap between databases, the correlation between databases is not specified. For example, water level data in the WDL are also in CASGEM, but this link is not mentioned in WDL records. This lack of connection poses problems for gathering water level and quality data in the Eastern San Joaquin Subbasin and throughout California. For instance, if certain water level data are gathered through CASGEM but not uploaded to NWIS, users who gather water level measurements through NWIS would miss the CASGEM data. Efforts have been made in the development of this Plan to overcome the issue related to overlap and poor correlation between databases, but the issue remains. It is recommended that agencies work together to utilize a common unique identifier to ease use of multiple datasets.

1.2.2.4 Land Subsidence Monitoring

Subsidence monitoring is performed using continuous global positioning system (CGPS) stations.

UNAVCO's Plate Boundary Observatory Program – Reporting since 2004, the UNAVCO (formerly University Navigation Satellite Timing and Ranging or NAVSTAR Consortium) Plate Boundary Observatory network consists of a network of about 1,100 continuous global positioning system (CGPS) and meteorology stations in the western United States to measure deformation resulting from the constant motion of the Pacific and North American tectonic plates in the western United States. Stations located within the Subbasin contain data from at least 2006 to current and include station P309 located east of Linden and station P273 located west of Lodi. Other stations are also available in nearby Subbasins.

Subsidence analyses have also been conducted using satellite-based methods over limited time periods, as described below.

United States Geological Survey – The USGS report *Land Subsidence along the Delta-Mendota Canal in the Northern Part of the San Joaquin Valley, California, 2003-10* (Sneed et al., 2013) presents land subsidence data in the southwestern portion of the Eastern San Joaquin Subbasin from 2007 to 2010. Data for about 100 square miles of the Subbasin were recorded using Interferometric Synthetic Aperture Radar (InSAR) processing, a satellite-based remote sensing technique that can detect ground-surface deformation. Two InSAR techniques were used: conventional InSAR and persistent scatter (PS) InSAR. Both sources of data were collected from the Japanese Aerospace Exploration Agency's Advanced Land Observing Satellite.

Other -– DWR has made two InSAR datasets available for SGMA application: TRE Altamira InSAR point and raster data and NASA JPL raster data. Vertical displacement approximations in both datasets are collected by the European Space Agency's Sentinel-1A satellite. The two different datasets represent two different processing results, one by TRE Altamira Inc. and one by NASA JPL. The TRE Altamira data have coverage between January 2015 and June 2018. Both annual and total raster datasets from TRE Altamira are available and represent interpolations of the vertical displacement point features. The NASA JPL processed dataset spans Spring of 2015 to Summer of 2017 (CA DWR, 2019). The TRE Altamira dataset is mapped in Figure 2-64 and discussed in Section 2.2.5.

1.2.2.5 Groundwater Storage Monitoring

There are no existing programs that conduct regular monitoring specific to groundwater storage in the Eastern San Joaquin Subbasin. The ESJWRM historical model was used to generate estimates for historical groundwater storage based on a series of inputs including historical groundwater elevation data. The ESJWRM generated estimates for current and projected volumes of groundwater in storage based on assumptions for how future conditions may change relative to historical conditions.

1.2.2.6 Interconnected Surface Water Monitoring

There are no existing programs that conduct regular monitoring specific to the interconnection of surface water to groundwater in the Eastern San Joaquin Subbasin. However, surface water monitoring and groundwater level monitoring will be integrated to characterize spatial and temporal exchanges between surface water and groundwater and to estimate potential depletions of surface water caused by groundwater extractions. Additional information on how the depletions monitoring network was developed, monitoring frequency, and summary protocols is provided in Chapter 4: Monitoring Networks. Sources of groundwater level data are described in Section 1.2.2.1. Surface water data on stream flows and levels from stream gages are available from the USGS, CDEC, and local agencies.

1.2.2.7 Existing Water Management Programs and Plans

The subsections below contain descriptions of existing water management programs and plans, including Integrated Regional Water Management Plans (IRWMPs), Agricultural Water Management Plans (AWMPs), and Urban Water Management Plans (UWMPs) that apply to the Eastern San Joaquin Subbasin.

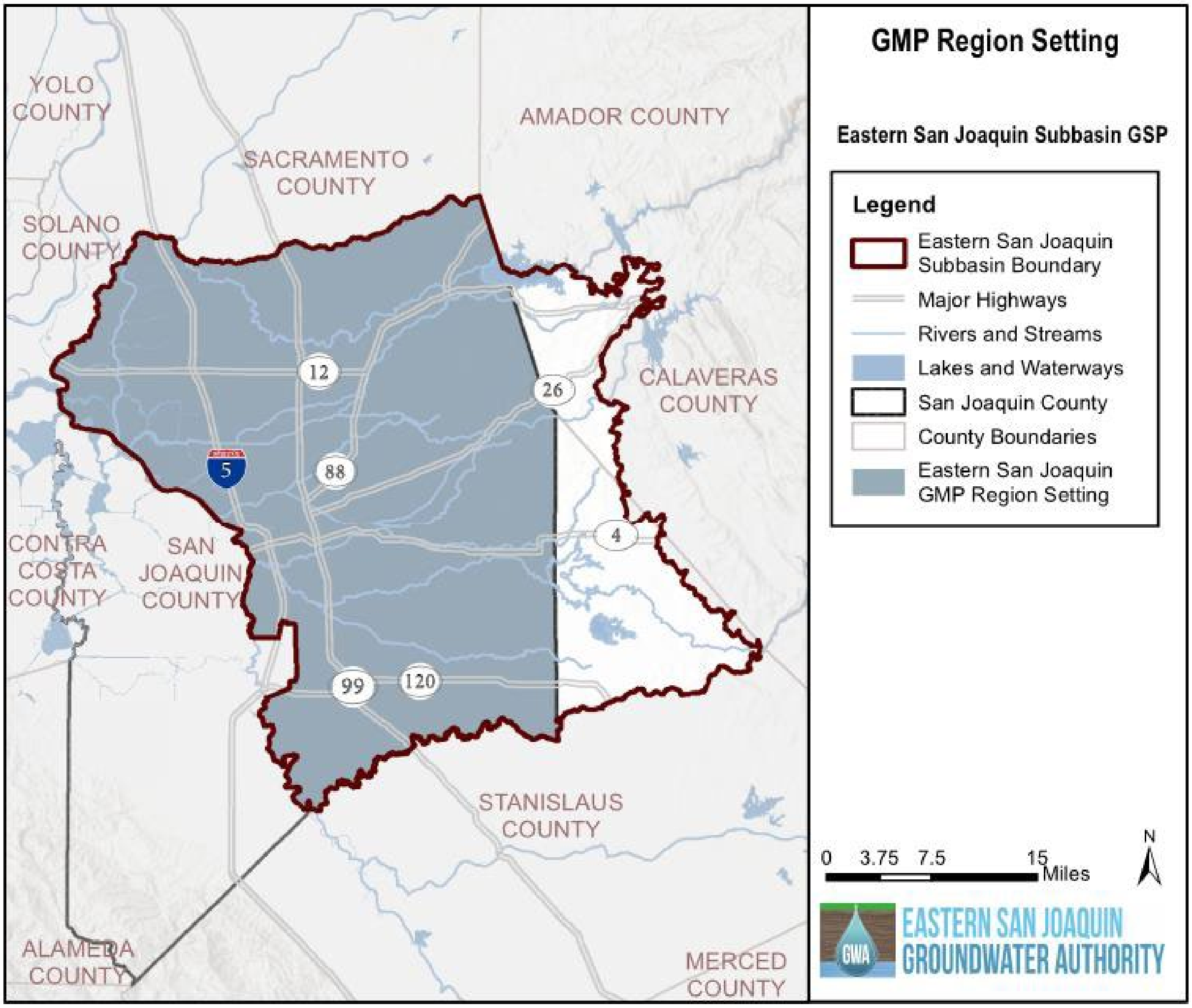
1.2.2.7.1 Groundwater Management Plan

The Eastern San Joaquin Groundwater Basin Groundwater Management Plan (GMP), developed by the Northeastern San Joaquin County Groundwater Banking Authority in September 2004, was a collaborative effort between local water interests with historically diverse viewpoints to reinforce local control and provide direction for the sustainable development of groundwater resources. The GMP covers a geographic region that includes the entire Eastern San Joaquin Subbasin that falls within San Joaquin County but excludes portions within Calaveras and Stanislaus counties to the east. The GMP boundaries are generally defined by the San Joaquin County line to the east, the San Joaquin River to the west, Dry Creek to the north, and the Stanislaus River to the south. A map of the Eastern San Joaquin GMP Region is shown in Figure 1-15.

The 2004 GMP provides valuable resources related to potential concepts, projects, and monitoring strategies that are leveraged in this GSP (Northeastern San Joaquin County Groundwater Banking Authority, 2004). The following management objectives will influence implementation of the GSP:

- Maintain or enhance groundwater elevations to meet the long-term needs of groundwater users within the Groundwater Management Area
- Maintain or enhance groundwater quality underlying the Basin to meet the long-term needs of groundwater users within the Groundwater Management Area
- Minimize impacts to surface water quality and flow due to continued Basin overdraft and planned conjunctive use
- Prevent inelastic land subsidence due to continued groundwater overdraft

Figure 1-15: Eastern San Joaquin GMP Region Setting



1.2.2.7.2 Integrated Regional Water Management Plan

The Eastern San Joaquin Integrated Regional Water Management Plan (Eastern San Joaquin IRWMP) is a collaborative regional planning document that was published in June 2014. The IRWMP defines and integrates key water management strategies to establish protocols and courses of action to implement the Eastern San Joaquin Integrated Conjunctive Use Program (ICU Program). The ICU Program was designed to implement a comprehensive, prioritized set of projects and management actions to meet adopted Best Management Objectives, moving the Eastern San Joaquin County Region toward the goal of sustainable and reliable water supplies (Eastern San Joaquin County GBA, 2014).

The following 2014 IRWMP objectives related to groundwater use would potentially influence implementation of the GSP:

- Minimize adverse impacts to agriculture, communities, and the environment
- Maximize efficiency and beneficial use of supplies

- Protect and enhance water rights and supplies

An update to the 2014 IRWMP is currently underway.

1.2.2.7.3 Mokelumne Interregional Sustainability Program Report

The Mokelumne Watershed Interregional Sustainability Evaluation (MokeWISE) was formed following efforts made by the Mokelumne River Forum over seven years by a diverse set of stakeholders in the Upper and Lower Mokelumne River watersheds, with the objective to develop and evaluate alternatives to optimize water resources management within the Mokelumne-Amador-Calaveras (MAC) and Eastern San Joaquin IRWM planning regions. The plan offers a bi-regional approach by bringing together stakeholders, and it brings together the interregional sections of two IRWM regions identified as the Mokelumne River Forum (San Joaquin GBA, 2015).

The following MokeWISE objectives related to groundwater use would potentially influence implementation of the GSP:

- Groundwater is not considered a viable additional source in Amador and Calaveras counties
- The Eastern San Joaquin Subbasin is considered critically overdrafted
- Groundwater is not considered a viable additional supply source in Amador and Calaveras counties due to low yield, unreliability, age of groundwater, and limited storage options, although conjunctive use and recharge opportunities may be available

1.2.2.7.4 Agricultural Water Management Plans

AWMPs were developed and adopted by OID, SEWD, SSJID, and WID in 2015 in compliance with SB X7-7 of 2009, which requires certain agricultural water suppliers to prepare an AWMP and implement Efficient Water Management Practices (EWMPs). The Critical EWMPs include:

- Measure the volume of water delivered to customers with sufficient accuracy to comply with requirements of the Water Code
- Adopt a pricing structure based at least in part on quantity delivered (Volumetric Pricing)

Applicable Conditional EWMPs that have the benefit of less applied water or increasing system efficiency include:

- Facilitate alternative land use for lands with exceptionally high water duties
- Facilitate use of available recycled water
- Facilitate financing of capital improvements for on-farm irrigation systems
- Implement an incentive pricing structure that promotes one or more of the goals identified in the Water Code
- Expand line or distribution systems, construct regulating reservoirs to increase distribution system flexibility and capacity, decrease maintenance, and reduce seepage
- Increase flexibility in water ordering by, and delivery to, water customers within operational limits
- Construct and operate supplier spill and tailwater recovery systems
- Increase planned conjunctive use of surface water and groundwater
- Automate canal control structures

- Facilitate or promote customer pump testing and evaluation
- Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress reports
- Provide for the availability of water management services to water users
- Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage
- Evaluate and improve the efficiencies of the supplier's pumps

The 2015 AWMPs provide a framework of management practices to help meet water management goals that align with the goals of the Eastern San Joaquin GSP.

1.2.2.7.5 Urban Water Management Plans

UWMPs were developed by Cal Water, CCWD, City of Lodi, City of Manteca, City of Ripon, City of Stockton, SSJID, and SEWD, according to requirements of the Water Code.

Agencies acting as GSAs use the following actions to encourage conservation and efficient use of water:

- Water waste prohibition ordinances
- Metered distribution systems
- Tiered water rates and conservation pricing
- Public education and outreach efforts
- Water conservation program coordination and staffing support
- Free residential plumbing retrofit devices
- Washing machine rebate program

1.2.2.8 Canal Diversions and Seepage

Canal seepage in the Eastern San Joaquin Subbasin is tracked on a district-by-district basis. All of the major irrigation districts utilize a combination of natural watercourses, canals, and pipelines to distribute surface water diversions to their customers.

OID diverts water from the Stanislaus River at Goodwin Reservoir through the Joint Main Canal on the north side and the South Main Canal on the south side. Approximately 330 miles of laterals carry water to landowners off of the main canals. While the entire lateral system historically consisted of open, unlined ditches, 100 miles of the laterals have been converted to pipelines; 105 miles are open, concrete-lined ditches; and the rest remain unlined. Approximately 40 percent of the OID service area is within the Eastern San Joaquin Subbasin. According to the district-wide water balance developed by OID as part of the 2015 Agricultural Water Management Plan, canal seepage is calculated to be 33,746 AF on average in wet years and 37,647 AF in dry years. Drain seepage is estimated to be 5,579 AF and 6,219 AF for wet and dry years, respectively. Deep percolation of applied water contributes about 27,474 AF of recharge on average overall. Within OID, approximately 44 percent of all recharge is due to canal seepage, and an additional 33 percent of all recharge is due to deep percolation of applied water (OID, 2015).

In SSJID, similarly, the primary source of recharge in the groundwater system is conveyance seepage and deep percolation of applied water. SSJID diverts from the Stanislaus River initially and then sends the water through a system of lateral canals to its customers. Like OID, the entire system was open and unlined, but over time it has been slowly concrete lined and replaced with buried pipelines. By 2015, SSJID used 312 miles of piped laterals and 38 miles of concrete-lined ditches. The 18 miles of the Main Distribution Canal is the only unlined portion. Recharge from canal seepage and deep percolation are estimated to be 144,000 AF/year, with 34 percent of total recharge from canal seepage and 66 percent from deep percolation (SSJID, 2015a).

SEWD uses two unlined canal systems to deliver water from the Stanislaus River: Upper Farmington Canal and Lower Farmington Canal. SEWD also uses natural watercourses to distribute their water, such as rivers, creeks, and sloughs. SEWD's two canals are estimated to lose about 5 percent of their flow to seepage, and natural water courses within the district may lose as much as 40 percent of their flow to seepage during the irrigation/delivery season. CSJWCD also uses the Upper Farmington Canal for distribution, as well as natural watercourses within its boundaries. SEWD estimates that 26,000 AF overall is recharged through canal and natural watercourse seepage within district boundaries for an average year (SEWD, 2015).

Historically, WID has also made efforts to improve the efficiency of the delivery infrastructure it maintains. Water for WID is diverted from the Mokelumne River and from the Delta at the end of Beaver Slough. In 2015, WID had about 100 miles of lined and unlined canals, and pipelines. Approximately 60,000 AF/year of Mokelumne River water is recharged through deep percolation and in-lieu recharge in WID. To address these losses, the District has imposed a $2 per acre fee on land benefiting from the use of unlined portions of the canal network (WID, 2016).

Canal seepage, generally considered a loss to districts in the short term, provides groundwater recharge and has played and will continue to play a crucial role in the long-term sustainability of groundwater resources in the Eastern San Joaquin Subbasin.

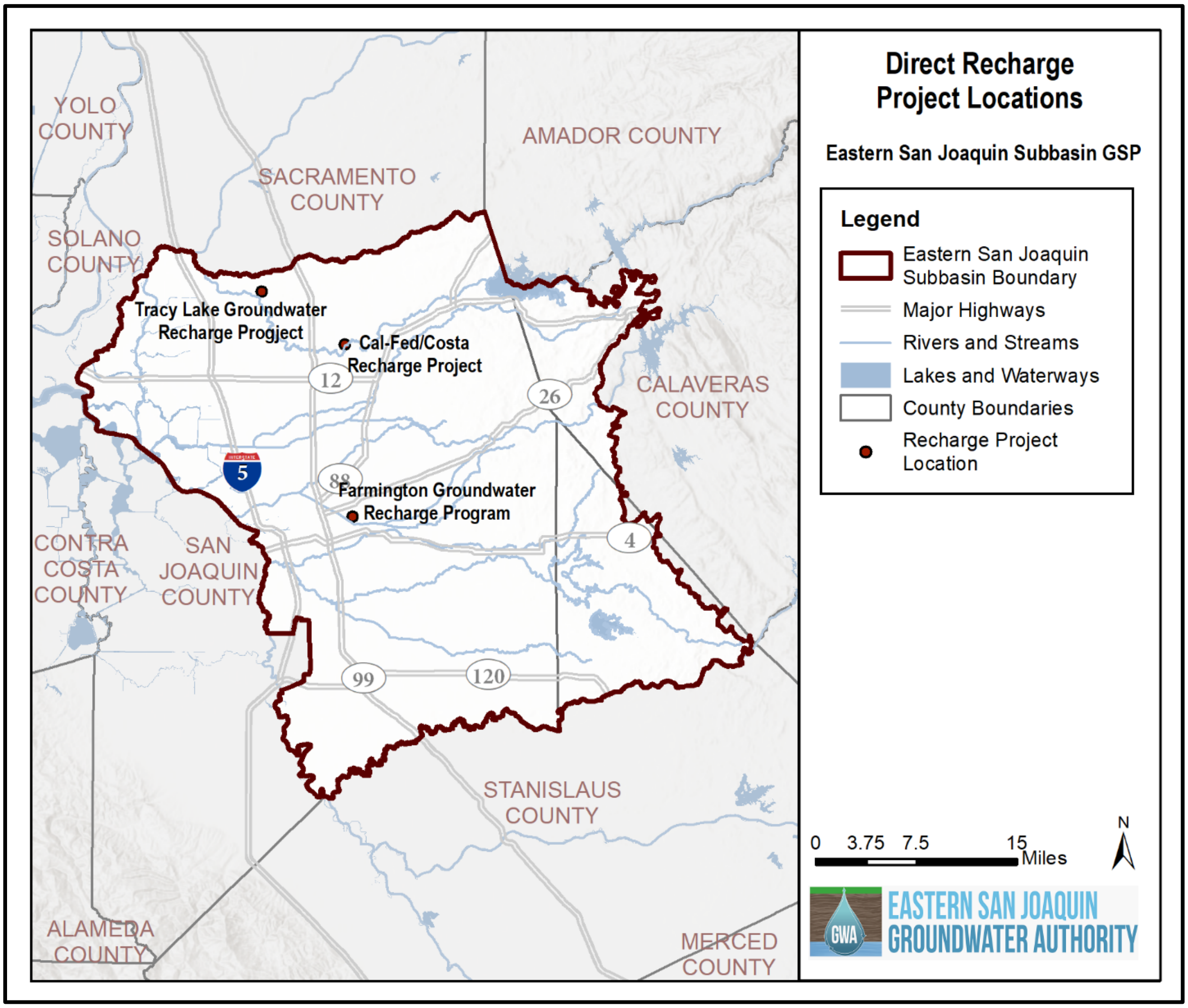
1.2.2.9 Conjunctive Use Programs

Conjunctive use is the use of surface water to allow the Subbasin to recharge and store additional water supply, either through in-lieu use or direct recharge. This section describes conjunctive use programs in the Eastern San Joaquin Subbasin, including both in-lieu recharge and direct recharge projects.

In-lieu recharge occurs for both agricultural and municipal purposes wherever surface water is being delivered to offset the use of groundwater. Agencies conducting in-lieu recharge include CCWD, City of Lodi, City of Manteca, City of Stockton, CSJWCD, OID, SEWD, SSJID, and WID. Riparian users of surface water are also benefitting from in-lieu recharge.

Direct recharge projects exist in NSJWCD and SEWD, as shown below in Figure 1-16. NSJWCD's Tracy Lake Groundwater Recharge Project includes direct recharge of 500 to 1,000 AF/year by placing surface water in the bed of South Tracy Lake to allow for percolation. The Cal-Fed/Costa Recharge project includes direct recharge of about 300 AF/year by flooding about 20 acres of vineyards post-harvest. NSJWCD is in the process of looking to expand all of these programs and add additional in-lieu and direct recharge projects in its service area. SEWD's Farmington Groundwater Recharge Program was developed in 2001 with a conceptual plan to recharge surface water via field flooding on about 1,200 acres. SEWD has operated a 60-acre recharge site since 2003 as a result of the Farmington Program with additional 73 acres coming online in 2019. The observed recharge amount ranges from 2,800 AF/year to 5,800 AF/year with an average of 4,400 AF/year for a total recharge volume of about 65,000 AF since the inception of the project. SEWD also has several wells to pump some of this recharged water for municipal supply during especially dry years.

Figure 1-16: Locations of Existing Groundwater Recharge Projects



1.2.3 Land Use Elements or Topic Categories of Applicable General Plans

1.2.3.1 General Plans in the Plan Area

San Joaquin County has jurisdiction over land use planning for the majority of the surface area of the Subbasin. Stanislaus County, Calaveras County, and the incorporated cities of Stockton, Manteca, Lodi, Ripon, and Escalon make up the remaining area. Implementation of the Eastern San Joaquin GSP may be affected by the policies and regulations outlined in the San Joaquin County General Plan, as well as the General Plans for the five cities, given that the long-term land use planning decisions that would affect the Subbasin are under the jurisdiction of the counties and respective cities.

This section describes how implementation of the various General Plans may change water demands in the Subbasin, how the General Plans may influence the GSP's ability to achieve sustainable groundwater use, and how the GSP may affect implementation of General Plan land use policies. Policies outlined in the General Plans that will potentially influence implementation of the GSP are discussed below and listed in Appendix 1-E.

1.2.3.1.1 San Joaquin County General Plan

The San Joaquin County General Plan describes the official county "blueprint" on the location of future land use, type of development encouraged, and decisions regarding resource conservation. Stakeholder input informed the development of the county's vision and guiding principles, which represent the county's core values and establish benchmarks for the General Plan's goals and policies. The General Plan encourages preservation of the San Joaquin County's groundwater resources and states that future urban and agricultural growth should occur within the sustainable capacity of these resources (SJC, 2016b).

1.2.3.1.2 Calaveras County General Plan

The Calaveras County General Plan has provided a framework for growth and development in Calaveras County. The Calaveras County General Plan was developed in 1996 in collaboration with local stakeholders and policymakers to understand the challenges facing the community and to enact a common vision for the future. The Calaveras County Planning Commission has been working since 2008 to revise the General Plan, which is now more than 20 years old.

The Calaveras County General Plan recognizes that water is a limited and valuable resource and that the region is experiencing localized problems with both water supply and quality. To mitigate these issues, the General Plan delineates policies and goals that promote sustainable water resources management in the region (Calaveras County, 1996).

1.2.3.1.3 Stanislaus County General Plan

The Stanislaus County General Plan provides a comprehensive, long-term plan to guide development within the Stanislaus County boundaries through 2035. The General Plan was updated and adopted in 2016 to reflect the evolving conditions of the region. While Stanislaus County's economic base remains predominantly agricultural, the county's land use and economy continue to diversify in response to increased pressure to convert productive agricultural lands to non-agricultural uses. To address the region's changing water needs, the Stanislaus County General Plan supports goals, policies, and implementation measures that promote sustainable water management and protect the local groundwater sources (Stanislaus County, 2016).

1.2.3.1.4 City of Stockton General Plan

The City of Stockton General Plan establishes the City's 2040 vision and provides supporting goals, policies, and actions needed to achieve it. The General Plan for the 2040 vision was built upon the prior 2035 Stockton General Plan (adopted in 2007) and was a collaborative process that involved a diverse group of stakeholders and interests. The General Plan update incorporated feedback from City Council study sessions, Planning Commission study sessions, community workshops, and numerous other public meetings and outreach events (City of Stockton, 2016).

The City of Stockton's General Plan recognizes that groundwater supplies are vital to Stockton's ability to meet current and future water demands. The city has focused attention on optimizing available surface water supplies and cooperating with agencies in the region to manage the groundwater resources at a sustainable yield and to address regulatory pressures, droughts, and saline intrusion (City of Stockton, 2016).

1.2.3.1.5 City of Lodi General Plan

The City of Lodi General Plan Update, published in 2010, outlines a vision for Lodi's future and provides a set of policies and programs that guide community growth and development. The 2010 General Plan Update replaced the 1991 General Plan and was informed by input from community members and stakeholders who participated in the planning process through different avenues, including public workshops and meetings, mail surveys, interviews, presentations, and newsletters (City of Lodi, 2010).

The General Plan recognizes that groundwater contamination and overdraft in the Eastern San Joaquin Subbasin can threaten the city's ability to meet current water demands and limit future development (City of Lodi, 2010).

1.2.3.1.6 City of Manteca General Plan

The City of Manteca adopted the current Manteca General Plan in 2003 and is currently working on the Manteca General Plan Update to reflect the current conditions of the city. The Manteca General Plan Update is anticipated to conclude in 2020 and is a collaborative process between community members, city staff, and decision-makers to produce a General Plan that is current, progressive, flexible, and viable. The General Plan Update also reevaluates the existing vision for Manteca through 2040, incorporates new planning strategies, and brings the General Plan into compliance with recent social and environmental justice policies and laws (City of Manteca, 2017).

The Manteca General Plan Update recognizes that groundwater is a large source of potable water supply for the city and that the Eastern San Joaquin Subbasin is in overdraft. To address groundwater overdraft in the city, a significant number of policies in the General Plan promote increased understanding of the Eastern San Joaquin Subbasin.

1.2.3.1.7 City of Escalon General Plan

The Escalon General Plan was developed by the city in 1994 and updated in 2010 to reflect the most current conditions of the city and to provide comprehensive planning for future development. The Escalon General Plan was developed through a cooperative effort involving the City Council and Planning Commission, city staff and their consultants, and stakeholders (City of Escalon, 2010). The Escalon General Plan delineates policies that support the long-term preservation of water supplies and water quality in the Eastern San Joaquin Subbasin (City of Escalon, 2010).

1.2.3.1.8 City of Ripon General Plan

The City of Ripon's General Plan was updated in 2006 to guide the use of private and public lands within the community's boundaries through 2040. The General Plan update provides a framework for promoting growth and reevaluates where growth should be located. The General Plan development process was informed by community members representing a wide variety of interests, city department heads, and staff representatives of public agencies (City of Ripon, 2006).

The General Plan supports the preservation of groundwater quantity and quality as it is an important source of water supply for the City of Ripon. Future development within the planning area is expected to have minimal effects on groundwater supplies, although it is unknown how development will impact groundwater quality. The General Plan predicts that the City of Ripon may have to abandon a large number of wells as sources of potable water due to localized contamination, and, as a result, additional development may be prohibited until an adequate source of potable water can be identified. Surface water is expected to meet water demands for surrounding agricultural uses (City of Ripon, 2006).

1.2.3.2 Effect of GSP Implementation on Applicable General Plans

The General Plans in the Subbasin provide guidelines to facilitate anticipated growth within the sustainable capacity of existing resources. Successful land use planning also promotes sustainable water supply and use within the region. Due to the complementary nature of the General Plans and the GSP, the goals and policies in the General Plans support the ability of the GSAs to achieve sustainability.

Implementation of the GSP, including changes in groundwater management, may influence the type of land use and location of future development, depending on the level of changes set forth by the GSP, such as enacted programs, plans, and policies. While General Plan implementation may result in land use changes and changes in water consumption, minimal change in water demand is expected from GSP implementation. The potential for future management actions, which could impact water supplies and development, is discussed in Section 6.5. Most of the land within the Eastern San Joaquin Subbasin is currently developed to some use, and conversion from agricultural uses to urban uses is not anticipated to increase water demand. However, conversion from agriculture to urban use may have an effect on water source, depending on the location in the Subbasin, and may shift supply from groundwater to surface water.

1.2.3.3 Land Use Plans Outside the Plan Area

Land use decisions in neighboring areas experiencing overdraft are likely to affect groundwater conditions in the Eastern San Joaquin Subbasin. Ongoing coordination with neighboring groundwater subbasins will include updates on major land use planning that may impact the groundwater system. The cities of Tracy, Lathrop, Modesto, Galt, and Elk Grove are the largest urban areas neighboring the Eastern San Joaquin Subbasin. The portions of the Tracy and the Delta-Mendota Subbasins that are adjacent to the Eastern San Joaquin Subbasin are also located within San Joaquin County. These land use planning areas are covered by the San Joaquin County General Plan described in Section 1.2.3.1.1.

The City of Tracy, located within San Joaquin County and the Tracy Subbasin, updated its General Plan in 2011. The City of Tracy General Plan identifies the Tracy Subbasin as a source of water supply for the city. The City of Tracy is working towards reducing its reliance on groundwater and reserving its use for emergency situations and droughts (City of Tracy, 2011).

The City of Lathrop, located within San Joaquin County and the Tracy Subbasin, relies on potable water supplies consisting of a combination of groundwater and treated surface water from the South County Water Supply Program. The General Plan for the City of Lathrop was first adopted in 1991 and last amended in 2004. The General Plan reflects the city's long-range aspirations by defining goals and policies for current and future development and by providing guidance on proposed projects.

The City of Modesto, located in Stanislaus County, relies on the Modesto and Turlock Subbasins for its groundwater supplies. The City of Modesto General Plan identifies declining groundwater levels as an environmental concern for the City of Modesto as a result of increased urban demands. The General Plan calls for continued protection and conservation of groundwater sources while pursuing additional water supplies (City of Modesto, 2008).

The City of Galt, located in Sacramento County, is on the southern edge of the Cosumnes Subbasin and last updated its General Plan in 2009. Groundwater from the Cosumnes Subbasin is the sole source of water supply for the city. The General Plan outlines policies to ensure groundwater availability and protection (City of Galt, 2009).

The City of Elk Grove, located in Sacramento County, relies heavily on groundwater from the South American Subbasin. To address years of drought conditions and low precipitation, the City of Elk Grove Draft General Plan outlines several goals and policies to protect groundwater supplies while meeting increased water demands from agricultural production and a growing population (City of Elk Grove, 2018).

1.2.3.4 Well Permitting

1.2.3.4.1 San Joaquin County

San Joaquin County oversees a well permitting program for any new, replacement, back-up, and de minimis well construction. The purpose of this program is to prevent groundwater contamination and safety hazards by regulation of the location, construction, repair, and destruction of water supply, monitoring, and geophysical wells and borings. Pursuant to Water Code §13808, all new wells that do not meet the exemption criteria must submit additional information prior to the issuance of a permit by the Environmental Health Department. The permit program is enforced by Ordinance Code of San Joaquin County §9-1115, and Municipal Codes of Stockton, Lodi, Manteca, Tracy, Escalon, and Ripon. Applicants must provide information about groundwater elevation estimates, land elevation estimates, extraction volume estimates, depth of Corcoran Clay, and other basic well characteristics.

San Joaquin County has established water well standards for new wells that define property line setbacks (at least 10 feet depending on well type), casing perforations, gravel packing, well seals, backflow prevention, disinfection requirements, sampling taps, and more, as well as the requirement for installing monitoring device(s) for groundwater extraction, elevation, and/or water quality. Other setbacks for potential sources of contamination or pollution require at least 50 feet depending on the contamination source and well type.

The San Joaquin County Well Standards outline well grouting and construction standards to prevent contamination, pollution, and degradation of water wells and of the groundwater by intrusion of poor-quality water. Wells must have a watertight annular seal near the land surface to keep surface water and other potential contamination out of the well. The minimum depth of the annular seal depth for wells in San Joaquin County is summarized in Table 1-1 (San Joaquin County, 1993).

Table 1-1: Minimum Depth of Seal Below Ground Surface for Wells in San Joaquin County

Well Type	Feet
Public Water Supplies	100
Individual Domestic Well	100
Industrial Wells	100
Agricultural Wells	50

1.2.3.4.2 Calaveras County

The Calaveras County Board of Supervisors adopted a well construction and destruction ordinance in 1998. The ordinance mandates that a permit must be obtained from the Calaveras County Environmental Health Department prior to development or modification of any well within the Calaveras County boundaries. The purpose of the program is to regulate the construction, alteration, abandonment, and destruction of wells such that groundwater will not be contaminated and that groundwater supplies will not jeopardize the health, safety, or welfare of Calaveras County residents.

To prevent polluted or contaminated water from entering the well, the well program established a minimum depth at which the annular space should be filled as well as minimum horizontal setback requirements. Horizontal setbacks from property lines range from 10 feet (for small parcels) to 150 feet (for underground storage with nearby wells at least 25 feet away). The minimum annular seal depths for wells in Calaveras County are summarized in Table 1-2 (Calaveras County Board of Supervisors, 2008).

Table 1-2: Minimum Depth of Seal Below Ground Surface for Wells in Calaveras County

Well Type	Feet
Public drinking water well	50
Commercial well	50
Industrial well	50
Individual domestic well	20
Agricultural well	20
Vertical geothermal exchange wells	20
Wells within 25 feet of a water way	20 feet below the bed of the water way

1.2.3.4.3 Stanislaus County

Pursuant to Chapter 9.36 of the Stanislaus County Code, well owners must first receive a valid permit from Stanislaus County to construct, install, repair, or destroy any well or well seal within the county. Stanislaus County DER is responsible for reviewing the applications and issuing permits. The Stanislaus County Code also states that all wells must have an annular seal, except for agricultural wells that are not used for domestic purposes and are located more than 300 feet from a domestic well (Stanislaus County, 2019a).

In 2014, the DER adopted a groundwater ordinance to prohibit unsustainable extraction of groundwater in unincorporated areas of the county. The DER reviews each well permit application and determines whether the well is subject to, or exempt from, the prohibitions in the Groundwater Ordinance. Permit applications for wells intended to extract 2 AF/year of groundwater or less are exempt from the prohibitions in the groundwater ordinance (Stanislaus County, 2019b). If the permit applicant is not exempt, a non-exempt wells supplemental application must be submitted and show that the groundwater pumped from the well is being sustainably extracted and will not cause any of the "Undesirable Results" listed in § 97.030 (9) of the groundwater ordinance. Additional permit application fees may be required, and the application review is conducted at the expense of the applicant (Stanislaus County, 2019c).

The minimum annular seal depths for wells in Calaveras County are summarized in Table 1-3, and are consistent with the state well standards (CA DWR, 1991).

Table 1-3: Minimum Depth of Seal Below Ground Surface for Wells in Stanislaus County

Well Type	Feet
Community water supply well	50
Industrial well	50
Individual domestic well	20
Agricultural well	20
Air conditioning well	20
All other types	20

1.2.3.4.4 Sacramento County

Sacramento County, which borders the northern boundary of the Eastern San Joaquin Subbasin (see Figure 1-6), oversees well permitting within their jurisdiction and requires property owners to obtain a permit for work including well construction, modification, repair, inactivation, destruction, installation, and replacement. Each well or pump requires its own permit application and fee, but waivers can be considered for multiple wells or exploratory borings of similar construction (Sacramento County, 2019).

The Sacramento County Code water well standards are designed to meet or exceed the water well standards in DWR's Bulletin 74-81 and 74-90. These standards apply to all types of monitoring wells, vapor extraction wells where applicable, and any other well installed in an area where special precautions are necessary to protect groundwater quality. The Sacramento County Environmental Management Department has the power under special circumstances to grant a variance from provisions in Chapter 6.28 of the Sacramento County Code and to prescribe alternative requirements in their place (Sacramento County, 2019).

The minimum annular seal depth for wells in Sacramento County is 50 feet for all well types, except for in cases of special approval (Sacramento County, 2019).

1.2.4 Additional GSP Elements

The Additional GSP Elements section of the GSP provides GSAs with the opportunity to discuss "any additional Plan elements included in Water Code §10727.4 that the Agency determined to be appropriate". These additional elements include:

- Control of saline water intrusion
- Wellhead protection areas and recharge areas
- Migration of contaminated groundwater
- A well abandonment and well destruction program
- Replenishment of groundwater extractions
- Activities implementing, opportunities for, and removing impediments to, conjunctive use or underground storage
- Well construction policies
- Measures addressing groundwater contamination cleanup, groundwater recharge, in-lieu use, diversions to storage, conservation, water recycling, conveyance, and extraction projects
- Efficient water management practices, as defined in Water Code §10902, for the delivery of water and water conservation methods to improve the efficiency of water use
- Efforts to develop relationships with state and federal regulatory agencies
- Processes to review land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity
- Impacts on groundwater dependent ecosystems

Each of the Additional Elements listed are relevant and important to the Eastern San Joaquin Subbasin, and are discussed throughout this GSP, as identified below.

Control of saline water intrusion – Section 2.2.3 describes the current status of saline water intrusion in the Subbasin. Section 3.2.4 addresses seawater intrusion as a sustainability indicator and identifies minimum thresholds, measurable objectives, and interim milestones. Actions to identify and monitor for saline water intrusion early is described in Section 3.2.4.4.

Wellhead protection areas and recharge areas – Section 1.2.3.4 addresses wellhead protection programs in San Joaquin County, Calaveras County, and Stanislaus County.

Migration of contaminated groundwater – The migration of contaminated groundwater that may impair water supplies is addressed in Section 3.2.3.

A well abandonment and well destruction program – Requirements and procedures for well destruction and abandonment are discussed in Section 1.2.3.4.

Replenishment of groundwater extractions – Proposed projects and management actions that will facilitate replenishment of groundwater extraction are discussed in Chapter 6: Projects and Management Actions. Areas where potential groundwater replenishment could occur through direct recharge are described in Section 2.1.4.5.

Activities implementing, opportunities for, and removing impediments to, conjunctive use or underground storage – Existing conjunctive use projects are identified in Section 1.2.2.9. The proposed projects and management actions that will address implementing, opportunities for, and removing impediments to, conjunctive use or underground storage projects in the Subbasin are discussed in Chapter 6: Projects and Management Actions.

Well construction policies – Section 1.2.3.4 addresses well construction policies in San Joaquin County, Calaveras County, and Stanislaus County. Annular well seal depth requirements are tabulated in Tables 1-1, 1-2, and 1-3.

Measures addressing groundwater contamination cleanup, groundwater recharge, in-lieu use, diversions to storage, conservation, water recycling, conveyance, and extraction projects – Proposed projects and management actions that address groundwater recharge, in-lieu use, diversions to storage, conservation, and water recycling are discussed in Chapter 6: Projects and Management Actions.

Efficient water management practices, as defined in Section 10902, for the delivery of water and water conservation methods to improve the efficiency of water use – Ongoing efforts to implement efficient water management practices are described in Section 1.2.2.7. Conservation methods and efficiency of water use are also noted in many local or regional general plans, detailed in Section 1.2.3. Projects relevant to this topic are discussed in Chapter 6: Projects and Management Actions.

Efforts to develop relationships with state and federal regulatory agencies – A strong relationship between the GSAs and existing regulatory agencies is valuable to the success of this GSP. Efforts to develop this relationship are described in Chapter 7: Plan Implementation.

Processes to review land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity – Summaries of land use plans both inside the Subbasin and in nearby Subbasins can be found in Section 1.2.3. Efforts are being made at the local level to develop a formal opportunity for GSAs to provide input on the land use and water-related elements of future General Plans and CEQA documentation to promote consistency with the GSP.

Impacts on groundwater dependent ecosystems – Groundwater dependent ecosystems (GDEs) are defined in Section 2.2.7. The methodology for identifying GDEs can be found in Section 2.2.7.1. A map of identified GDEs in the Subbasin is shown in Section 2.2.7.2. Adverse impacts to GDEs are described under Depletions of Interconnected Surface Water, Section 3.2.6, as part of the undesirable results discussion.

1.3 NOTICE AND COMMUNICATION

1.3.1 Beneficial Uses and Users in the Basin

The CVRWQCB designates all groundwaters in the Sacramento River Basin and San Joaquin River Basin as suitable or potentially suitable, at a minimum, for municipal and domestic water supply, agricultural supply, industrial service supply, and industrial process supply (CA RWQCB Central Valley Region, 2016).

As listed in Water Code §10723.2, beneficial uses and users of groundwater in the region include the following interests:

- Agricultural users and domestic well owners that hold overlying groundwater rights.
- Public water systems/municipal well operators in the Subbasin.
- Community water systems (wells serving 15 or more connections or more than 25 people per day). 433 community water systems were identified in the Eastern San Joaquin Subbasin and are presented in Appendix 1-F Of these 433 community water systems, 182 are located in DAC or SDAC areas, shown also in Appendix 1-F.
- Local agencies that have land use planning jurisdiction. These include counties of San Joaquin, Calaveras, and Stanislaus, and cities of Stockton, Lodi, Manteca, Escalon, and Ripon.
- Environmental users of groundwater, including species and habitat reliant on instream flows, as well as wetlands and GDEs. Identified GDEs are mapped in Figure 2-69 in Section 2.2.7.2. Freshwater species in the Eastern San Joaquin Subbasin are listed in Appendix 1-G.

- Irrigation districts in the Subbasin that divert surface water to deliver to their customers.
- Lands managed by the federal government. The San Joaquin River National Wildlife Refuge lies just outside of the Subbasin boundary. While managed by the State of California, Caswell Memorial SP is in the Subbasin and Carnegie SVRA and Franks Tract SRA are situated just outside of the Subbasin.
- DACs and SDACs. DACs and SDACs are mapped in Figure 1-8 and are primarily in the western portions of the Subbasin. Approximately 33 percent of the Subbasin area is considered disadvantaged and 7 percent is considered severely disadvantaged. 55 percent of the Subbasin population is considered either DAC or SDAC; within that, 25 percent of the population is SDAC. DACs include the following census designated places (CDPs)[1]: Stockton City CDP, Collierville CDP, Lockeford CDP, Terminous CDP, and Valley Home CDP. Severely disadvantaged communities include: Kennedy CDP, August CDP, French Camp CDP, Taft Mosswood CDP, and Thornton CDP.
- Entities that monitor and report groundwater elevations. Monitoring in the Subbasin is extensive. A list of monitoring agencies can be found in Section 1.2.2.
- California Native American tribes

1.3.2 List of Public Meetings Where the GSP was Discussed

During the development of this GSP, meetings of the ESJGWA Board, Advisory Committee, and Workgroup were open to the public, with meeting information noticed, as appropriate, and posted to the ESJGWA website (discussed below in Section 1.3.4.1). In addition, informational open house events were held throughout GSP development (see Section 1.3.2.4).

Below is a list of the public meetings where the GSP was discussed. The following includes the public meetings held from June 2017 through July 2019.

1.3.2.1 ESJGWA Board Meetings

In 2017, ESJGWA Board meetings were held on June 14, July 12, August 9, September 13, October 11, and November 8.

In 2018, ESJGWA Board meetings were held on February 14, March 14, April 11, May 9, June 13, July 11, August 8, September 12, October 10, and November 14.

In 2019, ESJGWA Board meetings were held on February 13, March 13, April 10, May 8, June 12, July 10, August 14, September 11, and October 17.

ESJGWA Board meetings are anticipated for November 13, 2019; December 11, 2019; and January 8, 2020 prior to GSP submittal.

1.3.2.2 ESJGWA Advisory Committee Meetings

In 2018, Advisory Committee meetings were held on May 9, June 13, July 11, August 8, September 12, October 10, and November 14.

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[1] A census designated place is a concentration of population identified by the United States Census Bureau for statistical purposes. CDPs are delineated for each decennial census as the statistical counterparts of incorporated places, such as cities, towns, and villages.

In 2019, Advisory Committee meetings were held on January 9, February 13, March 13, April 10, April 24, May 8, June 12, July 10, September 11, and October 17.

ESJGWA Advisory Committee meetings are anticipated for November 13, 2019; December 11, 2019; and January 8, 2020 prior to GSP submittal.

1.3.2.3 Groundwater Sustainability Workgroup Meetings

In 2018, Workgroup meetings were held on June 12, July 10, August 15, September 11, October 9, and November 13.

In 2019, Workgroup meetings were held on January 9, February 13, March 13, April 10, May 8, June 12, and September 11.

1.3.2.4 Informational Open House Events

In 2018, informational open house events were held on August 29 and November 7.

In 2019, informational open house events were held on February 12 and July 18.

1.3.2.5 Outreach Presentations to Community Groups

In 2018, presentations to community groups were conducted for targeted outreach on May 10 (Manteca Kiwanis Sunrise Club), August 8 (San Joaquin County Farm Bureau Federation), August 27 (NSJWCD Board of Directors), September 24 (Delta-Sierra Group), and November 14 (San Joaquin County Hispanic Chamber of Commerce).

In 2019, presentations to community groups were conducted for targeted outreach on February 20 (Manufacturers Council of the Central Valley), and September 25 (Stanislaus County Board of Supervisors).

In 2019, GSAs conducted informational community meetings, which included outreach presentations, on March 26 (City of Lodi), August 7 (French Community), August 8 (Thornton Community), and August 16 (Mokelumne River Association).

1.3.3 Decision-Making Process

The ESJGWA Board is tasked with the vote and approval of policy decisions for the development and implementation of this GSP. The ESJGWA Board receives input from an Advisory Committee, the Workgroup, and the public, as described in Section 1.1.4.2.

The governing bodies of each of the individual GSAs take action and provide direction to their Board member representatives and must individually approve the final GSP. Projects will be administered by the GSA project proponents. Although the ESJGWA does not provide direct authority to require GSAs to implement projects, the GWA will be working on GSA-level water budgets and will be requesting annual or biannual progress reports to evaluate progress. A description of the agencies that comprise the GSAs can be found in Section 1.1.4.3.

1.3.4 Opportunities for Public Engagement and How Public Input was Used

Throughout the process of GSP development, the ESJGWA has engaged stakeholders and the public in the development of the GSP, including the actions listed below. This effort has been greatly aided by the facilitation support provided through DWR's Facilitation Support Services Program. This included a Situation Assessment to determine stakeholder concerns related to the GSP development process. The Situation Assessment is discussed in more detail in Section 1.3.4.6.

1.3.4.1 ESJGWA Website

The ESJGWA website has been online since 2018 and continues to be maintained on a regular basis at **www.esjgroundwater.org**. It contains an introduction to SGMA, details on member agencies, and ESJGWA Board updates with meeting information and materials posted regularly. There are detailed sections for GSP resources, technical reports and data, educational materials, and meeting notices with the accompanying presentation materials and minutes. A section of the website is devoted to press releases, newsletters, public notices, and other major events and accomplishments. Contact information is readily available for interested parties to communicate with ESJGWA members and staff, and members of the public can subscribe to the ESJ GWA mailing list to receive updates on GSP development and outreach events.

1.3.4.2 Groundwater Sustainability Workgroup

The ESJGWA developed a Workgroup in order to promote stakeholder input and relied upon the Workgroup when developing the GSP. The Workgroup began with an application process to ensure a diverse cross section of populations were represented to serve on the Workgroup. Workgroup members participated and provided valuable input throughout the GSP development process.

Applications were distributed to organizations within every GSA to establish a Workgroup that represented the region's broad interests, perspectives, and geography. The Workgroup included members from a variety of organizations who represent one or more of the interested parties' groups. Table 1-4 lists the organizations and interests represented on the Workgroup.

Table 1-4: Groundwater Sustainability Workgroup Interests

Eastern San Joaquin Groundwater Authority
Groundwater Sustainability Workgroup – Interests Represented

AG	Agricultural	**BUS**	Business
CM	Community Neighborhood	**DAC**	Disadvantaged Communities
ENV	Environmental	**INST**	Institutional
FM	Flood Management	**NA**	Native American
GU	Groundwater User		

Role/Organization	AG	BUS	CM	DAC	ENV	FM	GU	INST	NA	Application Notes
2Q Farming	✓		✓			✓				2Q Farming is interested in making a difference for agriculture and communities, and in preserving water rights for future generations so they will have the ability to irrigate and access the water necessary for life.
Agricultural Business – Farmer Representative	✓	✓	✓	✓	✓	✓	✓			As a representative of agricultural business, this member sees SGMA as an opportunity to manage the Subbasin while keeping jurisdiction, implementation, monitoring, and oversight at the local level.
Calaveras County Resource Conservation District	✓		✓	✓	✓	✓	✓	✓		Calaveras County RCD hopes to partner with groundwater users in the western part of Calaveras County to address sustainability and recharge.
California Sportfishing Protection Alliance	✓				✓	✓	✓	✓		California Sportfishing Protection Alliance, longtime Mokelumne River stakeholder, is interested in reducing groundwater overdraft, managing surface water responsibly, and resolving longstanding conflicts. Representative is interested in the technical aspects of groundwater management and gaining a better understanding of recharge.

Eastern San Joaquin Groundwater Authority
Groundwater Sustainability Workgroup – Interests Represented

AG	Agricultural	**BUS**	Business
CM	Community Neighborhood	**DAC**	Disadvantaged Communities
ENV	Environmental	**INST**	Institutional
FM	Flood Management	**NA**	Native American
GU	Groundwater User		

Role/Organization	AG	BUS	CM	DAC	ENV	FM	GU	INST	NA	Application Notes
Catholic Charities of the Diocese of Stockton			✓	✓	✓	✓	✓			The Environmental Justice Program of the Catholic Charities of the Diocese of Stockton works with disadvantaged communities. Some of these communities have concerns regarding drinking water quality and toxic contamination of groundwater supplies.
Environmental Justice Coalition for Water			✓	✓		✓	✓			The Environmental Justice Coalition for Water is interested in ensuring that environmental justice interests are present, informed, and meaningfully engaged in a process that bears considerable importance for health, wealth, and growth.
J.R. Simplot Co.	✓	✓			✓					As a local industry representative with a stake in groundwater quality, this representative sees benefit in being part of the stakeholder process.
Lima Ranch	✓	✓			✓	✓	✓			Lima Ranch views water as a precious commodity that must be conserved and used sustainably. Representative values preserving water rights and using water efficiently.
Machado Family Farms	✓		✓				✓			Representative manages a family farm and brings agricultural experience and experience with the California Public Utilities Commission to provide a balanced perspective.
Manufacturers Council of the Central Valley	✓	✓			✓	✓	✓			Through their involvement as a stakeholder, Manufacturer's Council of the Central Valley provides resources to manufacturers impacted by the implementation of GSPs and to GSAs looking to work with the sector.

Eastern San Joaquin Groundwater Authority
Groundwater Sustainability Workgroup – Interests Represented

AG	Agricultural	**BUS**	Business
CM	Community Neighborhood	**DAC**	Disadvantaged Communities
ENV	Environmental	**INST**	Institutional
FM	Flood Management	**NA**	Native American
GU	Groundwater User		

Role/Organization	AG	BUS	CM	DAC	ENV	FM	GU	INST	NA	Application Notes
Restore the Delta			✓	✓	✓	✓	✓			Representative is interested in the link between surface water flows for the Sacramento-San Joaquin Delta and groundwater management. Additionally, this member brings connections for broad environmental justice outreach.
San Joaquin Audubon					✓					San Joaquin Audubon is interested in overall water use and environmental issues.
San Joaquin County Environmental Health Department			✓		✓		✓			The San Joaquin County Environmental Health Department plays a role in protecting the area's groundwater resource, drinking water, and public health.
San Joaquin Farm Bureau	✓	✓	✓			✓	✓			The San Joaquin Farm Bureau is interested in helping manage and utilize the groundwater reservoir to better supply all needs for the short and long term.
Sequoia ForestKeeper					✓					Sequoia ForestKeeper has been submitting comments on water-related issues to the SWRCB since 2015.
Sierra Club - Delta-Sierra Group	✓		✓	✓	✓	✓	✓			Sierra Club cares about the future of the Eastern San Joaquin Subbasin and sustainability. They believe that representation of individuals is lacking and there is insufficient outreach.
Spring Creek Golf & Country Club		✓	✓		✓	✓	✓			Representative is golf course superintendent at Spring Creek Golf & Country Club and is interested in groundwater rights and contributing to the stakeholder Workgroup.

Eastern San Joaquin Groundwater Authority Groundwater Sustainability Workgroup – Interests Represented										
AG Agricultural **CM** Community Neighborhood **ENV** Environmental **FM** Flood Management **GU** Groundwater User	**BUS** Business **DAC** Disadvantaged Communities **INST** Institutional **NA** Native American									
Role/Organization	**AG**	**BUS**	**CM**	**DAC**	**ENV**	**FM**	**GU**	**INST**	**NA**	**Application Notes**
The Hartmann Law Firm	✓	✓	✓			✓	✓			Representative is Advisory Water Commissioner, District Counsel for multiple reclamation districts.
The Wine Group	✓	✓			✓		✓			The Wine Group has technical knowledge and provides a unique viewpoint that supports the successful development of a GSP for the Eastern San Joaquin Subbasin.
Trinchero Family Estates and Sutter Home Winery	✓	✓	✓		✓		✓			Trinchero Family Estates and Sutter Home Winery is interested in helping develop a balanced approach for communities and businesses.
University of the Pacific		✓	✓			✓				Representative is an Emeritus Professor of Operations/Engineering Management at the University of the Pacific and is engaged in research on stream flow diversion for groundwater recharge.

The Groundwater Sustainability Workgroup meetings were held approximately monthly, typically on the second Tuesday or Wednesday of each month. The meetings were open to the public and provided opportunities for attendees to learn more about the process and provide input.

1.3.4.3 Stakeholder Outreach and Engagement Plan

With the support of the Workgroup, the ESJGWA developed an initial Stakeholder Outreach and Engagement Plan (see Appendix 1-H) for the San Joaquin Subbasin detailing a stakeholder engagement strategy has been developed to achieve the following goals:

- Keep interested list of stakeholders informed and aware of opportunities for involvement through email communications and/or their preferred mode of communication
- Engage DWR for facilitated support to aid in the development of the GSP
- Open ESJGWA planning efforts to the public with agendas and meeting minutes published on the ESJGWA website
- Inform and obtain comments from the general public through public meetings held on an approximately quarterly basis
- Facilitate productive dialogue among participants at Advisory Committee, Workgroup, and public meetings through the use of qualified facilitators to obtain, consider, and integrate feedback accordingly throughout the planning process
- Seek the input of interest groups during the implementation of the GSP and any future planning efforts
- Obtain input from the Workgroup about preferred locations to conduct public informational meetings to reach diverse audiences and disadvantaged communities
- Provide timely and accurate public reporting of planning milestones through the distribution of outreach materials and posting of materials on the ESJGWA website for the GSP
- Secure quality media coverage that is accurate, complete, and fair
- Maintain an active communications tracking tool to capture stakeholder engagement and public outreach activities and to demonstrate the reporting of GSP outreach activities

1.3.4.4 Stakeholder Database

The ESJGWA developed a database of stakeholders who represent the region’s interests, perspectives, and geography. The database was developed by leveraging existing stakeholder lists and databases from prior Eastern San Joaquin Subbasin engagement efforts, conducting new research, and obtaining referrals from key stakeholders and stakeholder groups.

During the initial development of the stakeholder database, the ESJGWA worked with those responsible for implementing the GSP to obtain contact lists of interested parties within the Subbasin as well as other diverse contact lists they maintain.

This robust stakeholder list of interested parties includes, but is not limited to, the following:

- Community water systems
- Agricultural well owners

- Domestic well owners
- Municipal well operators
- Groundwater users (including agricultural)
- Local land use planning agencies
- Government agencies
- Nonprofit organizations
- Environmental organizations
- Higher education institutions
- Community based organizations
- Neighborhood organizations
- California Native American Tribes
- Disadvantaged communities
- Private citizens

The Stakeholder Database was regularly updated by adding additional parties who expressed interest at public meetings and through website signups. Contacts were updated or removed as needed. The database served as the foundation for targeted outreach and communication throughout the project and was also used to:

- Provide a single repository to collect, store, and organize information on Subbasin stakeholders
- Allow individuals to self-identify their SGMA interests when they sign up as an interested stakeholder
- Identify the interests and concerns of organization contacts and individual stakeholders
- Plan meetings and send notices to stakeholders based upon their identified interests and role
- Document all stakeholders invited to GSP development meetings and their primary input at the meetings
- Post meeting agendas and minutes
- Produce communication and engagement summary reports

Table 1-5 provides a summary breakdown of the number of parties and interests represented in the Stakeholder Database.

Table 1-5: Stakeholder Database Summary

Eastern San Joaquin Groundwater Authority Stakeholder Database	
Interest Represented	**Number of Stakeholders**
Agricultural	31
Government Agency	19
Groundwater	152
Business	33
Nonprofit	5
Higher Education	1
Community Based Organization/Neighborhood Association	14
Disadvantaged Communities	21
Environmental	30
Flood Control	6
Community Water Systems	433
Native American Tribe	4
Private Citizen	17
Total	**766**

Outreach materials promoting informational open house events were distributed via email to the stakeholder database, and hard copies were distributed to the 433 community water systems, in August 2018, October 2018, January 2019, and July 2019.

1.3.4.5 Stakeholder Education and Outreach

Recognizing that an inclusive outreach and education process supports the success of a well-prepared GSP, the ESJGWA has prioritized stakeholder involvement and outreach in plan development and implementation, dedicating staff and financial resources for this high-priority effort.

- The ESJGWA held four informational open house events devoted to SGMA outreach and providing information to the public on the GSP development process. The purpose was to provide participants with information on GSP development, seek feedback from stakeholders and the public, provide a forum for the public to interact with their GSA representatives, and address questions in a transparent manner. These events were held on an approximately quarterly basis in different locations throughout the Subbasin, as listed below.
    - **August 2018 –** Robert J. Cabral Agricultural Center, Stockton (51 attendees)
    - **November 2018 –** Manteca Transit Center, Manteca (25 attendees)
    - **February 2019 –** Lockeford Community Center, Lockeford (61 attendees)
    - **July 2019 –** Robert J. Cabral Agricultural Center, Stockton (38 attendees)
- Targeted outreach presentations were given at community meetings to the following groups:
    - Delta-Sierra Group (September 2018)
    - Manteca Kiwanis Sunrise Club (May 2018)
    - Manufacturers Council of the Central Valley (February 2019)

    - North San Joaquin Water Conservation District Board of Directors (August 2018)
    - San Joaquin County Hispanic Chamber of Commerce (November 2014)
    - San Joaquin Farm Bureau Federation (August 2018)
    - Stanislaus County Board of Supervisors (September 2019)
- Additionally, GSA member agencies hosted local informational community meetings related to the SGMA process and to publicize the release of the Public Draft GSP for public comment.
    - City of Lodi – City of Lodi Public Outreach Event (Hutchins Street Square, Lodi) (March 2019)
    - San Joaquin Public Works Department – French Community SGMA Outreach Event (Robert J. Cabral Agricultural Center, Stockton) (August 2019)
    - San Joaquin Public Works Department – Thornton Community SGMA Outreach Event (Thornton Community Center, Thornton) (August 2019)
    - Stanislaus County – Mokelumne River Association Meeting SGMA Outreach Opportunity (Hotel Leger, Mokelumne Hill) (August 2019)
- Individually, member GSAs provided targeted outreach materials to their constituencies through the distribution of outreach and informational materials.
- The ESJGWA distributed SGMA outreach materials at various programs and events to reach growers. Outreach flyers containing information on SGMA and GSA contact information were distributed at the San Joaquin County Pesticide Applicator Permitting meetings in November 2018.
- Factsheets and email announcements were used to raise awareness about topics and events relevant to the GSP development process. Outreach included providing overviews of participation opportunities for GSP planning processes.
- Social media channels, such Facebook, were used to distribute targeted information relevant to the GSP planning process and ways to get involved. A Facebook page for the ESJGWA was developed, and social media templates were distributed to members of the ESJGWA Board, Advisory Committee, and Workgroup for use on their agency social media accounts.
- Comment cards, provided in postcard format at every public informational open house, allowed the public and stakeholders to contribute written comments, solicit additional information, make suggestions, and submit other feedback as appropriate.
- News releases were distributed to regional media agencies, including local newspapers and radio stations, to draw attention to important ESJGWA events such as workgroup and public meetings.

1.3.4.6 Situation Assessment

The ESJGWA applied for and received facilitation support through DWR's Facilitation Support Services Program to conduct a Situation Assessment, the purpose of which was to facilitate the stakeholder engagement process by determining stakeholder concerns related to the GSP development process. The facilitation services supported third-party interviews conducted with the members of the Workgroup in the winter of 2018 as part of the Situation Assessment. All Workgroup members were invited to participate in the Situation Assessment, and 17 were interviewed during a series of in-person and phone interview sessions. Assessment summary and highlights are available on the ESJGWA website.

Situation Assessment questions covered topics including:

- Outreach and engagement approach
- Meeting presentations
- Meeting discussions
- Strengthening the Workgroup process
- Decision making and input
- GSP development and plan content
- Resource and management conditions data
- Implementation considerations

Situation Assessment findings were presented to the Workgroup, the Advisory Committee, and the ESJGWA Board. Changes, including those to the Workgroup process, meeting presentations and discussions, and draft GSP development and review schedule were made based on feedback from the Workgroup members.

1.3.4.7 Incorporation of Stakeholder Feedback

The development of this GSP was informed and supported by stakeholder feedback, which was documented, addressed, and incorporated at numerous points throughout the development process. The public was invited to provide input at each Advisory Committee and ESJGWA Board meeting, including the Projects and Management Actions Workshop, which featured a public feedback survey. Information provided for GSP development was refined based on input from public meetings. Stakeholder involvement was additionally supported through monthly meetings of the Workgroup, a 23-member multidisciplinary stakeholder group that was formed for the specific purpose of soliciting input on GSP development from a wide range of beneficial users of groundwater in the Subbasin. Questions raised by participants at these meeting were addressed, with follow-up content presented and discussed at subsequent meetings.

Ideas generated at the Workgroup meetings were directed to decision makers at the ESJGWA Board meetings. Input was captured in monthly meeting summaries, which were reviewed by Workgroup members prior to being presented to the ESJGWA Board in meeting agenda packets and posted to the ESJGWA website. In addition, summaries of prior month Workgroup meetings, as well as highlights and key takeaways from those meetings, were presented regularly as a standing agenda item at ESJGWA Board meetings.

In addition to influencing GSP development and decisions related to groundwater management, feedback from stakeholders played a key role in enhancing education and outreach efforts, and the stakeholder involvement process more broadly. Changes were made to the Open House format following stakeholder comment, and outreach events with community groups (as referenced in Section 1.3.4.5 above) were added based on feedback to further spread the word about SGMA and local GSP development efforts. Changes to the Workgroup meeting structure and process were also made based on findings of the Situation Assessment.

1.3.4.8 Draft GSP Public Comment Review Period

The Public Draft GSP was posted on the ESJGWA website for a 45-day public comment period from July 10 through August 25, 2019. Notices and press releases were provided in English and Spanish publicizing the public comment period and inviting members of the public to attend the July 2019 informational open house event for more information. This event was scheduled to align with the release of the Draft GSP to provide a forum for the public to receive information, ask questions, and provide input. Hard copies of the Draft Plan were placed in libraries and at GSA main offices for public viewing and were available by request.

The following libraries received hard copies of the Public Draft GSP:

- Lodi Public Library
- Cesar Chavez Central Library
- Margaret Troke Library
- Maya Angelou Library
- Fair Oaks Branch Library
- Weston Ranch Library

The ESJGWA received 19 public comment submissions from a range of interested parties, including non-government organizations, neighboring subbasins, ESJGWA GSAs, state and federal agencies, and others. These individuals and organizations are listed below, and comments are provided in Appendix 1-I.

- California Department of Fish and Wildlife, North Central Region
- California Poultry Federation
- California Sportfishing Protection Alliance, including comments by Greg Kamman (Kamman Hydrology & Engineering, Inc.)
- Collective comments by The Nature Conservancy, Audubon California, Clean Water Action, Clean Water Fund, American Rivers, and Union of Concerned Scientists
- Collective comments by The League of Women Voters of San Joaquin County; Environmental Justice Coalition for Water; Sierra Club, Delta Sierra Group; Puentes; and Restore the Delta
- Cosumnes Subbasin
- East Bay Municipal Utility District (EBMUD)
- Jane Wagner-Tyack (Communication Consultant)
- Larry Walker Associates, on behalf of agricultural interests
- North San Joaquin Water Conservation District
- Restore the Delta
- Sierra Club, Delta-Sierra Group
- South San Joaquin GSA
- Stockton East Water District
- Terra Land Group, LLC

- The Freshwater Trust, on behalf of Northern Delta GSA and associate member Staten Island-Conservation farms and ranches
- The Nature Conservancy
- The Wine Group
- Tracy Subbasin

The ESJGWA appointed an Ad-Hoc Committee to review and summarize public comments, and to draft proposed response to comment recommendations for approval by the ESJGWA Board. The Comment Review Ad-Hoc Committee convened for three workshops on September 19, September 24, and October 4, 2019. The ESJGWA reviewed the Ad-Hoc Committee's recommendation and took action to approve functional changes to the Public Draft GSP on October 17, 2019. The ESJGWA's responses to comments are provided in Appendix 1-J.

1.3.5 Inter-basin Coordination

As part of the SGMA process, stakeholder outreach includes inter-basin coordination efforts. To date, there have been initial meetings between representatives of the ESJGWA and the neighboring subbasins to initiate this process. The purpose of these coordination meetings was to share and discuss elements included in the Eastern San Joaquin Draft GSP, including water budget estimates, boundary flow assumptions, and minimum thresholds. Participants discussed next steps for data sharing and ongoing coordination.

A summary of the initial inter-basin coordination meetings with neighboring subbasins is below.

- Cosumnes Subbasin – April 15, 2019
- Tracy Subbasin – June 20, 2019
- Modesto Subbasin – July 10, 2019
- South American, Solano, and East Contra Costa Subbasins – July 19, 2019

The ESJGWA plans to reach out to neighboring subbasins as part of GSP implementation to increase coordination as neighboring subbasins further GSP development.

1.3.6 Notice of Intent to Adopt the GSP

A notice of intent (NOI) to adopt a GSP was signed by the GSAs and distributed on August 16, 2019. The NOI was posted to the ESJGWA website homepage and hard copies were mailed cities and counties within the Subbasin, including the following:

- County of Calaveras
- County of Stanislaus
- County of San Joaquin
- City of Escalon
- City of Ripon
- City of Manteca
- City of Oakdale

- City of Ripon
- City of Stockton
- Linden County Water District
- Lockeford Community Services District

The signed NOI is provided in Appendix 1-K.

This revised GSP was accepted by the ESJGWA on July 13, 2022 and subsequently adopted by each of the individual GSAs. The NOI to adopt the revised GSP was distributed by ESJGWA on behalf of the GSAs on April 15, 2022. The signed NOI to adopt the revised GSP is provided in Appendix 1-L.

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2. BASIN SETTING

This Basin Setting chapter contains three main sections as follows:

- **Hydrogeologic Conceptual Model –** Section 2.1 (Hydrogeologic Conceptual Model) provides the geologic information needed to understand the framework under which water moves through the Subbasin. It focuses on geologic formations, aquifers, structural features, and topography.
- **Current and Historical Groundwater Conditions –** Section 2.2 (Current and Historical Groundwater Conditions) describes and presents groundwater trends, levels, hydrographs and level contour maps, estimates changes in groundwater storage, identifies groundwater quality issues, addresses land subsidence, and addresses surface water interconnection.
- **Water Budgets –** Section 2.3 (Water Budgets) describes the data used to develop the water budget. This section also discusses how the budget was calculated and provides water budget estimates for historical conditions, current conditions, and projected conditions.

2.1 HYDROGEOLOGIC CONCEPTUAL MODEL

2.1.1 Data Compilation

This section describes the HCM for the Eastern San Joaquin Subbasin. The regulatory framework is based on the California Code of Regulations (CCR) Title 23 § 354.14. The HCM presents the physical characteristics used to define water movement throughout the Eastern San Joaquin Subbasin.

Data supporting development of the Eastern San Joaquin Subbasin HCM is available to the public from a variety of local, state, and federal agencies, as well as from non-governmental entities. The data presented herein were compiled from numerous studies conducted in the eastern portion of the San Joaquin Valley (SJV). Information from several online databases that support ongoing monitoring and development of the groundwater resources within the Eastern San Joaquin Subbasin and across California were amassed, digitized, evaluated, and reconfigured in support of the HCM. To accomplish the data compilation task, software programs such as Microsoft Excel, ArcGIS, QGIS and CrossView provided platforms for entering, storing, displaying, and evaluating the volume of data available. The following subsections describe the online programmatic databases from which much of the data were sourced and provides insight on the unique obstacles within each.

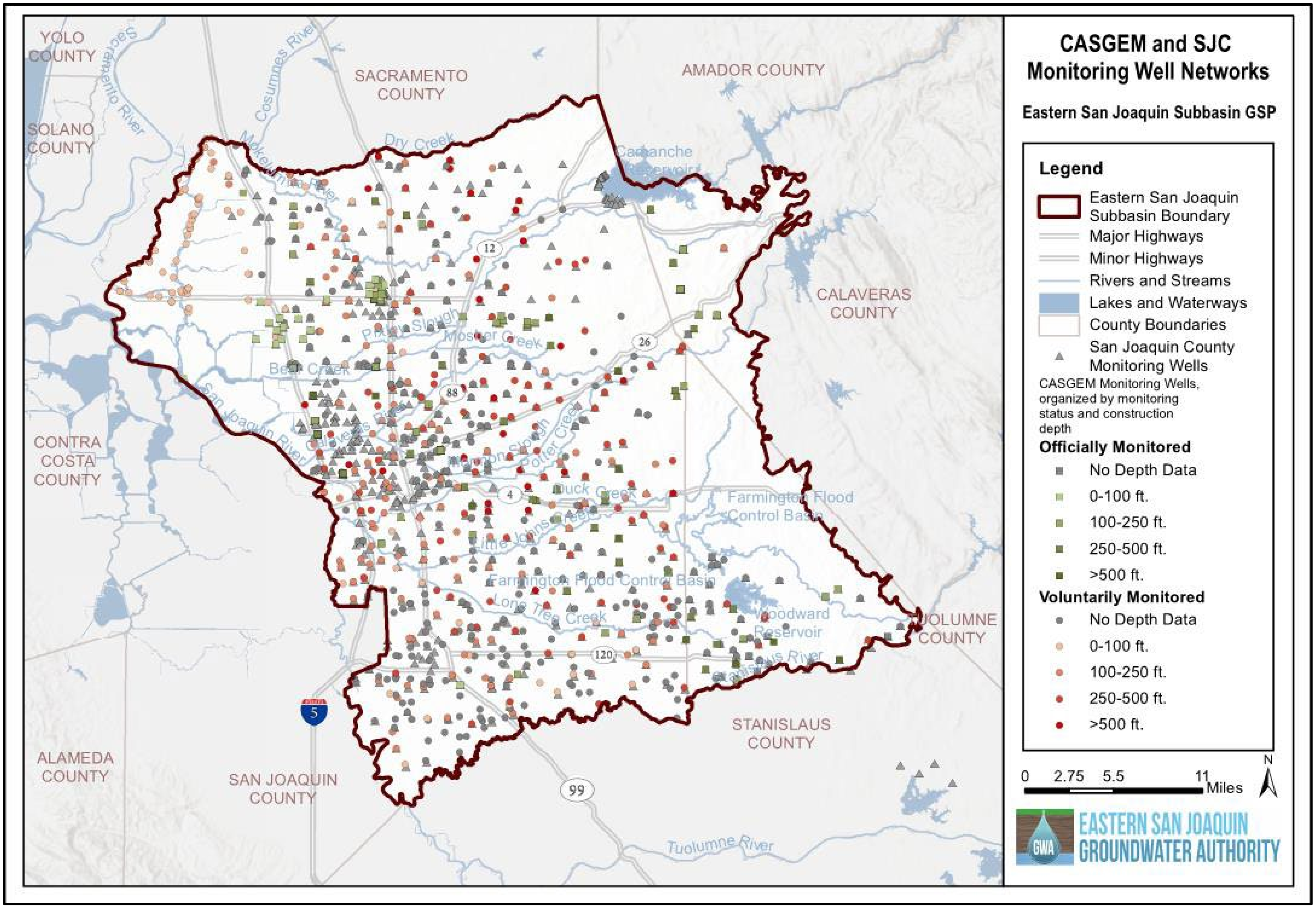
2.1.1.1 Groundwater Level Data

The California Statewide Groundwater Elevation Monitoring (CASGEM) and San Joaquin County monitoring well networks provide the basis for determining groundwater levels across the Eastern San Joaquin Subbasin. CASGEM maintains a website that allows users to download site locations and groundwater level information. San Joaquin County's monitoring well data comes from the San Joaquin County Flood Control and Water Conservation District (SJCFCWCD).

The two monitoring networks have substantial overlap, thus combining the databases was a necessary step in the data compilation effort. Because CASGEM uses the local, State, and CASGEM ID, whereas the San Joaquin County network uses the local and State ID, correlating or joining these two databases required manipulating or changing the State ID to a consistent format during the data compilation effort. Additionally, the databases cannot be merged based on well location because wells are often clustered together in close proximity and location information for the same well can vary between datasets.

The CASGEM and San Joaquin County monitoring well networks together include approximately 1,000 unique wells across the Eastern San Joaquin Subbasin. Despite the large number of wells, horizontal and vertical data gaps still exist. Large areas of the Subbasin contain very few wells, particularly in the northwest and southeast portions of the Subbasin (see Figure 2-1).

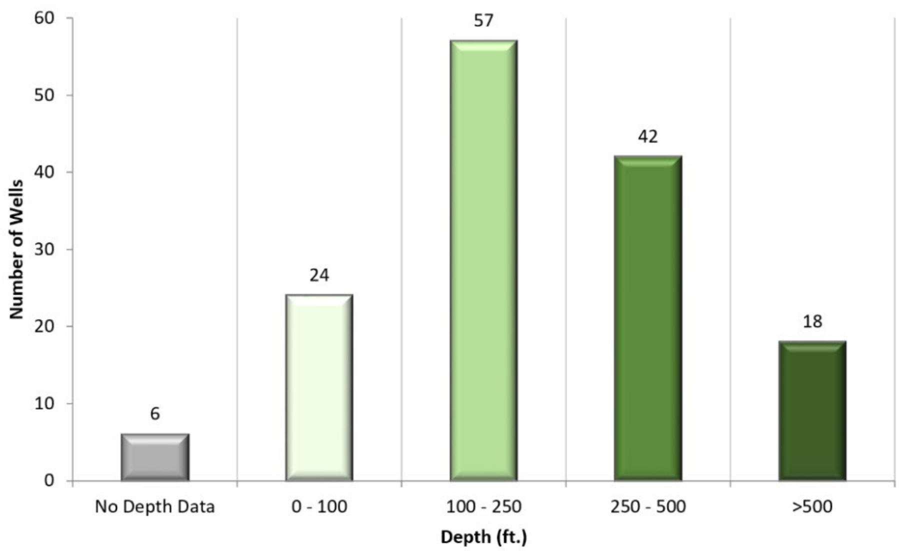
Figure 2-1: CASGEM and San Joaquin County Monitoring Well Networks



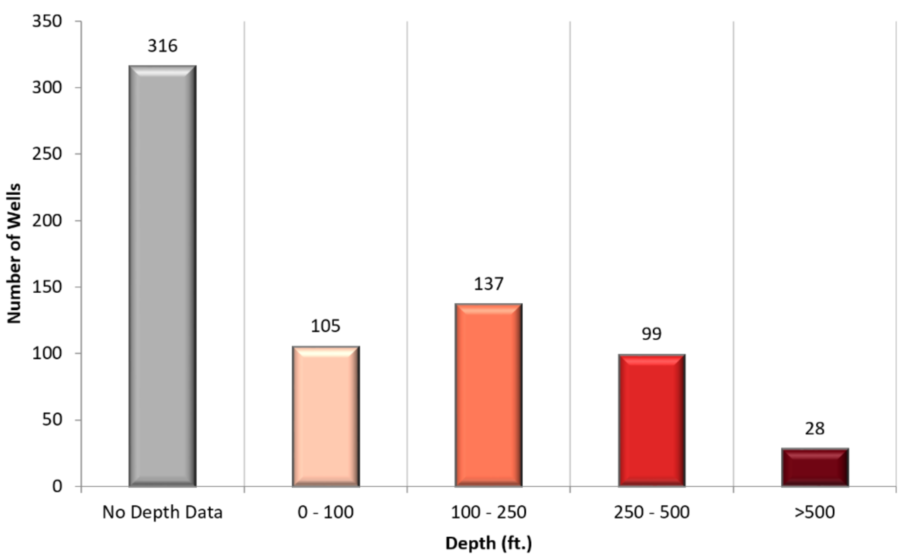
Vertical data gaps are even more pronounced, as lack of construction data is an obstacle. Figure 2-2 shows the distribution of well depths of officially and voluntarily monitored CASGEM wells, a large number of which do not have construction depth or screen interval information. This makes determining groundwater levels for depth-discrete aquifer intervals impossible. Groundwater elevation contour maps were prepared for the single principal aquifer, consistent with CCR Title 23 § 354.16 Groundwater Conditions requirements. Despite uncertainties due to limited construction information, this Groundwater Sustainability Plan (GSP) presents maps that provide a useful description of groundwater conditions.

Figure 2-2: Depth Distribution of Wells in the CASGEM Network

Officially Monitored CASGEM Wells



Voluntarily Monitored CASGEM Wells



2.1.1.2 Groundwater Quality Data

This GSP relies on groundwater quality data from the Groundwater Ambient Monitoring and Assessment (GAMA) Program. GAMA includes water quality data from numerous sources, such as United States Geological Survey (USGS) and Department of Water Resources (DWR). The GAMA database contains approximately 6,800 well sites throughout the Eastern San Joaquin Subbasin with over 1.6 million water quality measurements (Figure 2-3).

Although GAMA provides data on a large number of groundwater parameters and wells throughout the Eastern San Joaquin Subbasin, significant data gaps remain. For instance, there are inconsistencies in the parameters measured, as well as in the sampling periods. Some wells are sampled at regular intervals (i.e., quarterly or annually), while others are sampled irregularly. Such assorted schedules make analysis over a given period of time difficult. Data gaps are also apparent when looking at parameters over a longer timeframe. For example, chloride, an important and commonly measured groundwater quality parameter, is reported in only a small fraction of the total number of GAMA wells. As shown in Figure 2-4, out of the over 6,800 wells listed in GAMA for the Eastern San Joaquin Subbasin, no more than 700 chloride measurements were taken during any year since 2005.

Figure 2-3: GAMA Monitoring Well Network

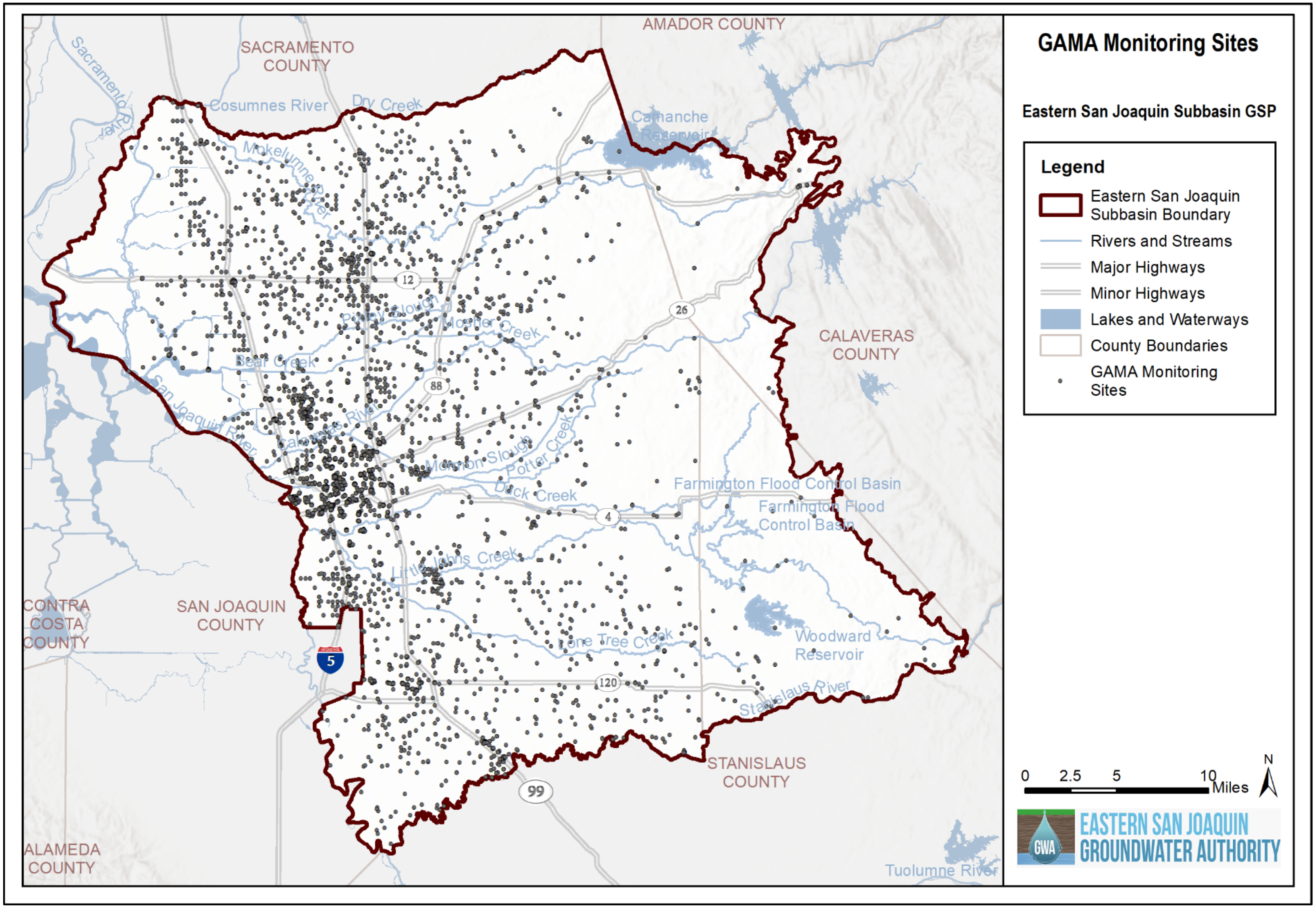
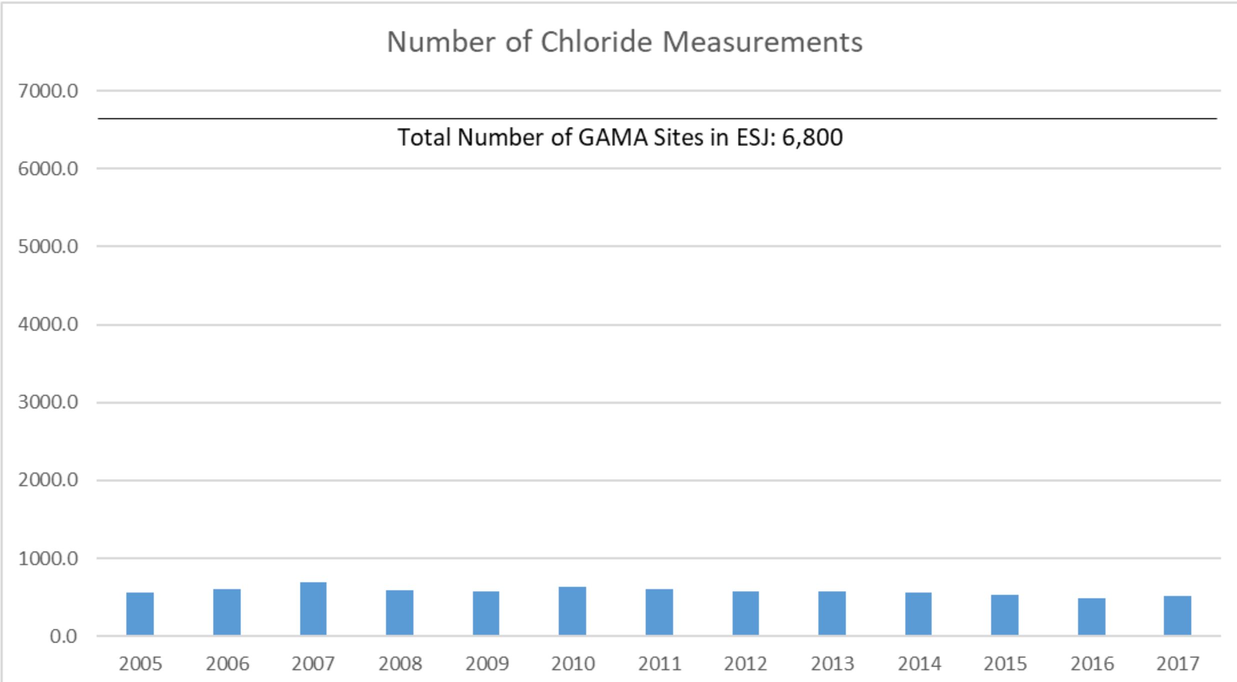


Figure 2-4: Number of Chloride Measurements Taken at GAMA Monitoring Sites (2005-2017)



Below is a list of attributes for each groundwater quality result in GAMA:

- Well ID
- Results
- Chemical
- Units
- Qualifier
- RL (Reporting Limit)
- Approximate Latitude
- Approximate Longitude
- Well Type
- Well Depth
- Top of Screen
- Screen Length
- Source
- Source Name
- Other Names

The attributes of each well in the GAMA database are not always complete or accurate. Well depths and screen interval data, where available, promote vertical analysis of groundwater quality data because these data can be correlated to depth-discrete aquifer zones. Additional depth-specific water quality monitoring is a focus of the monitoring network for this GSP, as discussed in the monitoring network section of this GSP.

2.1.1.3 Stratigraphic Data

The Online System for Well Completion Reports (OSWCR) provided a majority of the groundwater well logs used in developing the HCM. This online database, developed and maintained by DWR, is a compilation of well completion reports accessible to the public for viewing and downloading. Tables of water well records are also available which contain attributes such as construction depth and well type (e.g., domestic or agricultural). However, not every well record is complete within the tables or only a few attributes may be listed. None of the stratigraphic or geologic data are provided in the tables. Stratigraphic or geologic data must be obtained from the individual well completion reports, which are only available as scanned images downloadable in portable document format (pdf). Once the well completion reports are retrieved from the database, the geologic information can then be manually digitized into MS Excel or other database software.

Critical information needed from the well completion reports are construction depth, screen interval, and borehole stratigraphy. The quality and completeness of the reports are, however, highly variable. Very few well logs contain all of the critical data; many more list only a few of the key attributes or none at all. Descriptions of the borehole stratigraphy also vary widely, from comprehensive geologic descriptions to single-word captions (e.g., sand, sandstone, or clay). Given the volume of wells in the Eastern San Joaquin Subbasin and the critical importance of the data being retrieved, great attention was paid to this aspect of the data compilation effort.

Once compiled, the well construction and stratigraphic data from OSWCR were correlated with well data available from the CASGEM and San Joaquin County monitoring well databases. To accomplish this task, individual well logs from OSWCR were assigned a unique location and then matched to a specific well within the CASGEM and San Joaquin County datasets (CA DWR, 2000).

Although the State ID format does not allow for matching between OSWCR, CASGEM, and San Joaquin County databases, well completion reports from OSWCR were correlated to wells in the other databases. This connection was made by plotting CASGEM/San Joaquin County well locations in Geographic Information System (GIS) software and correlating well completion reports to nearby wells with similar attributes. For instance, the State ID of the CASGEM/San Joaquin County wells and the modified State ID of the OSWCR were used to locate the features within the same Township/Range/Section. Well completion reports were matched to wells by attributes such as screen interval and seal depth or based on written location descriptions or hand-drawn sketches of the location.

To further support spatial analysis, well completion reports from OSWCR with no corresponding well in any database were added to the data set. Well completion reports for wells from other sources, including USGS nested wells and municipal wells, were also added. Well completion reports from OSWCR that did not correspond to wells in a different database were plotted using latitude and longitude coordinates listed in OSWCR. These coordinates are often approximations of the actual location; many latitude and longitude values are the centroid of the section containing each well. All totaled, the borehole stratigraphy from approximately 330 groundwater wells was digitized to provide horizontal spatial coverage.

While groundwater wells provide valuable data in the shallower portion of the basin that are mostly accessed for groundwater use, the hydrostratigraphic units within the Eastern San Joaquin Subbasin are much deeper, reaching a maximum depth of approximately 1,000 feet. Data from the Division of Oil, Gas, and Geothermal Resources (DOGGR) were used to assess the geologic strata at the depths important to the HCM, as these wells are typically much deeper than groundwater wells.

Interpretation of geologic formations from the well completion reports and DOGGR well logs was undertaken after digitizing stratigraphic data from the various sources. This process relied heavily on the distinguishing features of each formation (Section 2.1.5), surficial geologic maps (Section 2.1.5), location and depth of borehole (Section 2.1.7), and professional judgement.

2.1.1.4 GIS Data

In accordance with CCR Title 23 § 354.14, maps of various basin attributes are required as part of the HCM. To produce these maps, GIS software was used to store, manage, and analyze spatial and tabular data. GIS software was also used to extrapolate data through complex processes in cases where information or guidance was limited. For example, in accordance with CCR Title 23 § 354.16, groundwater elevation contour maps are required based on the best available information. This requirement does not specify methods to use for producing the data, but the DWR Best Management Practice (BMP) for HCM suggests techniques used in Tonkin, M. and Larson, S. (2002), which uses geostatistical methods in conjunction with logical interpretations of groundwater level data to provide an adequate level of detail and accuracy.

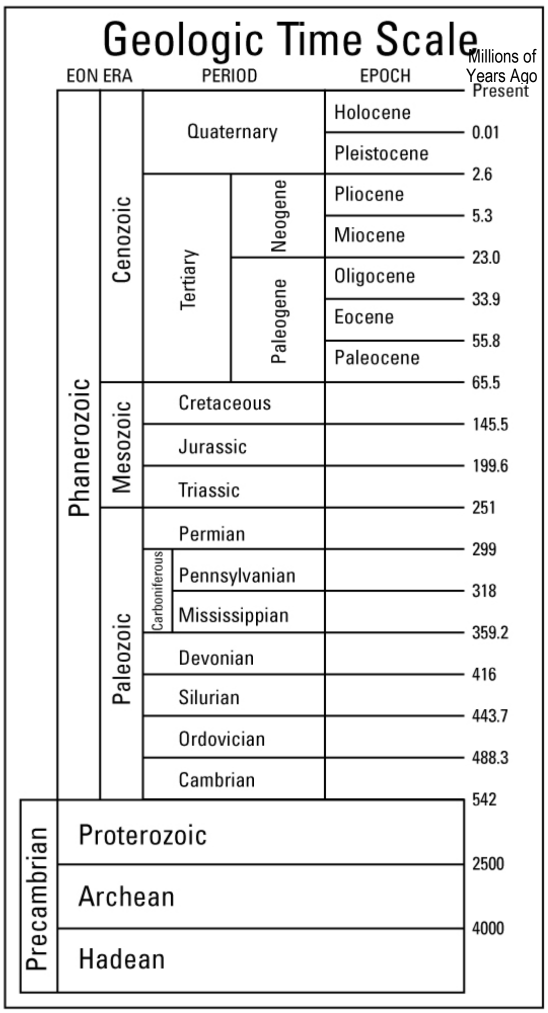
Certain GIS software programs, including QGIS and ArcGIS, were relied on heavily. QGIS is a powerful open-source program, whereas ArcGIS is the industry standard. Both are capable of completing the required elements for the GSP.

QGIS provided the graphical capabilities for final map production. ArcGIS was specifically utilized because of a third-party extension, CrossView, which is capable of generating hydrogeologic cross-sections that are presented in Section 2.1.7. The Universal Transverse Mercator (UTM) coordinate system and North American Datum of 1983 (NAD 83) were utilized along with the North American Vertical Datum of 1988 (NAVD 88) for all spatial data.

2.1.2 Regional Geologic and Structural Setting

The Eastern San Joaquin Subbasin lies within the San Joaquin Valley, which is part of the Central Valley of California. The Central Valley is a 400-mile-long, 50-mile-wide, northwestward trending asymmetrical structural trough filled with geologic units deposited over a long period of time. See Table 2-2 (Section 2.1.5) for the generalized stratigraphic column and Figure 2-5 below for the geologic time scale. The Sierra Nevada Mountain Range, east of the Central Valley, consists of pre-Tertiary igneous and metamorphic continental rocks. The Coast Range, to the west, consists of pre-Tertiary and Tertiary semi-consolidated to consolidated marine sedimentary and continental rocks. The material sources for the Central Valley continental deposits are the Coast Range and the Sierra Nevada, which are composed primarily of granite, related plutonic rocks, and metasedimentary and metavolcanic rocks from Late Jurassic to Ordovician age (Bertoldi et al., 1991).

Figure 2-5: Geologic Time Scale



2.1.3 Geologic History

The origin of geologic formations within the Eastern San Joaquin Subbasin varies in geologic time ranging from recent to Pre-Cretaceous bedrock or basement. Six to 10 miles of sediment have been deposited within the Central Valley and include both marine and continental deposits consisting of gravels, sands, silts, and clays. During the middle Cretaceous (~100 million years ago), parts of the Central Valley were inundated by the Pacific Ocean resulting in deposition of marine deposits. Marine conditions persisted through the middle to late Tertiary period (~3-30 million years ago) after which time sedimentation changed from marine to continental deposits due to the retreat of the sea and the regional rising of land mass previously inundated by the ocean. Intermittent volcanism dominated with the deposition of rhyolites and andesites (CA DWR, 1967).

2.1.4 Near-Surface Conditions

2.1.4.1 Topography

Ground surface elevations vary extensively across the Eastern San Joaquin Subbasin from almost 1,000 feet above mean sea level (MSL) in the upland areas in the east to around sea level in the flat lying valley floor to the west. The Eastern San Joaquin Subbasin topographic map is provided as Figure 2-6.

The modern-day physiographic features are a direct result of the geologic history of the region. Surficial features on the valley floor in the Eastern San Joaquin Subbasin can be divided into physiographic units as described by CA DWR (1967) and Burow and others (2004): river flood plains, channels, and overflow lands; low alluvial plains and fluvial fans; and dissected uplands. The dissected uplands lie along the flanks of the valley between the Sierra Nevada to the east and the alluvial plains and fluvial fans to the west. Local relief ranges in excess of 100 feet in the form of dissected hills and gently rolling lands. The most extreme slopes are observed in Calaveras County, which are steeper than 25 percent. West of the dissected uplands is a belt of coalescing fluvial fans of low relief (less than 10 feet) that forms the low alluvial plains and fans that range in width from about 14 to 20 miles. These fans lie between the dissected uplands and the nearly flat surface of the valley trough. River floodplains and channels occur as narrow, disconnected strips along the channels of the major rivers. Overflow lands of the valley trough tributary to the San Joaquin River define the area inundated by rivers when floods are highest under natural conditions.

2.1.4.2 Major Hydraulic Features

The major hydrologic features within the Eastern San Joaquin Subbasin are shown in Figure 2-7. The Subbasin is bounded on all sides except to the east by streams. Adjacent groundwater subbasins also share an interest in the impacts of the Sustainable Groundwater Management Act (SGMA) on these boundary streams.

In the Eastern San Joaquin Subbasin, the major rivers running east-west have headwaters high in the Sierra Nevada and flow west toward the axis of the valley (Figure 2-7). Little deposition is taking place currently, and the rivers are cutting downward on the upper reaches of the fans where the river floodplains are commonly entrenched to depths of 50 to 80 feet. However, toward the lower ends of the fans where river gradients are low, many small streams and tributaries of the major rivers are actively aggrading their beds.

Figure 2-6: Topography

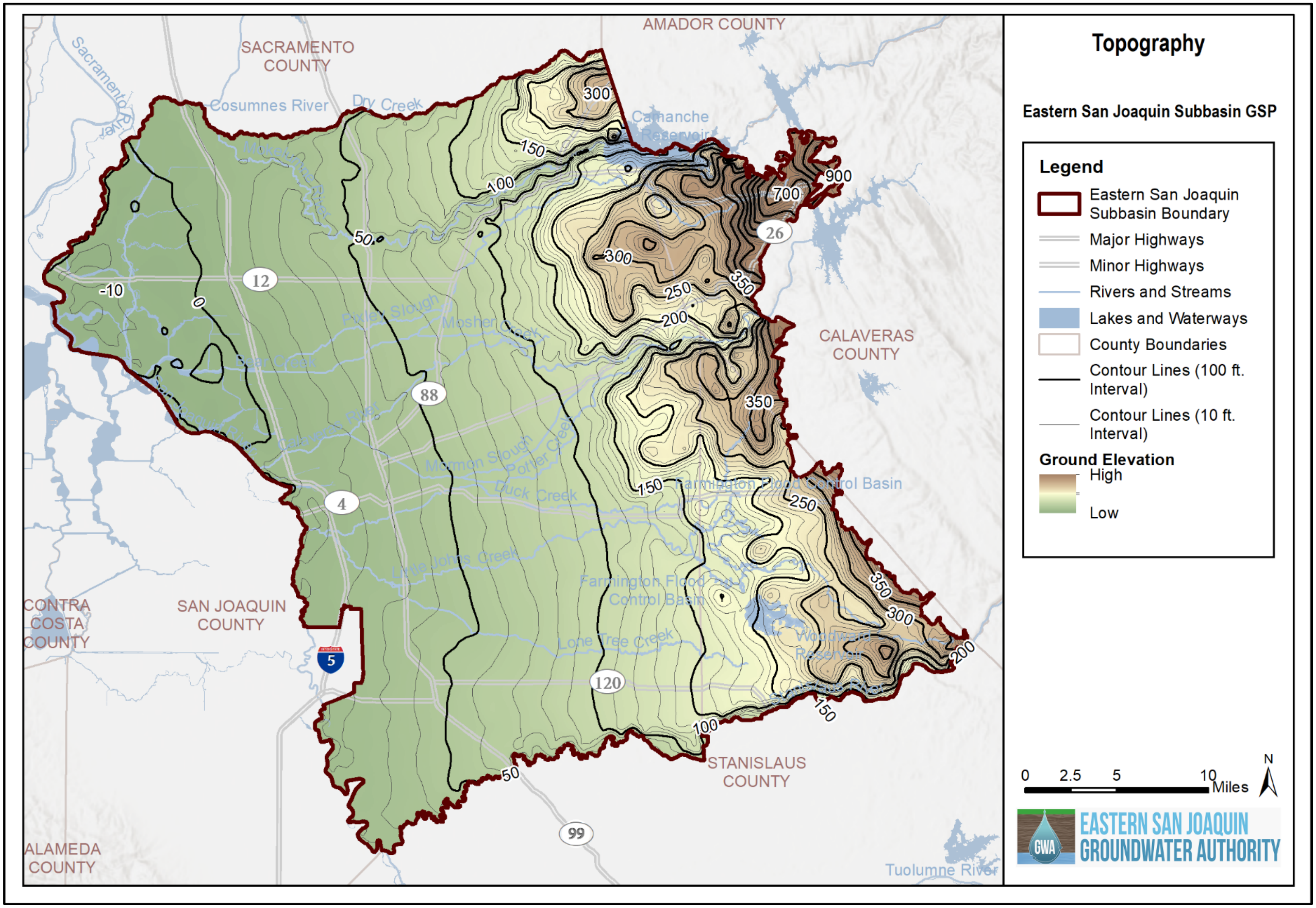
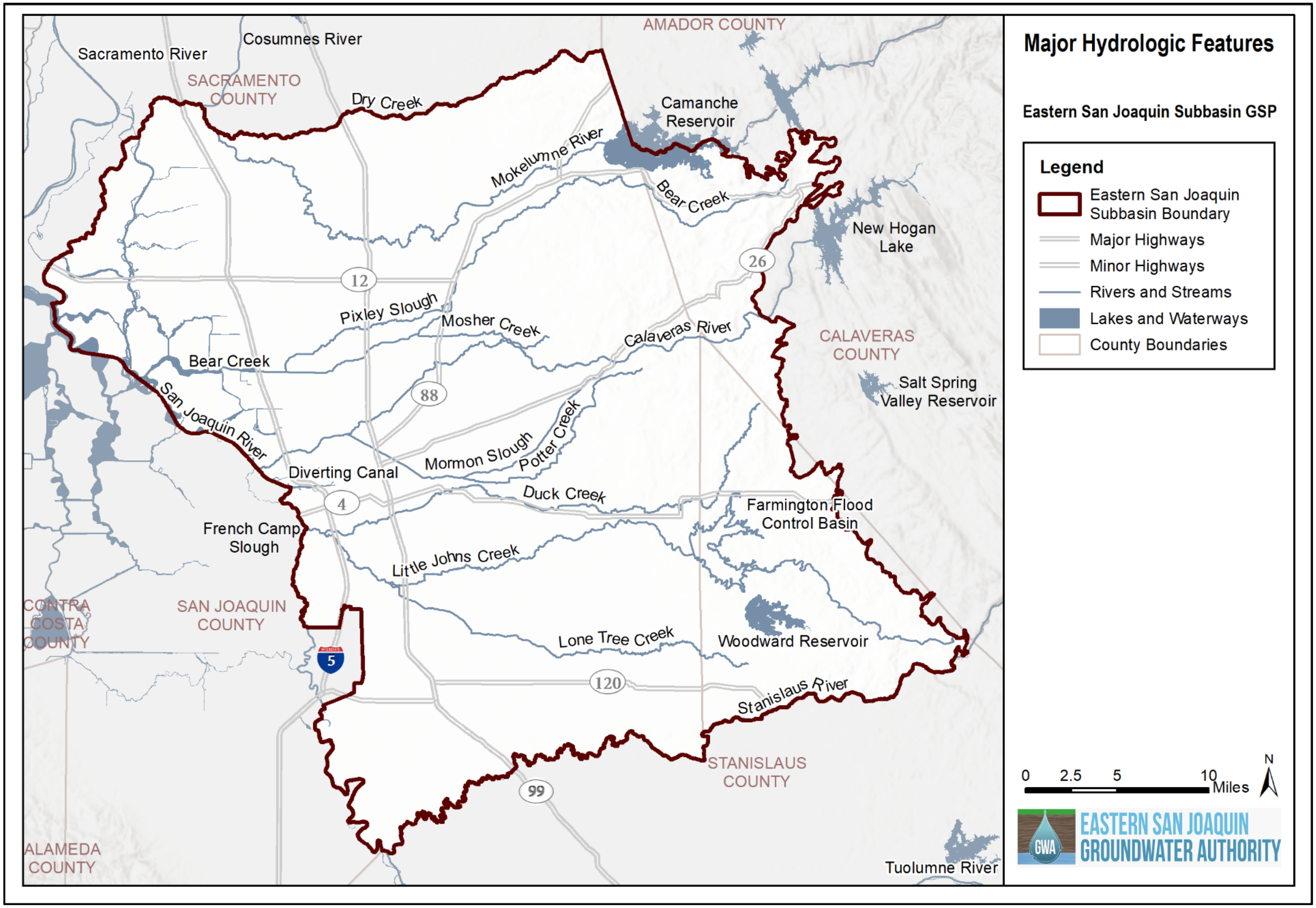


Figure 2-7: Major Hydrologic Features



The San Joaquin River is the principal drainage outlet of the northern San Joaquin Valley, flowing northward on the west margin of the Eastern San Joaquin Subbasin to its confluence with the Sacramento River in the Sacramento-San Joaquin River Delta (Delta) (Burow et al., 2004). Two major westerly flowing tributaries to the San Joaquin River within or adjacent to the Eastern San Joaquin Subbasin are the Stanislaus River (Subbasin south boundary), the Mokelumne River (north portion of Subbasin), and the Calaveras River (central portion of Subbasin).

The Stanislaus River drains a watershed of about 1,040 mi^2 (Burow et al., 2004) and flows through the dissected uplands between Knights Ferry and Oakdale, along the low alluvial plains and fans near the City of Riverbank to the confluence with the San Joaquin River near Vernalis (see Figure 2-8). Most of the watershed area falls within Modesto Subbasin. The flow in the Stanislaus River varies seasonally from less than 134 acre-feet per day (AF/day) during the dry season in early fall to over 16,400 AF/day during wet season in winter. These flows correlate to discharges from 68 to over 8,270 cubic feet per second (cfs) recorded at the Orange Blossom Bridge gauging station approximately one mile east of Oakdale and eight miles west of the Subbasin boundary along the river (CA DWR, 2019).

The Mokelumne River drains a watershed of about 5,550 km^2 (2,140 mi^2) and flows through the dissected uplands between Jackson and San Andreas into Pardee Reservoir where it is released to flow downstream into Camanche Reservoir and out along the alluvial plains and fans toward its confluence with the San Joaquin River near Isleton. On the north boundary of the Eastern San Joaquin Subbasin is Dry Creek and the Lower Dry Creek Watershed, the majority of which is within Cosumnes Subbasin. Dry Creek is mapped as an ephemeral drainage and is tributary to the Mokelumne River with its confluence near Thornton. Flow in the Mokelumne River below the Camanche Reservoir varies seasonally and is dependent on discharges from the on-stream reservoir, from less than 200 AF/day during the dry season to 9,900 AF/day during the wet season. These flows correlate to discharges from as low as 100 to no more than 5,000 cfs reported by the USGS below the Camanche Dam. Major watersheds of the river are the Upper Mokelumne River (most of which is outside of the Subbasin to the east with a small portion overlapping with Cosumnes Subbasin) and the Lower Mokelumne River (mostly contained in the Subbasin with a small portion intersecting the South American and Solano Subbasins).

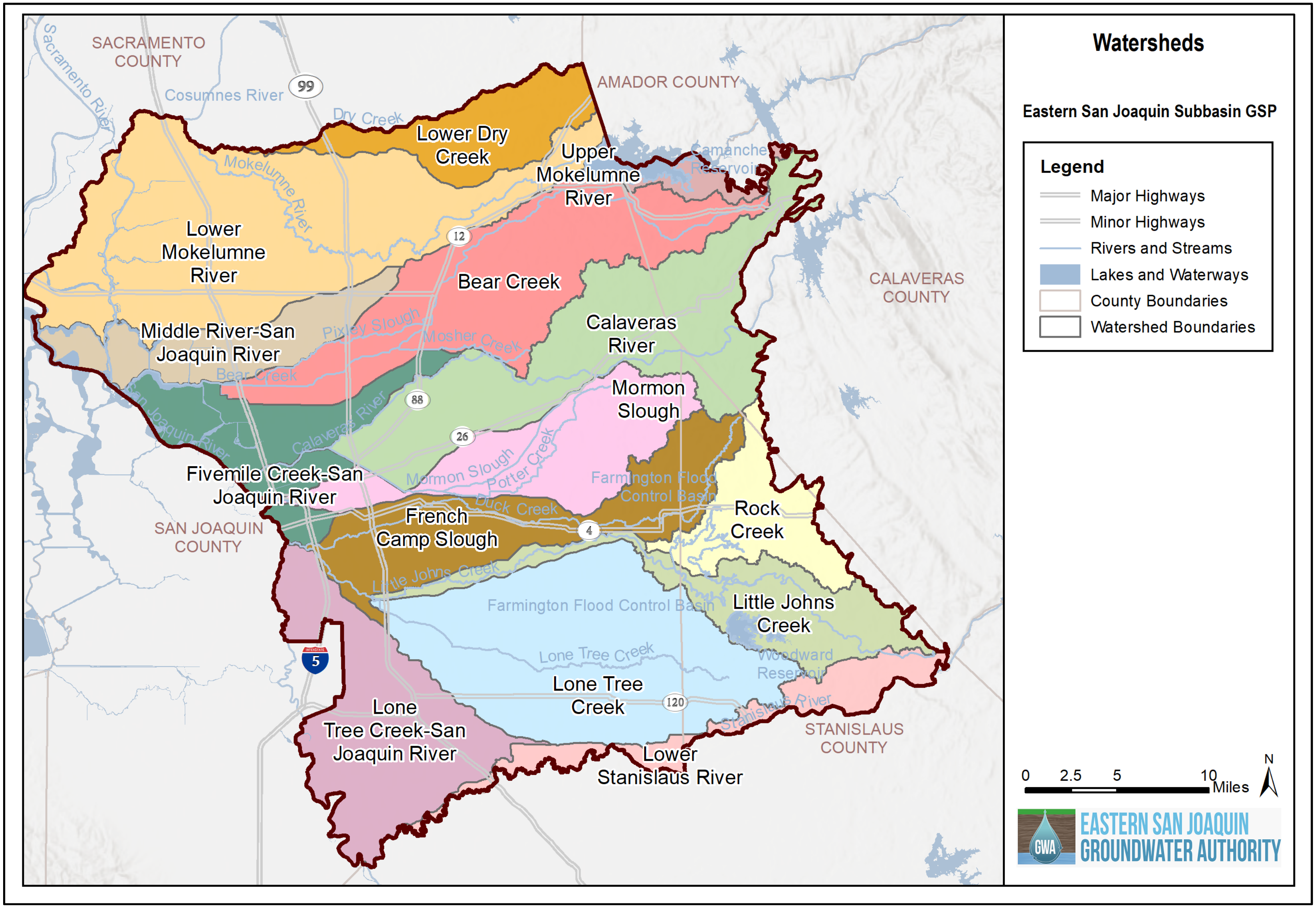
The Calaveras River, also with headwaters in the Sierra Nevada, drains a watershed of about 1,370 km^2 (530 mi^2) and flows into and across the Subbasin to its confluence with the San Joaquin River on the northwest side of Stockton. Flow in the Calaveras River below the New Hogan Reservoir varies seasonally from 608 AF/day to 19,800 AF/day and is dependent on discharges from the on-stream reservoir. These flows correlate to discharges from 223 to over 10,000 cfs reported by the USGS below the New Hogan Reservoir.

In addition to the Stanislaus, Mokelumne, and Calaveras Rivers, 10 watersheds extend into and across the Eastern San Joaquin Subbasin. Three of these watersheds extend beyond the western boundary of the Eastern San Joaquin Subbasin into the East Contra Costa or Tracy Subbasins: Middle River-San Joaquin, Five Mile Creek-San Joaquin, and Lone Tree Creek-San Joaquin. The Lone Tree Creek-San Joaquin watershed has its headwaters in the Coast Range foothills. Figure 2-8 depicts the Eastern San Joaquin Subbasin and the watersheds that overlie the Subbasin. Table 2-1 is a list of watersheds that overlie the Subbasin.

Table 2-1: Eastern San Joaquin Subbasin Watershed Details

Watershed Name	Total Area (square miles)	Area within Subbasin (square miles)	Percentage of Watershed within Subbasin
Lower Mokelumne River	223	202	91
Lower Dry Creek	88	47	53
French Camp Slough	88	88	100
Upper Mokelumne River	93	15	16
Lone Tree Creek	158	158	100
Little Johns Creek	122	63	52
Rock Creek	107	44	41
Calaveras River	224	133	60
Middle River-San Joaquin River	213	49	23
Mormon Slough	75	75	100
Lower Stanislaus River	218	37	17
Lone Tree Creek-San Joaquin River	169	98	58
Five Mile Creek-San Joaquin River	154	62	40
Bear Creek	127	127	100

Figure 2-8: Eastern San Joaquin Subbasin Watersheds



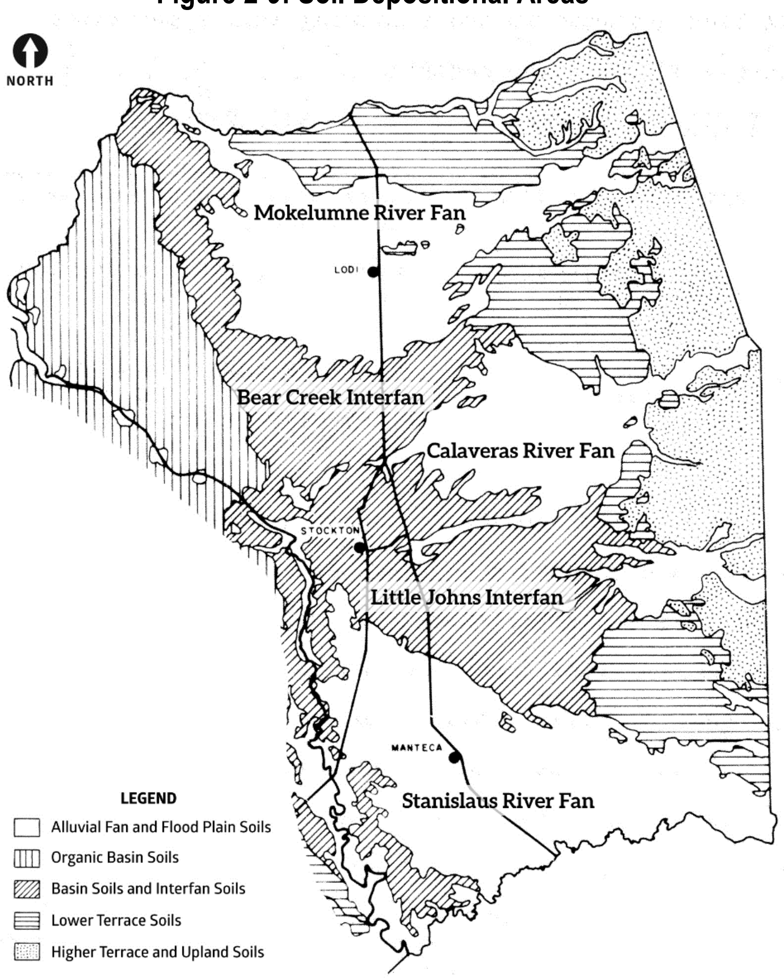
2.1.4.3 Surface Soils

Soils in the Eastern San Joaquin Subbasin are one of the primary controlling factors on surface water percolation rates through the vadose zone down to the groundwater table. As described in CA DWR (1967), soils in the region of the Eastern San Joaquin Subbasin can be grouped into five main categories:

1. Alluvial fan and flood plain soils
2. Organic basin soils
3. Basin soils
4. Lower terrace soils
5. Higher terrace and upland soils

These groupings coincide in part with the geologic formations in that the oldest soils are found on the nearly level high terraces and old fluvial fans in the eastern part of the area. The oldest soils typically have claypan or hardpan layers at depths of 2 feet or less. The youngest soils are forming on the recently deposited alluvium along stream bottoms and on recently exposed surfaces. These soils are generally deep and rich in nutrients. The soils at intermediate stages of development are on the low terraces. Figure 2-2-9 shows the areal distribution of the five soil types in San Joaquin County (CA DWR, 1967).

Figure 2-9: Soil Depositional Areas



Alluvial fan and floodplain deposits are present in three areas of the Eastern San Joaquin Subbasin bounding major east-west rivers: Mokelumne, Calaveras, and Stanislaus Rivers. Figure 2-9 depicts soil depositional areas within the Subbasin. These areas have the best infiltration rates, exclusive of the peat locales in the Delta (northwest portion adjacent to the Mokelumne River).

Soils of the Mokelumne and Stanislaus River fans have young soil profiles of sandy loam to loam. Infiltration rates of the soils are predominantly between 0.6 to 2 inches per hour. Areas of silt loam are also common especially in the floodplain and have a lower infiltration rate of less than 0.6 inches per hour. Soils in the alluvial fans tend to coarsen toward the apex of the fan. The soil types show little compaction and slight accumulation of lime or clay. Hardpan development, which would preclude infiltration, is minimal.

The soils of the Calaveras fan have deeper profiles of loam and clay loam with an infiltration rate of less than 0.6 inches per hour. These soils tend to be darker and heavier than the Stanislaus and Mokelumne River fan soils likely due to the source area being restricted to metamorphic or pre-Tertiary sedimentary material and the Mokelumne and Stanislaus Rivers received large contributions from a granitic source (CA DWR, 1967).

The organic basin soils are restricted to the lower Delta portion of the Eastern San Joaquin Subbasin. Peat, muck, and clay loam are terms commonly applied to soils in this group. The organic basin soils have variable infiltration capacity. Where peat is the dominant soil constituent, infiltration is high (greater than 2 inches per hour); where clay loam or muck occurs, infiltration is low (less than 0.6 inches per hour) (CA DWR, 1967).

The interfan and basin soils lie between the Mokelumne, Calaveras, and Stanislaus River fans in a northwesterly trending belt and around the periphery of the organic basin soils. These soils generally have well-developed profiles, medium-to-heavy textures, and fairly well compacted subsoils. Locally, hardpan overlies silty to silty clay loams. Consequently, these soils have low infiltration rates (less than 0.6 inches per hour).

The terrace and upland soils have profiles containing moderately dense accumulation of clay and claypan, relatively near the surface. These layers are impervious barriers to the local downward movement of water, except where root holes and other breaks permit infiltration.

The Natural Resource Conservation Service (NRCS) categorizes soils by hydrologic soil groups. The hydrologic soil group is an estimation of the infiltration rate of the first 5 feet of soil based on depositional characteristics (mostly grain size and sorting) and secondary characteristics (compaction, lithification, and weathering). Hydrologic soil groups and their relative infiltration rates are listed below:

- A (high)
- B (medium)
- C (slow)
- D (very slow)

Figure 2-10 shows the distribution of soils mapped by hydrologic soil group across the Eastern San Joaquin Subbasin. The broad geologic features of the Eastern San Joaquin Subbasin reflecting the river drainage elevations, areas, and percent above snowline are also apparent in the map of soils distribution. The Stanislaus and Mokelumne River alluvial fans have the overall highest infiltration rate followed by the Calaveras River fan. The smaller foothill watersheds have the lowest average infiltration rates. The relatively high permeability of windblown sands on the Mokelumne and Stanislaus River fans and the recent alluvium of the current Mokelumne and Calaveras River floodplains are also recognizable (Figure 2-10).

Hardpan is a strongly cemented weathering profile that limits infiltration unless it is modified by ripping or excavating. Some hardpan is discontinuous and relatively shallow (located at a depth of 5 feet or less) and often is ripped with a bulldozer for agricultural purposes. However, in other areas, particularly in the older pre-Modesto formations, the hardpan is more continuous and extends to depths that cannot be reached by ripping methods.

The Farmington Groundwater Recharge/Seasonal Habitat Study Final Report, prepared by Montgomery Watson Harza (MWH), dated August 2001 (MWH, 2001), overlaid the NRCS's interpretation of where hardpan soils would be found under natural conditions. The extent of the thickest hardpan is shown in Figure 2-11 in dark blue cross hatching.

Figure 2-10: Hydrologic Soil Groups

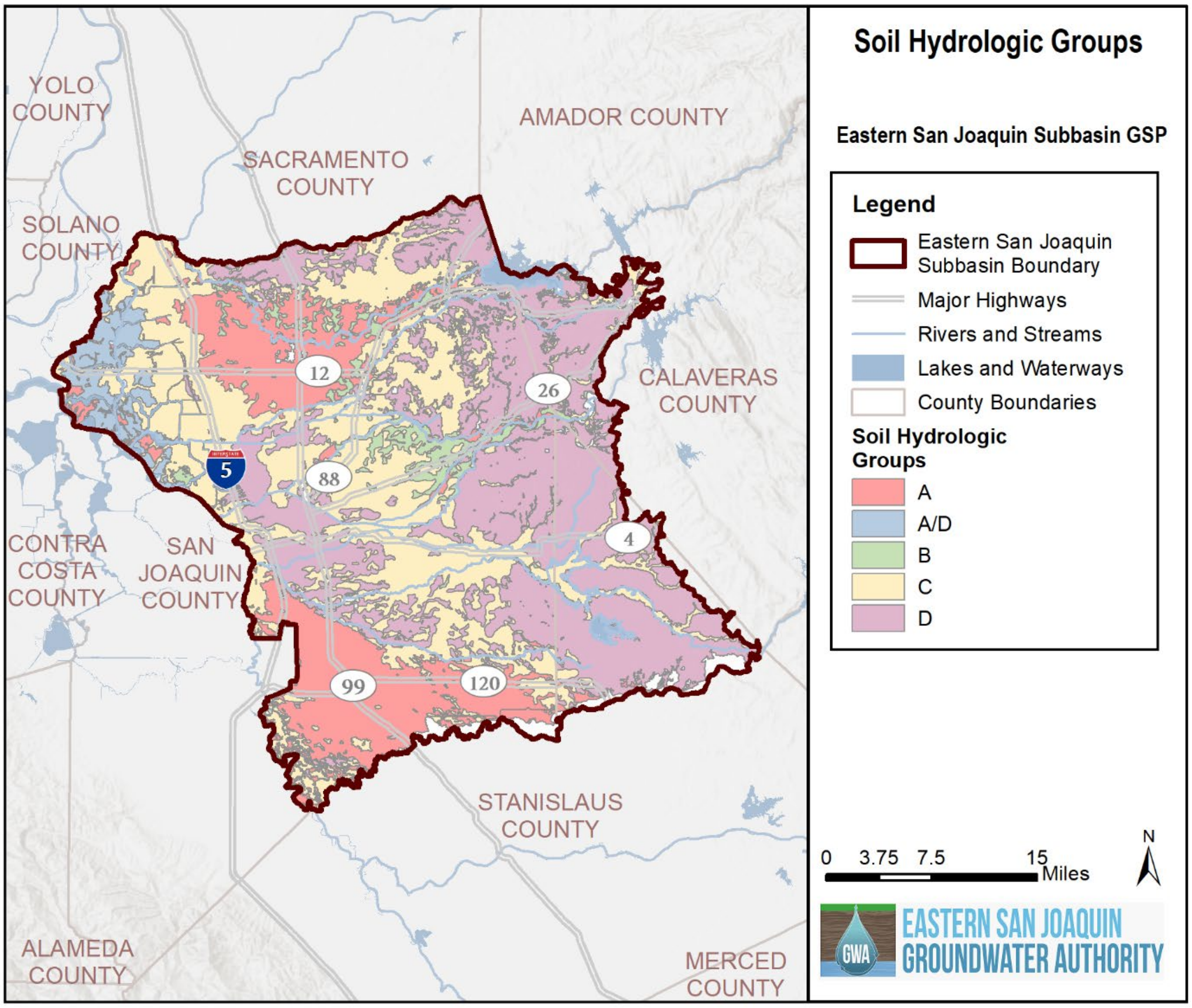
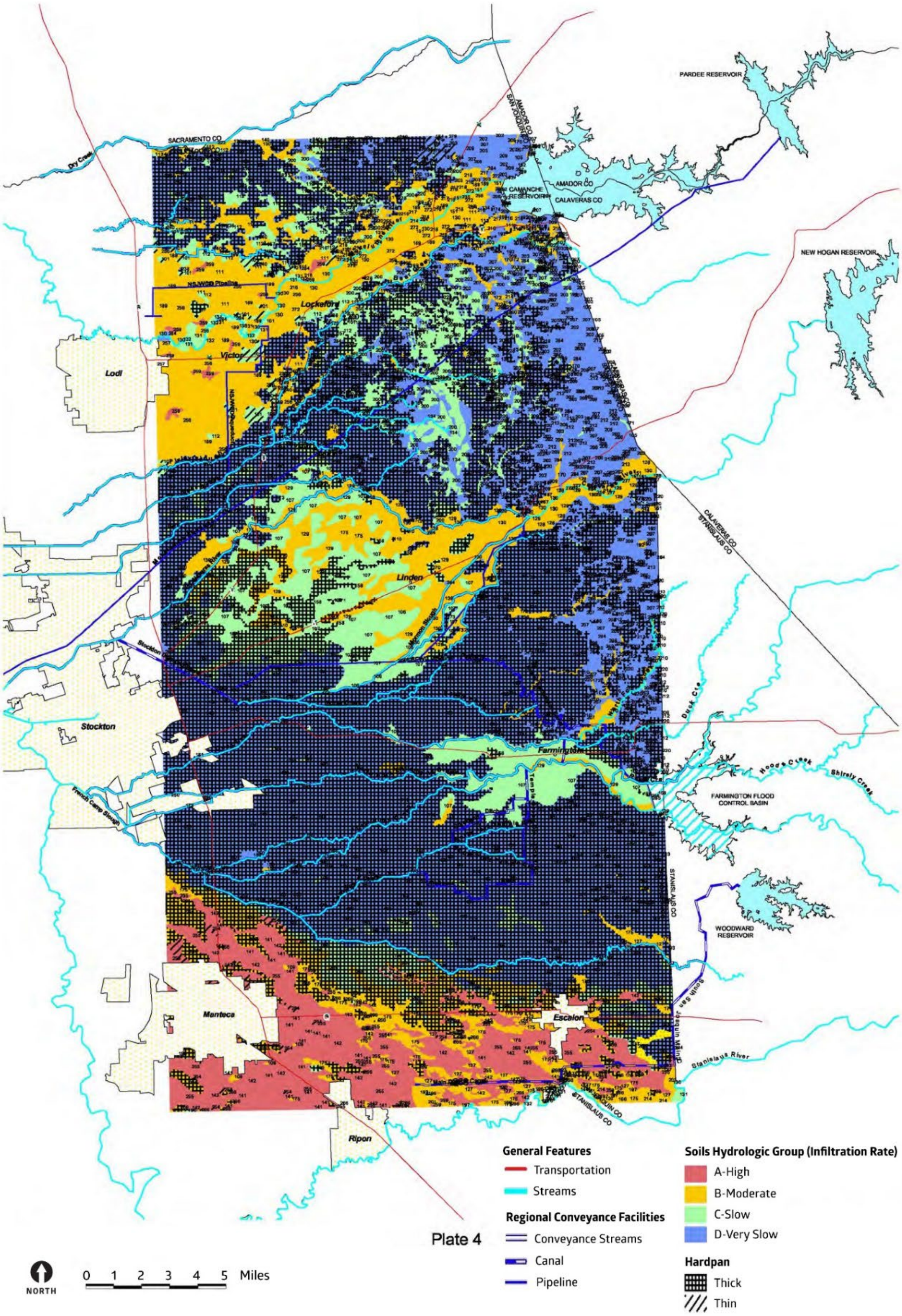


Figure 2-11: Occurrence of Hardpan within the Eastern San Joaquin Subbasin



2.1.4.4 Imported Water

The Eastern San Joaquin Subbasin does not rely on imported water supplies. All surface water used within the Subbasin originates from sources either within or directly tributary to the Subbasin. Several districts receive surface water from the Stanislaus River with a point of diversion approximately four miles upstream of the eastern boundary of the Subbasin (located in the Sierra Nevada foothills and not part of a Bulletin 118 groundwater basin). While this diversion point occurs outside of the Subbasin boundary, this water naturally enters the Subbasin by diversion or by surface-groundwater interaction.

2.1.4.5 Groundwater Recharge and Discharge Areas

Groundwater recharge and discharge is driven by both natural and anthropogenic (human-influenced) factors. Areas of recharge and discharge within the Eastern San Joaquin Subbasin are discussed below. Quantitative information about all natural and anthropogenic recharge and discharge is provided in Section 2.3.

2.1.4.5.1 Description of Recharge Areas

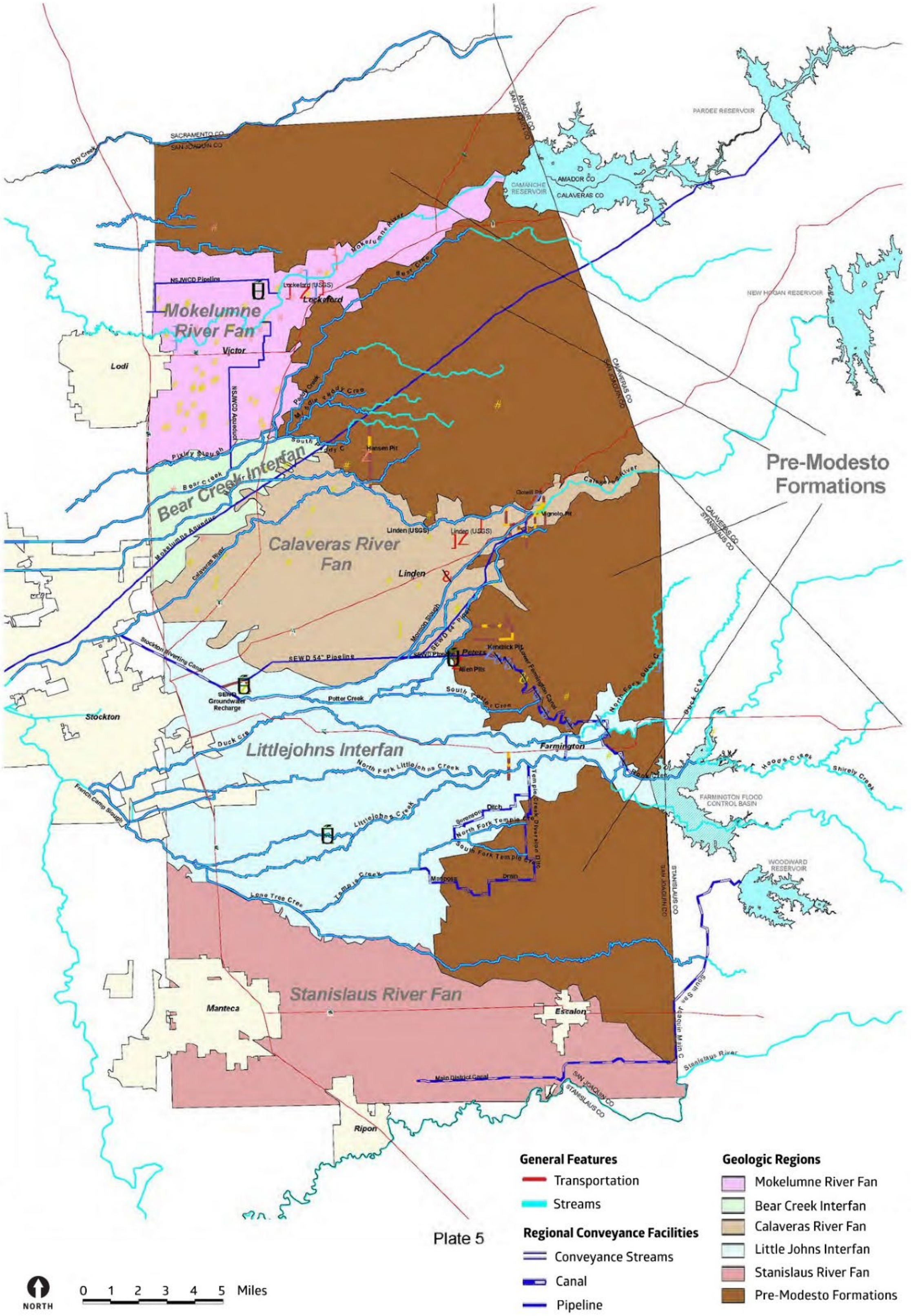
The recharge potential of soils and formations encountered in the Eastern San Joaquin Subbasin varies considerably and is dependent on primary and secondary geologic effects. Primary geologic patterns that influence permeability relate to grain size and sorting as a result of depositional characteristics. Secondary geologic effects that influence soil recharge characteristics are associated with post-depositional events such as consolidation, lithification, and weathering, including the development of hardpan soils (MWH, 2001). Additional information on geologic formations is provided in Section 2.1.5.

The primary (original) geologic permeability of the pre-Modesto formations is variable depending on grain size, but in general is low due to secondary (post-depositional) effects including the development of hardpan soils. However, the units are heterogeneous (variable), and permeable channels are common beneath the hardpan. The primary permeability of the Modesto Formation varies both east-west and north-south due to grain size differences in the original depositional environments. On any given drainage, the alluvium is generally coarsest (and most permeable) in the east where the gradient is steepest, and the relatively high energy stream carries and deposits a high proportion of coarse bedload sand and gravel (the proximal fan). Suspended sediment (clay and silt) is generally not deposited until it is carried farther west to a lower energy environment (the distal fan). As a result, the average permeability, and thus the average recharge rates, of the alluvial fan decreases overall from east to west (MWH, 2001).

The grain size distribution produced from each watershed depends on several characteristics, including the type of geologic materials in the source area, the watershed's gradient and total area, and the portions of the watershed subject to rainfall and snowmelt runoff.

During the Pleistocene Epoch when the Modesto and Riverbank formations were deposited (approximately 1 million to 10,000 years ago), a colder, wetter climate produced a lower snowline than at present, and coarse glacial outwash dominated the major streams originating in the interior of the Sierra Nevada (Mokelumne and Stanislaus River fans). Alluvium of the smaller foothill watersheds consists primarily of fine-grained material in interfan areas (Bear Creek and Little Johns/Rock Creek drainages). The Calaveras River drainage is intermediate between the two, forming a moderately coarse alluvial fan between the Calaveras River and Mormon Slough (MWH, 2001). Figure 2-12 depicts the aerial extents of the alluvial fans, interfan areas, and pre-Modesto formations.

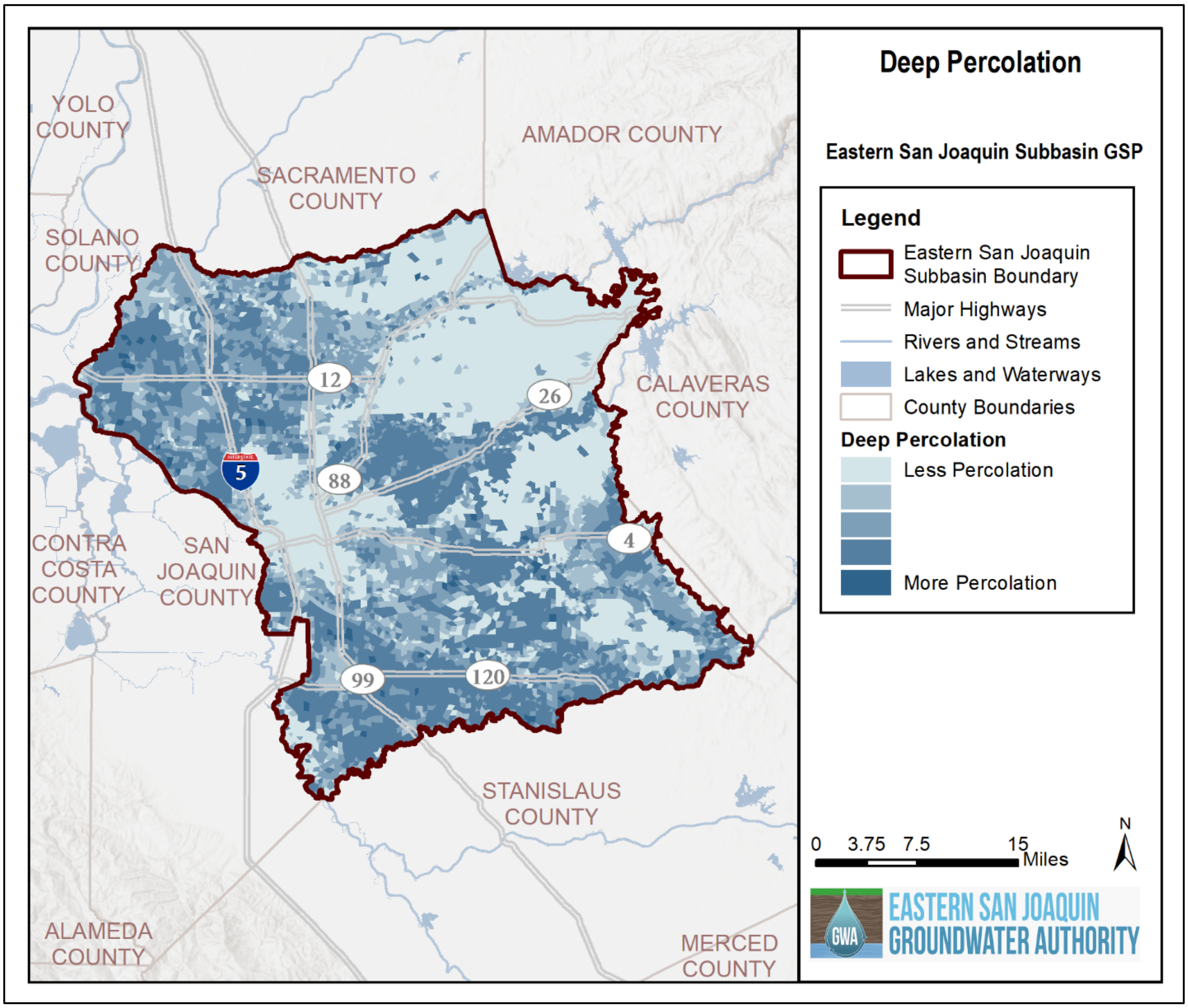
Figure 2-12: Areal Extents of Alluvial Fans, Interfans and Pre-Modesto Formations



Within this overall framework, the alluvial fans of each drainage contain coarse-grained channel and levee deposits of relatively high permeability within finer-grained overbank and floodbasin deposits of low permeability. Stream channels migrate and abruptly jump to new locations over time in this depositional environment, creating deposits that are heterogeneous both laterally and vertically. As a result of this depositional environment, localized silt and clay lenses are common even in the alluvial fan areas. However, no regional clay layer is expected to exist that would severely reduce or inhibit vertical migration of water. The recent (Holocene) alluvium in the current incised river floodplains (Mokelumne and Calaveras Rivers) and windblown (eolian) sand deposits are of limited extent but relatively permeable (MWH, 2001). These present and historical alluvial depositional factors are useful in understanding rainfall percolation rates when the soil moisture deficit is zero and groundwater recharge occurs; groundwater system preferential vertical movement pathways through the principal aquifer and aquitards; and future groundwater management alternatives.

The Eastern San Joaquin Water Resources Model (ESJWRM) estimates the recharge that occurs in different areas of the Eastern San Joaquin Subbasin, largely due to the percolation of rainfall and applied irrigation water. Figure 2-13 shows the spatial distribution of percolation in the Subbasin, with generally less percolation occurring in finer soil areas (e.g., Hydrologic Soil Group D) and areas without extensive irrigation (i.e., native landscape). The higher percolation areas are those that substantially contribute to the replenishment and recharge in the Subbasin. Section 1.2.2.9 describes existing conjunctive use programs, and Figure 1-16, shown previously in Chapter 1: Agency Information, Plan Area, and Communication, maps direct recharge areas in the Subbasin.

Figure 2-13: Existing Areas of Groundwater Recharge



Note: Figure shows the distribution of deep percolation of precipitation and applied water based on ESJWRM model outputs. It does not include recharge from rivers and streams, boundary flows, or recharge projects.

2.1.4.5.2 Description of Discharge Areas

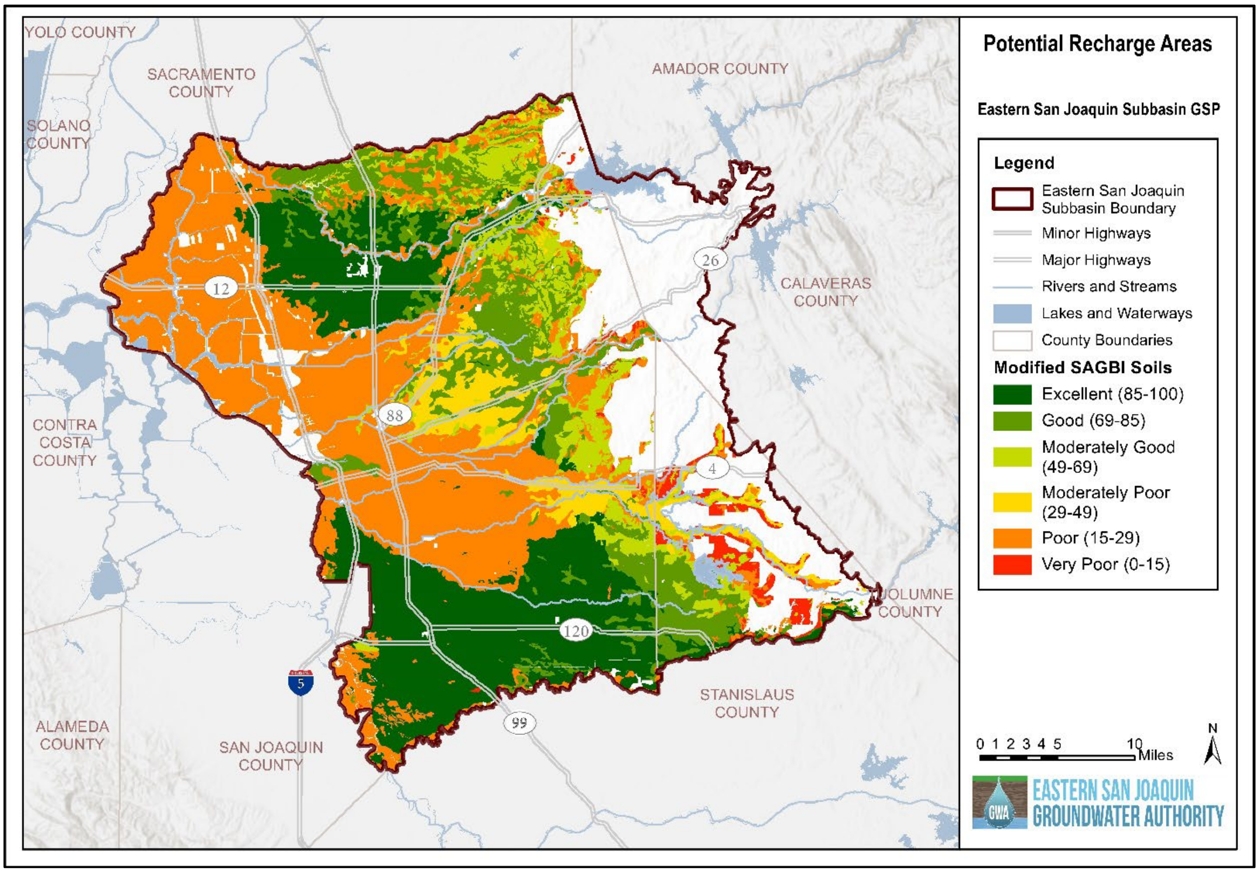
Groundwater discharge primarily occurs through groundwater production wells. Groundwater production in Eastern San Joaquin Subbasin is discussed further in Section 2.2. Groundwater also discharges to rivers and streams where groundwater elevations are higher than river stage. Other sources of groundwater discharge are evapotranspiration from riparian areas, phreatophyte woodlands, and other groundwater dependent ecosystem (GDE) communities. Groundwater discharge to streams is described more in Section 2.2.6 and discusses analysis based on modeling results from the ESJWRM for approximately 900 stream nodes (locations along simulated streams where calculations are made related to stream flows and interaction with groundwater) in the Eastern San Joaquin Subbasin.

2.1.4.5.3 Description of Potential Recharge Areas

Figure 2-14 shows areas with their potential for groundwater recharge, as identified by the Soil Agricultural Groundwater Banking Index (SAGBI). SAGBI provides an index for the groundwater recharge for agricultural lands by considering deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition.

SAGBI data are derived from “modified” SAGBI data. “Modified” SAGBI data show higher potential for recharge than unmodified SAGBI data because the modified data assume that the soils have been or will be ripped to a depth of 6 feet, which can break up fine grained materials at the surface to improve percolation. Modified SAGBI data categorize 310,098 acres out of 610,890 acres (51 percent) of agricultural and grazing land within the Subbasin as moderately good, good, or excellent for groundwater recharge (University of California, Davis, 2018).

Figure 2-14: Potential Recharge Areas



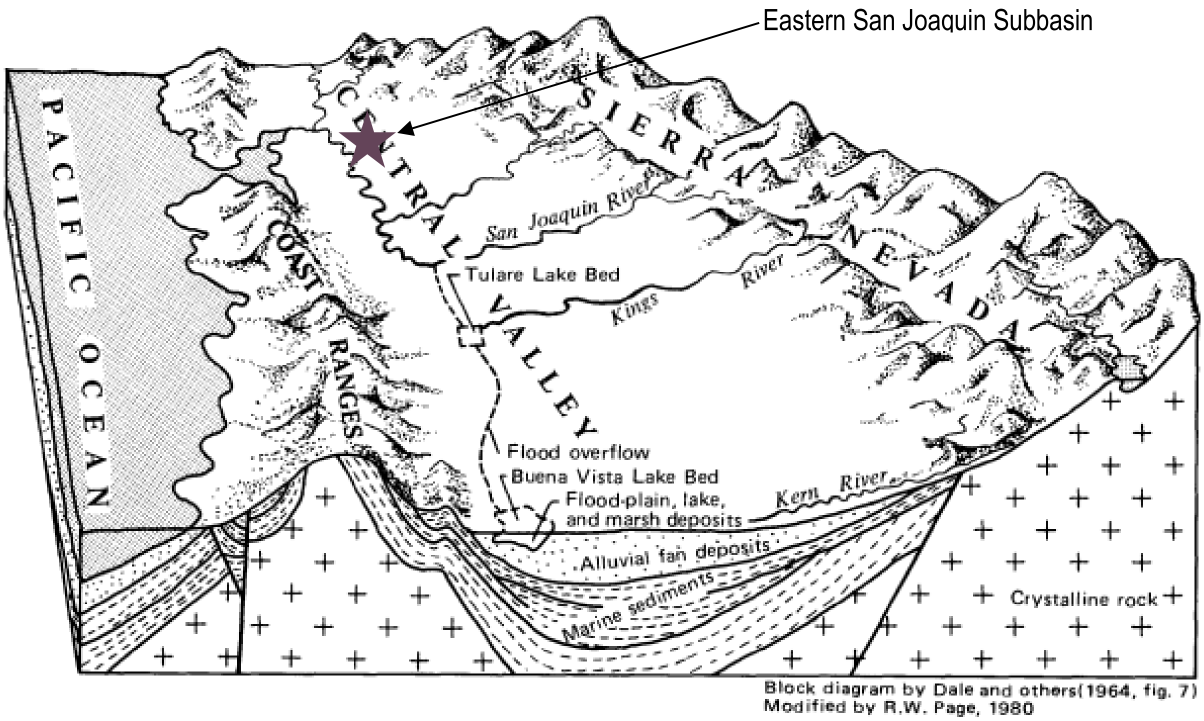
2.1.5 Geologic Formations and Stratigraphy

Geologic formations within the Central Valley and Eastern San Joaquin Subbasin are generally grouped as either eastside or westside formations based on their location relative to the San Joaquin River and the source of the sedimentary material of which they are composed. The Eastern San Joaquin Subbasin is located to the east of the San Joaquin River. Eastside continental formation material generally originates from deposits from the Sierra Nevada and westside continental formation material generally originates from the deposits of the Coast Range. Rising land masses contributed to the erosion and deposition of alluvial sands and fan deposits. Glaciation in the Pleistocene also contributed to the steepening of streams during melt water periods (CA DWR, 1967).

The block diagram of the Central Valley (Figure 2-15) provides a generalized geologic cross-sectional view of the geologic setting. The Eastern San Joaquin Subbasin is located in the foothills margin between the roughly horizontal alluvial sediments of the Central Valley geomorphic province, labeled "Central Valley" in Figure 2-15, and the granitic Sierra Nevada geomorphic province, labeled "Sierra Nevada" in Figure 2-15.

Sediment deposits can be subdivided into consolidated and unconsolidated deposits, with the consolidated sediments underlying the unconsolidated sediments. The most important fresh water-bearing formations in the Eastern San Joaquin Subbasin are the sands within the consolidated Mehrten and Laguna formations and the unconsolidated younger alluvial deposits consisting of the Riverbank and Modesto formations.

Figure 2-15: Generalized Geologic Section and Eastern San Joaquin Subbasin Setting



With depth, the stratigraphy of unconsolidated sediments consists initially of Recent to Pleistocene Age alluvial deposits of the Post-Modesto deposits and the Modesto and Riverbank Formations. The sediments of these units are typically unconsolidated sands and gravels interbedded with considerable silts and clays. These clays separate the upper sediments over the lower Late Plio-Pleistocene Age Laguna Formation and the older Eocene to Pliocene Age Mehrten Formation. The Laguna and Mehrten are poorly consolidated sediments and are differentiated based on color and sand type. The Laguna Formation is typically light brown and the differentiating characteristic of the Mehrten is black sands derived from volcanic detritus. The Valley Springs and Ione Formations are encountered below the Mehrten Formation. The formations have a distinct geologic dip and thickness to the west.

The geologic map shown in Figure 2-16 illustrates the surface deposits of the Pleistocene-aged Modesto Formation and Turlock Lake Formation largely within the valley floor (Wagner et al., 1981; Wagner et al., 1991). The knolls and ridges to the east represent outcrops of the Tertiary-aged Laguna, Mehrten, Valley Springs, and Ione Formations. The geologic stratigraphic column is provided on Table 2-2.

Figure 2-16: Geologic Map

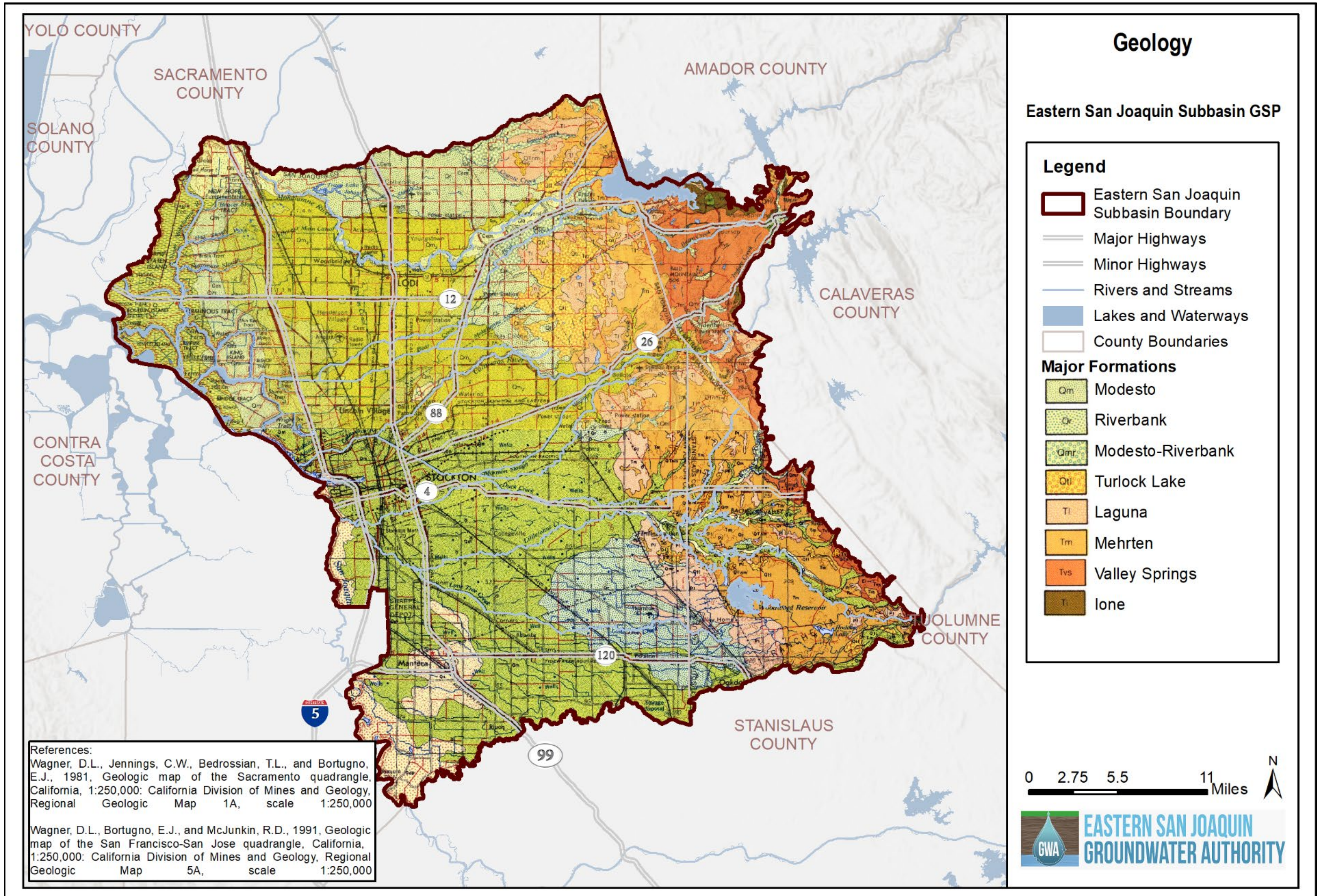


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Table 2-2: Generalized Stratigraphic Column, Formation Descriptions, and Water-Bearing Properties

Era*	Period*	Epoch*	Formation & Map Symbol	Thickness Maximum (feet)	Rock Characteristics and Environment	Water-Bearing Properties
CENOZOIC	*Quaternary*	Holocene	Stream Channel Deposits	50±	Continental unconsolidated gravel and coarse to medium sand deposited along present stream channels.	High permeability, significant avenue for percolation to underlying formations.
		Late Pliocene	Modesto (Qm)	65-130±	Continental fan and interfan material, locally some basin types, lenticular gravel, sand, silt, clay.	Moderate permeabilities. Unconfined aquifer.
		Pliocene	Riverbank (Qr)	150 to 250	Continental fan and interfan material, locally some basin types, lenticular gravel, sand, silt, clay. Reddish clay-rich duripan caps the unit.	Moderate permeabilities. Unconfined aquifer.
		Recent to Plio-Pleistocene	Flood Basin Deposits (Qb) Turlock Lake Formation (Qtl)	0-1,000±	Continental basinal equivalent of Laguna, Tulare & younger formations. Clay, silt & sand, organic in part.	Generally low permeabilities, saturated environment, unconfined to confined.
		Plio-Pleistocene	Laguna (Tl)	0-1000±	Continental, semi-to unconsolidated silt, sand & gravel, poorly sorted, includes Arroyo Seco Gravel pediment of Mokelumne R. area.	Moderate permeability, Unconfined to locally semi-confined. Restricted perched bodies in some areas.
	Tertiary	Mio-Pliocene	Mehrten (Tm)	0-600±	Continental andesitic derivatives of silt, sand and gravel & their indurated equivalents; tuff; breccia; agglomerate.	Moderate permeability to high where "black sands" occur. Confined to unconfined.
		Miocene	Valley Springs (Tvs)	0-500±	Continental rhyolitic ash, clay, sand & gravel and their indurated equivalent.	Low permeability. Not considered as significant in groundwater studies.
		Eocene	Ione (Tl)	0-500±	Light colored clay and sand. Marine shale, siltstone and sandstone	Contains saline waters except where flushed in outcrop areas.
MESOZOIC	*Creta-ceous* / *Pre-Cretace-ous*	Cretaceous Jurassic	Undifferentiated Bedrock		Igneous, metamorphics and ultramafics.	Contains saline waters. Not relevant to fresh water basin except as possible contaminant source.

Sources: CA DWR, 1967; Burow et al., 2004
* Figure 2-5 contains time scales corresponding to formations

2.1.5.1 Geologic Formation Descriptions

The Tertiary-age units that overlie the basement rocks and generally outcrop within the Eastern San Joaquin Subbasin are discussed in the following sections, from oldest to youngest.

2.1.5.1.1 Pre-Ione Eocene Rocks

The pre-Ione Eocene rocks, as described by Chapman and Bishop (1975), were deposited in a pre-Ione bedrock paleochannel system. Their composition includes sedimentary rocks of marine origin with biotite, chlorite, and muscovite. Feldspar is a significant component of this unit (Creely & Force, 2007). The thickness of this unit is highly variable in the foothill area as it is controlled by basement complex topography. The unit "wedges out" to the east and assumes a more uniform regional thickness to the west in the Central Valley Mesozoic-Cenozoic sediment pile (Creely & Force, 2007). Depictions and full geologic formation detail are provided in Table 2-2. The Tertiary volcanic and sedimentary rocks and terrace deposits are separated from the Jurassic volcanic/metamorphic basement by an angular unconformity from small-scale faulting. The Franciscan Group, Cretaceous, and Eocene Undifferentiated deposits have been impacted by the east-west Stockton Fault (CA DWR, 1967).

2.1.5.1.2 Ione Formation

The Eocene Age Ione Formation has been mapped along the eastern margin of the Eastern San Joaquin Subbasin and, as described by Loyd (1983), contains interbedded kaolinitic clay, quartz sand, sandy clay, and lignite. The Ione Formation is characteristically light in color, with color influenced by iron oxide, lignite, and carbonaceous mud rocks and shale (Creely & Force, 2007). Pask and Turner (1952) subdivided the Ione Formation into upper and lower members based on mineralogy. The upper and lower members contain kaolinite (anauxite) clays. Deposits can include coarse-grained sand (up to 2 mm diameter).

Ione sand is one of the most important sources of commercial clay and silica sand in the Ione Formation (Creely & Force, 2007). Ione sand has a white color with a pearly luster and appears massive; however, closer examination usually reveals cross stratification, heavy mineral laminae, and burrows (Creely & Force, 2007). Quartz is abundant with varying feldspar content in both members.

The lower member contains 8 to 10 percent feldspar with the upper member containing 20 to 25 percent feldspar. The minerals biotite and chlorite are rare in the lower member and common in the upper member. Heavy mineral deposits vary. The lower member contains mature minerals like zircon and ilmenite. The upper member contains hornblende and epidote. Chromite is also commonly found in the Ione Formation. The upper member is largely absent north of Jackson Valley due to erosion and deposition during the development of the overlying Valley Springs Formation. The Ione Formation is deposited in both marine and fluvial continental environments (Creely & Force, 2007).

2.1.5.1.3 Valley Springs Formation

The Oligocene-Age Valley Springs Formation is described by Loyd (1983) as stream channel and alluvial deposits derived mainly from rhyolitic volcanic rocks including some white, welded tuffs, and ash flows. The basal contact of the Valley Springs Formation is characterized, locally, by the presence of rhyolitic conglomerate. These tuffs may display alteration to clays, and, in extreme cases, only a claystone bed with relict tuffaceous texture remains. Pure deposits of rhyolitic ash exist in areas, while many sand and ash beds are present. In general, the clay beds of the Valley Springs Formation are greenish in color, may contain silt, sand, and large pumice fragments. The sandstones range in grain-size from fine to coarse and are typically well cemented. Predominantly composed of quartz and pre-Cretaceous material, the relatively sparse conglomerate lenses within the tuff, clay, and sandstone may also contain pumice fragments. In general, the Valley Springs Formation is predominantly fine-grained, containing less coarse-grained deposits. In the Central Valley, the Valley Springs Formation is considered to be largely non-water-bearing.

2.1.5.1.4 Mehrten Formation

Overlying the Valley Springs Formation is the Miocene Age Mehrten Formation, described as being stream channel, alluvial, and mudflow deposits derived mainly from andesitic volcanic rocks. The Mehrten Formation is considered the oldest significant fresh water-bearing formation within the Eastern San Joaquin Subbasin.

Bartow (1992) generally describes the Mehrten in the east-central portion of the Central Valley as being sandstone composed of amphiboles, pyroxenes, and pebbles (mostly volcanic) with lenticular bedding and gray to blue color. Bartow discusses a major change in regional volcanism as the rhyolitic pyroclastic deposits of the Late Oligocene and earliest Miocene were replaced near the end of the Early Miocene by reestablished andesitic arc volcanism in the northern Sierra Nevada. This andesitic volcanism provided the source materials for the Mehrten Formation.

Ferriz (2001) discusses how the Mehrten Formation outcrops discontinuously along the eastern flank of the Valley and was laid down in the Mokelumne area by streams carrying andesitic debris from the Sierra Nevada. The Mehrten thickens in the northeastern part of the San Joaquin Valley; generally, it can be more than 700 to 1,200 feet thick at depths ranging from more than 300 feet below ground on the east side of the valley to depths exceeding 1,400 feet along the central portion of the valley. The contact between the Mehrten Formation and underlying Valley Springs Formation is a non-distinct unconformity.

The formation is subdivided into upper and lower units. The upper unit contains finer grained deposits (black sands interbedded with brown-to-blue clay), and the lower unit consists of dense tuff breccia. Deep wells in the Stockton area indicate the upper portion of the Mehrten Formation contains a high percentage of clay, suggesting that the upper portion of the unit may be finer grained than the middle or lower portions, with resulting semi-confined conditions (CA DWR, 1967).

The black sands of the Mehrten Formation (black andesite detrital grains) generally have moderate to high permeability and yield large quantities of fresh water to wells, which makes them a preferred exploration target for groundwater supply in the eastern half of the Central Valley (Davis & Hall, 1959; CA DWR, 1967). East of Jack Tone Road, a large number of wells are produced from the relatively permeable “black sands” commonly described as hard sandstones (CA DWR, 1967).

2.1.5.1.5 Laguna Formation

The Pliocene to Pleistocene Laguna Formation is composed of discontinuous lenses of unconsolidated to semi-consolidated alluvial sands, gravels, and silts and is typically light brown. These poorly exposed stream-laid alluvial deposits form high terraces and are associated with the last major uplift in the Sierra Nevada.

The Laguna Formation outcrops in the northeastern part of San Joaquin County and dips at 90 feet per mile and reaches a maximum thickness of 1,000 feet, with the thickest areas (400 to 1000 feet) observed near the Mokelumne River in the Stockton Area (CA DWR, 1967). The Laguna Formation is moderately permeable with some reportedly highly permeable coarse-grained fresh water-bearing zones.

2.1.5.1.6 Turlock Lake Formation

The Turlock Lake Formation consists primarily of arkosic alluvium, mostly fine sand, silt, and in places clay, at the base grading upward into coarse sand and occasional coarse pebbly sand or gravel (Marchand & Allwardt, 1981). The age of the Turlock Lake Formation is about 600,000 to greater than 730,000 years old, but younger than about 1 million years. The Turlock Lake commonly stands topographically above the younger fans and terraces throughout the northeastern San Joaquin Valley in a broad band between the Merhten, Laguna, and the younger Riverbank and Modesto alluvial fans to the west. A buried soil separates the Turlock Lake Formation into two units (Upper and Lower) in the northeastern San Joaquin Valley. The thickness of the Turlock Lake is variable and appears to increase toward the east. Estimates of thickness in the subbasins to the south range from 295 to 850 feet for eastern Stanislaus County, 1,000 feet for northern Merced County, and 160 to 720 feet in the Chowchilla area.

The Turlock Lake Formation is differentiated from the west to east by its Corcoran Clay member that is present in the southwest corner of the Subbasin near Manteca and dominates the area west of Highway 99 south of the Eastern San Joaquin Subbasin. The Corcoran Clay becomes interbedded with the sands and silt of the upper Turlock Lake and is not found in the central and northern portions of the Subbasin. This member is found ranging in thickness from a feather edge to 160 feet beneath the present bed of Tulare Lake. The Turlock Lake Formation is dominant within the basins to the south.

2.1.5.1.7 Riverbank Formation

The Riverbank Formation consists primarily of arkosic sediment derived mainly from the interior Sierra Nevada, which forms at least three sets of terraces and coalescing alluvial fans along the eastern San Joaquin Valley (Marchand & Allwardt, 1981). The Riverbank Formation is about 130,000 to 450,000 years old. The Riverbank, as exposed in the northeastern San Joaquin Valley, is primarily sand, containing some scattered pebbles, gravel lenses, and some interbedded fine sand and silt. The Riverbank unconformably overlies the Laguna Formation, and its terraces and fans truncate or are cut into Turlock Lake alluvium or fill post-Turlock Lake gullies and ravines, which, in turn, are cut and filled near the foothills by terraces of the lower member of the Modesto Formation. The Riverbank Formation is informally subdivided into three units (lower, middle, and upper) which appear to coarsen upward, like those of the older Turlock Lake Formation. The Riverbank Formation also shows a variable thickness that tends to increase toward the major river channels; 150 to 200 feet is reported in northern Merced and eastern Stanislaus Counties, 260 feet along the Merced River, and about 65 feet along the Chowchilla River.

2.1.5.1.8 Modesto Formation

The Modesto Formation is composed of mainstream arkosic sediments and associated deposits of local derivation laid down during the last major series of aggradation events in the eastern San Joaquin Valley (Marchand & Allwardt, 1981). Gravel, sand, and silt were deposited as a series of coalescing alluvial fans extending continuously from the Kern River drainage on the south to the Sacramento River tributaries in the north. They occur in a wide band immediately east of the San Joaquin Valley axis and to the west of the Riverbank and older fan remnants. Radiocarbon dating estimates the age of the Modesto Formation to be older than 9,000 years before present (B.P.) to 42,000 years B.P. Most of the prime agricultural land and many of the major cities are located in the young alluvial soils associated with the undissected Modesto terrace and fan surfaces. Modesto deposits overlie late Riverbank alluvium and older units and are locally incised or covered along modern channels by post-Modesto deposits.

The materials of the Modesto Formation are virtually identical to those of the Laguna, Turlock Lake, and Riverbank Formations, but their association with low terraces and young fans and their moderate to slight degree of erosional modification and soil profile development clearly differentiate them from older alluvium. The total thickness of the Modesto deposits is reported to be 50 to 100 feet in eastern Stanislaus County, 130 feet along the Merced River, and about 65 feet along the Chowchilla River fan. The Modesto Formation also thickens toward each river channel and toward the south; there is significant evidence of local facies changes laterally. Exposed sections differ substantially from exposures near the foothills and from exposures along the westward draining rivers.

2.1.5.1.9 Post-Modesto Deposits – Recent Alluvium and Basin Deposits

In general, these younger units are less consolidated and sedimentary in nature, representing a sequence of young alluvial fills including alluvial fans, channel, point bar, levee, crevasse splay, interdistributary, and floodbasin alluvium. The alluvial fan deposits are much smaller than the late Modesto fans. The age of these deposits ranges from 9,000 years B.P to modern time. Lacustrine, swamp, and marsh deposits are presently accumulating in poorly drained areas on the alluvial fan toes. In oxbow lakes on river flood plains, near the edge of the Delta where Holocene sea level rise caused alluviation of the lower Mokelumne and Cosumnes Rivers, lakes and swamps have formed where tributary gullies have been blocked by mainstream aggradation (Marchand and Allwardt, 1981).

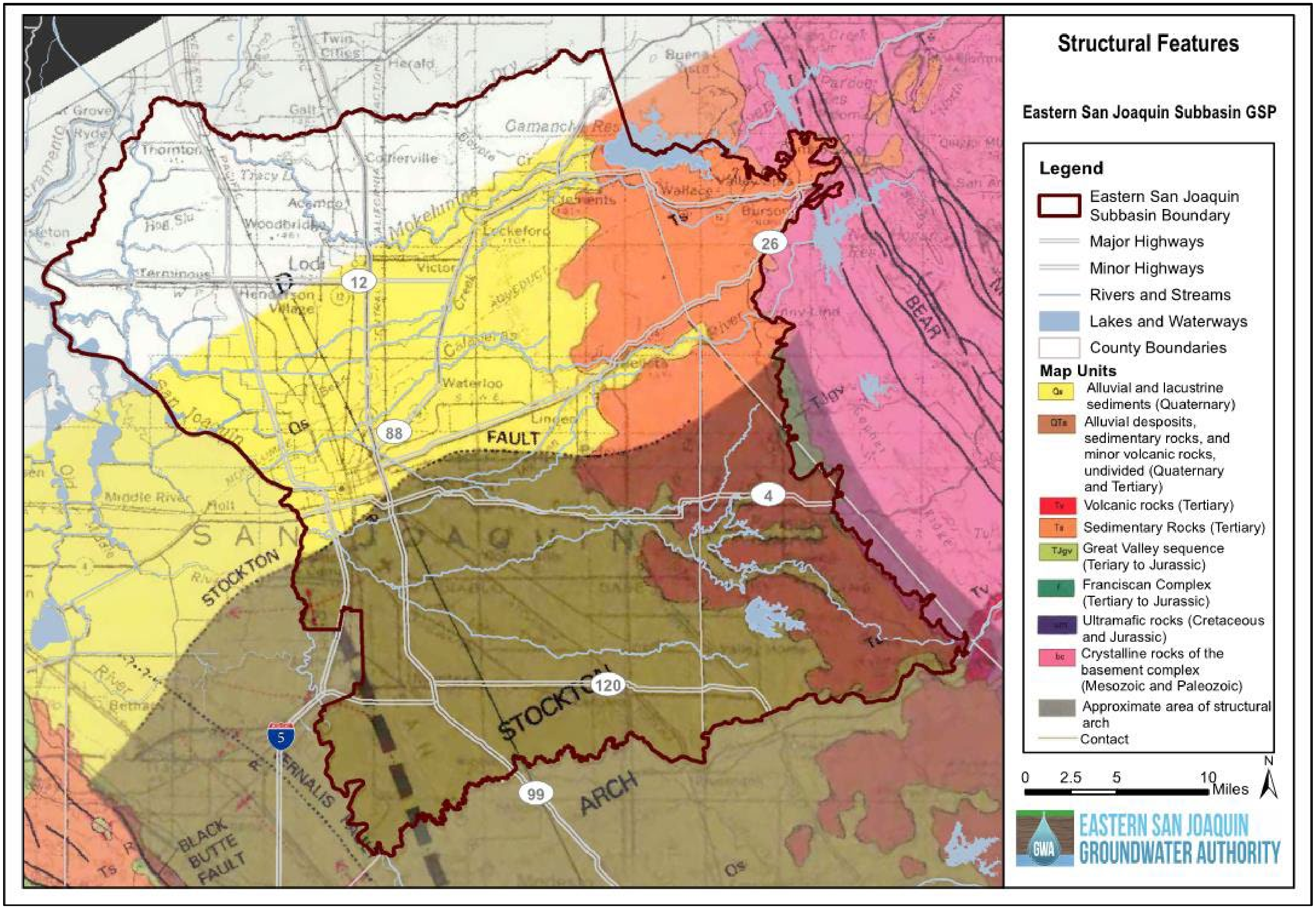
2.1.6 Faults and Structural Features

The Stockton Fault – The Stockton Fault is the largest fault in the Eastern San Joaquin Subbasin, shown in Figure 2-17. It is a large reverse fault with displacements of up to 3,600 feet (1,100 m) that trends transverse to the regional structure and bounds the Stockton Arch on the north. Bartow (1985) shows relative movement along the fault as north side down. The timing of the vertical movement is predominantly post-Eocene (Hoffman, 1964), and the latest movements appear to have been subsequent to deposition of the basal part of the Valley Springs Formation probably during Miocene time.

The Vernalis Fault – The Vernalis Fault is a reverse fault with northwest-southeast trend that bounds the Tracy-Vernalis anticlinal trend that is mapped outside of the west boundary of the Eastern San Joaquin Subbasin. East-side-down movement of as much as 1,500 feet (460 m) probably took place at the same time as the major movements on the Stockton Fault (Bartow, 1985). The relative thickness of sediments can be inferred from the elevations of the base of the freshwater aquifer system shown in Figure 2-5. The freshwater aquifer system on the north side of the Stockton Fault extends approximately 600 feet deeper than the aquifer system south of the fault. Relative movement along the fault is north-side-down, thus allowing for greater accumulation of the continental Tertiary sediments and deepening of the aquifer materials in this area.

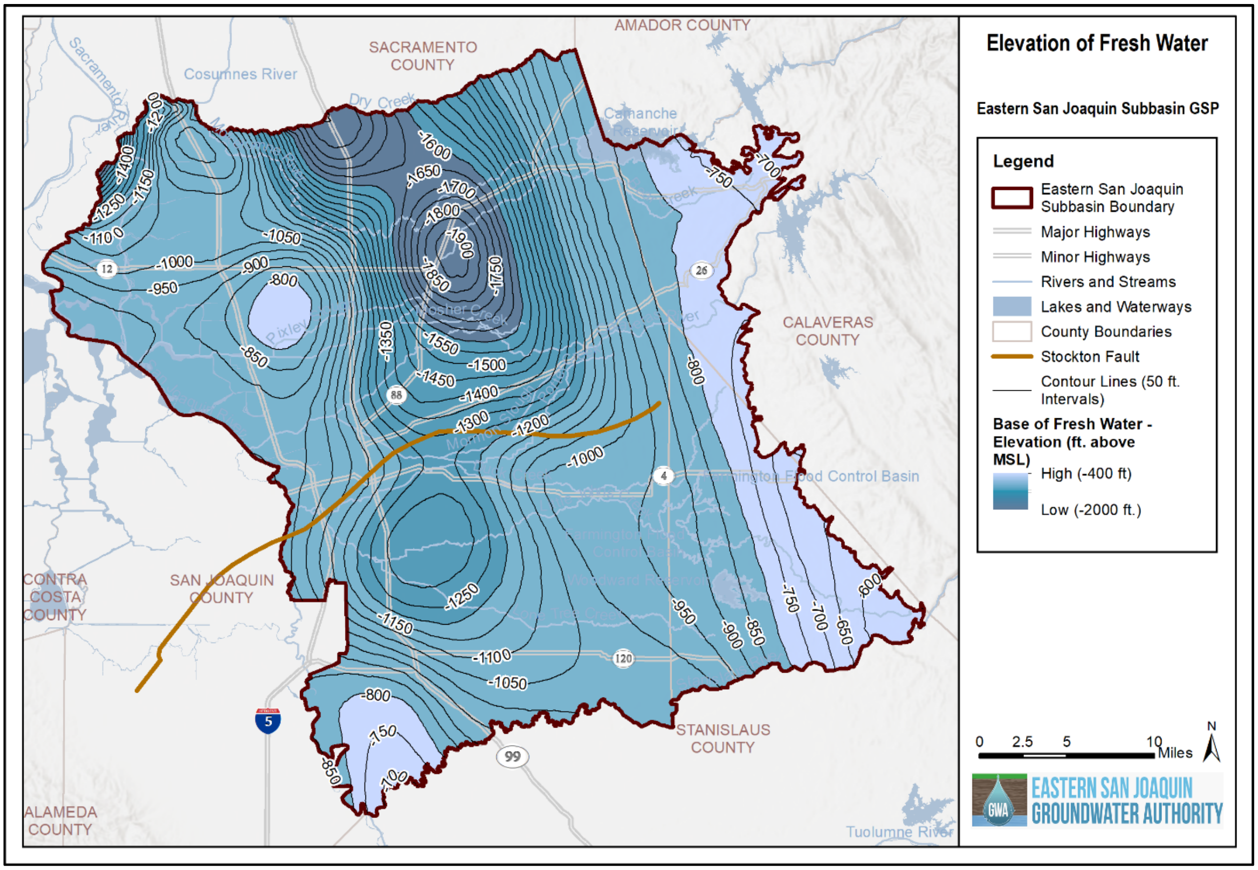
Stockton Arch – The Stockton Arch is a broad transverse structure that underlies the southern half of the Eastern San Joaquin Subbasin. The arch is bounded on the north by the Stockton Fault, and the southern limit is the line of truncation of Paleogene strata south of Modesto (Bartow, 1985). Indications of northward-shallowing marine facies in the lower Paleogene sequence suggests that the arch was present by Paleocene time. Erosion during the Oligocene time apparently reduced whatever physiographic expression the arch may have had and left a nearly flat plain prior to deposition of the later Tertiary units.

Figure 2-17: Faults and Structural Features



As a result of the north-side-down movement along the Stockton Fault, the Tertiary sediments are thicker north of the fault and thinner south of the fault. This feature also influences the location, depth, and thickness of the "base of the fresh water", as shown below in Figure 2-18. The base of fresh water is discussed further in Sections 2.1.7 and 2.1.8.2.

Figure 2-18: Base of Fresh Water Elevation and Stockton Fault



Angular unconformities – There are a series of angular unconformities formed during the Cenozoic-related to uplift of the Sierra Nevada to the east (Bartow, 1985). The Cenozoic history of the Sierra Nevada is one of progressive westward tilting, perhaps episodic, with an increasing rate in the late Cenozoic. The subtle angular unconformities that separate the Tertiary units are evidence of this progressive tilting. The Tertiary units rarely have dips of more than 2 degrees; the difference in dip between the Ione and the Valley Springs Formations, for example, may be less than 1 degree. The discordances are most apparent in terms of gradients of depositional surfaces measured in distances of several miles. The largest discordances are between the Ione Formation (about 1,500 ft/mile) and the Valley Springs Formation (94 - 120 ft/mile), between the Mehrten Formation (99 - 131 ft/mile) and the Laguna Formation (52 - 79 ft/mile), and between the Laguna Formation and the Quaternary deposits (less than 18 ft/mile). The Ione-Valley Springs unconformity represents the Oligocene regression that affected most of central and southern California, and the Mehrten-Laguna unconformity probably marks the accelerated uplift of the Sierra Nevada beginning 3 to 5 million years ago (Huber, 1981) in the central part of the range. The Sierra Nevada was relatively stable through the Miocene with only a minor discordance between the Valley Springs and Mehrten Formations; their lithological difference reflects primarily a change from rhyolitic to andesitic volcanism in the source area. Uplift of the Sierra Nevada continued through the Quaternary, but the record is complicated by Quaternary climatic events (e.g., glaciation) which were the principal controlling factor in Quaternary sedimentation for the east side of the Great Valley.

2.1.7 Geologic Cross-Sections

Five geologic cross-sections (A-A', B-B', C-C', D-D', and E-E') were developed for the Eastern San Joaquin Subbasin based on the stratigraphic information amassed as part of the data compilation efforts. A geologic cross-section is an interpretive diagram of the lateral and vertical subsurface relationships of geologic formations. A cross-section location map with locations of groundwater and oil and gas wells reviewed in the development process is provided as Figure 2-19. Three of the cross-sections (A-A' through C-C') are along east-west transects in the north, central, and southern portion of the Subbasin, respectively; two of the cross-sections (D-D' and E-E') are generally along north-south transects. Cross-section D-D' generally transects the cities of Lodi, Stockton, and Manteca in the west portion of the Subbasin, and cross-section E-E' transects the Eastern San Joaquin Subbasin along the alignment of Jack Tone Road from the northeast to the southwest portion of the Subbasin. Each of the five geologic cross-sections are provided in Figure 2-20, Figure 2-21, and Figure 2-22.

Figure 2-19: Cross-Section Location Map

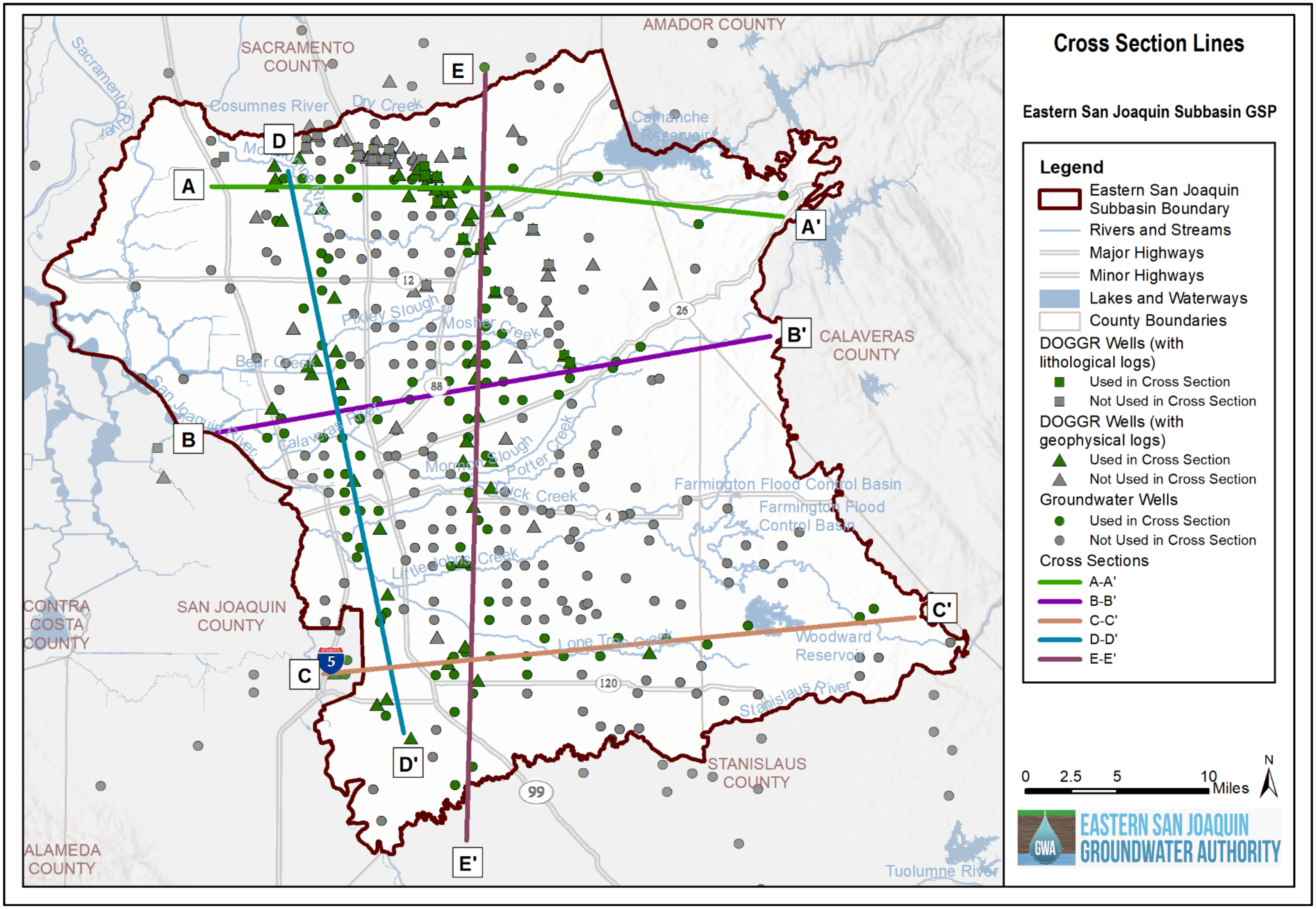


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Figure 2-20: Hydrogeologic Cross-sections A-A' and B-B'

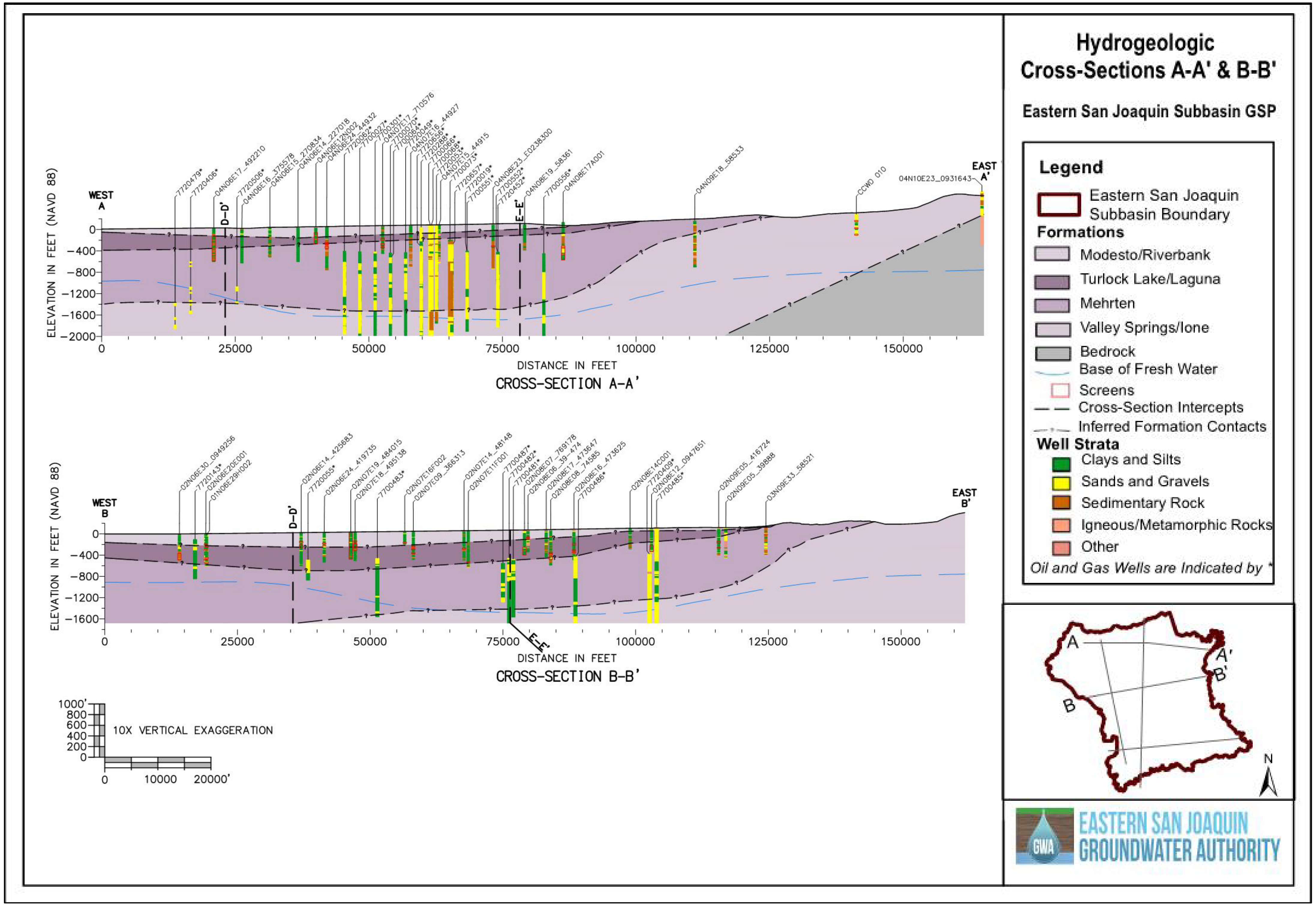


Figure 2-21: Hydrogeologic Cross-sections C-C' and D-D'

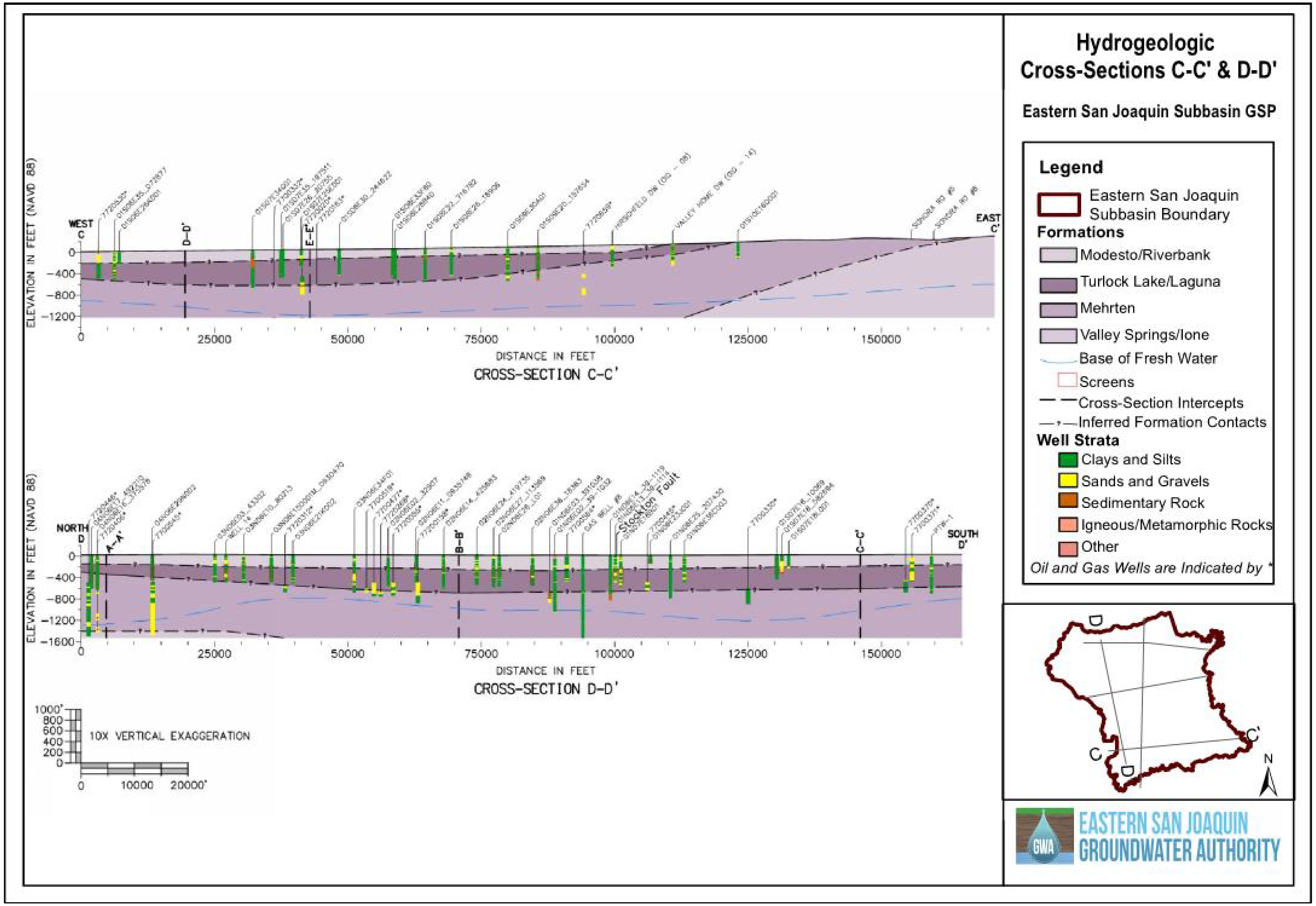
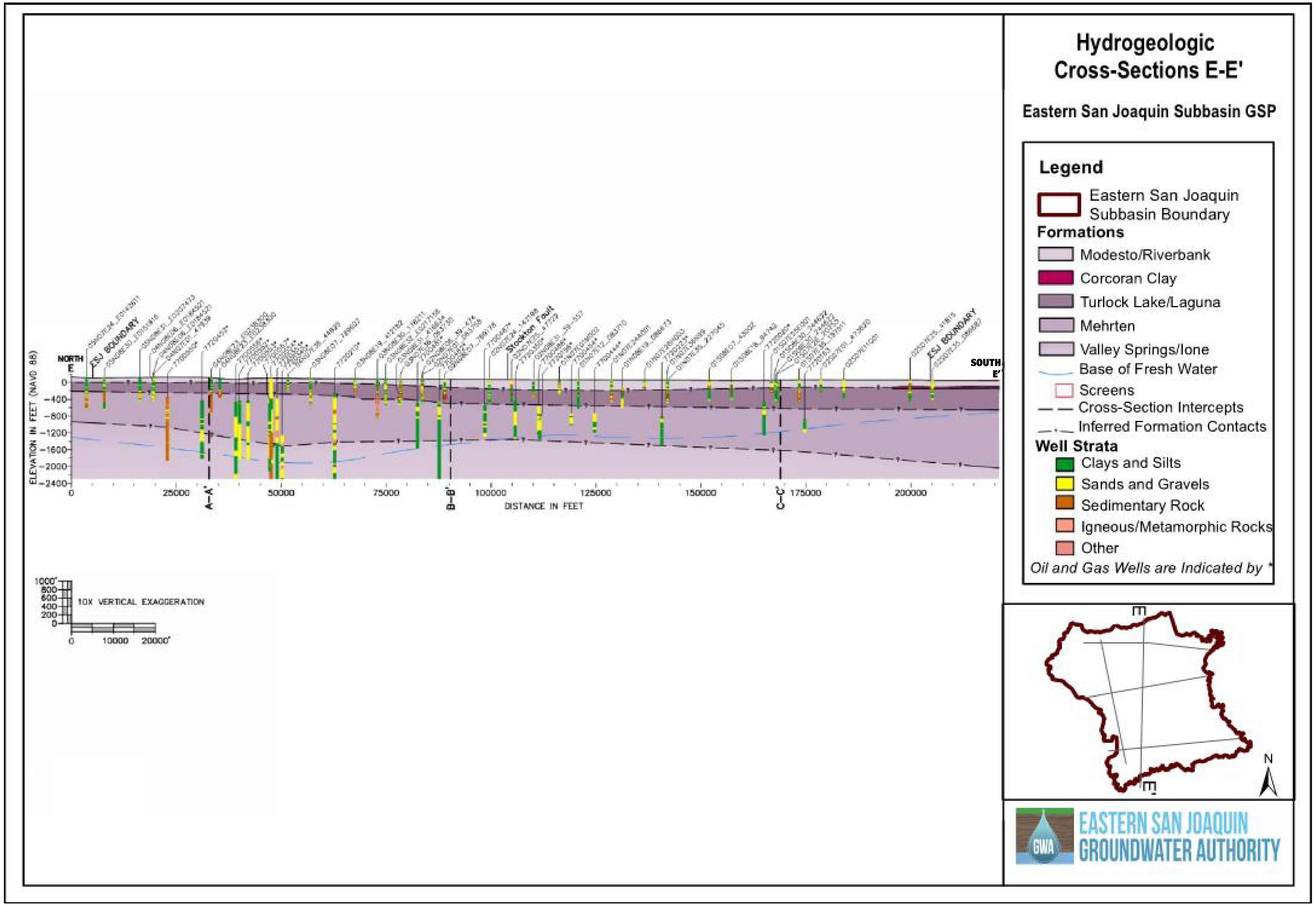


Figure 2-22: Hydrogeologic Cross- section E-E'



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Stratigraphic data from well completion reports of hundreds of water wells and oil and gas wells (indicated by an asterisk on the cross-sections) were used to develop the geologic cross-sections. Stratigraphy (e.g., clays and silts, sands and gravels, sedimentary rock, metamorphic and igneous rock) is presented directly on the cross-sections along with the well screen interval (shown in red). The deeper oil and gas wells are shown extending to the bottom depth of the cross-sections, but many extend several hundred to thousands of feet beyond the depictions provided.

The analysis interpreted geologic formations from the borehole data after digitizing stratigraphic data from the various well log sources. This process relied heavily on the distinguishing features of each formation. Particularly, the black sands prevalent in the Mehrten Formation and evidence of shells noted in the descriptions that likely indicated a change to marine sediments of the Ione Formation were often mentioned in well logs. The analysis used surficial geology, location, and depth of the borehole to determine geologic formations. The analysis inferred formation contacts in places where data were limited, including areas on the east and west limbs of the cross-sections, as well as vertically throughout.

As evident on the east-west geologic cross-section transects, the oldest formations are present on the east side of the Eastern San Joaquin Subbasin, shown overlapping the older sedimentary and/or basement rocks of the Sierra Nevada (A-A'), with progressively younger formations present to the west and vertically occupying shallower depth intervals. The east-west depictions also show the contacts of the formations steeply dipping in the east and nearly flat lying or at low gradients to the west. The northwest-southeast trending cross-section D-D' shows the formations in their relatively flat-lying positions, with oldest formations on the bottom and progressively younger formations above. This cross-section transect is essentially normal to the dip of the beds. In slight contrast to D-D', the transect of cross-section E-E' is somewhat oblique to the dip of the beds, thus there is an apparent down-dip toward the south. This effect is seen because the transect is moving into younger materials from the south toward the north.

The base of fresh water is superimposed on the cross-sections as supported by works from Page (1974) and Williamson (1989), as represented in Figure 2-18. The base of the fresh water represents the vertical extent of fresh non-saline groundwater within the Eastern San Joaquin Subbasin principal aquifer. The sands of the Mehrten Formation are thickest in the northeast portion of the basin and there is a corresponding deepening of the freshwater aquifer on the north side of the Stockton Fault, as shown on cross-sections A-A' and B-B'. The depth of the base of fresh water is shallower south of the Stockton Fault in the southern portion of the Eastern San Joaquin Subbasin. Further discussion of the principal aquifer is provided in Section 2.1.9.

Well depths generally decrease in total depth from north to south across the Subbasin and locally within proximity of the major surface water drainages. In general, coarser sands are found at shallower depths within the lower unit of the Laguna Formation and upper Mehrten Formation (C-C') in the area of the Stanislaus River Drainage. Similarly, shallow well completions evident on cross-section D-D' and the southern portion of E-E' are indicative of the sandier nature of the recent alluvial deposits, the Turlock Lake, and Laguna Formations near the San Joaquin River.

2.1.8 Basin Boundaries

2.1.8.1 Lateral Boundaries and Boundaries with Neighboring Subbasins

The Eastern San Joaquin Subbasin is within the larger San Joaquin Valley, which comprises the southernmost portion of the Great Valley Geomorphic Province of California. Groundwater subbasins bounding the Eastern San Joaquin Subbasin are shown in Figure 1-6 and include:

- Cosumnes Subbasin to the north of Dry Creek
- Modesto Subbasin to the south of the Stanislaus River
- South American Subbasin to the northwest of the Mokelumne River
- Solano Subbasin to the northwest of the Mokelumne River

- East Contra Costa Subbasin to the west of the San Joaquin River
- Tracy Subbasin to the west of the San Joaquin River

Foothill and bedrock highs are to the east within Calaveras and Amador Counties.

2.1.8.2 Definable Bottom of the Basin

The base of the fresh water defines the bottom of the basin, the maximum vertical extent of fresh non-saline groundwater within the Eastern San Joaquin Subbasin. While water-bearing materials exist below this depth, the saline nature of the groundwater, in addition to the depth itself, generally makes accessing deeper groundwater not economically viable.

Because of the extreme depths to the base of fresh water shown in Figure 2-18, efforts by the USGS have been used to define the "base of fresh water" through the interpretation of the California DOGGR well logs and deep oil well geophysical logs as depicted on maps and cross-sections above. Base of fresh water (encountered saline) has been observed as shallow as 650 feet below ground surface (bgs) in the eastern part of the basin to over 2,000 feet bgs in the northern part of the basin as depicted on the surface contour map and supported by work completed by Williamson (1989).

2.1.9 Principal Aquifer

The Eastern San Joaquin Subbasin HCM has one principal aquifer that provides water for domestic, irrigation, and municipal water supply and that is composed of three water production zones. The zones have favorable aquifer characteristics that deliver a reliable water resource because of their basin location and sand thickness.

The zones are:

- Shallow Zone that consists of the alluvial sands and gravels of the Modesto, Riverbank, and Upper Turlock Lake Formations
- Intermediate Zone that consists of the Lower Turlock Lake and Laguna Formations
- Deep Zone that consists of the consolidated sands and gravels of the Mehrten Formation

Details on the formations are provided in Section 2.1.5.

2.1.9.1 Zones within Principal Aquifer

Zones within the principal aquifer are based on the compilation of five hydrogeologic cross-sections (see Figure 2-20 through Figure 2-22). Cross-sections were based on over 330 well logs in the Subbasin. From this data, well depths for municipal and irrigation wells range from 75 to over 800 feet bgs, with an average depth of 350 feet bgs. Well logs were reviewed for the following information used in putting together the cross-sections:

- Depth of water table
- Depth and thickness of saturated fine to coarse grained sand and gravel layers
- Depth and thickness of discrete layers of sands
- Depth and thickness of discrete clay or silt layers that locally confine groundwater
- Depth of water-bearing aquifer materials (e.g., sands and gravels) down to the base of fresh water and deeper, where available

Analysis identified significant permeable zones with high production rates and good water quality at relatively shallow depths (less than 700 feet bgs) due to the following conditions:

- The relatively shallow depths of production wells had high specific capacity that met the water supply demand and reduced the cost associated with drilling deeper
- The base of fresh groundwater is deep; ranging from depths of 700 to 1,900 feet bgs
- Deeper water is saline and not considered suitable for potable or agricultural use

Figure 2-23 and Figure 2-24 depict the wells used during this hydrogeologic characterization effort. Information compiled was used to detail the three permeable water-bearing zones described from surface downward in the following sections.

Figure 2-23: Bottom Elevation of Water-Bearing Zones (Shallow)

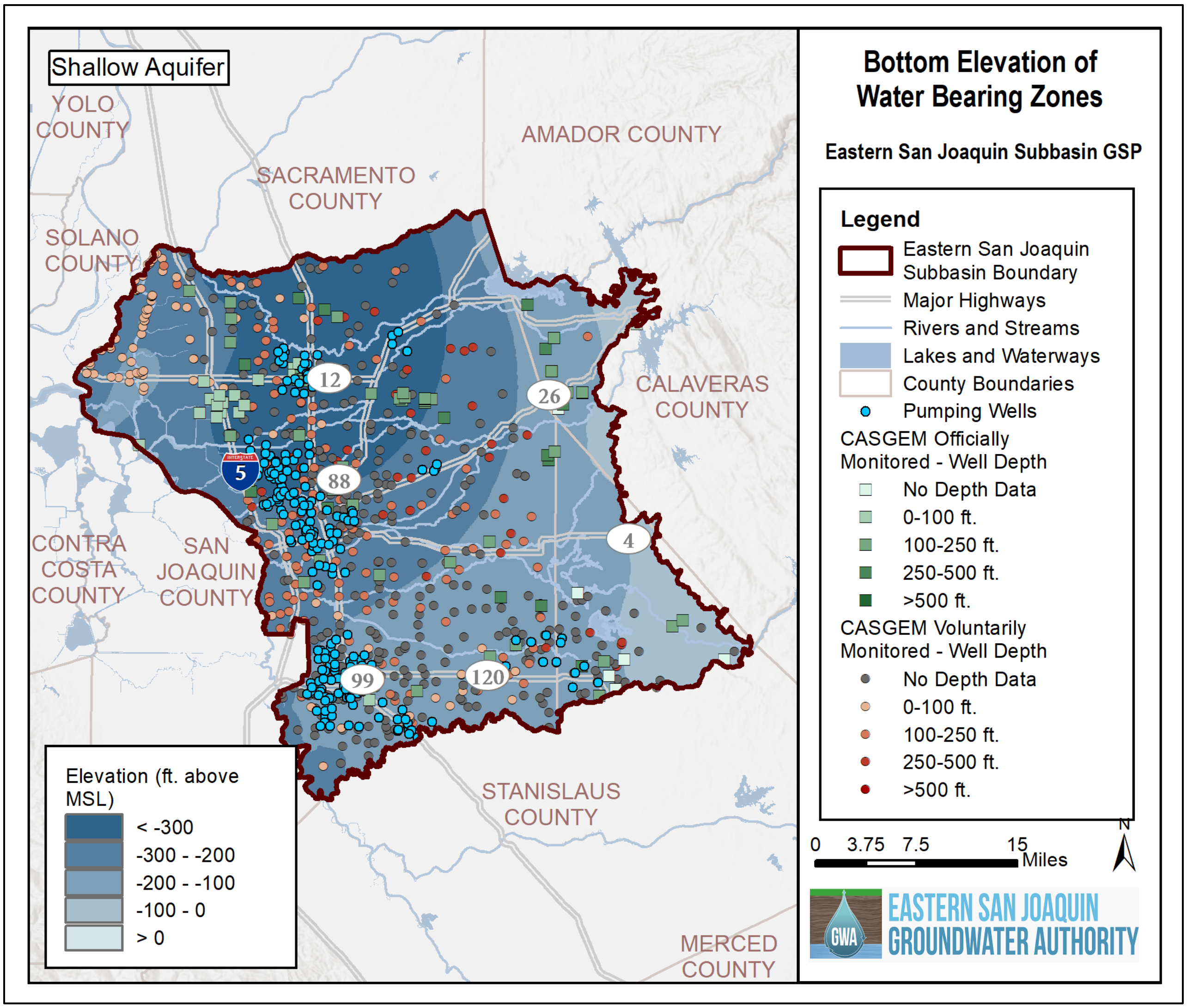
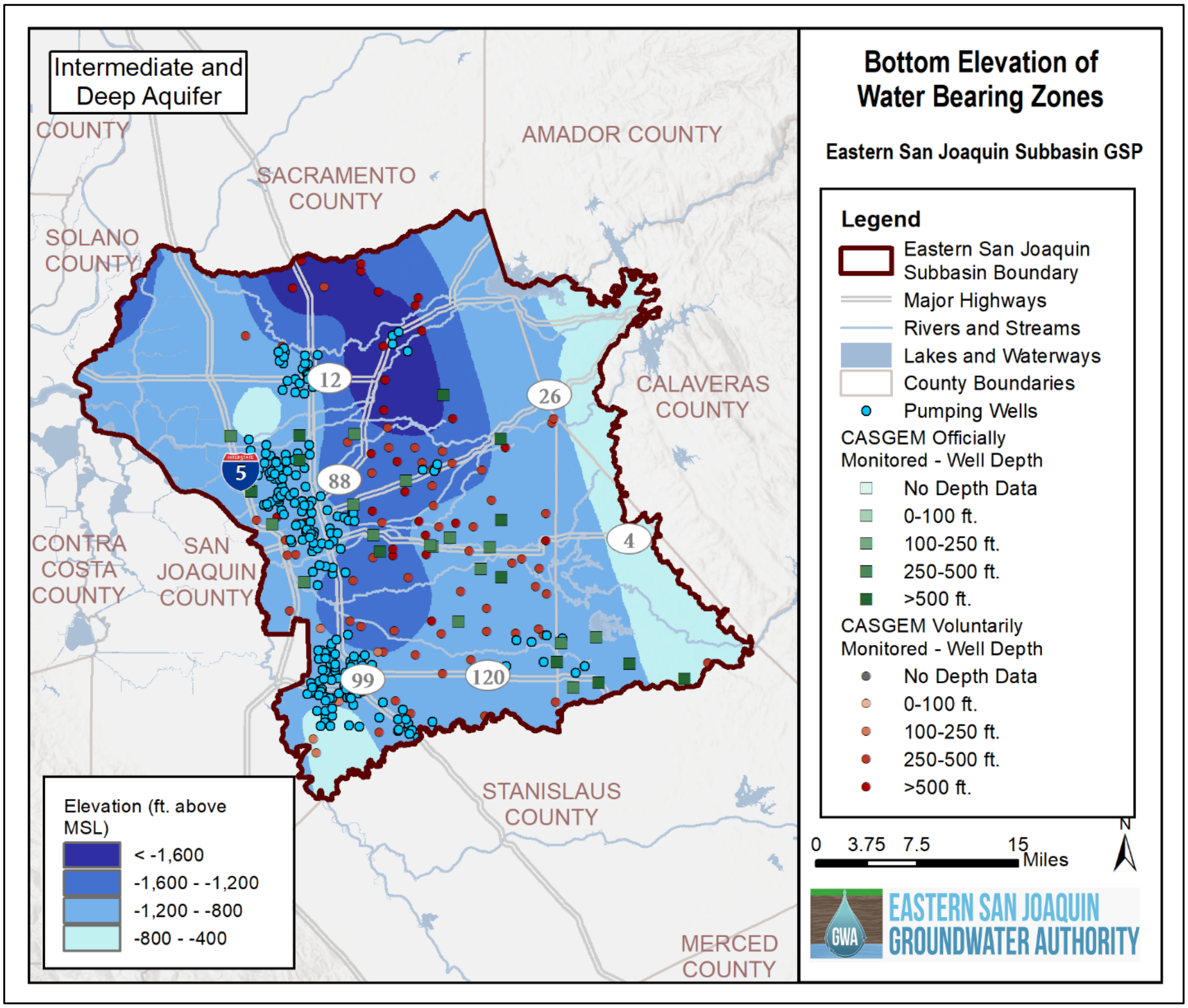


Figure 2-24: Bottom Elevation of Water-Bearing Zones (Deep and Intermediate)



2.1.9.1.1 Shallow Zone

The shallow water-bearing zone is composed of permeable sediments from recent alluvium, Modesto/Riverbank Formations, and the upper unit of the Turlock Lake Formation that are present west of the older geologic formations and extend across the majority of the Eastern San Joaquin Subbasin. This zone is generally unconfined above the aquitards (clays/silts, including Corcoran clay, and old soil horizons/hardpan layers).

The depositional structure on the eastern side of the valley trough is depicted on the hydrogeologic cross-sections A-A' through E-E' (see Figure 2-20, Figure 2-21, and Figure 2-22). This structure results in the groundwater flow that follows both the dip of the beds and hydraulic head differentials. Erosional and depositional features dominate aquifer characteristics. The cross-sections also depict the aquifer thickness from 30 feet to greater than 300 feet.

The Shallow Zone characteristics are supported by the sand thickness information detailed below along with review of basin aquifer parameters. This zone has high yielding wells. Aquifer characteristic values range as follows (CA DWR, 2967; Burow et al., 2004):

- Transmissivities up to 90,000 gpd/ft

- Specific yields up to 17 percent
- Vertical permeability estimates up to 0.1 ft/day

2.1.9.1.2 Intermediate Zone

As depicted on the hydrogeologic cross-sections A-A' through E-E' (see Figure 2-20, Figure 2-21, and Figure 2-22), sands, typically from 10 to over 60 feet thick, are found below the low permeable clay layers or aquitards. The sands and gravels are developed with one relatively continuous sand unit at 350 feet bgs, within the top of the lower unit of the Turlock Lake Formation and Laguna Formation, thinning out at topographic highs to the east. Eastern basin depositional structure shows a pinching, wedging, and combination water-bearing zones with the surficial alluvium.

The aquifer characteristics are supported by the sand thickness information detailed herein for the principal aquifer. The eastern distribution of this water-bearing zone near the surface suggests unconfined groundwater conditions. Typically, this zone is found semi-confined with high yielding wells and is considered the current primary production zone. Area groundwater numerical models support the CA DWR (1967) and Burow and others (2004) aquifer characteristic values range as follows:

- Transmissivities up to 59,500 gpd/ft
- Storage coefficients typically 0.00001 (unitless)
- Vertical permeability estimates up to of 0.07 ft/day

2.1.9.1.3 Deep Zone

The water-bearing "black sands" of the semi-consolidated Mehrten Formation are considered a significant source of water for Eastern San Joaquin Subbasin production wells. The formation is thick in the west with a limited number of deep wells that penetrate the entire depth of this unit as depicted on the hydrogeologic cross-sections A-A' through E-E' (see Figure 2-20, Figure 2-21, and Figure 2-22). This water-bearing zone is confined due to the thick overlying clay units, consolidation, and basin location. Semi-confined conditions are more likely to the east because of the dipping of beds and stratigraphic layer thinning and erosion of clay/silt beds. The dipping beds of the Mehrten Formation dip are at a steeper slope of 90 to 180 feet per mile westward. Consolidated sediments of the Mehrten and Valley Springs Formations are at valley bottom depth and exposed on the eastern foothills. Recharge to these aquifer formations occurs because of the high topographic setting with increased rainfall and exposure of weathered surface and runoff from the adjacent fractured Sierran bedrock.

As depicted on the hydrogeologic cross-sections A-A' through E-E' (see Figure 2-20, Figure 2-21, and Figure 2-22), boring logs indicate a significant 30-foot thick gravel encountered at a depth from 140 to 170 feet. Thickly bedded sands were found to exceed 250 feet. At the eastern margins of the basin, consolidated portions of the Mehrten, Valley Spring, and Ione Formations are important for low-yielding bedrock wells and are considered aquifer recharge sources for the Eastern San Joaquin Subbasin. The relatively low permeability and consolidated nature of the Valley Springs and Ione Formations act as the bottom of the Deep Zone (Burow et al., 2004).

The aquifer characteristics are supported by the sand thickness information. The well yields are high in this zone, over 1,000 gallons per minute (gpm). Area groundwater numerical models support the CA DWR (1967) and Burow and others (2004) aquifer characteristic values range as follows:

- Transmissivities up to 250,000 gpd/ft
- Storage coefficients that are typically 0.0001
- Vertical permeability estimates up to of 0.05 ft/day

2.1.9.1.4 Limited Aquitards

The Corcoran Clay member of the Turlock Lake Formation and other interbedded clay/silts are aquitards that inhibit groundwater flow. The Corcoran Clay (found at the base of the upper unit of the Turlock Formation) is present at a depth of about 200 feet bgs. The Corcoran Clay has a limited distribution in the extreme southwestern extent of the Subbasin, southwest of the City of Manteca (Figure 2-22). The clay is typically 20 to over 100 feet thick and is locally eroded and interfingered with coarser materials at its margin. Groundwater below the Corcoran Clay is confined. The Corcoran Clay is found more significantly in subbasins to the south where it is a significant vertical barrier to flow.

Thick clay and silt layers are found within the Laguna and Mehrten Formations. These two formations each have two documented upward coarsening alluvial sequences (Burow et al., 2004). Significant clay and paleosols divide the water-bearing zones at the base of each sequence. The cross-sections (Figure 2-20, Figure 2-21, and Figure 2-22) show both the clay and silt horizons range in thickness from less than 10 feet to over 150 feet. The vertical permeability estimates range from 0.01 to 0.007 feet per day (Burow et al., 2004).

Discontinuous clay horizons have been eroded significantly by the movement of the ancestral rivers. As depicted on the cross-sections, thickest sequences of uppermost permeable units and overbank fines below these layers have been observed. The general thickness and depth are supported by a southeast to northwest movement of river channels to the existing channel location.

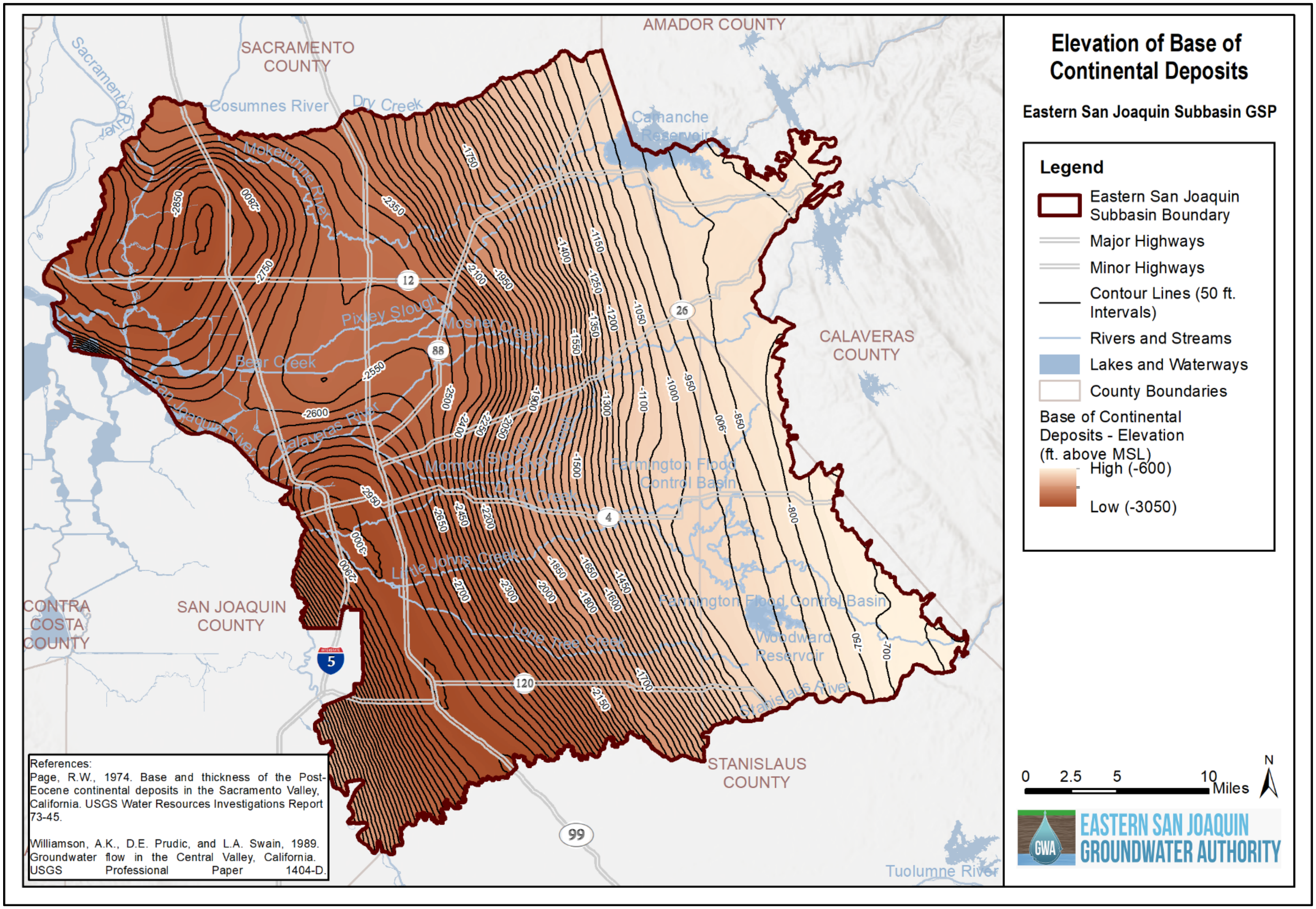
Hydraulic connection for the entire depth of the principal aquifer is supported by cross-section depictions that indicate the laterally extensive interbeds of high and low permeable layered deposits. The historical erosional and depositional history supports the referenced hydraulic interconnection. This observation is consistent with the possible thinning and wedging out of the regional clay units due to reworking or ancestral erosion (Davis et al., 1959).

In addition to the natural connectivity, the number of water wells drilled through these zones also indicates additional hydraulic connection because of the construction of long well gravel packs that connect the water-bearing zones.

2.1.9.1.5 Deep Saline Groundwater

Connate or saline water occurs from the base of fresh water (shown in Figure 2-18 or Figure 2-24) to the base of continental deposits (shown in Figure 2-25), forming a saline layer that ranges in thickness from 50 to 2,250 feet from the east to the west across the Subbasin. The deep saline layer is not currently a water production zone for consumption or land application. Information used in developing the thickness of the saline water above continental deposits is from Page's 1974 *Base and Thickness of the Post Eocene Continental Deposits in the Sacramento Valley* and the thickness of the aquifer developed by Williamson and others (1989).

Figure 2-25: Elevation of Base of Continental Deposits



2.1.9.2 Aquifer Characteristics and Groundwater Quality

Because of the horizontal and vertical distribution of sediments and hydraulic connection between the water-bearing zones, one Principal Aquifer is defined.

An important step in aquifer characterization includes the completion of sand and gravel thickness (isopach) maps. An isopach map illustrates thickness variations within a tabular layer or stratum. Isopachs are contour lines of equal thickness over an area. The combined isopach map for the principal aquifer is depicted on Figure 2-26. The isopach map details are as follows:

- Over 313 water supply well logs with depths to 1,000 feet were used, with an average depth of 540 feet bgs
- Average sand and gravel thickness is 140 feet
- The thickest sand and gravel sequences ranged from 500 to 700 feet near the Stanislaus River, south of Woodward Reservoir and northeast of Oakdale
- Thicknesses from 200 to 400 feet were observed west of Morada along Bear Creek and toward the Delta
- The 200 to 500 feet thickness contours were observed near Stockton along the Duck Creek historical drainage
- Recognizing the sand and gravel thickness and the relative hydraulic conductivity of these permeable units, a more comprehensive understanding of the aquifer transmissivity can be made as detailed in Section 2.1.9.2.1.

As discussed in Section 2.1.4.3, soils facilitate rainfall and applied water infiltration, which is a significant recharge source for the Shallow Zone. Other recharge takes place through infiltration and percolation of surface water bodies and via groundwater flow from upgradient areas to the zones within the entire principal aquifer and potentially from flow between subbasins from the north, south, and west. The Intermediate and Deep Zones are recharged via infiltration near sand and gravel layers that are typically thicker near historical river beds. Vertical movement of water through sand deposits is more rapid compared to the confining clay deposits. In the high topographic areas along the east margin of the Subbasin, water-bearing zone sediments are exposed at the surface and considered significant to recharge.

2.1.9.2.1 Aquifer Parameters and Production Zone Well Capacities

The GSP uses several sources to summarize the field-tested aquifer characteristics and production zone well capacity information for the principal aquifer.

For depiction purposes, Table 2-3 includes four investigation areas encompassing the entire Subbasin: Calaveras County, Farmington, Manteca, and near the Stanislaus Triangle Area (Riverbank). For these examples, the maximum well yields range from greater than 100 to 2,800 gpm. The range in specific capacity is 27 to 90 gpm/ft of drawdown. These numbers relate to the testing of individual well capacities and the anticipated pumping water level related to the pumping rate. Transmissivity and storage values relate to the aquifer character anticipated at a distance away from a pumping well. Specific yield (SY) is defined as a unit volume of water released from an aquifer per unit decline in water table. Specific storage (SS) of a saturated aquifer is defined as the amount of water released from storage per unit decline in hydraulic head (Freeze and Cherry, 1979).

Figure 2-26: Sand and Gravel Isopach Map

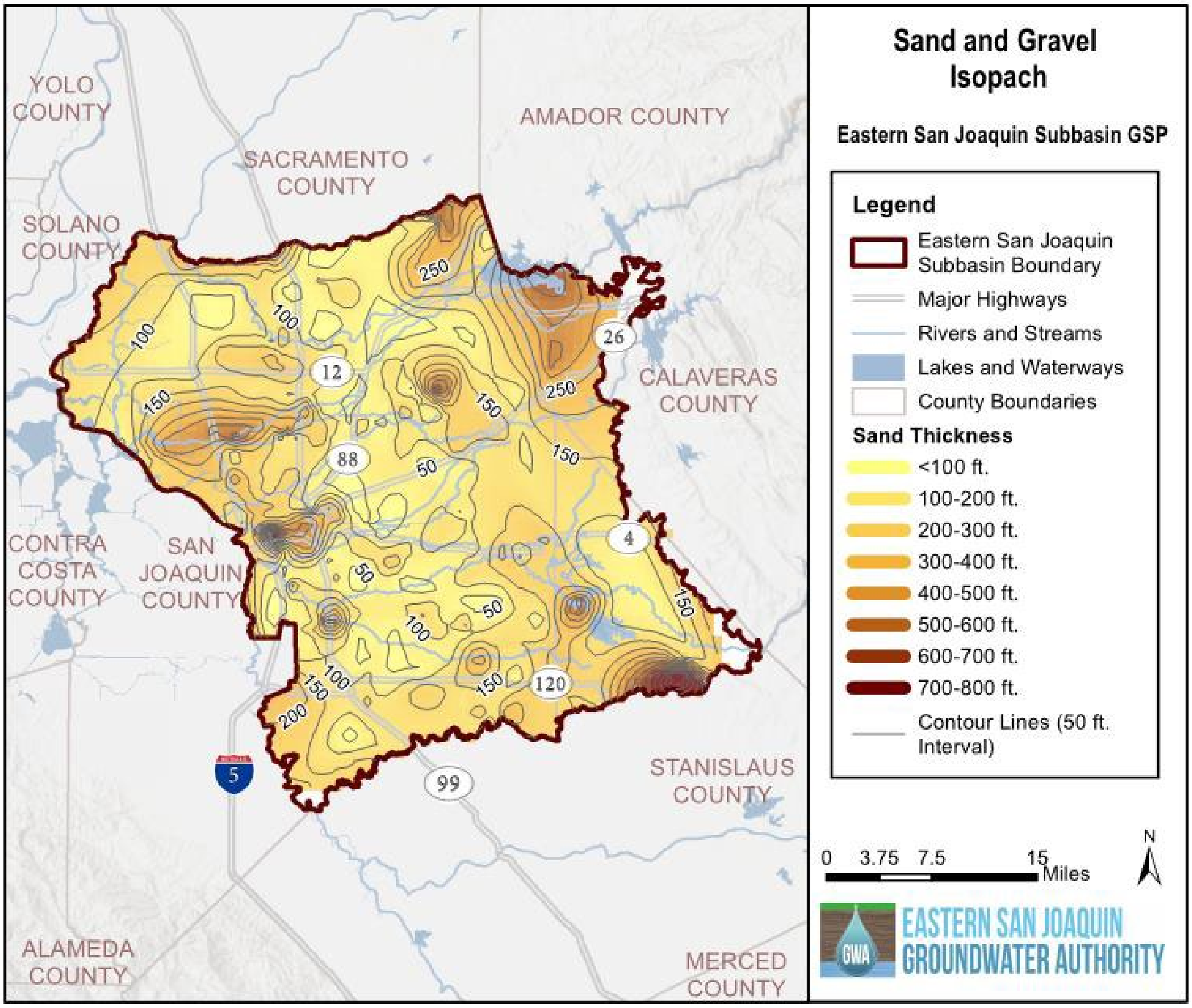


Table 2-3: Production Zone Capacities

Sources/Well Information	Maximum Well Yield (gpm)	Maximum Well Specific Capacity (gpm/ft drawdown)	Maximum Transmissivity (gpd/ft)	Maximum Specific Yield (Unconfined [%])	Specific Storage (Confined [Unitless])	Sand and Gravel Thickness	Encountered Mehrten Depth, (feet)
Entire Eastern San Joaquin Subbasin (CA DWR, 2006)	1,500	n/a	n/a	7.3 %		>150	400-600
Calaveras County (WRIME, 2003)	>100	>10	>35,000	>6 %		>120	At Surface
Farmington (DE, 2012)	800	27	19,600	>5 %	0.001	>110	230
Manteca (NV5, 2017)	2,500	90	61,000	>10 %	0.0001	>130	350
Stanislaus Triangle (Bookman-Edmonston, 2005)	>2,800	>40 (DE, 2007)	35,000	17 %	0.001	>150	Dip to the West

Using the basic physical properties of groundwater flow, a confined aquifer transmissivity is defined by:

$$T = Kb$$

Where: T is transmissivity
K is the hydraulic conductivity (rate of flow under a unit hydraulic gradient through a unit cross-sectional area)
b is the aquifer thickness.

Using a typical clean sand hydraulic conductivity value of 500 gpd/ft^2 and a thickness of 120 feet, the aquifer transmissivity averages approximately 60,000 gpd/ft which is similar to the documented values reported above (Freeze and Cherry, 1979).

For additional comparison, data for the four layers of the ESJWRM were provided in the ESJWRM Model Report (see Appendix 2-A)

The distribution of production wells and monitoring wells is provided on Figure 2-23 and Figure 2-24. Table 2-4 provides descriptors for the three water-bearing zones:

- Number of wells for each zone
- Well depths
- Wells used on the cross-sections

Additional aquifer parameter confirmation is provided by the ESJWRM as follows (Woodard & Curran, 2018):

- Horizontal Hydraulic Conductivity – The horizontal hydraulic conductivity varies across the non-saline model layers ranging from 1.1 ft/day to 72.7 ft/day or 0.148 to 10 gal/day/ft^2.
- Specific Storage and Yield – SS and SY are used to represent the available storage at nodes in confined and unconfined aquifers. SS values range from 4.18×10^{-6} to 2.05×10^{-4}. SY values range from 4 to 10 percent.

Table 2-4: Wells within Water-Bearing Zones

CASGEM Wells				
Water-Bearing Zone	Well Type	Number of Wells	Average Construction Depth (ft. bgs)	Average Construction Bottom Elevation (ft. MSL)
Shallow	CASGEM	124	174	-64
	Voluntary	328	155	-100
Intermediate and Deep	CASGEM	79	538	-397
	Voluntary	122	540	-424

Pumping Wells			
Water-Bearing Zone	Number of Wells	Average Bottom of Screen Depth	Average Bottom of Screen Elevation
Shallow	148	270	-238
Intermediate and Deep	113	369	-300

Groundwater Wells Used in Cross-Sections			
Water-Bearing Zone	Number of Wells	Average Bottom of Borehole Depth	Average Bottom of Borehole Elevation
Shallow	39	234	-144
Intermediate and Deep	273	672	-566

2.1.9.2.2 Regional Historic Groundwater Flow and Surface Water Interaction

The horizontal groundwater flow direction for the Eastern San Joaquin Subbasin is typically towards areas of lower groundwater near the center of the Subbasin. The flow generally mirrors topography and is relatively consistent over time. The flow direction follows the overall east dipping gradient of the geologic formations in the eastern portions of the Subbasin. Higher groundwater elevations are in the foothills on the east side of the Subbasin, and the elevations decrease following the topography. In the western portion of the Subbasin, groundwater flows east toward areas with relatively lower groundwater elevation. Horizontal groundwater flow is further discussed in Section 2.2.

The GSP evaluates vertical groundwater gradients using the USGS nested wells in the Eastern San Joaquin Subbasin. Clark and others (2012) drilled and assessed several nested wells or multiple well sites in the Eastern San Joaquin Subbasin. These nested well sites include three to five monitoring wells per borehole, with screen intervals at depths of approximately 100 to 900 feet (Clark et al., 2012). Groundwater elevation in these monitoring wells, measured from 2006 to 2008, usually indicate the same trend. Groundwater elevation is typically lower in monitoring wells with deeper screen placement, suggesting downward flow of groundwater. The difference in groundwater elevations from the shallowest to deepest monitoring wells, within each borehole, is typically between 5 and 20 feet (Clark et al., 2012). Additional discussion regarding differences and distribution across the Subbasin is provided in Section 2.2.

Historical groundwater-surface water interaction in the context of the twenty years of the historical model (ESJWRM) is discussed in Section 2.2.6.

2.1.9.2.3 General Groundwater Quality

2.1.9.2.3.1 Geologic Formation Groundwater Quality

The USGS and other government agencies completed several major studies concerning groundwater quality in the Central Valley of California, which includes the Eastern San Joaquin Subbasin. Repeatedly mentioned in these studies is the natural geochemical effects on groundwater quality that is specific to geologic formations (Creely & Force, 2007; Faunt, 2009; CA DWR, 1967). This natural effect is of great interest for the GSP implementation because groundwater level fluctuations from overdraft and recharge may result in water quality changes that is specific to geologic formations.

Natural geochemical reactions can be highly variable, even from well to well, as reactions depend on a number of factors, including the amount of: 1) reactive surface area of the formation sediments; 2) available oxygen in the formation as affected by fluctuations in groundwater elevation, depth to groundwater, and oxygenated near-surface recharge; and 3) potentially inorganic-oxidizing bacteria.

For the Eastern San Joaquin Subbasin, igneous and metamorphic rocks of the Sierra Nevada Mountains underlie the upstream drainages. These rocks predominately contain oxygen, silicon, aluminum, iron, calcium, sodium, potassium, and magnesium (Creely & Force, 2007). Rivers draining areas of granitic rocks typically have better water quality than metamorphic or volcanic rocks (CA DWR, 1967). For example, the Mokelumne River drains areas of granitic origin and has a lower salt content than the Calaveras River, which drains an area of primarily metamorphic rocks (CA DWR, 1967). Streams originating from either igneous or metamorphic rocks have relatively low amounts of dissolved solids, compared to marine sedimentary rocks that make up the Coast Range west of the Subbasin (Faunt, 2009). However, marine formations also underlie continental deposits in the Eastern San Joaquin Subbasin and have considerable amounts of chlorine, sulfur, bromine, and boron from connate water (Creely & Force, 2007). Connate water originates from fluids that are trapped in the pores of the sedimentary rocks as they are deposited and can contain many mineral components as ions in solution. Above these marine formations are continental deposits described in Section 2.1.5.

Groundwater quality of wells in Calaveras County is characterized by Metzger and others in a 2012 study, *Test Drilling and Data Collection in the Calaveras County Portion of the Eastern San Joaquin Groundwater Subbasin, California, December 2009 – June 2011* (Metzger et al., 2012). These wells are in the Eastern San Joaquin Subbasin, in an area underlain by the Ione and Valley Springs Formations. This study assessed groundwater samples and identified three water types present: calcium-magnesium-bicarbonate, sodium-bicarbonate, and mixed cation-mixed anion water. The mixed cation-mixed anion group consisted mostly of sodium and chloride. These groundwater samples also showed high levels of arsenic, which were attributed to pH level variation or redox potential (Metzger et al., 2012). The Ione formation, for instance, is known to have high sulfate levels in groundwater related to the pH influence on pyrite-sulfide rich coal deposits.

Arsenic is of particular concern because it is naturally occurring in the Eastern San Joaquin Subbasin and is hazardous to human health. Izbicki and other's (2008) study, *Source, Distribution, and Management of Arsenic in Water from Wells, Eastern San Joaquin Groundwater Subbasin, California*, assesses the concentration and sources of arsenic in various wells. Arsenic was detected mostly in San Joaquin County, and the largest concentrations were in the western portion of the subbasin (Izbicki et al., 2008). The surficial geology in this area consists of the Modesto and Riverbank Formations, which are underlain by the Turlock Lake and Laguna Formations (see Figure 2-16, Figure 2-20, Figure 2-21, and Figure 2-22). Sources of arsenic include weathering of minerals containing arsenic, desorption of arsenic under certain pH values, and release of arsenic in redox conditions (Izbicki et al., 2008).

Another element of great importance is nitrogen, as it is included in many compounds that are by-products of agriculture, which heavily dominates the landscape of the Eastern San Joaquin Subbasin. Elevated levels of nitrate can typically occur as a result of fertilizer application, manure and septic waste, and natural sources. Extensive work by Holloway and others (1998) showed the Mokelumne River watershed contained significant quantities of nitrogen from bedrock lithology. The upper part of the watershed, outside the Eastern San Joaquin Subbasin, is underlain by igneous and metamorphic rock, but the metasedimentary and metavolcanic rocks contained the highest levels of nitrogen (Holloway et al., 1998).

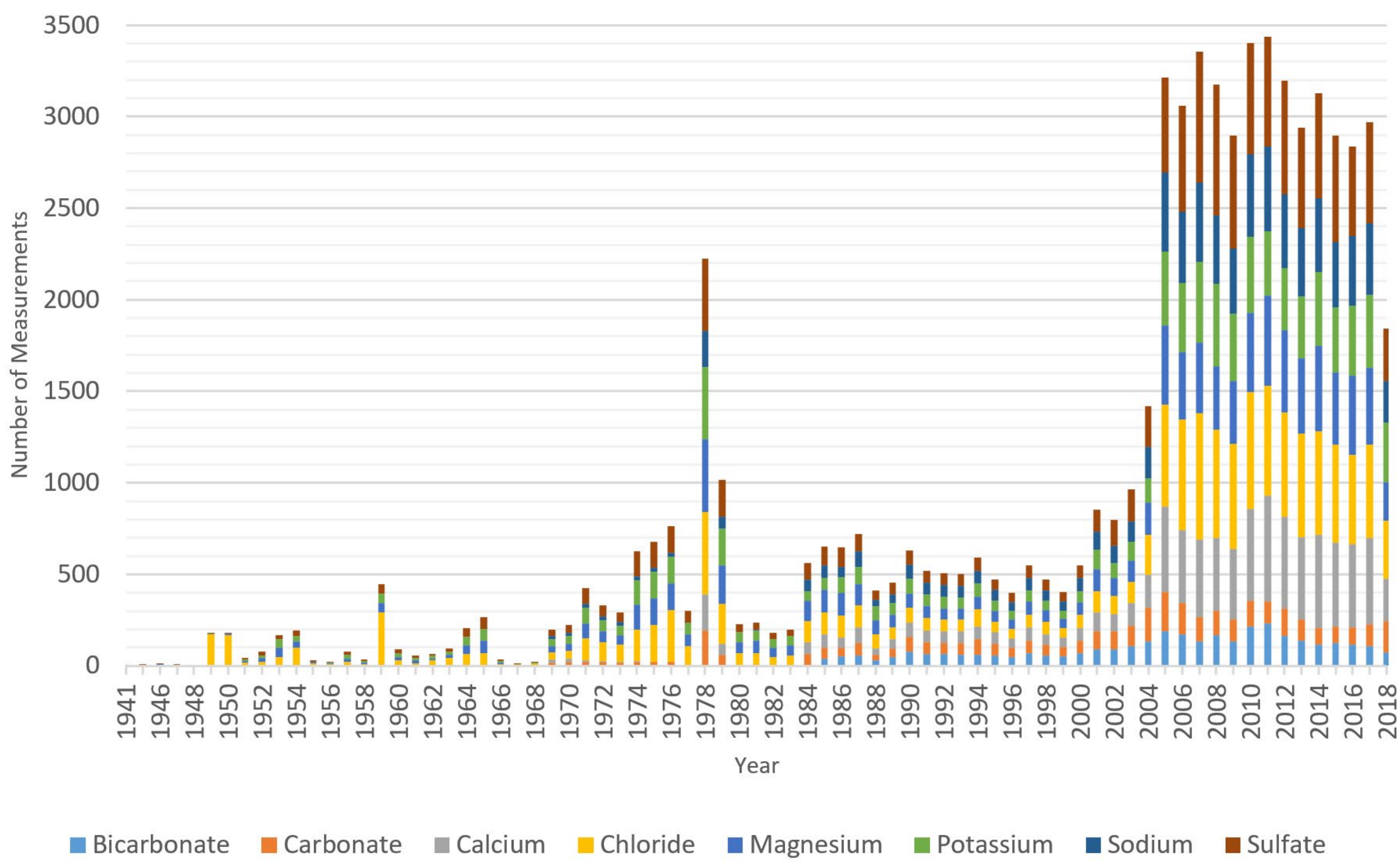
General water quality of principal aquifers is summarized in the following sections, as required by CCR Title 23 § 354.14. General water quality can be determined by assessing commonly measured inorganic parameters as indicators of change. Evaluating these inorganic parameters involves looking at historical trends and comparing results to certain thresholds, as well as determining water types. These parameters include major cations and anions, listed below:

Anions	Cations
Bicarbonate	Calcium
Carbonate	Magnesium
Chloride	Potassium
Sulfate	Sodium

2.1.9.2.3.2 Ion Composition

Evaluating the historical trends of these parameters is not straightforward. GAMA records include some groundwater quality results for the Eastern San Joaquin Subbasin going back to the 1940s. However, a thorough analysis requires a large amount of data on all the major cations and anions mentioned above. A large number of measurements of this kind were taken from 2005 to 2017, as shown in Figure 2-27. Data from 2018 are not included because at the time of this writing, the data were incomplete.

Figure 2-27: Total Number of Cation/Anion Measurements in the Eastern San Joaquin Subbasin



General water quality of the Subbasin can be determined by assessing water type over specific years within the time frame of 2005 to 2017. Evaluating the years 2005, 2011, and 2017 provides an even spread over the selected time frame and gives an idea of possible water type trends. Trilinear diagrams for each of these years show relative concentrations of the major cations and anions (see Figure 2-28). Each symbol in the diagram represents a water sample collected. Water samples, represented by the same symbol, are plotted in the two lower triangle diagrams for each year based on their relative cation (left) and anion (right) concentrations. The top diagram represents a projection of the two ternary diagrams for easier comparison.

Due to the difference in sampling locations, the years 2005 and 2011 show carbonate and bicarbonate-rich waters, and 2017 displays increased chloride and sulfate concentrations in some wells. These dates correlate to both data size increases and heavier rainfall periods. Chloride concentrations in 2017 are generally less than 150 milligrams per liter (mg/L), with some higher measurements reaching 2,000 mg/L. Sulfate concentrations in 2017 are mostly under 300 mg/L, but a few extremely high levels up to 100,000 mg/L exist near the City of Manteca.

The increased chloride concentrations apparent in 2017 may not be indicative of a long-term trend. Chloride concentrations are higher in more wells in 2017 when compared to 2005 and 2011, but there is little fluctuation in the range of values for each year (Figure 2-29). Sulfate concentrations are also increased in 2017 compared to 2005 and 2011. Similar to chloride, the range of sulfate results for each year between 2005 and 2017 does not show any obvious trends (Figure 2-30).

Higher chloride and sulfate concentrations during 2017 are apparent near the cities of Manteca and Stockton (Figure 2-31 and Figure 2-32). A further discussion and assessment of chloride measurements in the Eastern San Joaquin Subbasin is included in Section 2.2.

Figure 2-28: Trilinear Diagrams

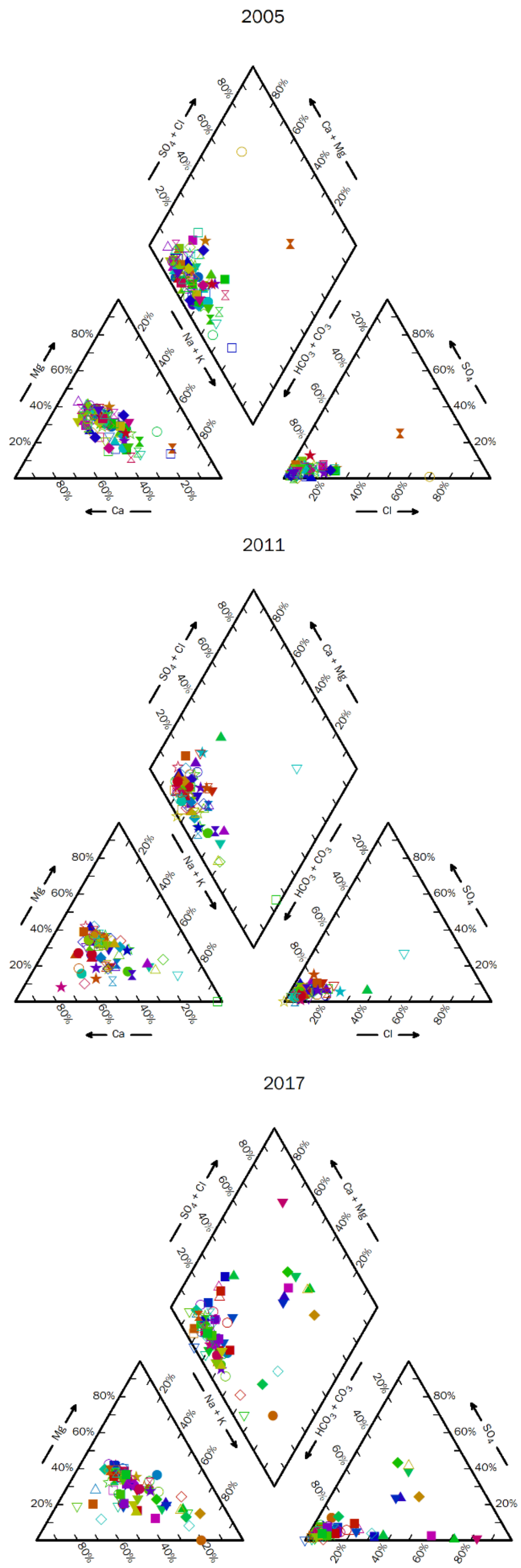


Figure 2-29: Chloride Annual Variation

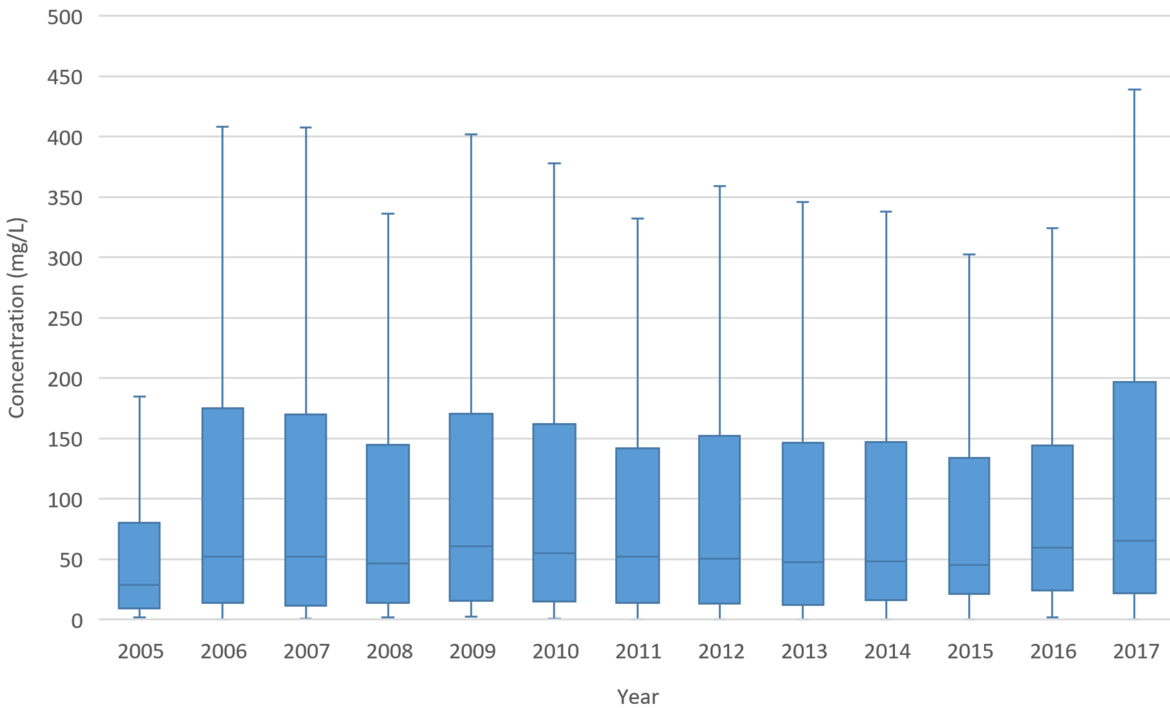
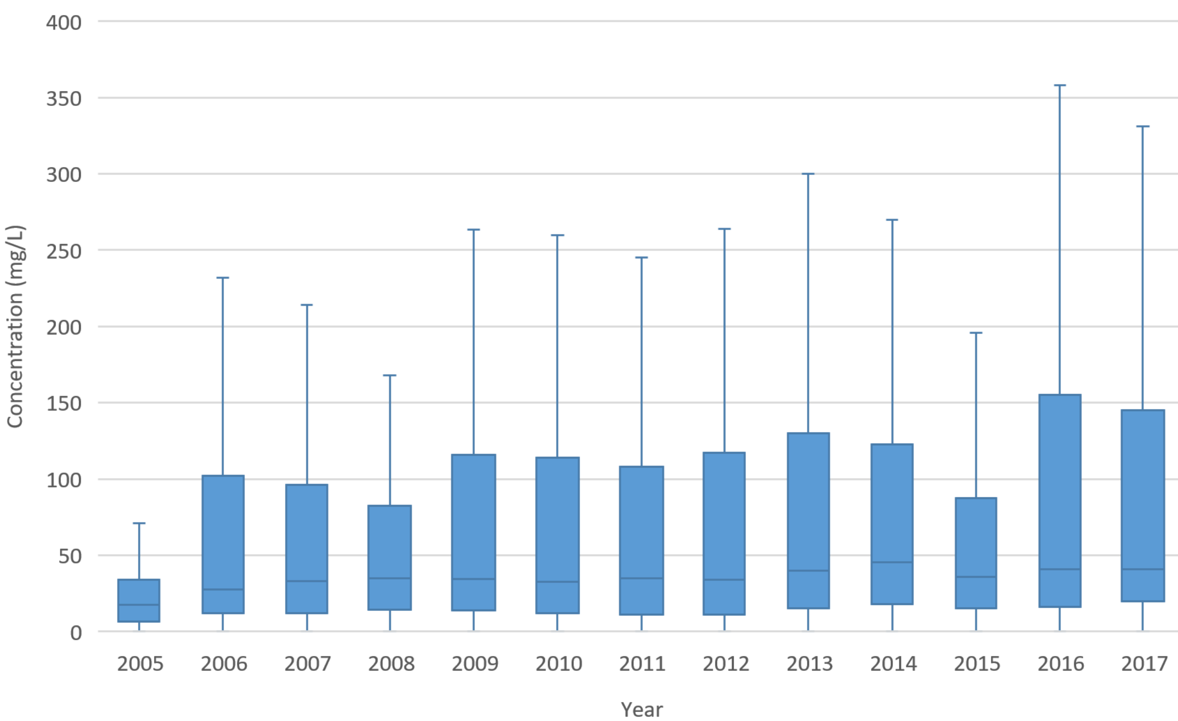


Figure 2-30: Sulfate Annual Variation



Note: This Box-and-Whisker plot represents a summary of five different statistic values of the distribution. Minimum and maximum values are represented by the end points of the extended lines. The center line indicates the median. The top and bottom of the rectangle indicate the first quartile (25th percentile) and third quartile (75th percentile) of the distribution, respectively.

Figure 2-31: Chloride Concentrations in 2017

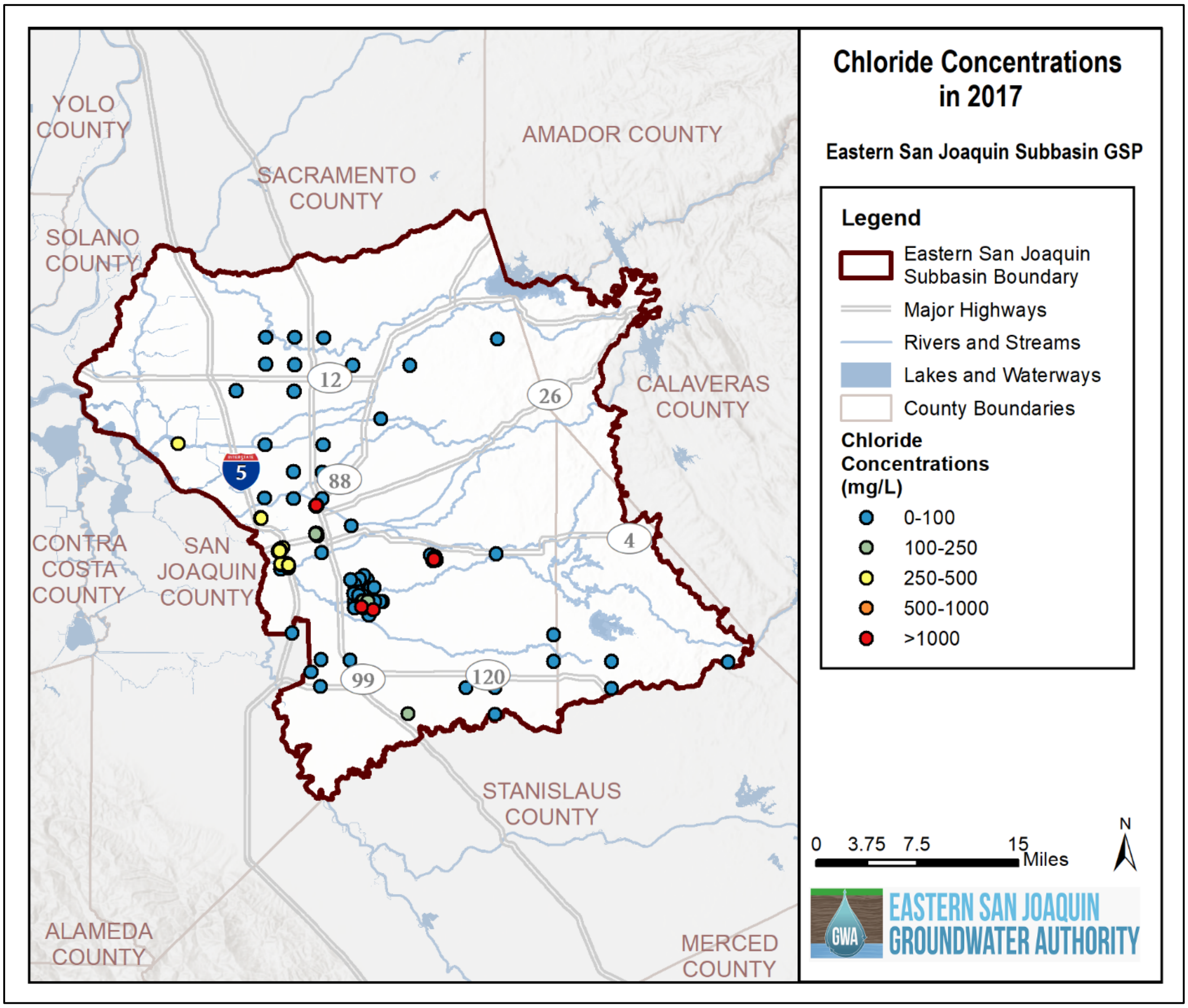
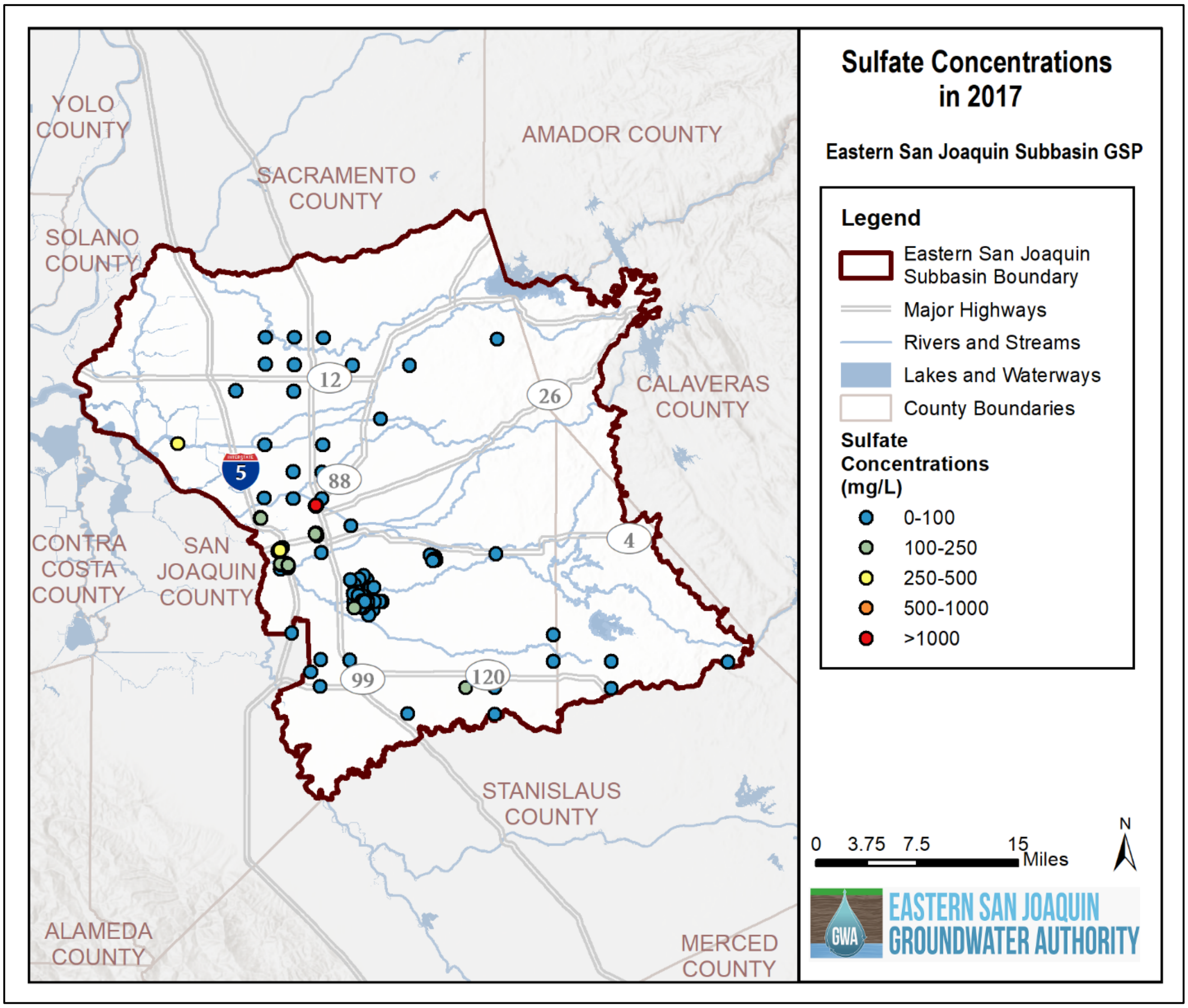


Figure 2-32: Sulfate Concentrations in 2017

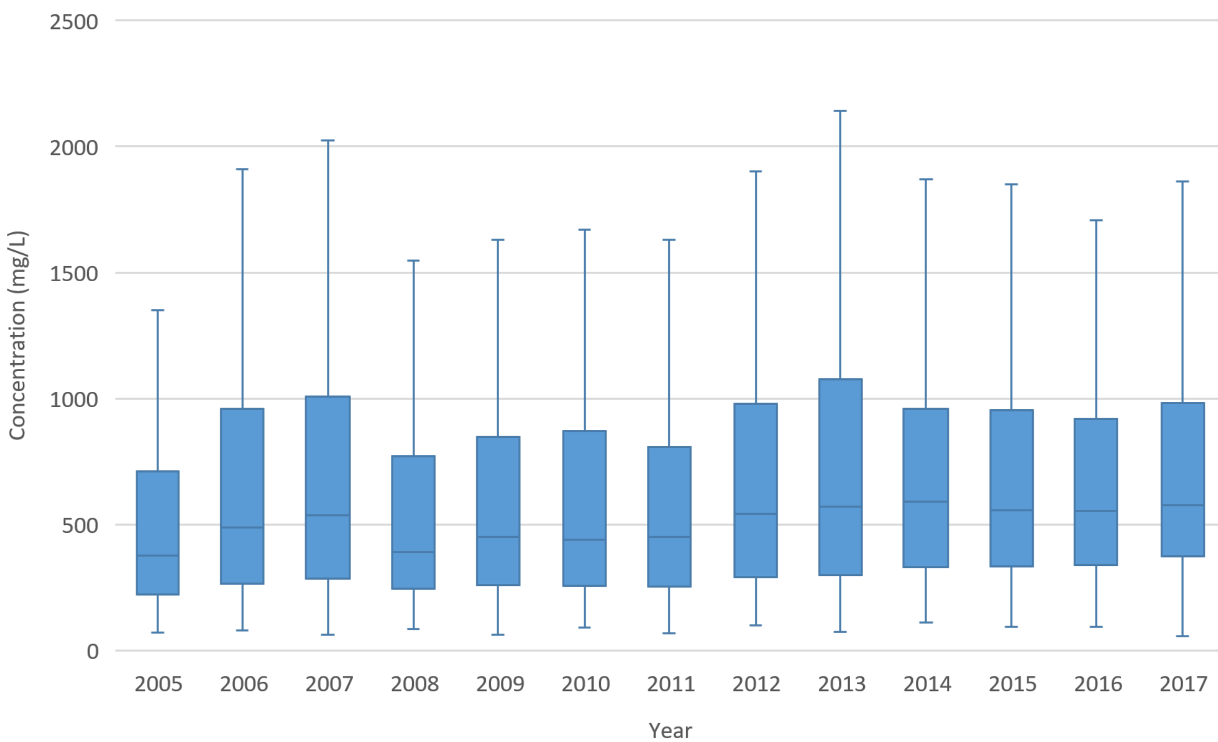


GAMA groundwater quality data in the northern portion of the San Joaquin Valley Groundwater Basin were assessed by Bennett et al. in 2006. Groundwater samples were compared to thresholds such as the U.S. Environmental Protection Agency (USEPA) secondary maximum contaminant levels (SMCL). None of the major cations and anions measured in the Eastern San Joaquin Subbasin resulted in exceedances of the SMCLs (Bennett et al., 2006). These measurements took place in December 2004 to February 2005. Additional parameters were sampled in this study and are discussed further in Section 2.2 (Current and Historical Groundwater Conditions).

2.1.9.2.3.3 Total Dissolved Solids

A wide range of total dissolved solids (TDS) values exist in the Eastern San Joaquin Subbasin. Based on data in the GAMA database from 2005 to 2017, TDS values generally varied from 100 to 2,000 mg/L (Figure 2-33), with a median value of 520 mg/L. Over the 13-year period shown in Figure 2-33, the median value has steadily increased from approximately 400 mg/L in 2005 to approximately 600 mg/L in 2017. Sources of TDS in the Subbasin include Delta sediments, deep deposits, and irrigation return water, as discussed in Section 2.2.4.1. Additional details on TDS concentrations is provided in Section 2.2 (Current and Historical Groundwater Conditions).

Figure 2-33: TDS Annual Variation



2.1.10 HCM Data Gaps

All hydrogeologic conceptual models contain a certain amount of uncertainty and can be improved with additional data and analysis. The Eastern San Joaquin Subbasin HCM data gaps are present in the understanding of the HCM presented in this GSP. The following data gap elements require additional information and will be updated with future monitoring, modeling, and data refinement efforts.

Aquifer Characteristics

- Aquifer characteristics (such as hydraulic conductivity) have a significant impact on how projects and management actions in one part of the Subbasin may influence sustainability in other parts of the Subbasin. Aquifer characteristics should be confirmed through additional aquifer testing or additional monitoring wells.

Groundwater Level Data

- Depth- or zone-specific water levels to assess vertical interconnection, including zones within the principal aquifer
- Additional shallow groundwater data near surface waters and natural communities commonly associated with groundwater (NCCAGs)
- Additional groundwater level data in the east and northwest areas of the Subbasin
- Additional groundwater level data near major creeks and rivers to improve quantification and understanding of subsurface flows between groundwater subbasins and surface water-groundwater interaction

Groundwater Quality Data

- Water quality of the three zones within the principal aquifer
    - Additional monitoring at various depths for different constituents will help inform the understanding of water quality. This can be achieved through installation of new monitoring wells or through determination of screened intervals of existing monitoring wells.
    - Additional depth-specific water quality data will inform minimum thresholds for the degraded water quality sustainability indicator and help monitor and identify potential undesirable results.
- Groundwater quality database compilation improvements to improve the linkage between the GAMA and CASGEM databases

Subsurface Conditions

- Stockton Fault extent and impact on the base of fresh water
- Improved characterization of near-surface soil conditions as they relate to recharge
- Further definition of aquifer characteristics (e.g., hydraulic conductivity, transmissivity, and storage parameters) within and near Subbasin boundary areas to the east, southeast, north, and northwest, including aquifer tests

2.2 CURRENT AND HISTORICAL GROUNDWATER CONDITIONS

This section describes the current and historical groundwater conditions in the Eastern San Joaquin Subbasin. As required by the GSP regulations, the groundwater conditions section includes:

- Definition of current groundwater conditions in the Subbasin
- Description of historical groundwater conditions in the Subbasin
- Description of the distribution, availability (storage), and quality of groundwater
- Identification of interactions between groundwater, surface water, groundwater dependent ecosystems, and subsidence

The groundwater conditions described in this section present the historical availability, quality, and distribution of groundwater which are the basis of this Plan's sustainable management criteria and monitoring network. The current and historical conditions discussed are further expanded upon in Chapter 3: Sustainable Management Criteria and are used to define undesirable results and to establish measurable objectives, interim milestones, and minimum thresholds.

Historically, the two aspects of greatest focus for groundwater management in the Eastern San Joaquin Subbasin have been groundwater elevation and, in some areas of the Subbasin, groundwater quality. As discussed herein, a groundwater depression exists in the central portion of the Subbasin, while higher groundwater levels characterize the west portion of the Subbasin. Additionally, there are elevated levels of salinity and nitrate in some areas, along with naturally occurring constituents commonly seen throughout the Central Valley. Detailed descriptions of these conditions are provided in the following sections as part of a discussion of the historical and current conditions for each of the six sustainability indicators:

- Groundwater Elevation (Section 2.2.1)
- Groundwater Storage (Section 2.2.2)
- Seawater Intrusion (Section 2.2.3)
- Groundwater Quality (Section 2.2.4)
- Land Subsidence (Section 2.2.5)
- Interconnected Surface Water (Section 2.2.6)

Details of GDEs are provided in Section 2.2.7 to support the sustainability indicator discussions.

2.2.1 Groundwater Elevation

2.2.1.1 Historical Groundwater Elevations

Data sources for groundwater elevation are abundant in the Eastern San Joaquin Subbasin. As discussed in Section 2.1, the CASGEM and San Joaquin County databases constitute the groundwater level data used for this analysis. These sources provide a robust dataset of groundwater levels going back to 1940.

To visually show long-term trends in groundwater elevations in the Eastern San Joaquin Subbasin, 10 wells that have periods-of-record greater than 40 years and that are relatively evenly distributed across the Subbasin were selected from available data (see Figure 2-34). Long-term hydrographs prepared for these wells show that, throughout most of the Eastern San Joaquin Subbasin, groundwater elevations have declined over time.

Average groundwater level decline was quantified for 1996-2015. In Section 0 (Water Budgets), the Historical Water Budget uses 1996-2015 as a representative hydrologic period which includes an average annual precipitation of 14.7 inches, very close to the long-term average of 15.4 inches. The 1996-2015 period also includes the recent 2012-2015 drought, the wet years of 2010-2011, and periods of normal precipitation. Based on data from the 10 selected wells in Figure 2-34, the average groundwater level decline was -0.5 ft/year from 1996-2015. Hydrographs for wells numbered #2, #5, and #6 show the largest decrease in groundwater elevation. These wells are located to the east of the City of Stockton. Hydrograph #9, which corresponds to a well located on the north edge of the Subbasin, shows the least decrease in groundwater elevation from 1996-2015. Hydrograph #4 corresponds with a well located in the western side of the Subbasin and is the only well to show an increasing trend in groundwater elevations. The northeast corner of the Subbasin is an area without a nearby representative hydrograph and was identified as a data gap in Section 2.1.10 (HCM Data Gaps).

Figure 2-34: Hydrographs of Selected Wells

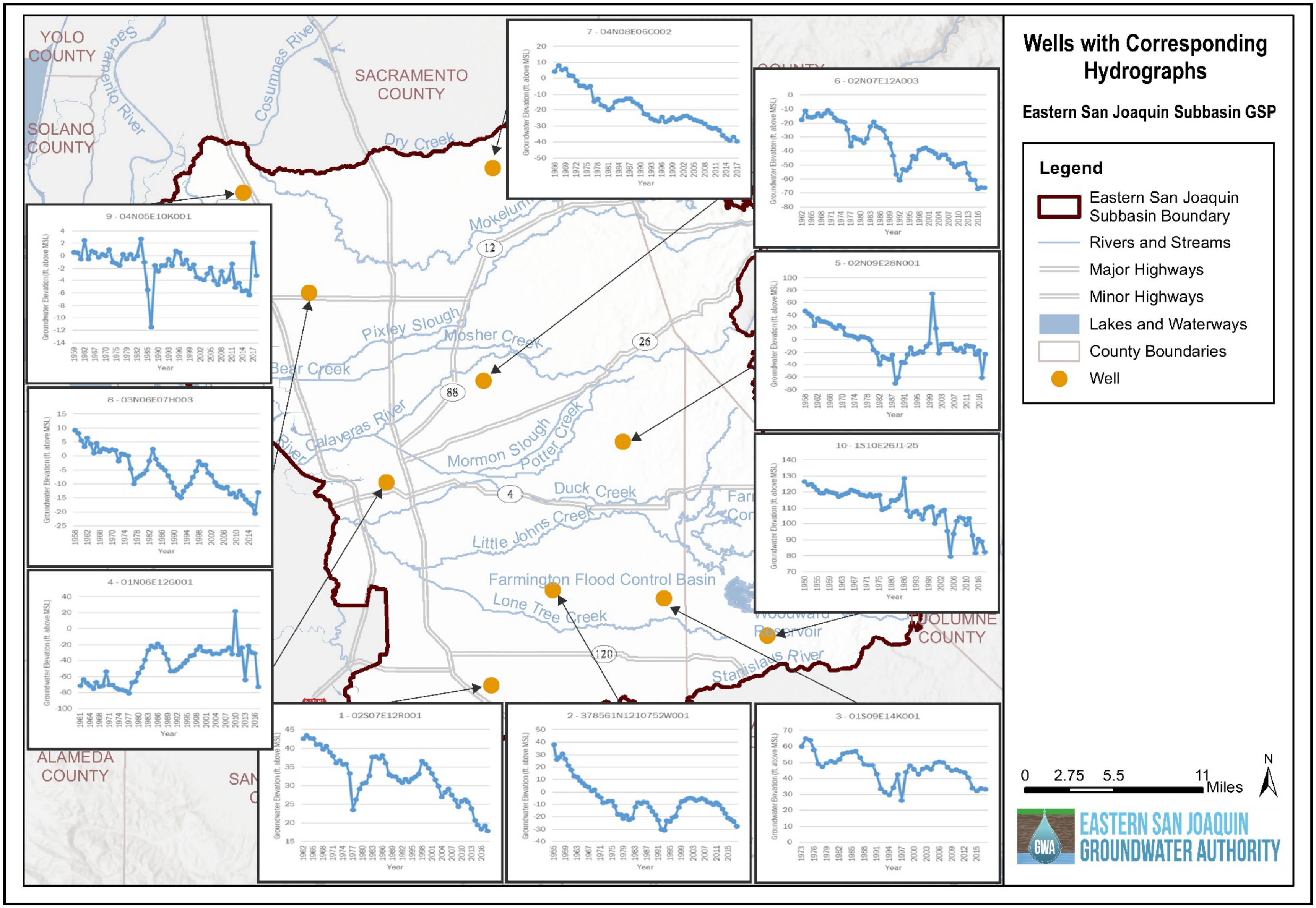
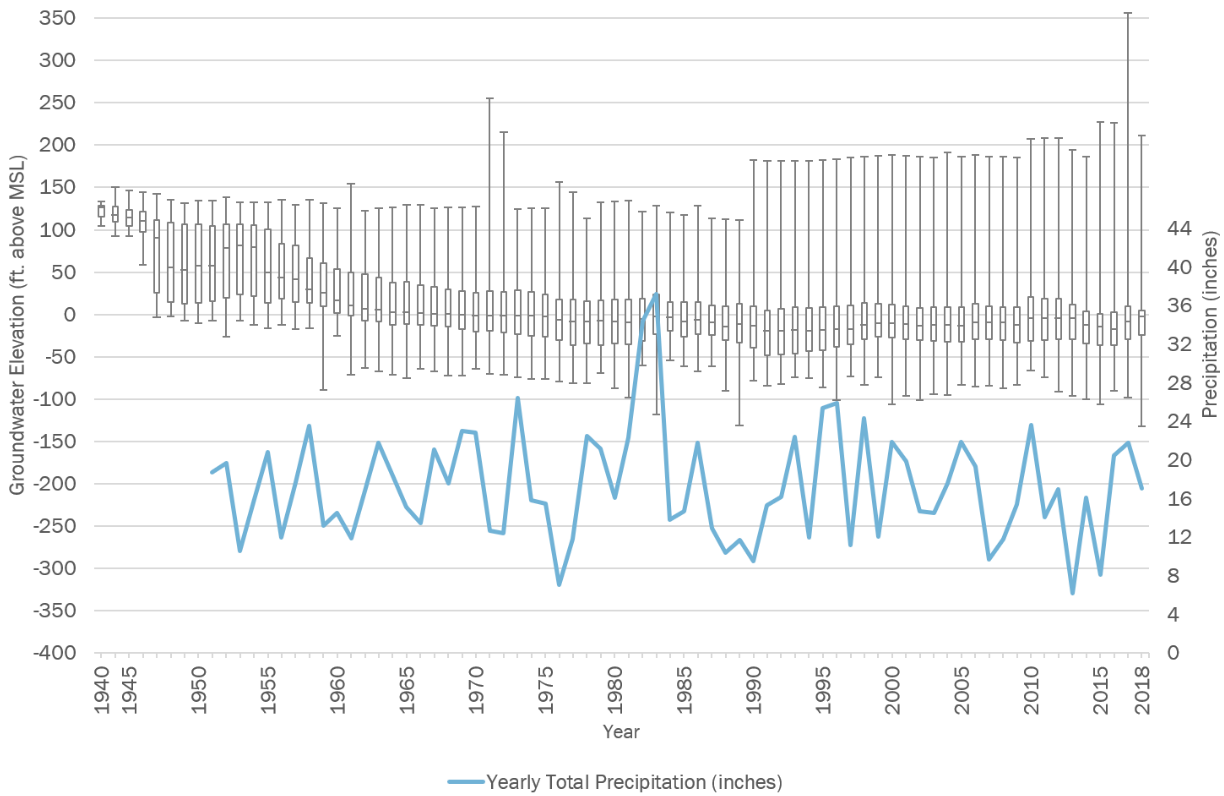


Figure 2-35 shows the distribution of the groundwater elevations from the CASGEM and San Joaquin County databases compared to average precipitation in and near the Subbasin. Figure 2-35 shows an overall decreasing trend in groundwater elevation levels with larger variability over time. The increasing variability comes partly due to a larger number of wells being sampled through time in more varied topography, but also reflects the long-term changes in groundwater levels described above and in Figure 2-34.

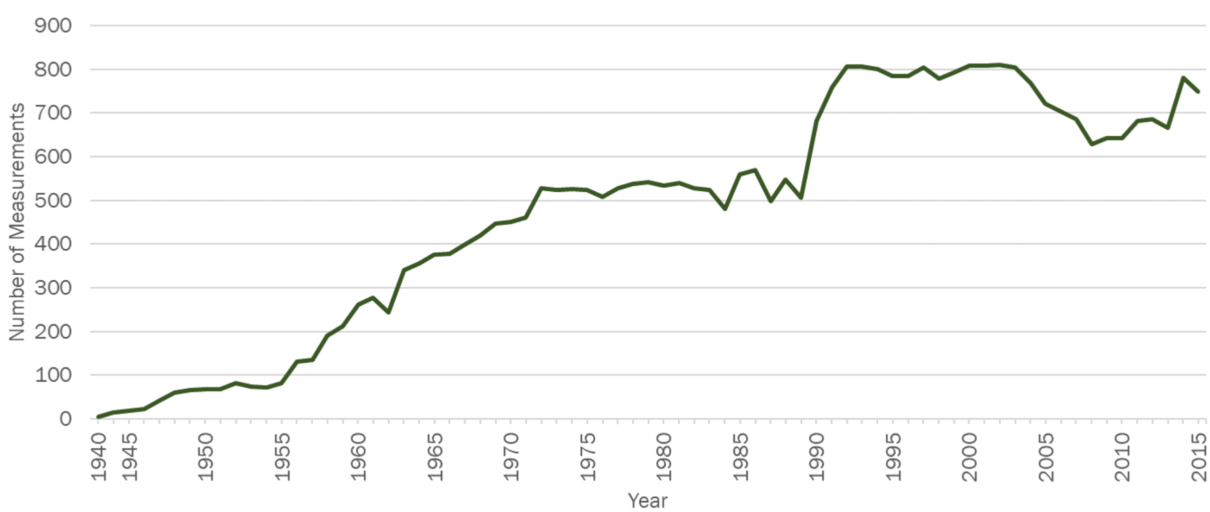
Periods of increases in groundwater elevation moderately correspond to the amount of precipitation in the Eastern San Joaquin Subbasin. A correlating trend can be seen with groundwater elevation increases in several hydrographs in the early 1980s and late 1990s, associated with periods of high precipitation.

Figure 2-35: Summary of Groundwater Elevation Data, 1940-2018

(a) Box-and-Whisker Plot with Precipitation

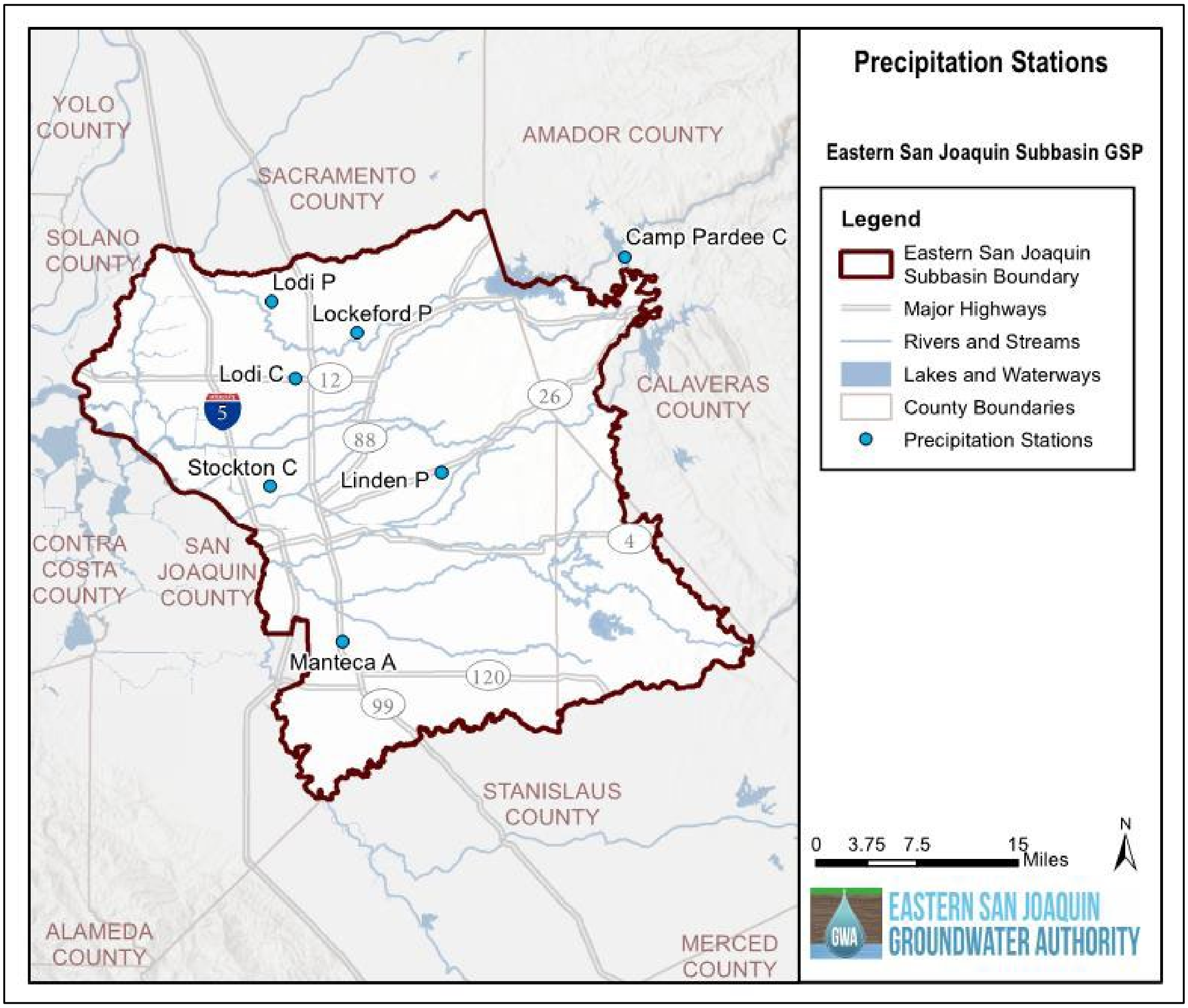


(b) Number of Groundwater Level Measurements



1. Each vertical bar in Figure 2-35 (a) represents the full range of groundwater level measurements recorded in a given year. The central gray box represents the middle 50% of measurements (ranging from the 25th percentile to the 75th percentile), with the horizontal line showing the median. The capped lines below and above the central box represent the minimum and maximum, respectively.
2. Precipitation monitoring depicted in Figure 2-35 (a) began in 1951.
3. The average annual precipitation line presented in Figure 2-35 (b) is based on an average of data collected at 7 stations which are mapped in Figure 2-36.

Figure 2-36: Precipitation Stations



1. These stations are operated by California Irrigation Management Information System (CIMIS) (“A”), National Oceanic and Atmospheric Administration (NOAA) (“C”), and PestCast (University of California Statewide Integrated Pest Management Program [UC IPM] and Department of Pesticide Regulation [DPR]) (“P”).

Additionally, extensive reports and research examining the groundwater conditions of the Central Valley are available from a variety of sources, including the USGS and DWR. These documents supplement the water level data provided by the CASGEM and San Joaquin County databases and were used to assess current and historical groundwater elevations.

USGS Water Supply Paper 780 – One of the earliest discussions of measured groundwater levels in the Eastern San Joaquin Subbasin is the USGS Water Supply Paper 780. The report details river stage of the Mokelumne River and the surrounding groundwater table from roughly 1900 to 1930. Groundwater levels in wells around the Mokelumne River varied, but mostly declined due to an increase in groundwater pumping. Even between years of minimal groundwater pumping, from 1927 to 1933, the water table decreased in elevation, most drastically in areas northeast and southeast of the City of Lodi (Piper et al., 1939).

DWR Bulletin 146 – DWR’s Bulletin 146 (1967) discusses water levels and flow directions in the 1960s and earlier, which provides added historical context to current groundwater conditions. Figures 4 and 5 of Bulletin 146 show groundwater elevation in most of the Eastern San Joaquin Subbasin in fall of 1950 and 1964, respectively. Both maps show groundwater levels at the lowest elevation underneath the City of Stockton, which is attributed to heavy groundwater pumping. This groundwater depression is attributed as causing groundwater from the Delta to flow toward the City of Stockton and is described as having relatively worse water quality due to natural mineral salts. Barriers between the poorer quality water from the Delta and higher quality water from the Sierra Nevada Mountains noted in previous studies around the City of Stockton are not apparent (CA DWR, 1967).

Williamson, 1989 – Groundwater conditions provided in the groundwater model report by Williamson (1989) included horizontal and vertical flows. A westerly groundwater flow direction that roughly parallels the ground surface in the Eastern San Joaquin Subbasin was confirmed, as depicted on Figure 14 of that report. Estimates of groundwater elevations for before-human-development were provided. Vertical flow characteristics before considerable human development were characterized and mapped; areas of wells that flowed without pumps are shown throughout the valley and in the western portion of the Eastern San Joaquin Subbasin. This is in contrast to current conditions, where wells flowing without pumps have not been currently observed in the Subbasin. At present, USGS nested monitoring wells confirm downward vertical flows (Williamson, 1989).

2.2.1.2 Current Groundwater Elevations

Current groundwater elevation conditions, for the purposes of this Plan, have been characterized as first quarter 2017 (recent seasonal high, measured in spring 2017) and fourth quarter 2017 (recent seasonal low, measured in fall 2017) groundwater elevation measurements. At the time of this report, these records constitute the most complete dataset. Groundwater elevations are mapped using the CASGEM dataset (including voluntarily monitored wells) and the San Joaquin County dataset.

Figure 2-37 and Figure 2-38 show the groundwater elevations for these periods. A pumping depression at the center of the Subbasin, east of the City of Stockton, exists during both of these periods. A localized pumping depression is shown expanding from the Cosumnes Subbasin across Dry Creek to the Eastern San Joaquin Subbasin in fourth quarter 2017. However, from the perspective of the entire Eastern San Joaquin Subbasin, the central pumping depression to the east of the City of Stockton is most significant to achieving sustainability in the Subbasin. Groundwater generally flows from the outer edges of the Subbasin towards the depression in the middle of the Subbasin. Along the eastern side of the Subbasin, the lateral gradient of groundwater levels ranges from approximately 21 ft/mi during the seasonal high to 16 ft/mi during the seasonal low. Along the western side of the Subbasin, the lateral gradient ranges from approximately 7 ft/mi during the seasonal high to 6 ft/mi during the seasonal low. The steeper gradients on the east side of the Subbasin compared to the west side is primarly due to the steeper topography in that area.

Figure 2-37: First Quarter 2017 Groundwater Elevation

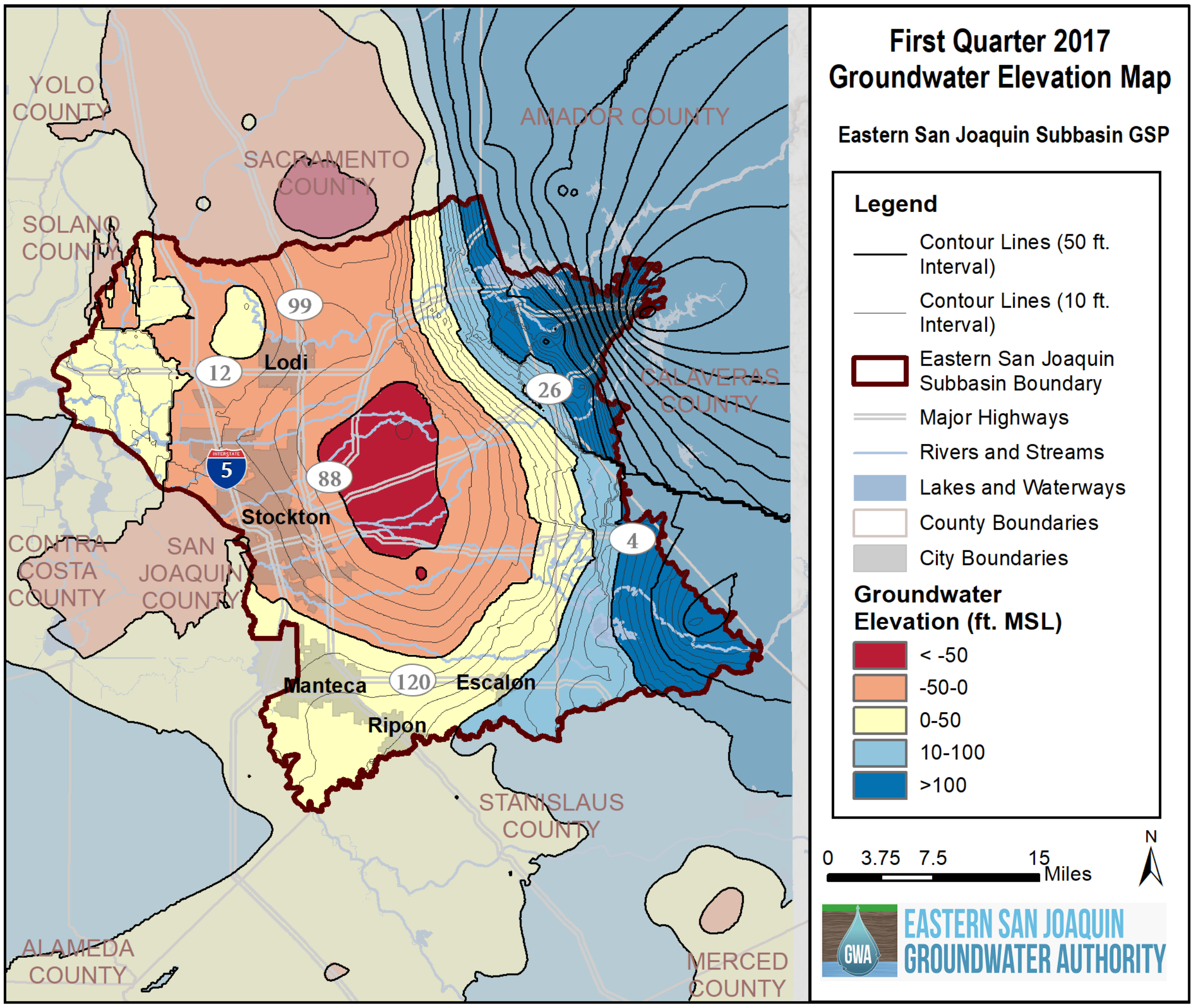
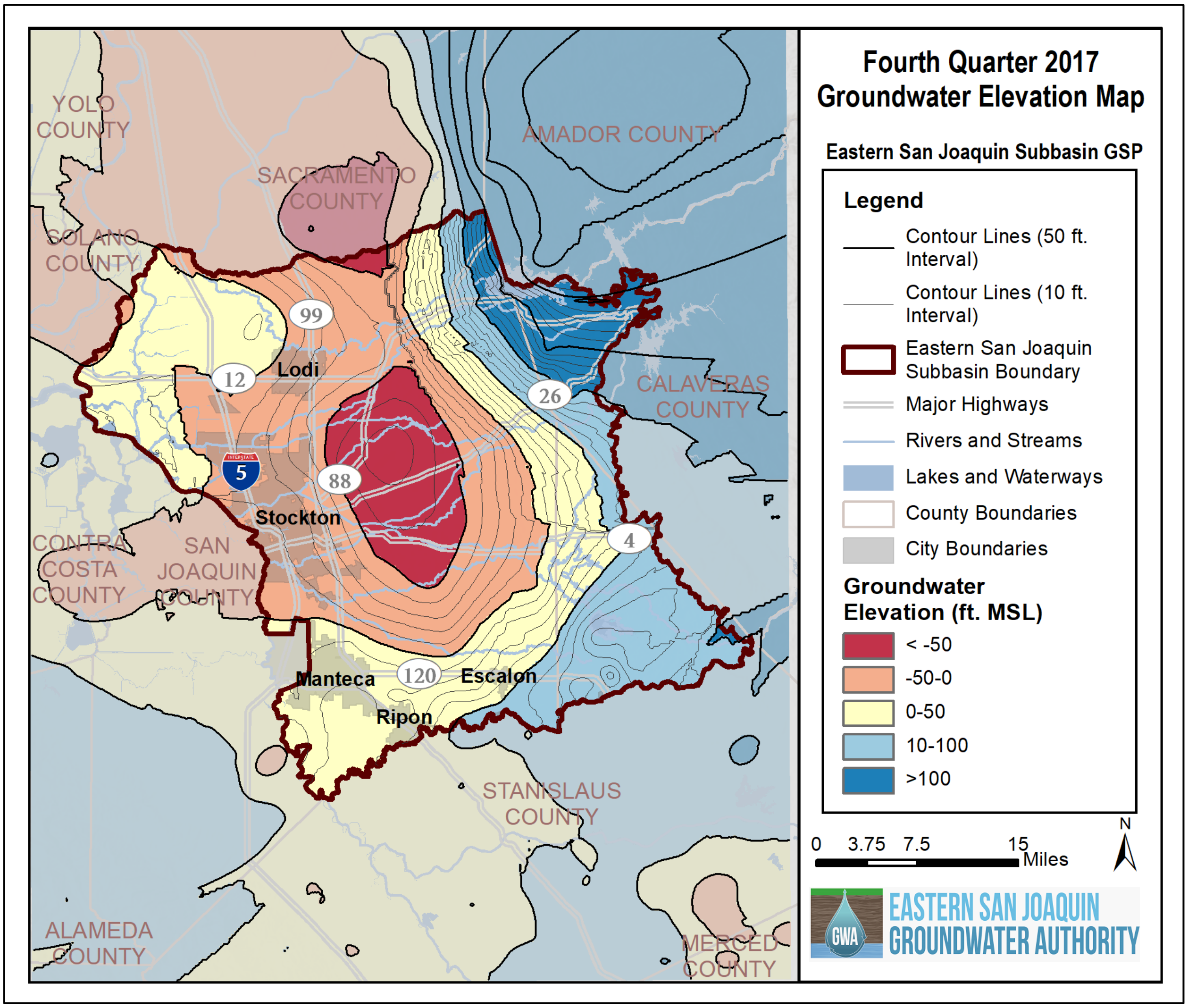


Figure 2-38: Fourth Quarter 2017 Groundwater Levels



2.2.1.2.1 Vertical Gradients

A vertical gradient drives the movement of groundwater perpendicular to the ground surface and is typically measured by comparing the elevations of groundwater in nested and/or clustered wells, wells with multiple completions at different depths. If groundwater elevations in the shallower completions are higher than in the deeper completions, the gradient is identified as a downward gradient. A downward gradient is one where groundwater is moving downward through the subsurface. If groundwater elevations in the shallower completions are lower than in the deeper completions, the gradient is identified as an upward gradient. An upward gradient is one where groundwater is moving upward through the subsurface. If groundwater elevations are the same throughout the completions, there is no vertical gradient. Knowledge about vertical gradients is required by regulation and is useful for understanding how groundwater moves in the Subbasin.

Vertical flow characteristics before considerable human development are characterized and mapped by Williamson (1989), showing that wells flowing without pumps existed in the western portion of the Eastern San Joaquin Subbasin, also corresponding with areas of upward vertical gradients. This contrasts with current conditions, where wells flowing without pumps have not been currently observed in the Subbasin. At present, USGS nested monitoring wells confirm downward vertical gradients (Williamson, 1989).

There are 16 nested and/or clustered well sites located in the Eastern San Joaquin Subbasin. The locations of the wells are shown in Figure 2-39. The majority of these wells are located in the northwest portion of the Subbasin near the cities of Stockton and Lodi. Hydrographs with groundwater elevations for each respective set of nested wells are shown in Figure 2-40 through Figure 2-49. 10 out of 16 sets of wells consistently show elevations in shallower completions that are higher than in the deeper completions which indicates a downward gradient. The remaining six wells are located in the City of Lodi. Four of these wells exhibit a minimal downward gradient and two show no downward gradient.

Figure 2-39: Map of Nested and/or Clustered Well Sites

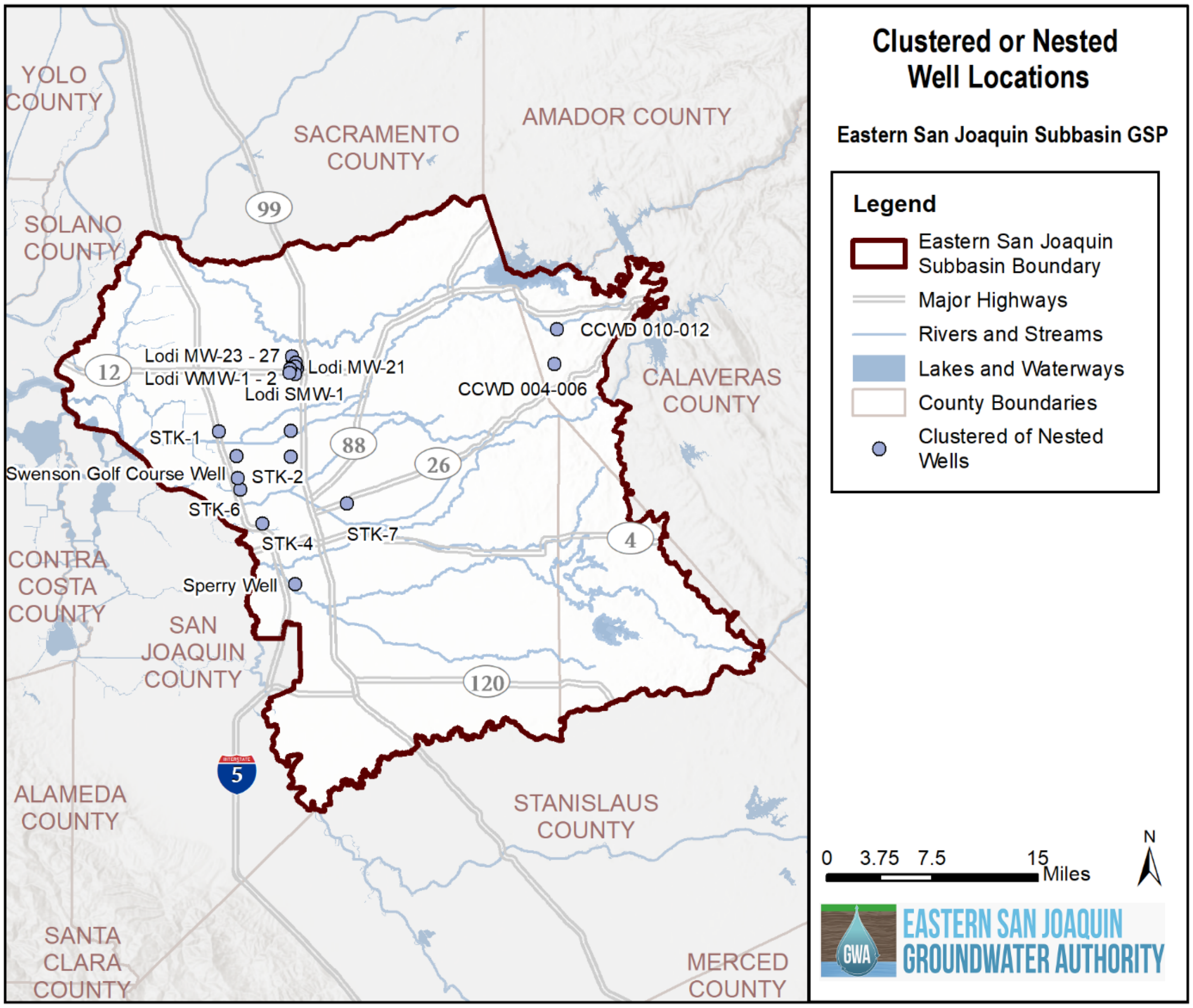


Figure 2-40: Nested Well Hydrographs: CCWD 004-006

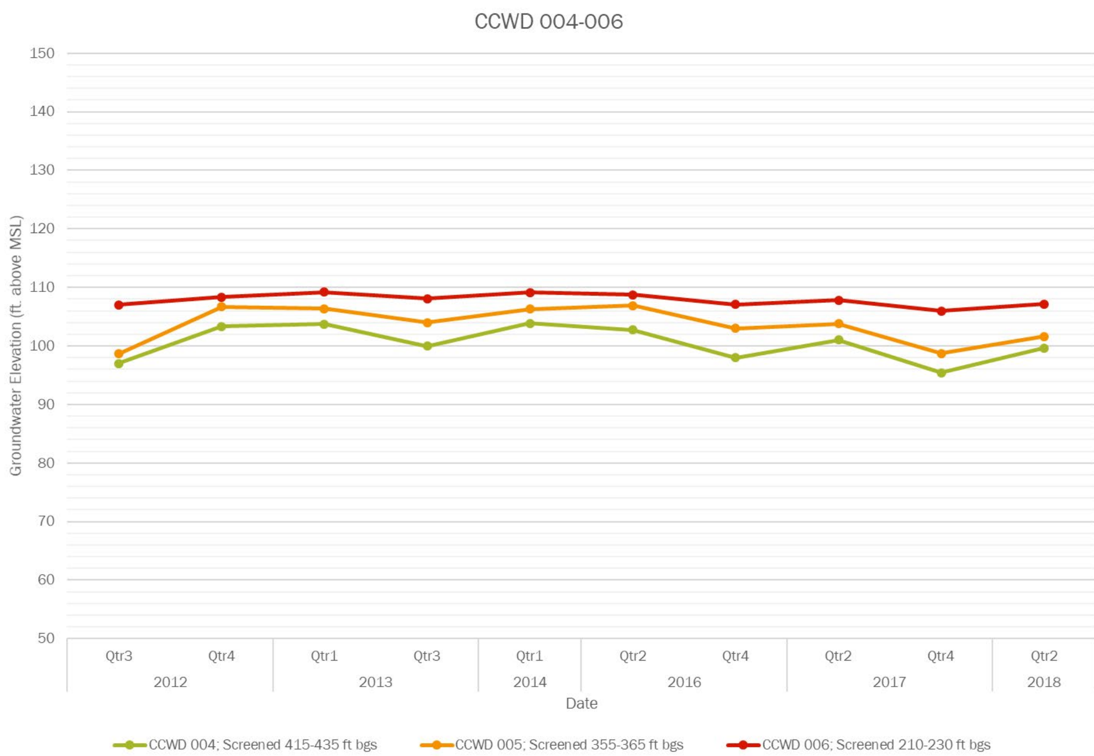


Figure 2-41: Nested Well Hydrographs: CCWD 010-012

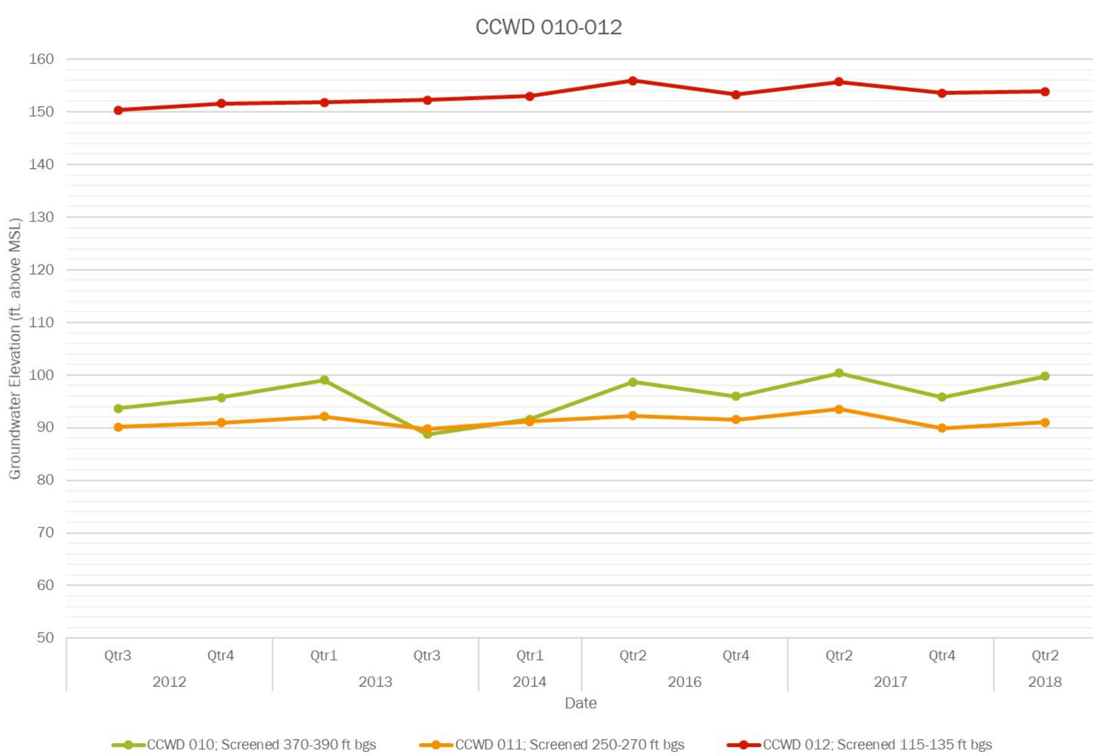


Figure 2-42: Nested Well Hydrographs: Sperry Well

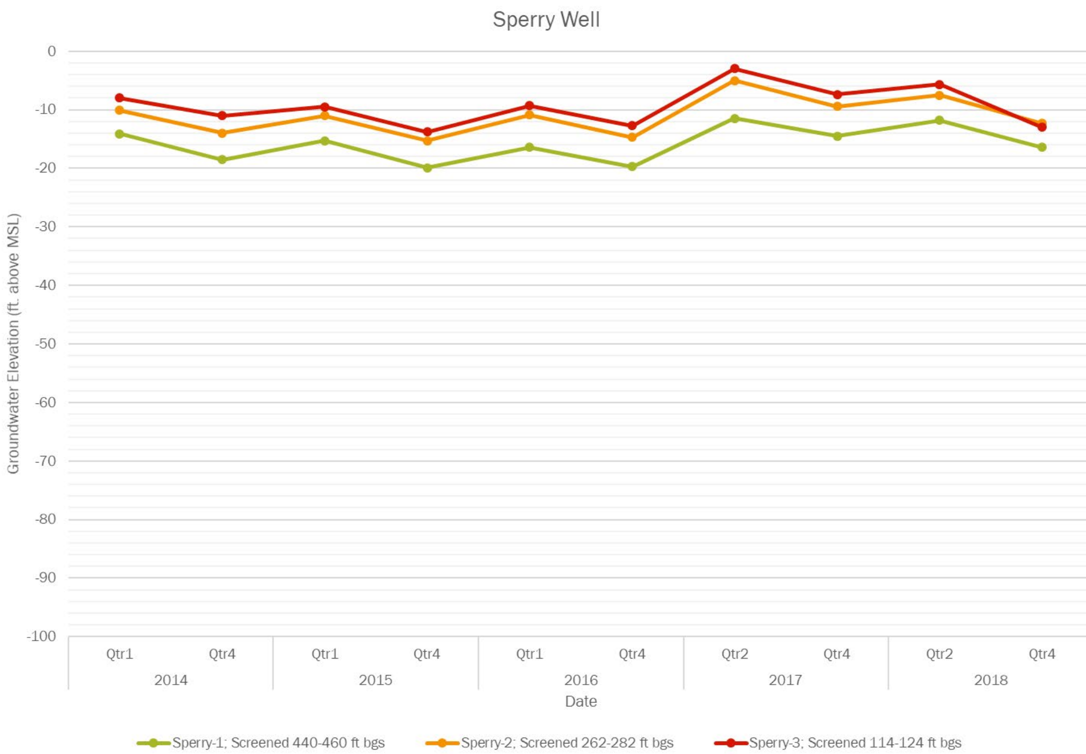


Figure 2-43: Nested Well Hydrographs: Swenson Golf Course

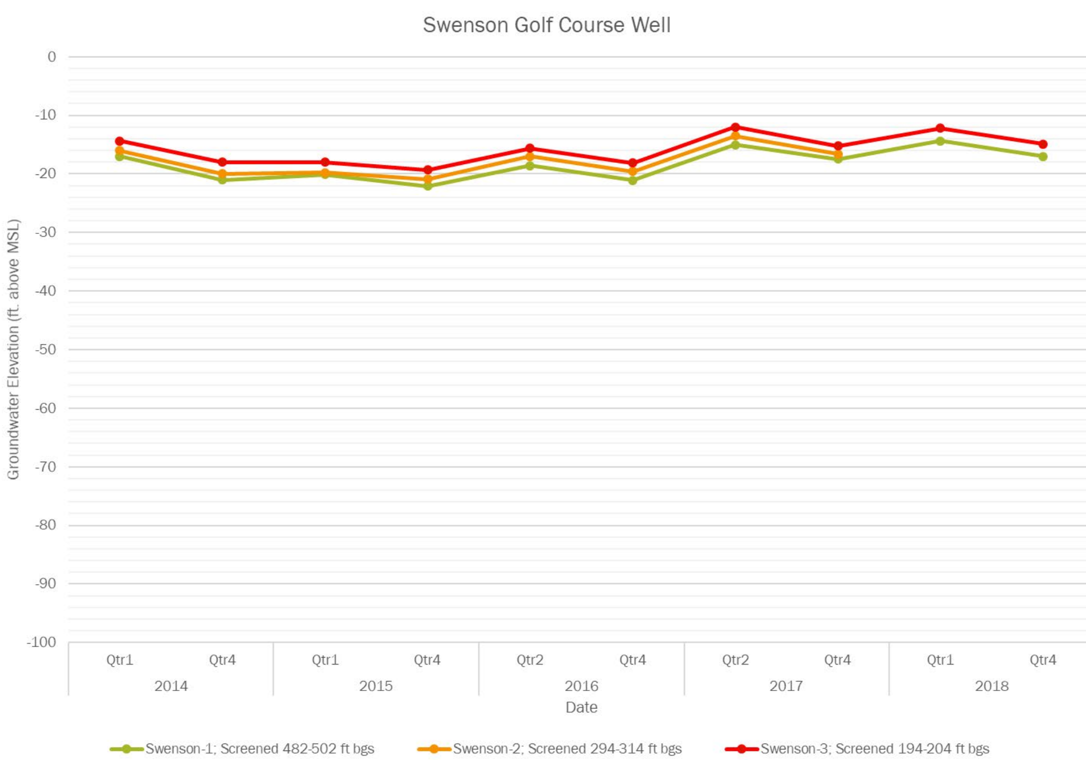


Figure 2-44: Nested Well Hydrographs: STK-1

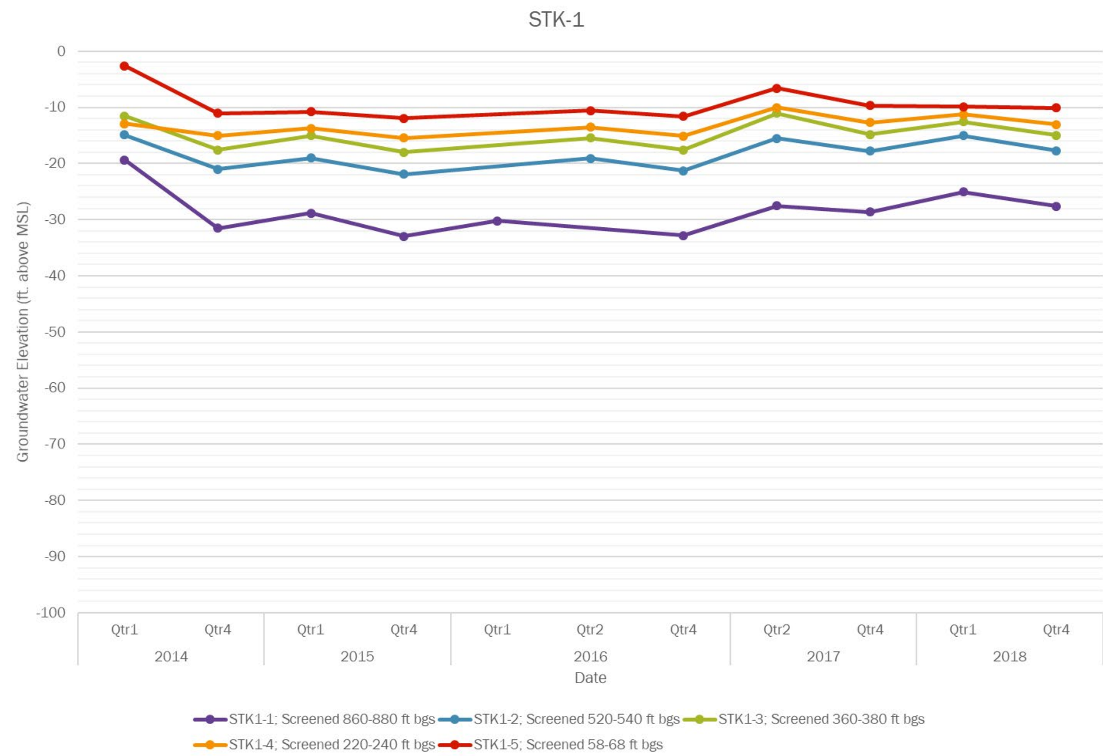


Figure 2-45: Nested Well Hydrographs: STK-2

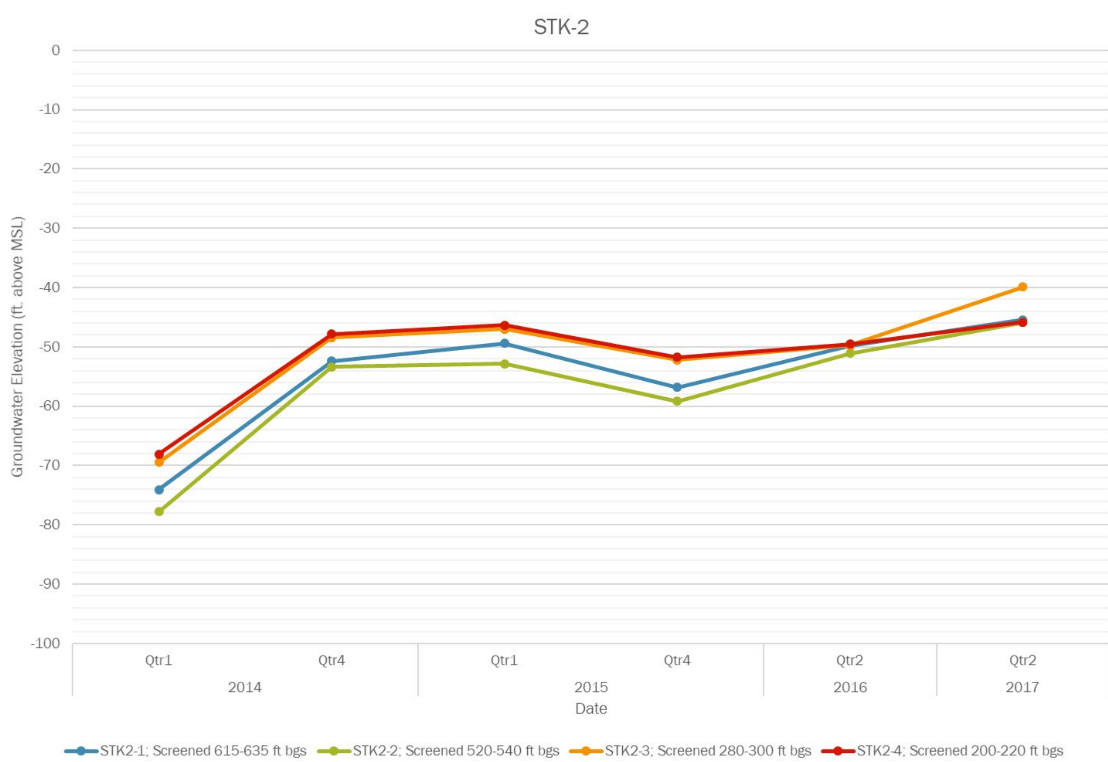


Figure 2-46: Nested Well Hydrographs: STK-4

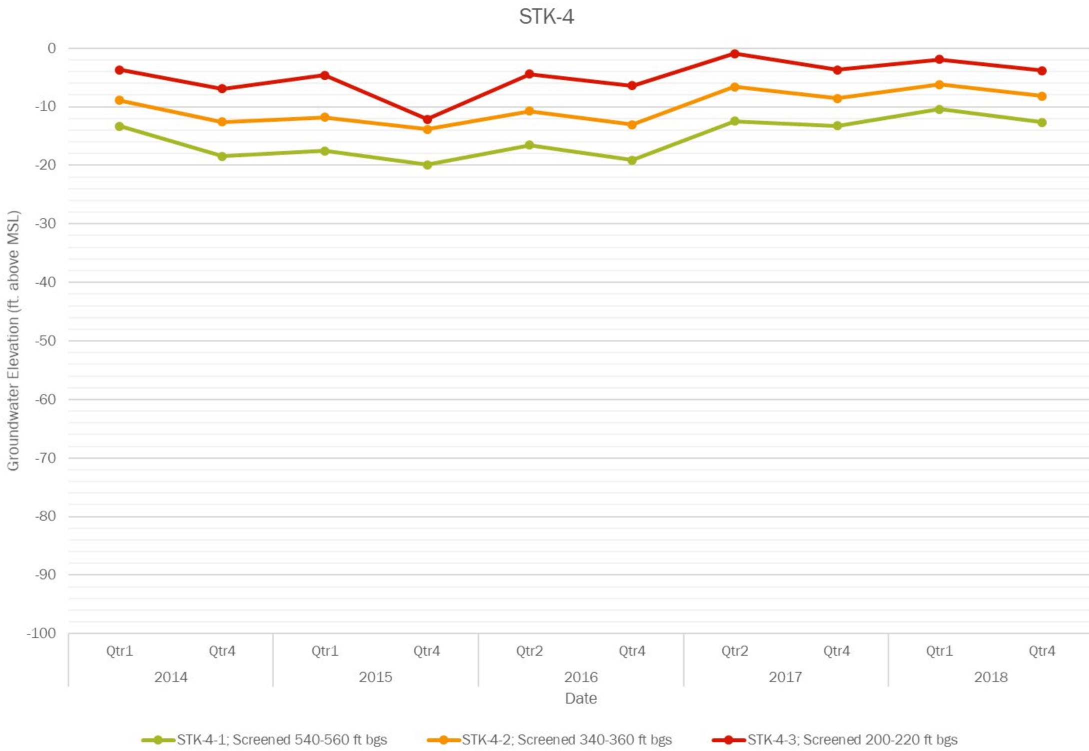


Figure 2-47: Nested Well Hydrographs: STK-5

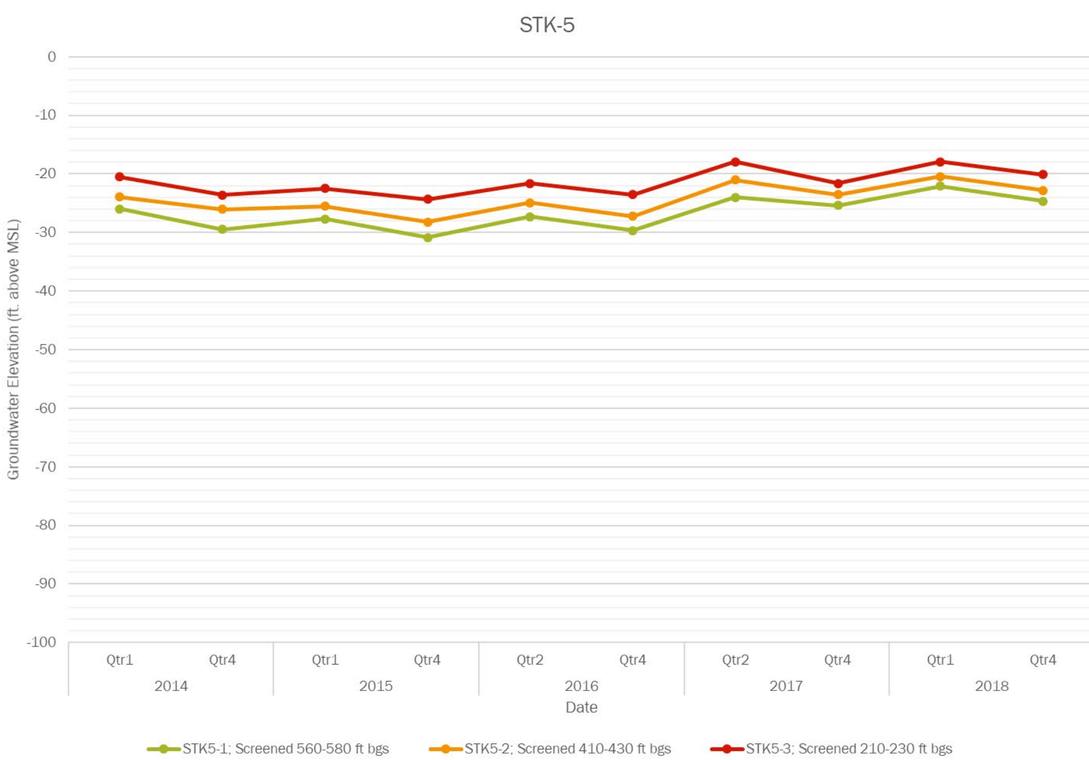


Figure 2-48: Nested Well Hydrographs: STK-6

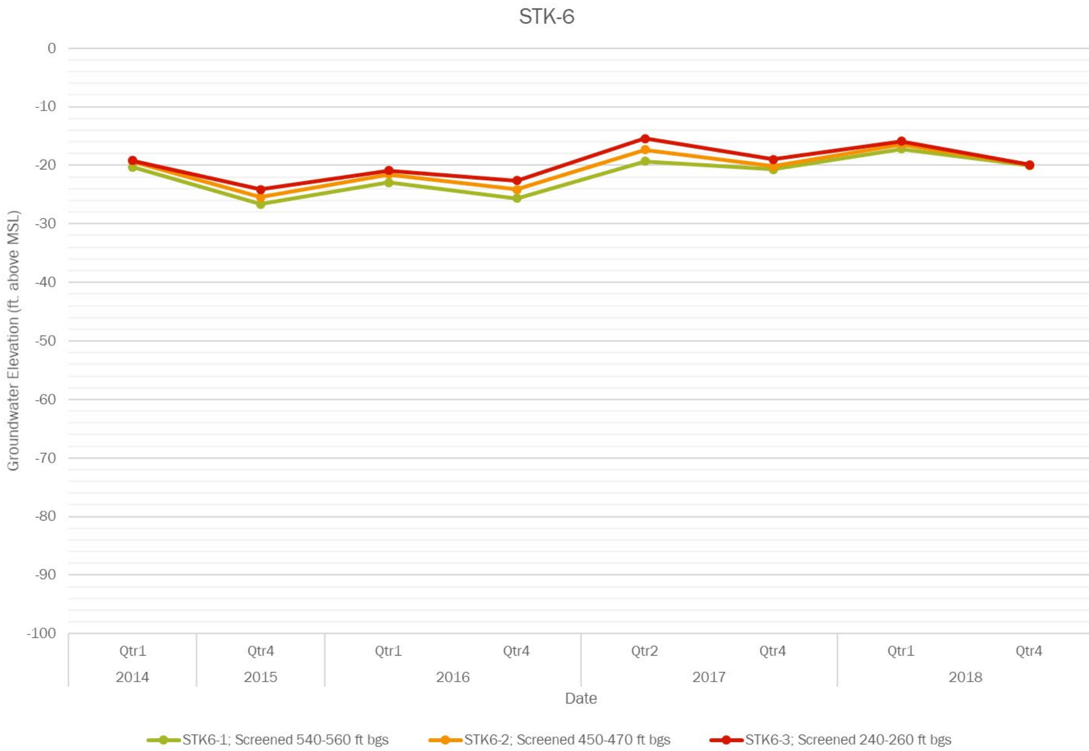


Figure 2-49: Nested Well Hydrographs: STK-7

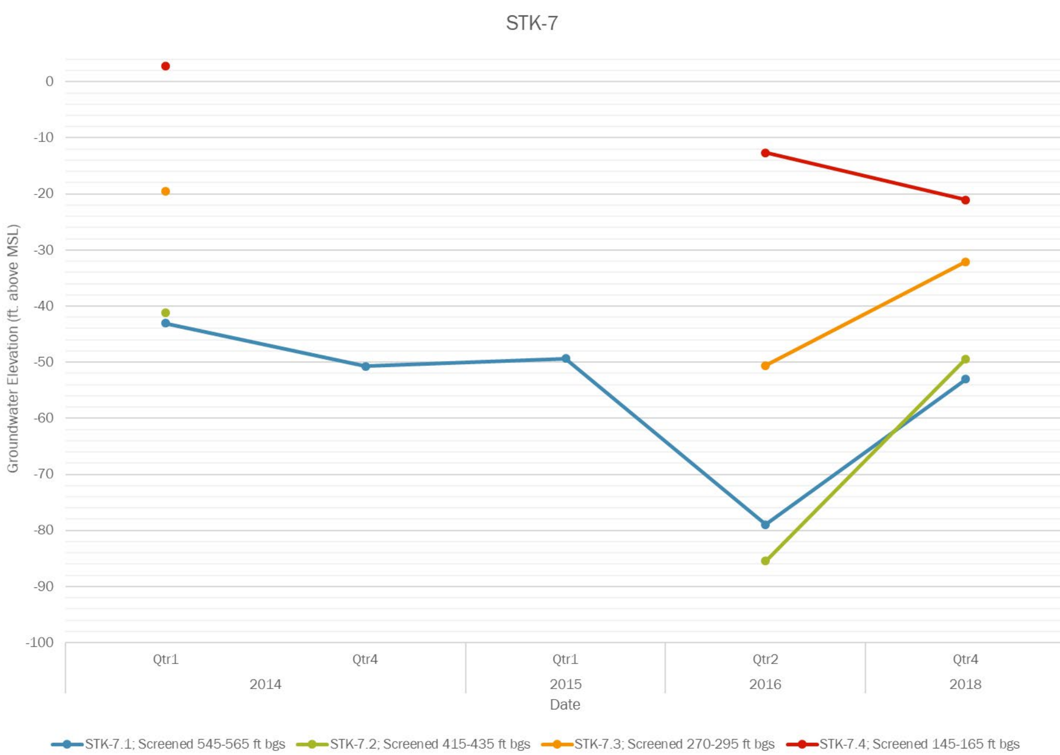


Figure 2-50: Nested Well Hydrographs: Lodi MW-21

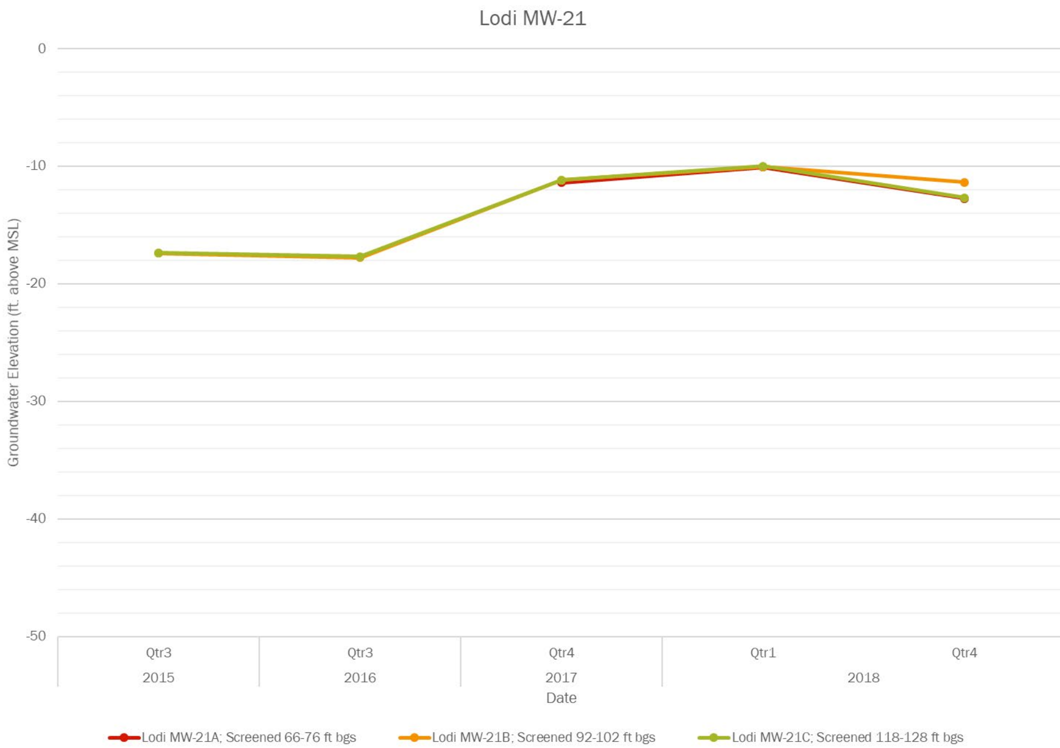


Figure 2-51: Nested Well Hydrographs: Lodi MW-24

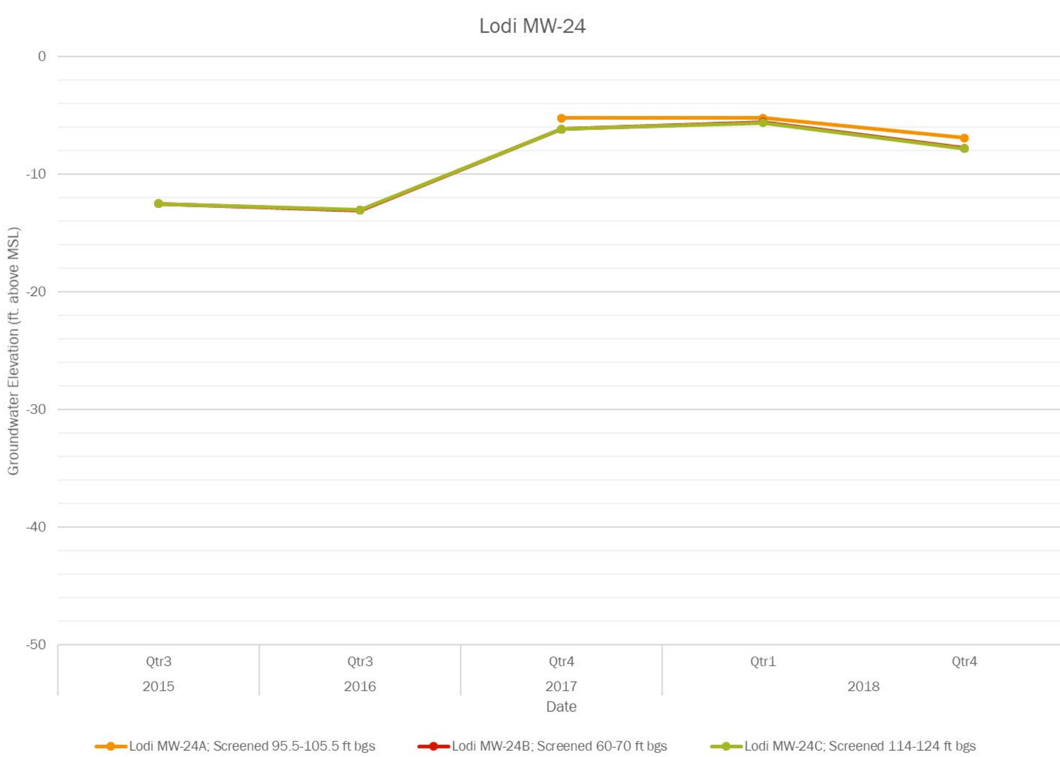


Figure 2-52: Nested Well Hydrographs: Lodi MW-25

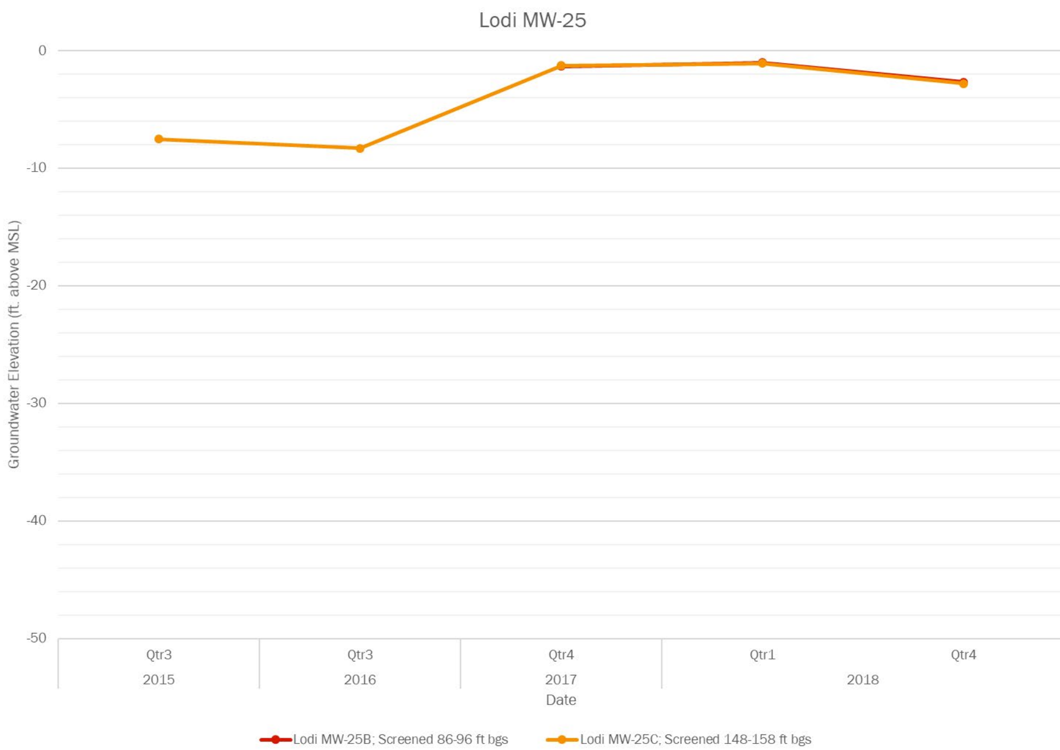


Figure 2-53: Nested Well Hydrographs: Lodi SMW-1

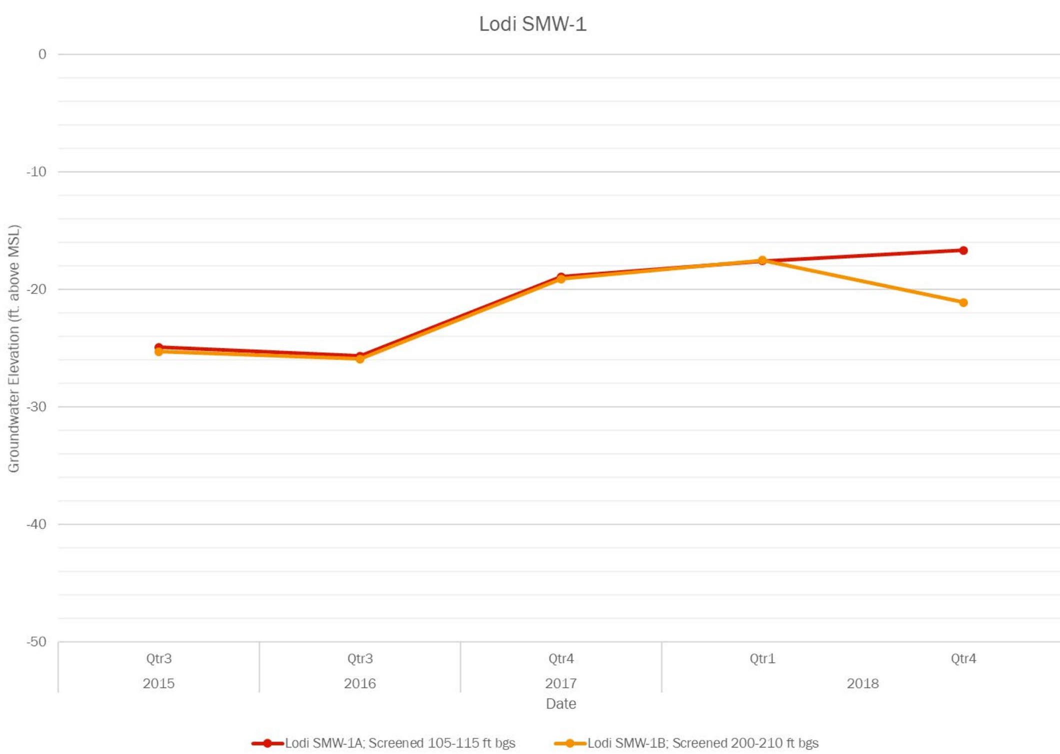


Figure 2-54: Nested Well Hydrographs: Lodi WMW-1

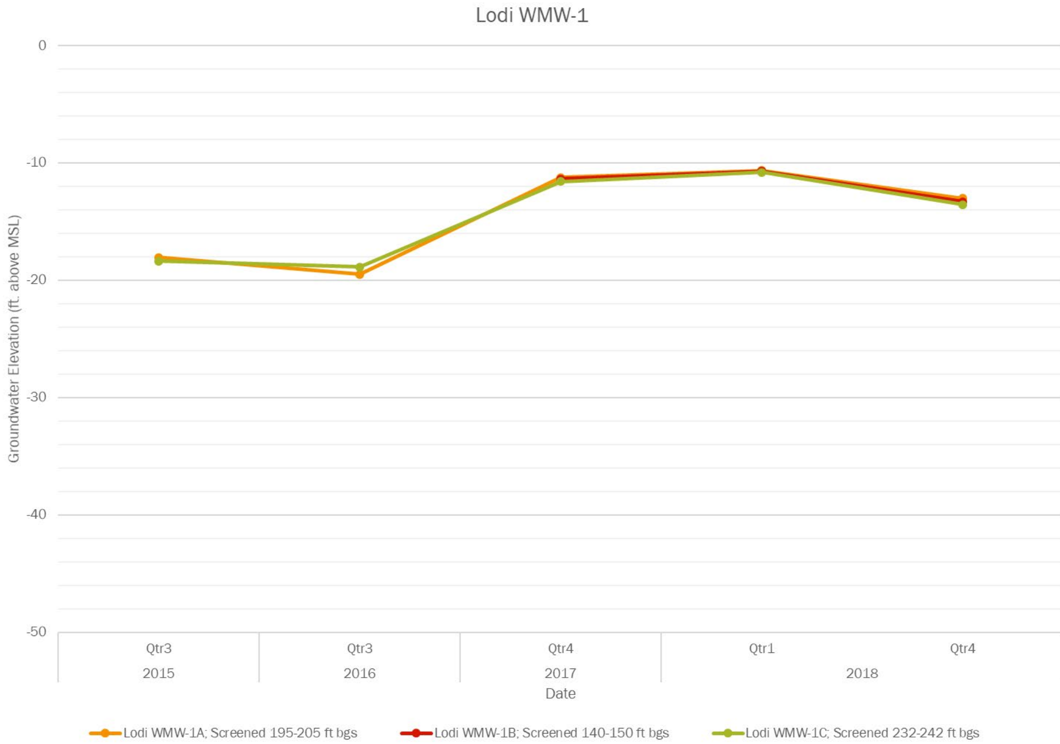
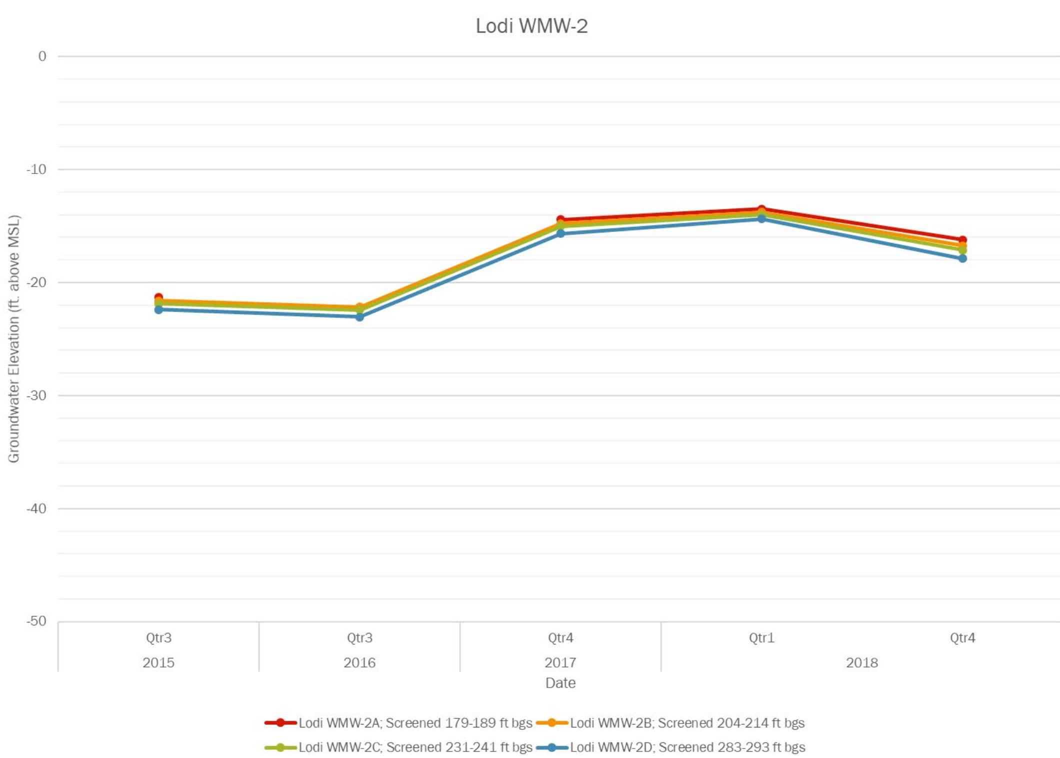


Figure 2-55: Nested Well Hydrographs: Lodi WMW-2



2.2.2 Groundwater Storage

The ESJWRM was used to estimate historical change in storage of the Eastern San Joaquin Subbasin from 1995-2015.

Figure 2-56 shows annual total storage for the combined ESJWRM fresh groundwater layers (not including the deep saline layer). Figure 2-57 shows the cumulative change in storage against annual storage change and water year type. In 2015, the total fresh groundwater storage was estimated as 53.0 million acre-feet (MAF). An additional 75.0 MAF in the deepest simulated layer of the model (not pictured) is saline water. The cumulative change in storage from 1996 to 2015 was estimated as -0.91 MAF or -0.05 million acre-feet per year (MAF/year). More information about the layers of the ESJWRM and calculation of storage changes can be found in model documentation in Appendix 2-A.

Figure 2-56: Historical Modeled Change in Storage

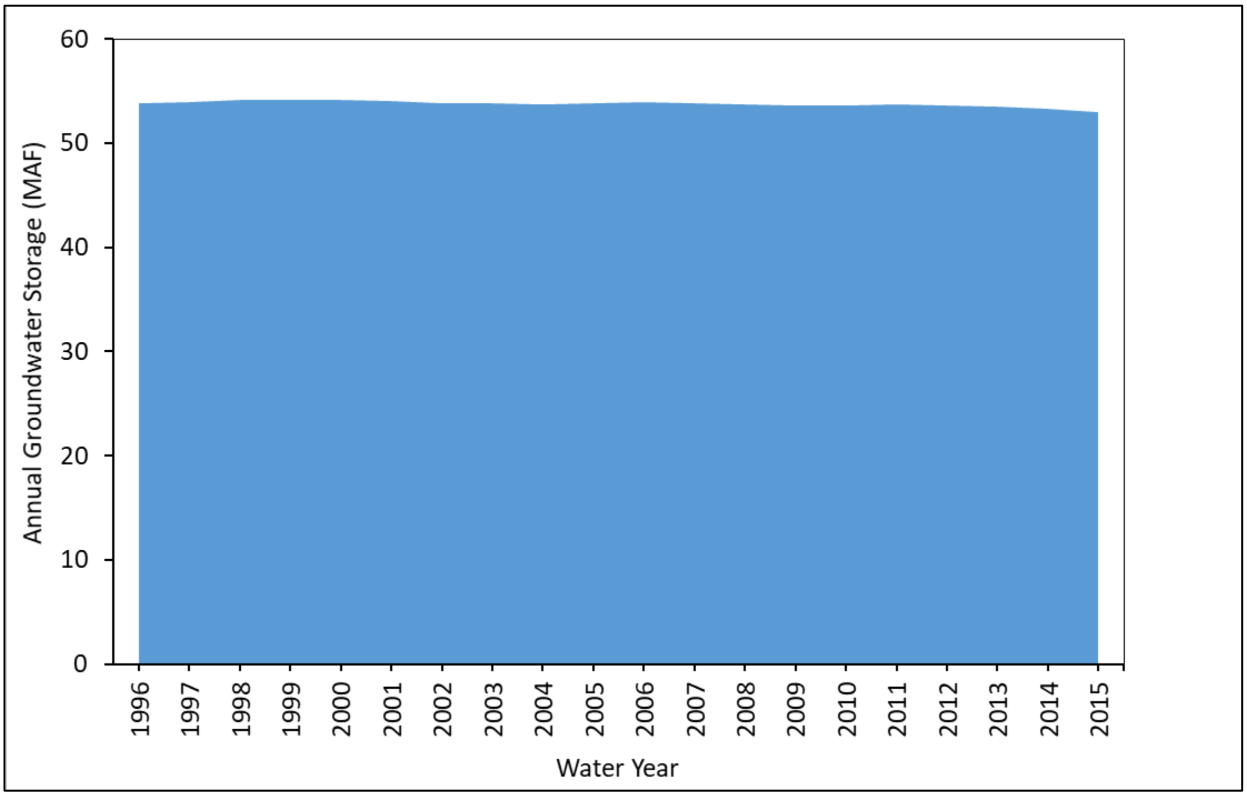
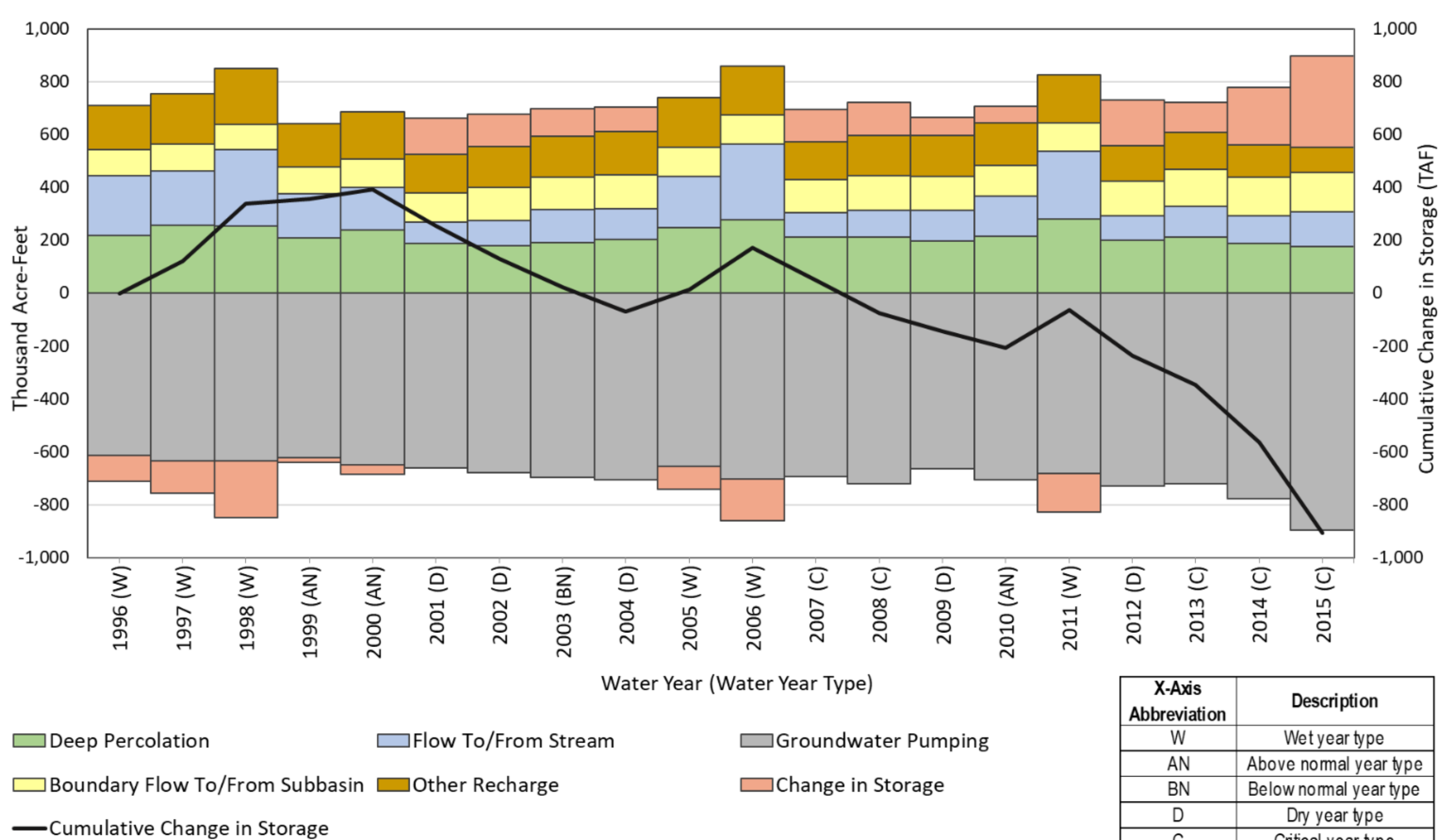


Figure 2-57: Historical Modeled Change in Annual Storage with Water Use and Year Type



X-Axis Abbreviation	Description
W	Wet year type
AN	Above normal year type
BN	Below normal year type
D	Dry year type
C	Critical year type

Notes:

1. Water Year Types based on San Joaquin Valley Water Year Index (CA DWR, 2018)
2. "Other Recharge" includes managed aquifer recharge, recharge from unlined canals and/or reservoirs, and recharge from ungauged watersheds.
3. "Change in Storage" is placed to balance the water budget. For instance, if annual outflows (-) are greater than inflows (+), there is a decrease in storage, but this would be shown on the positive side of the bar chart to balance out the increased outflows on the negative side of the bar chart.

2.2.3 Seawater Intrusion

The Eastern San Joaquin Subbasin is not in a coastal area and seawater intrusion is not present. While the Delta ecosystem evolved with a natural salinity cycle that brought brackish tidal water in from the San Francisco Bay, levees installed to allow development of agriculture, followed by development and operation of the Central Valley Project and the State Water Project, have altered the inward movement of seawater through the Delta. Current management practices endeavor to maintain freshwater flows through a combination of hydraulic and physical barriers and alterations to existing channels (Water Education Foundation, 2019). Portions of the Subbasin do, however, experience water quality issues related to salinity, which are addressed under Section 2.2.4.1 (Salinity). As described in Section 2.2.4.1, salinity in the Subbasin is due to other factors and are not the result of seawater intrusion.

2.2.4 Groundwater Quality

While groundwater quality in the Eastern San Joaquin Subbasin is generally sufficient to meet beneficial uses, a number of constituents of concern are either currently impacting groundwater use or have the potential to impact it in the future. Depending on the water quality constituent, the source may be anthropogenic in origin or naturally occurring, and the issue may be widespread or localized.

The primary naturally occurring water quality constituents of concern are salinity and arsenic, while primary water quality constituents are related to human activity include nitrates, salinity, and various point-source contaminants.

The sections herein provide information on the historical and current groundwater quality conditions for constituents including:

- Salinity (Section 2.2.4.1)
- Nitrate (Section 2.2.4.2)
- Arsenic (Section 2.2.4.3)
- Point-source contamination (Section 2.2.4.4), which includes petroleum hydrocarbons, solvents, and emerging contaminants

CCR Title 22 establishes water quality standards for drinking water contaminants. A primary maximum contaminant level (MCL) or SMCL is defined for a variety of parameters. For the purposes of this GSP, comparing parameter concentrations to their MCL or SMCL is used as the basis for describing groundwater quality concerns in the Eastern San Joaquin Subbasin. Comparisons to the MCL or SMCL must be considered in context as the measured concentrations represent raw water that may be treated or blended prior to delivery to meet the standard or may not be used for potable uses. Water quality is generally not known to have significantly adversely affected beneficial uses of groundwater in the Eastern San Joaquin Subbasin.

2.2.4.1 Salinity

As identified in prior planning efforts, and as referenced in Section 2.2 (Current and Historical Groundwater Conditions), localized salinity issues are a concern for some areas of the Eastern San Joaquin Subbasin. Pumping in excess of recharge has resulted in declining groundwater levels that have contributed to an increase of salinity in groundwater wells since the 1950s. As identified through isotopic typing, elevated salinity concentrations in the Subbasin are the result of natural processes and overlying land use activities (O’Leary et al., 2015). Within the Subbasin, there are three primary sources of salinity:

1. **Delta Sediments** – Evaporation of groundwater in discharge areas introduces naturally occurring soluble salts into Delta sediments.

2. **Deep Deposits** – Saline groundwater in the Subbasin is principally the result of the migration of a naturally occurring deep saline water body which originates in regionally deposited marine sedimentary rocks that underlie the San Joaquin Valley. This results in a saline aquifer underlying the freshwater aquifer, and well pumping can result in upwelling saline brines into the freshwater aquifer.

3. **Irrigation Return Water** – Irrigation return water is excess applied water that percolates into the groundwater system or flows to the stream system from an irrigated field following the application of irrigation water. Return water may include contaminants typical of agricultural practices (e.g., pesticides, herbicides) and can concentrate salts due to evapotranspiration. The return water may act as a conduit delivering these contaminants to the surrounding watershed or underlying groundwater aquifer. Areas in the Subbasin with salinity resulting from irrigation return water do not commonly exceed chloride concentrations of 100 mg/L (O'Leary et al., 2015).

Salinity is a measure of the mass of dissolved particles and ions in a volume of water. Salinity includes many different ions, including nitrate, but the most common are sodium, calcium, magnesium, chloride, bicarbonate, and sulfate. Chloride and TDS are two common ways to measure and analyze salinity. Each is described separately in the sections below.

2.2.4.1.1 Chloride

Chloride is one way to measure salinity and is reported as a concentration of the Cl^- ion that originates from the dissociation of salts in water. The California Department of Drinking Water (DDW) SMCL of 250 mg/L for chloride is a common approach to identifying water quality concerns for this constituent. The SMCL is a secondary drinking water standard that is established for aesthetic reasons such as taste, odor, and color and is not based on public health concerns. The 250 mg/L value is "recommended" by SWRCB as a threshold below which chloride concentrations are desirable for a higher degree of consumer acceptance of drinking water. An "upper" limit of 500 mg/L is used to define a range above the "recommended" value where chloride concentration is acceptable if it is neither reasonable nor feasible to provide more suitable waters (SWRCB, 2006). Comparisons to the SMCL must be considered in context as the measured concentrations represent raw water, which may be treated or blended prior to delivery to meet the standard or may not be used for potable uses.

As shown in Figure 2-58, the majority of observed chloride concentrations above 250 mg/L occur on the western side of the Subbasin. As shown in Figure 2-59, the number of measurements with observed concentrations above 250 mg/L has decreased since the 1970s. The GAMA dataset was used for analysis.

Figure 2-58: Maximum Chloride Concentration Greater Than 250 mg/L (1940s-2010s)

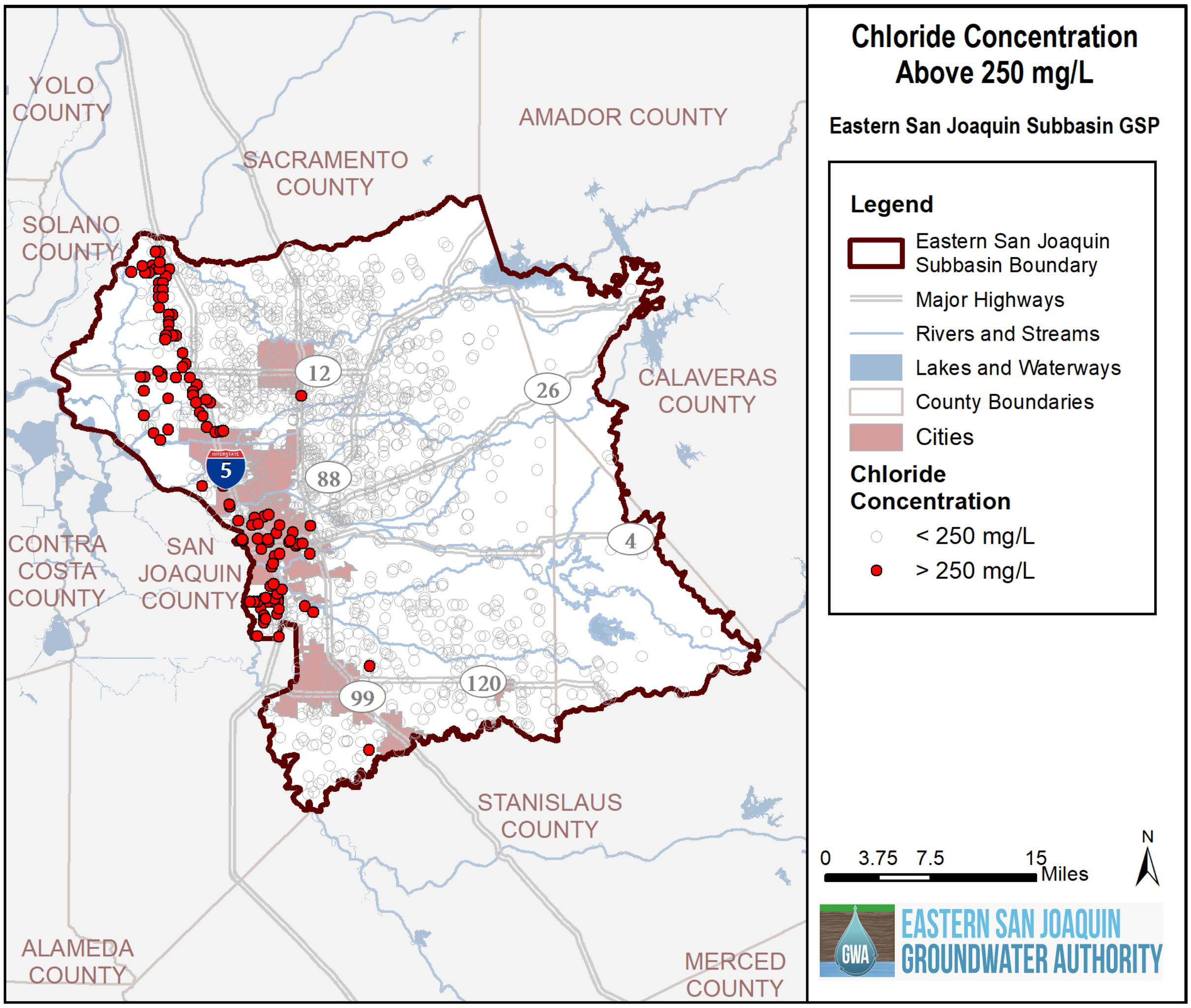


Figure 2-59: Maximum Chloride Concentration Above 250 mg/L by Decade

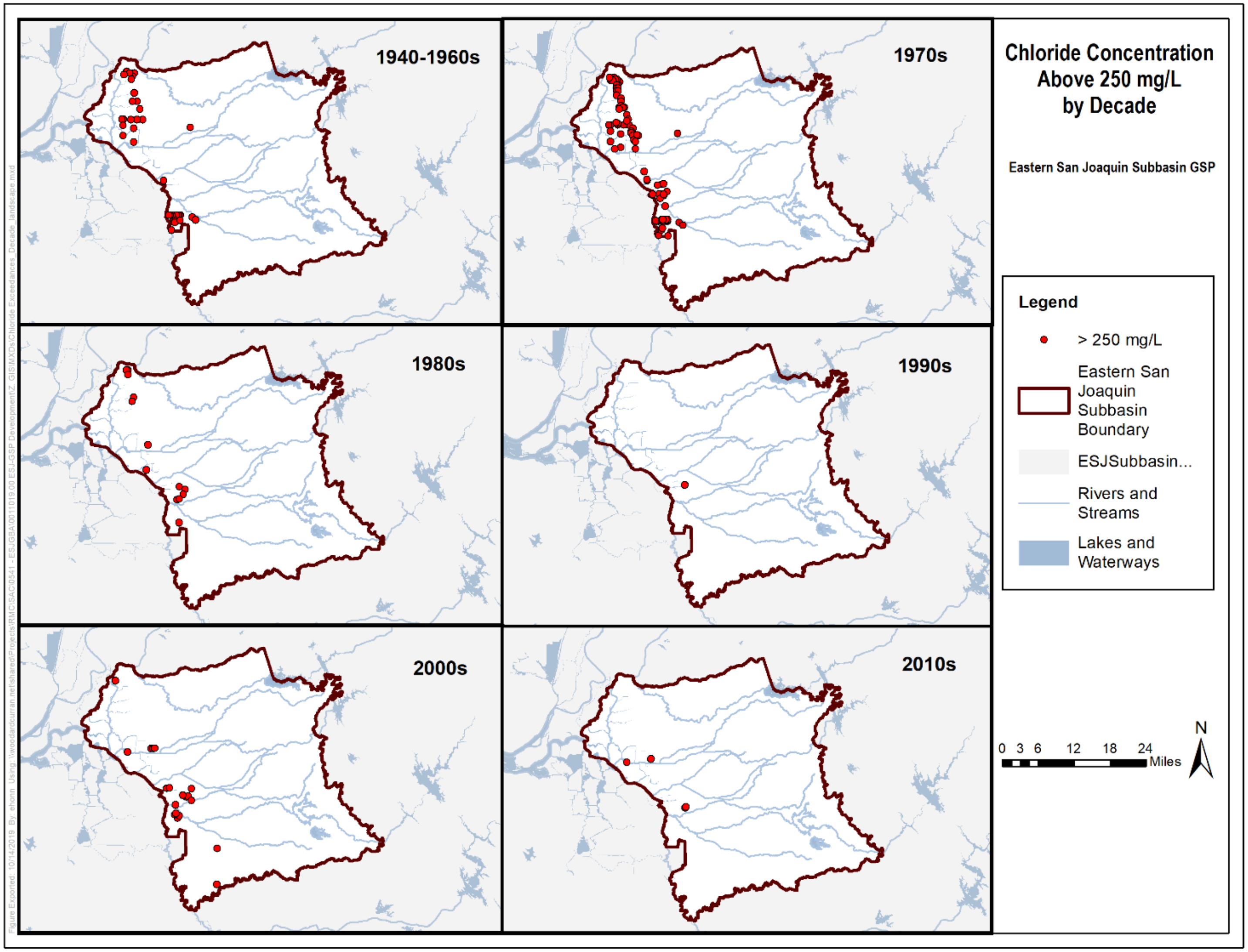


Table 2-5 shows occurrence of chloride measurements greater than 250 mg/L by decade. Chloride records have been observed above 250 mg/L both historically and recently. Sampling frequencies increased in the 1970s and 2000s.

Table 2-5: Summary of Chloride Data by Decade

Decade	Measurement Above 250 mg/L?		Range of Values (mg/L)				Total Number of Samples
	No	Yes	Minimum	Average	Median	Maximum	
1940	98%	2%	7.0	45.2	20.0	975	180
1950	93%	7%	2.3	89.4	25.0	3,750	699
1960	90%	10%	0.0	115.0	17.0	1,960	312
1970	90%	10%	1.8	85.9	19.0	3,310	1,780
1980	97%	3%	0.0	45.4	20.5	630	858
1990	99%	1%	0.0	31.2	19.0	533	663
2000	95%	5%	0.0	59.6	35.0	2,050	1,453
2010	98%	3%	0.0	34.8	39.0	2,050	986

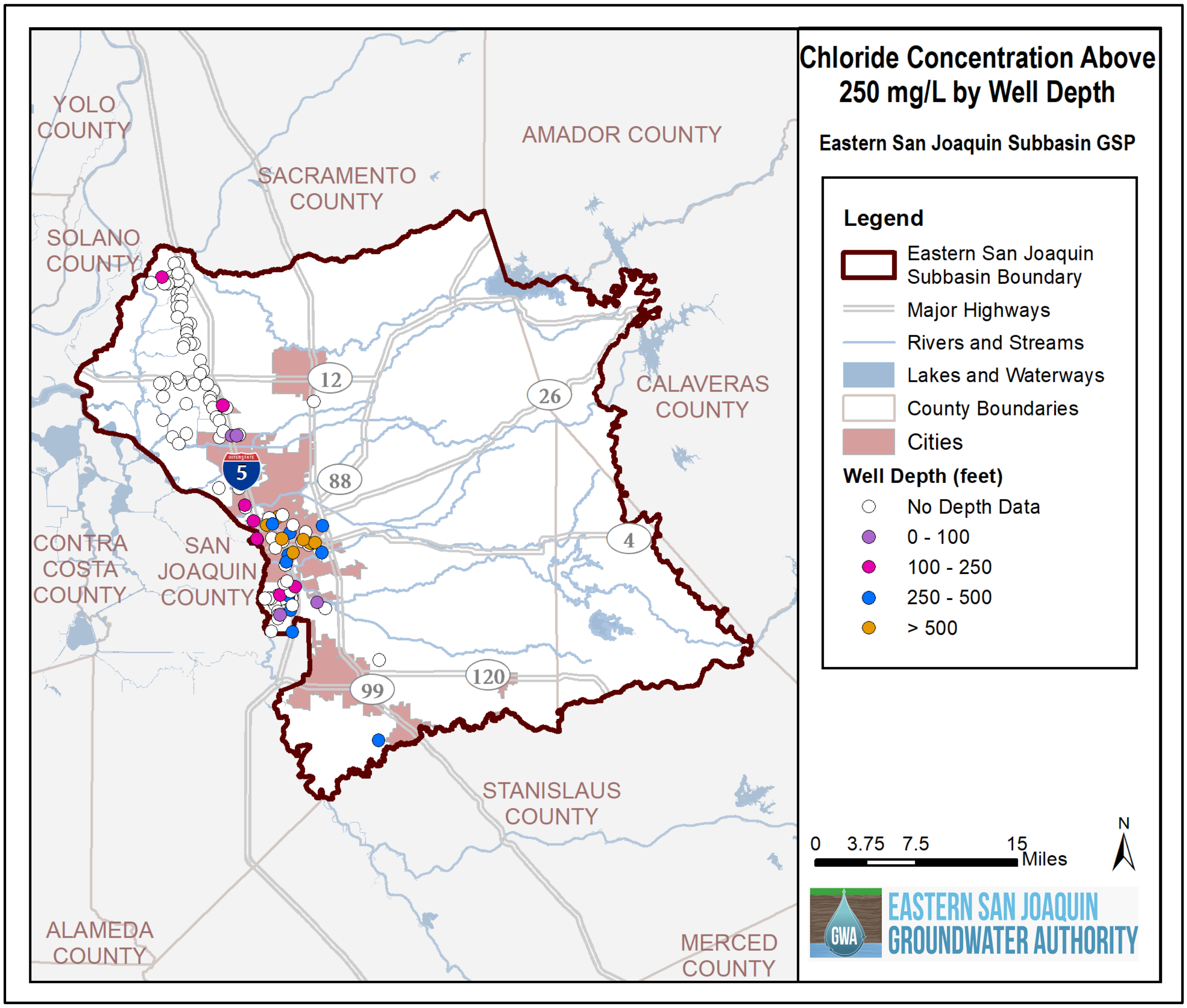
Table 2-6 shows chloride occurrences of concentrations greater than 250 mg/L by well depth. The highest proportion of readings above 250 mg/L occur in the shallowest wells, less than 100 feet deep (8 percent). The highest maximum value also occurred at this depth range (up to 2,050 mg/L).

Figure 2-60 shows the spatial distribution of chloride occurrences greater than 250 mg/L by well depth within the Subbasin.

Table 2-6: Summary of Chloride Data by Depth (1940s-2010s)

Depth (feet)	Measurement Above 250 mg/L?		Range of Values (mg/L)				Total Number of Samples
	No	Yes	Minimum	Average	Median	Maximum	
No Depth Data	92%	8%	0.0	82.5	20.0	3,750	3,566
0 - 100	92%	8%	0.8	73.5	60.0	2,050	239
100 - 250	97%	3%	1.0	44.2	36.0	1,400	1,215
250 - 500	98%	2%	0.0	32.4	16.0	1,100	1,487
> 500	95%	5%	2.7	62.1	15.6	1,940	424

Figure 2-60: Maximum Chloride Concentration Above 250 mg/L by Well Depth (1940s-2010s)



A lack of depth information presents a challenge to analyzing the vertical distribution of chloride measurements which would inform identification of chloride sources. Examples of depth information include total well construction depth or screened interval depths, which vary between wells. Some wells have total depth but not screened interval depth, or vice versa. For this analysis, screened interval depth was used first, and if this information was not available, total depth was used. Approximately 4,600 of the almost 13,000 chloride measurements in the Eastern San Joaquin Subbasin are from wells lacking any construction or screen depth information. Roughly half of the measurements above 250 mg/L occur in the wells lacking depth data, which also show the highest range in values occurring above 250 mg/L. Identifying the source of high-chloride water in wells of various depths over time requires further analysis of geochemical data; depth-specific water quality was identified as a data gap in the HCM.

2.2.4.1.2 Total Dissolved Solids (TDS)

TDS, which is a measure of all inorganic and organic substances present in a liquid in molecular, ionized, or colloidal suspended form, is commonly used to measure salinity. Recent TDS sample results show trends that match closely with the overall historical trends for chloride and highlight areas with elevated salinity concentrations in more recent years. TDS concentrations in the Eastern San Joaquin Subbasin ranged from 35 to 2,500 mg/L between 2015 and 2018. Spatially, the highest concentrations of TDS are found along the western margin of the Subbasin and the San Joaquin River and decrease significantly to the east, to typically less than 500 mg/L. TDS measurements, like chloride levels, are elevated near the cities of Stockton and Manteca, and in the Lodi GSA near the White Slough Water Pollution Control Facility.

Figure 2-61 shows the maximum and Figure 2-62 shows the average TDS concentrations from 2015 to 2018 as compared to the SMCL lower limit of 500 mg/L and upper limit of 1,000 mg/L. The GAMA dataset was used for analysis. The SMCL is a secondary drinking water standard that is established for aesthetic reasons such as taste, odor, and color and is not based on public health concerns. The 500 mg/L value is “recommended” by SWRCB as a threshold below which TDS concentrations are desirable for a higher degree of consumer acceptance of drinking water. The “upper” limit is used to define a range above the “recommended” value where TDS concentration is acceptable if it is neither reasonable nor feasible to provide more suitable waters (SWRCB, 2006). Comparisons to the SMCL must be considered in context as the measured concentrations represent raw water, which may be treated or blended prior to delivery to meet the standard or may not be used for potable uses.

Figure 2-61: Maximum TDS Concentrations 2015-2018

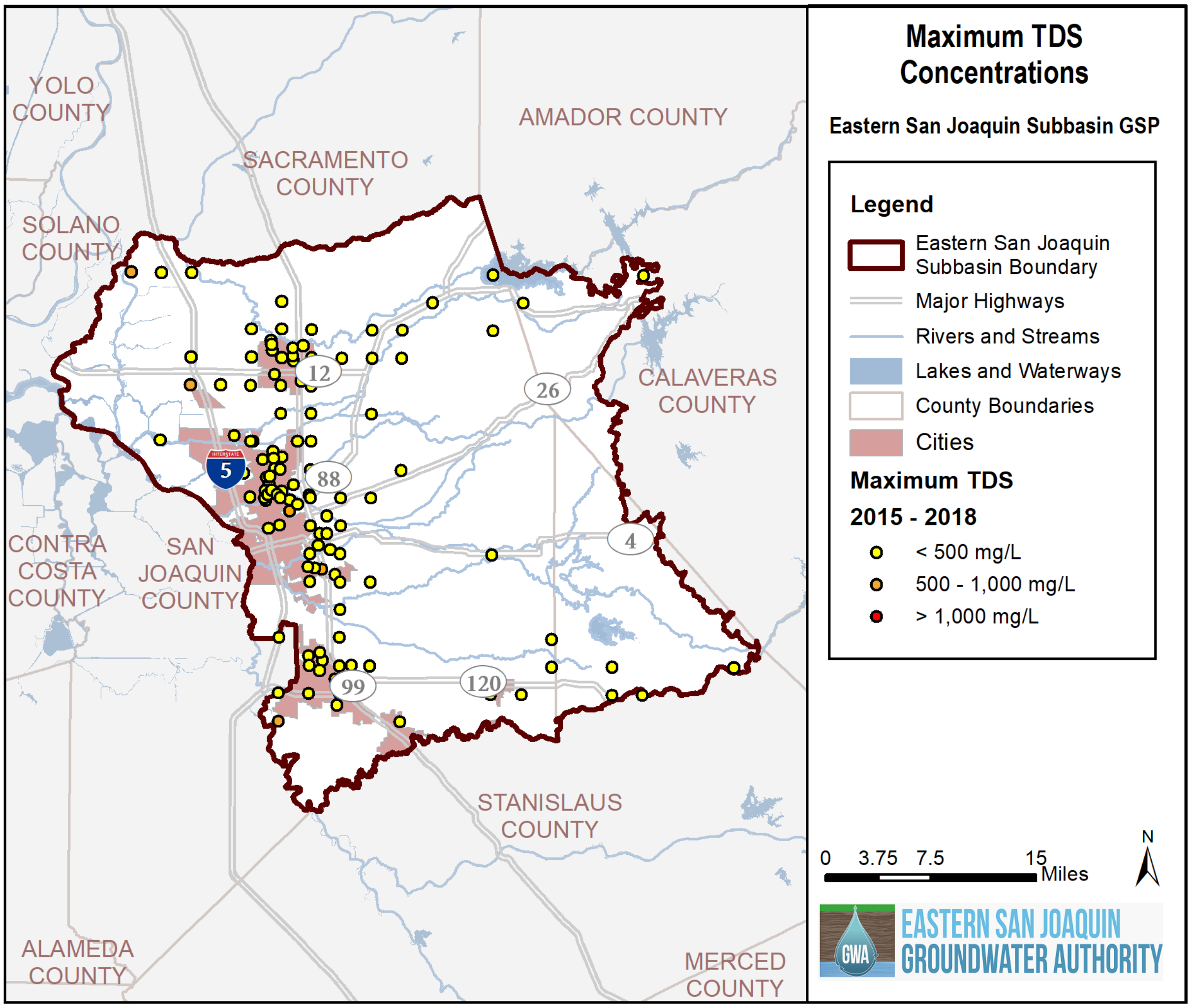
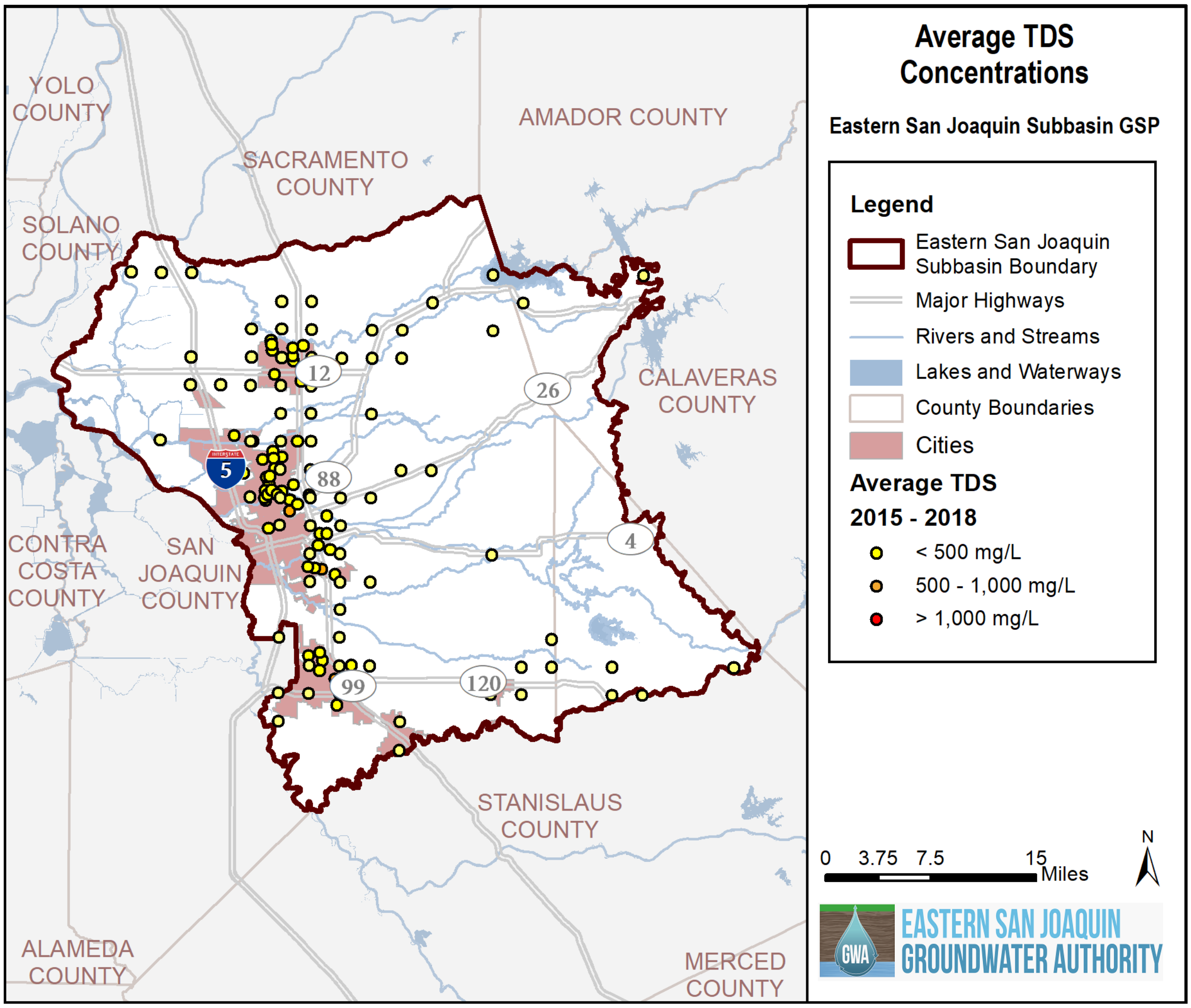


Figure 2-62: Average TDS Concentrations 2015-2018



Elevated TDS concentrations are apparent in very shallow groundwater in close proximity to the San Joaquin River, while deep wells (depths greater than 200 feet) typically have TDS concentrations below 500 mg/L. TDS trends by depth are summarized in Table 2-7.

Figure 2-63 shows the maximum TDS concentrations for shallow wells in the Eastern San Joaquin Subbasin from years 2015 to 2018, and Figure 2-64 shows the maximum TDS concentrations for deep wells in the same timeframe. As with chloride measurements, depth-dependent TDS data are not widely available. It was identified as a data gap in the HCM and will be a focus of the monitoring network for water quality, as described in the Chapter 4: Monitoring Networks.

Table 2-7: Summary of TDS Data by Depth (2015-2018)

Depth (feet)	% Measurements in Range			Range of Values (mg/L)				Total Number of Samples
	< 500 mg/L	500 – 1000 mg/L	> 1,000 mg/L	Minimum	Average	Median	Maximum	
No Depth Data	90%	8%	2%	94	339	310	1,180	451
0 - 100	N/A							0
100 - 250	54%	46%	0%	280	438	480	540	13
250 - 500	93%	7%	0%	120	344	340	560	75
> 500	N/A							0

Figure 2-63: Maximum TDS Concentrations in Shallow Wells 2015-2018

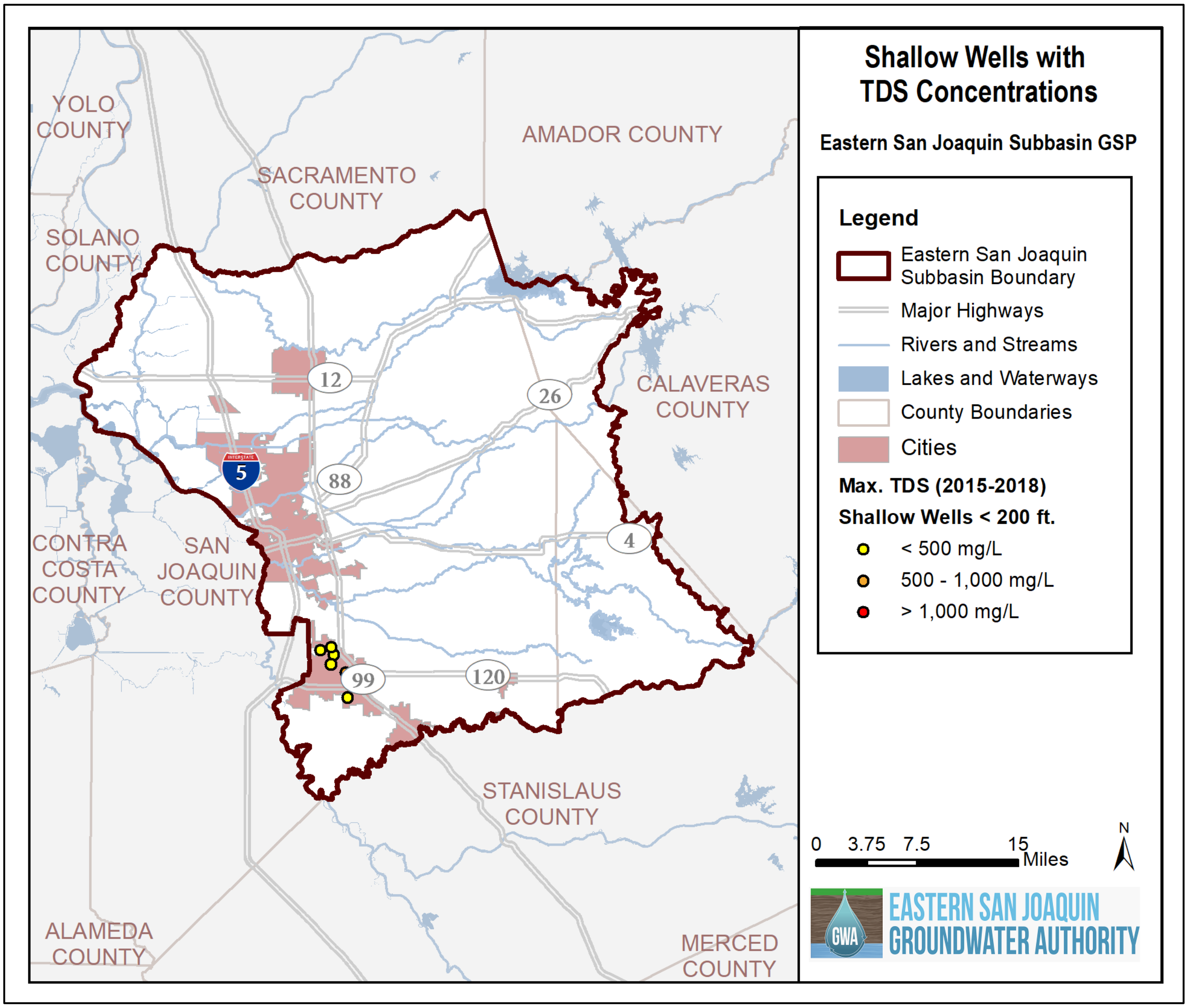
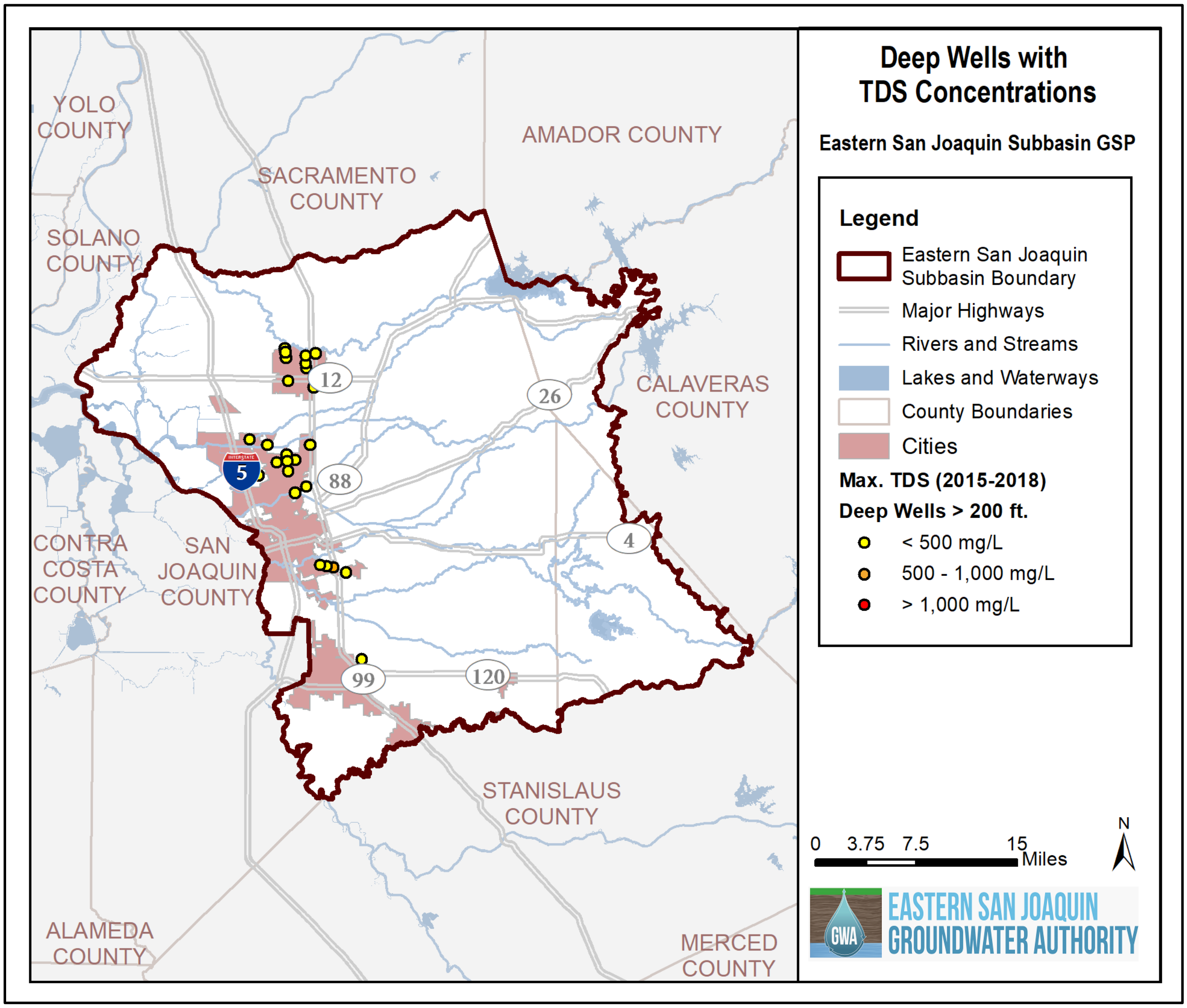


Figure 2-64: Maximum TDS Concentrations in Deep Wells 2015-2018



2.2.4.2 Nitrate

Nitrate is both naturally occurring and can be contributed a result of human activity. Nitrate can cause adverse human health effects. Anthropogenic sources of nitrate include fertilizers, septic systems, and animal waste. The DDW's MCL of 10 mg/L for Nitrate as N delimits high levels of nitrate for drinking water use. Many measured concentrations are above this value, both historically and recently. Comparisons to the MCL must be considered in context as the measured concentrations represent raw water, which may be treated or blended prior to delivery to meet the standard or may not be used for potable uses.

Table 2-8 provides the total number of nitrate values by decade and the percentage of those values greater than 10 mg/L. The total number of nitrate measurements has grown since 2000 as has the percentage of occurrences of concentrations greater than 10 mg/L. The GAMA dataset was used for analysis.

Table 2-8: Nitrate as N Concentrations by Decade

Decade	% of Samples		Number of Nitrate Samples
	<10 mg/L	>10 mg/L	
1940	88%	13%	8
1950	99%	1%	362
1960	99%	1%	240
1970	96%	4%	1,500
1980	95%	5%	420
1990	98%	2%	1,716
2000	87%	13%	9,679
2010	83%	17%	11,060

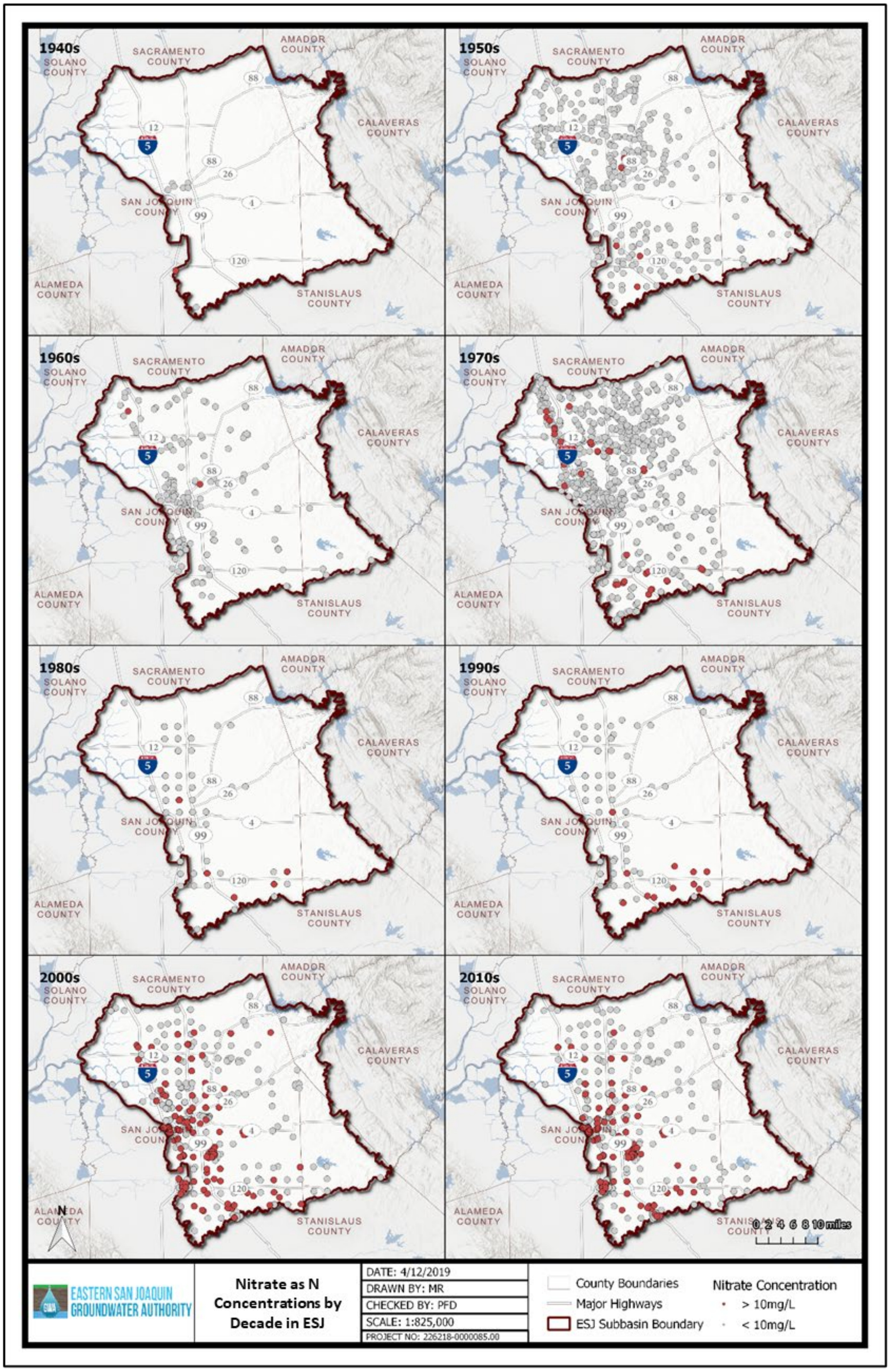
Figure 2-65 shows the historical spatial distribution of nitrate samples and detections by decade. During the 1940s, the earliest decade with nitrate measurements, very few records exist, and no significant conclusions can be made from this timeframe. The 1950s and 1960s have larger datasets, but measurements above 10 mg/L during these decades are sporadic and localized. Nitrate concentrations during the 1970s show a significant number of measurements above 10 mg/L in the northwest portion of the Eastern San Joaquin Subbasin, adjacent to Interstate 5. The 1980s and 1990s show similar patterns, with areas measurements above 10 mg/L primarily around the cities of Stockton, Lodi, and Manteca. Nitrate as N measurements above 10 mg/L are also located near the southern edge of the Eastern San Joaquin Subbasin, close to Highway 120. Although a much greater number of records exists for the 1990s than the 1980s, these decades have approximately the same spatial distribution. One possible explanation is similar wells were sampled during the 1980s and 1990s, but much more frequently in the 1990s. The 2000s and 2010s had both the greatest number of nitrate measurements and the largest number of measurements above 10 mg/L. Measurements above 10 mg/L during these decades follow previous trends: they are primarily between Highway 99 and Interstate 5, from Ripon to near Lodi.

Recent nitrate measurements above the MCL correspond to the overall historical trends and highlight areas with elevated nitrate concentrations in more recent years. These areas include the cities of Stockton and Ripon, areas of the Lodi GSA near the White Slough Pollution Control Facility, the N.A. Chaderjian Youth Correctional Facility, Republic Services Landfill on South Austin Road, and the Kruger and Sons, Inc. site off Highway 4 outside Farmington.

While the extent of groundwater quality impacts from nitrate is a data gap area, increased nitrate concentrations have not been found to have a causal nexus between SGMA-related groundwater management activities in the Subbasin. The causal nexus reflects that the degraded water quality issues are associated with groundwater pumping and other SGMA-related activities rather than water quality issues resulting from land use practices, naturally occurring water quality issues, or other issues not associated with groundwater pumping. Additional monitoring conducted through the implementation of this GSP will inform trends such that the Eastern San Joaquin Groundwater Authority (ESJGWA) can be informed to take action to address nitrite contamination if a causal nexus is identified.

Section 3.2.3.1.1 of this Plan discusses Irrigated Lands Regulatory Program (ILRP) and Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS), two existing regulatory programs for the monitoring and regulation of nitrate. Under the ILRP, the San Joaquin County & Delta Water Quality Coalition is required to test and potentially mitigate for nitrate in domestic wells. Additionally, the 2017 Salt and Nitrate Management Plan developed by CV-SALTS identifies long-term nitrate management practices (CVRWQCB, 2016).

Figure 2-65: Nitrate as N Concentrations by Decade



2.2.4.3 Arsenic

Arsenic is ubiquitous in nature and is commonly found in drinking water sources in California. Determining the source of arsenic in groundwater is difficult because arsenic is both naturally occurring and used in human activities such as agriculture. Public health concerns about arsenic in drinking water related to its potential to cause adverse health effects are addressed through DDW's MCL, established at 10 micrograms per liter (µg/L). California's revised arsenic MCL of 10 µg/L became effective on November 28, 2008. A 10-µg/L federal MCL for arsenic has been in effect since January 2006. Previous California and federal MCLs for arsenic were 50 µg/L.

Figure 2-66 shows the spatial distribution of arsenic concentrations contained in the GAMA database. From the 1970s to present, the total number and percentage of arsenic values above 10 µg/L has increased (see Table 2-9). The spatial distribution of measurements above 10 µg/L is similar to nitrate, largely between Interstate 5 and Highway 99, from Manteca to Lodi. The increased arsenic concentrations near urban areas are not necessarily indicative of contamination from these areas and may partially be due to the fact that arsenic measurements are more abundant in these urban areas; GAMA water quality records are rarely evenly distributed throughout the Subbasin for any constituent. Recent arsenic samples show measurements above 10 µg/L similar to the overall trends (see Figure 2-67). Measurements above 10 µg/L in years 2015, 2016, 2017, and 2018 are primarily located in the cities of Stockton and Manteca, with fewer occurring around the City of Lodi. While the extent of groundwater quality impacts from arsenic is a data gap area, increased arsenic concentrations have not been found to have a causal nexus between SGMA-related groundwater management activities in the Subbasin. Additional monitoring conducted through the implementation of this GSP will inform trends such that the ESJGWA can be informed to take action to address arsenic contamination if a causal nexus is identified.

Figure 2-66: Arsenic Concentrations by Decade

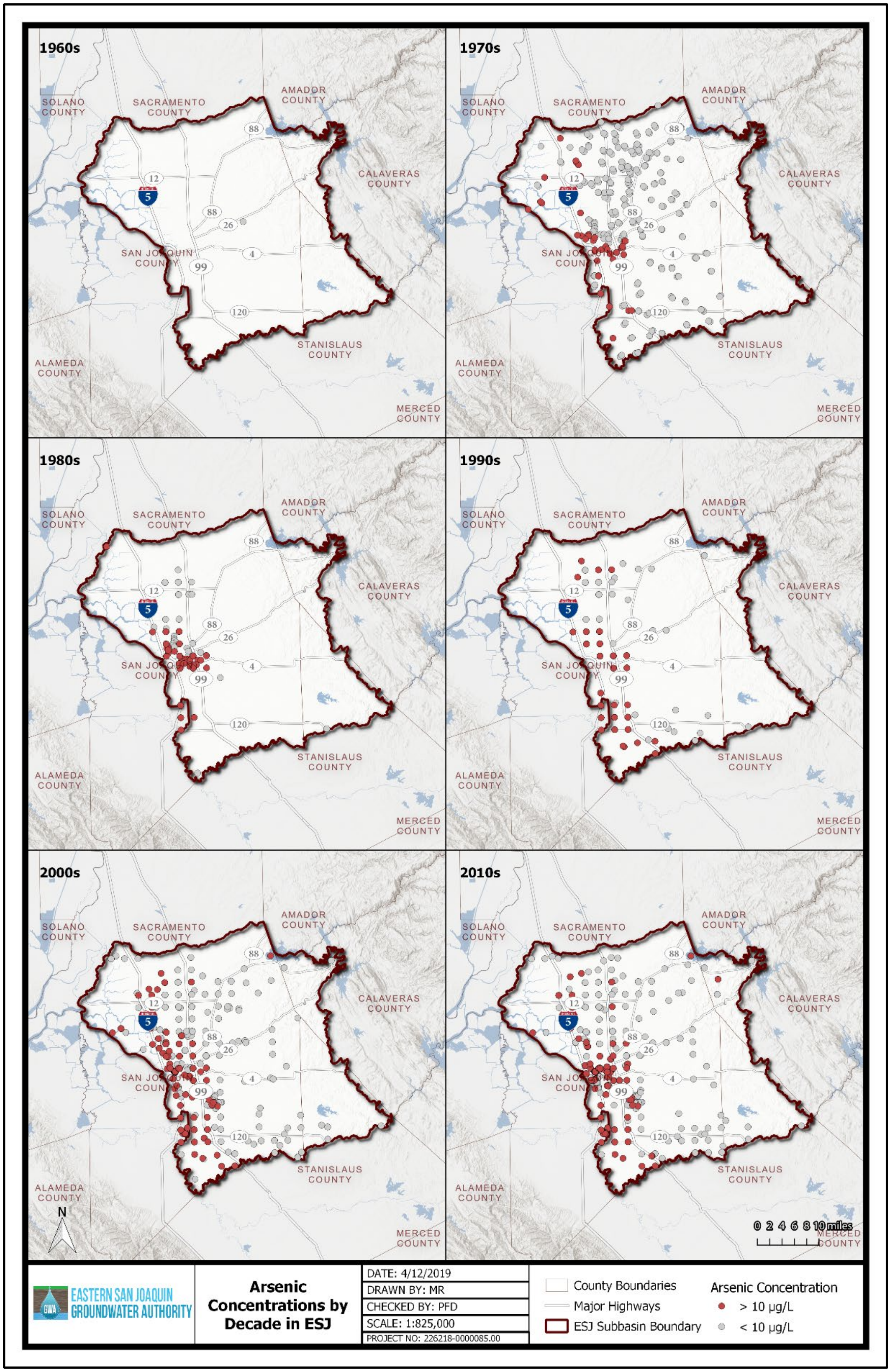
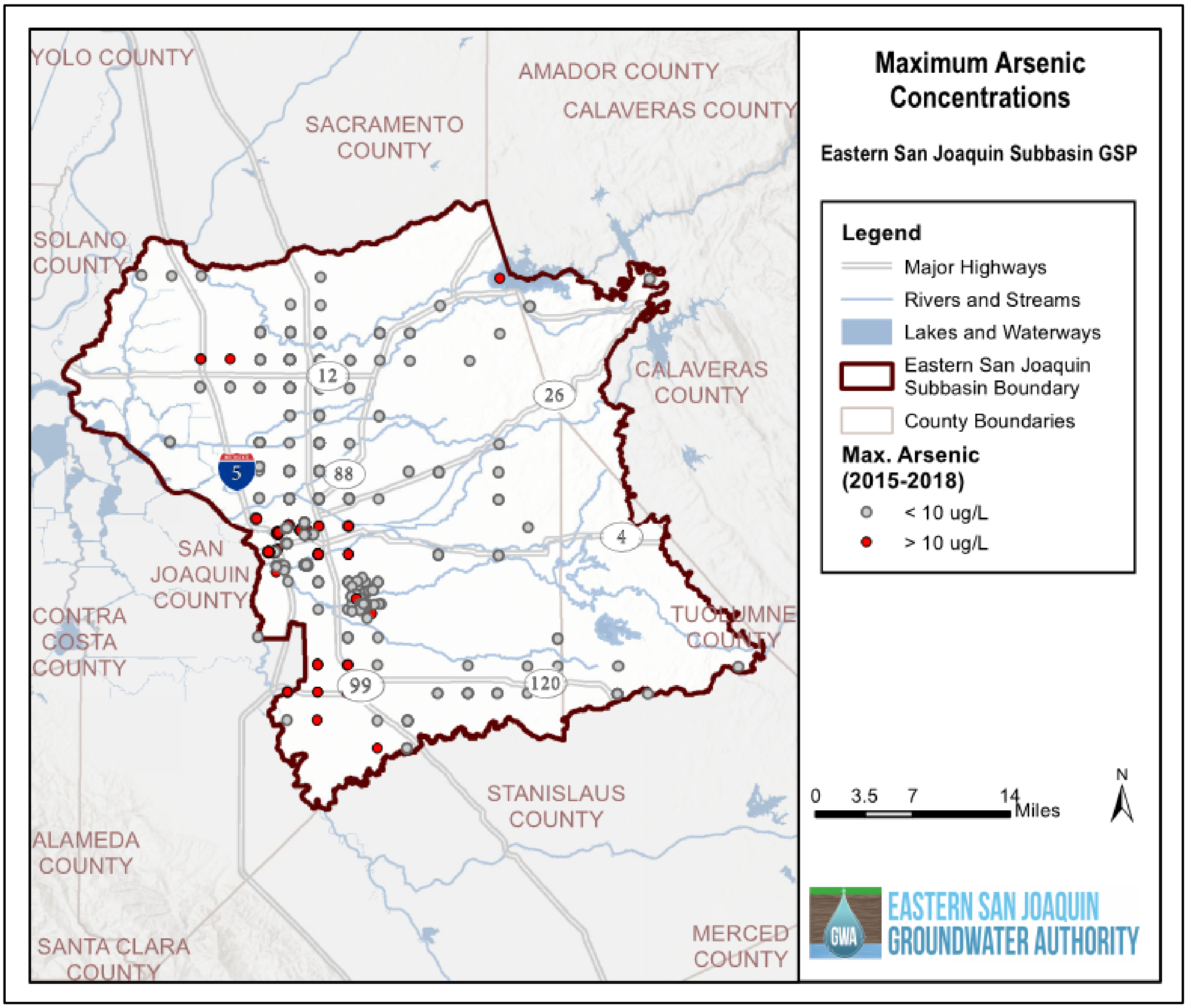


Table 2-9: Arsenic Concentrations by Decade

Decade	% of Samples		Number of Arsenic Samples
	<10 µg/L	>10 µg/L	
1960	100%	0%	1
1970	86%	14%	339
1980	72%	28%	363
1990	72%	28%	645
2000	56%	44%	4,051
2010	48%	52%	5,109

Figure 2-67: Maximum Arsenic Concentrations 2015-2018



2.2.4.4 Point Sources

Point sources are discrete or discernable sources of pollutants which may introduce undesirable constituents into groundwater and may negatively impact water quality. In the Eastern San Joaquin Subbasin, point sources include leaking underground storage tanks, landfills, dry cleaners, and others. These sites are actively investigated and monitored within the Eastern San Joaquin Subbasin in response to these known or potential sources of groundwater contamination.

The Regional Water Quality Control Board (RWQCB), the Department of Toxic Substances Control (DTSC), and the USEPA provide oversight of point-source pollution through existing regulatory programs, including management of remedial action for point-source contamination sites. Figure 2-68 shows the results of a query from both the GeoTracker database and the EnviroStor database. GeoTracker documents contaminant concerns that the RWQCB is or has been working with site owners to remediate while EnviroStor is the DTSC's data management system to track known contamination sites undergoing cleanup, permitting, enforcement, and investigation efforts. As shown in Figure 2-68, there are 258 active sites within the Eastern San Joaquin Subbasin which are color-coded based on the site's constituent(s) of concern: fuels (gas and/or diesel); synthetic organics (pesticides, herbicides, insecticides, etc.); or a mix of constituents (multiple constituents such as heavy metals and pesticides).

Most sites within the Eastern San Joaquin Subbasin are fuel sites (e.g., gas or diesel) that are under active investigation or remediation. Sites with the potential to cause plumes are mapped in Figure 2-69, which were identified by filtering for sites containing soluble and mobile constituents such as volatile organic compounds (VOCs); benzene, toluene, ethylbenzene, and xylenes (BTEX); and/or petroleum hydrocarbons (gas or diesel).

Sites with the potential to cause plumes are currently managed by existing regulatory programs through the RWQCB, DTSC, and USEPA, as described above. New projects undertaken by the GSAs as part of GSP implementation will evaluate contaminant plume movement in a CEQA document.

Specific point source sites and contaminants are discussed in the sections below.

Figure 2-68: Active Investigation and Remediation Sites

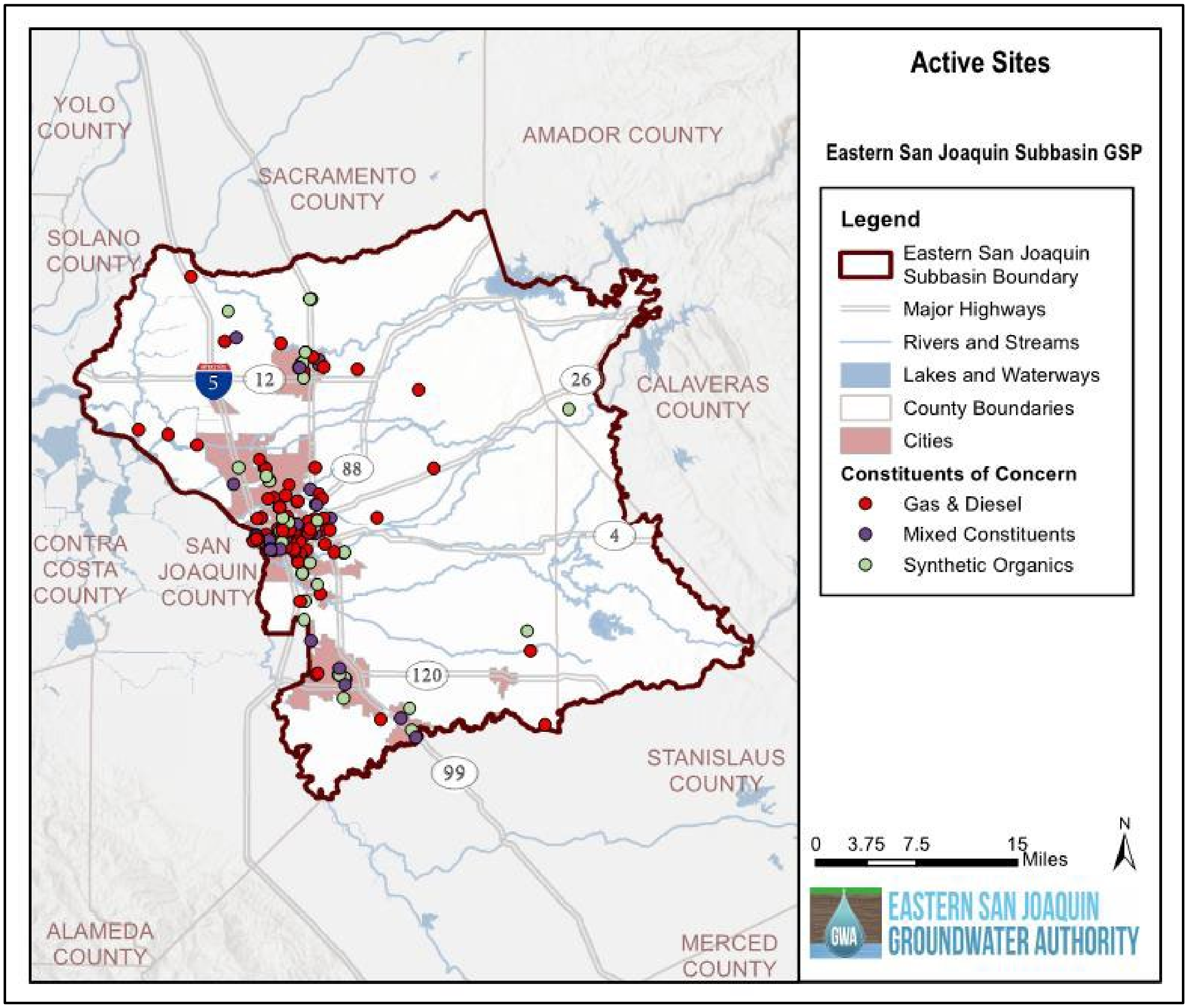
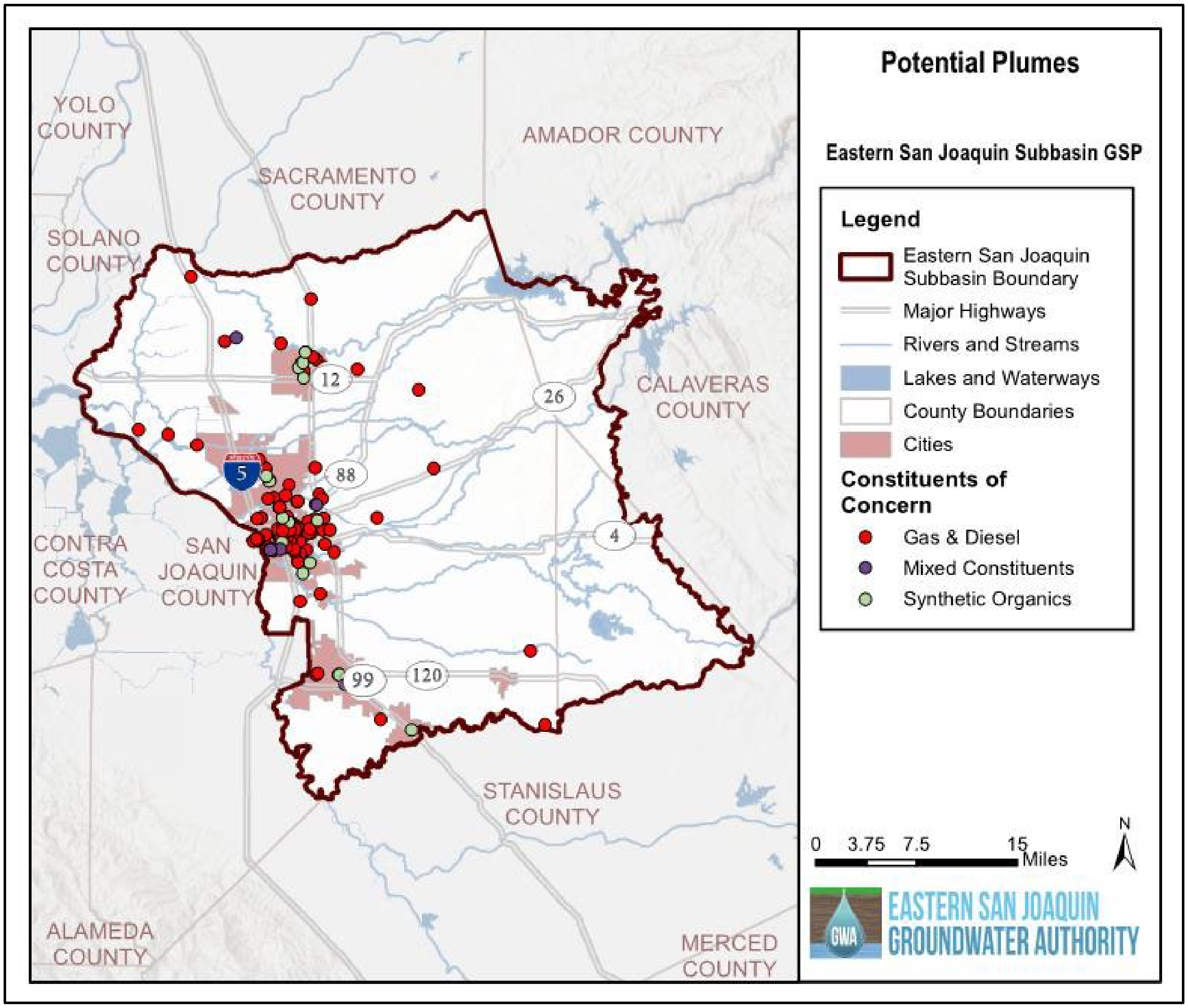


Figure 2-69: Active Sites with the Potential to Cause Plumes



2.2.4.4.1 Publicized Plumes in and near the Subbasin

As indicated above, the Eastern San Joaquin Subbasin has numerous open cleanup sites, including areas contaminated by chlorinated solvents, methyl tertiary-butyl ether (MtBE), pesticides and herbicides, and leaking underground storage tanks. Plume sites are often clustered around urban centers but are also found near sites where historical industrial or agricultural practices have released contaminants of concern. While other plumes exist in and around the Subbasin, three specific plumes have been highly publicized: the Lodi Plumes, the Sharpe Army Depot Plume, and the Occidental Chemical Corporation Plume.

In the late 1980s, the City of Lodi discovered the chlorinated solvents perchloroethylene (PCE) and trichloroethene (TCE) in drinking water supplies and pursued a groundwater investigation that revealed a series of five separate plume areas located in the northeastern portion of the city: the Northern, Western, Central, Southern, and Busy Bee plumes. The Busy Bee plume, named after a dry cleaner business that previously operated on the site, now has regulatory closure, with cleanup moving toward completion under CVRWQCB oversite (Water Resources Control Board, 2011).

Groundwater contamination plumes in the City of Lathrop, located just outside the Subbasin boundary, include the Sharpe Army Depot and Occidental Chemical Corporation sites. Contamination of groundwater at the Sharpe Army

Depot consists primarily of trichloroethene, tetrachloroethene, and cis-1,2-dichloroethene from historical industrial activities related to military activities. Due to concerns of potential contamination, the City of Lathrop abandoned their wells in the area. Three groundwater extraction and treatment systems are located at Sharpe Army Dept and are used to treat existing groundwater (EKI Environment & Water, 2015).

The Occidental Chemical Corporation Plume was discovered in the late 1970s and is the result of former leaking wastewater holding ponds containing pesticides and chemicals used for equipment cleaning by the Occidental Chemical Corporation. Contaminants of concern include the pesticides 1,2-dibromo-3-chloropropane (DBCP) and ethylene dibromide (EDB), lindane, 2,3,4,5-tetrahydrothiopene-1, 1-dioxide, sulfate, nitrate, chloride, and BHC (RWQCB, 2012). Since the discovery of these plumes in the 1980s, groundwater monitoring and evaluation at point source locations has led to the implementation of remedial activities such as the installation of groundwater extraction and remedial systems, implementation of a Salinity Reduction Plan, and mandated waste discharge requirements (WDRs) (RWQCB, 2012).

2.2.4.4.2 Petroleum Hydrocarbons

Approximately 134 sites in the Eastern San Joaquin Subbasin are identified as actively investigating or remediating an unauthorized release of petroleum hydrocarbons, according to the GeoTracker and EnviroStor databases. At these sites, petroleum hydrocarbon constituents are most commonly fuels (diesel, gasoline, motor oil, or aviation fuel) and VOCs commonly added to fuels, including MTBE and BTEX constituents. Concentrations of petroleum hydrocarbons have not been modeled across the Subbasin; concentrations are local and site specific. A summary description of the aforementioned constituents is provided in Table 2-10 below:

Table 2-10: MCLs for Common Petroleum Hydrocarbons and MTBE

Constituent	Source	Primary MCL
MTBE	Oxygenate commonly added to gasoline	13 µg/L
BTEX		
Benzene	Industrial solvent added to crude oil paint, varnish, and lacquer thinner	1 µg/L
Toluene	Aromatic hydrocarbon used in industrial feedstock, as a solvent, and to produce benzene and added to gasoline	150 µg/L
Ethylbenzene	Used as a solvent and added to fuel, asphalt, and naphthalene	300 µg/L
Xylenes	Naturally occurring in petroleum, coal and wood tar	1.750 mg/L

Source: (SWRCB, 2018)

2.2.4.4.3 Synthetic Organics

Approximately 47 sites in the Eastern San Joaquin Subbasin are identified as actively investigating or remediating an unauthorized release of synthetic organics, according to the GeoTracker and EnviroStor databases. At these sites, pesticides, herbicides, fertilizer, and pesticides are the most common constituents. Other constituents include VOCs such as PCE and TCE. Concentrations of synthetic organics have not been modeled across the Subbasin; concentrations are local and site specific. For context, a brief description of the aforementioned VOCs is provided in Table 2-11.

Table 2-11: MCLs for Common Synthetic Organic Constituents

Constituent	Source	Primary MCL[1]
TCE	Used as a solvent in manufacturing facilities and dry cleaners	5 µg/L
PCE	Used as a solvent in manufacturing facilities, dry cleaners, printing shops, and auto repair facilities	5 µg/L

Note:
[1] Source: (SWRCB, 2018)

2.2.4.4.4 Mixed Constituents

Approximately 28 sites in the Eastern San Joaquin Subbasin are identified as actively investigating or remediating an unauthorized release of mixed constituents, according to the GeoTracker and EnviroStor databases. Sites with mixed constituents are those that include a release of more than one type of contaminant, such as a mix of heavy metals, diesel, inorganics, and/or organics. At these sites, the most common constituents include a mixture of heavy metals (chromium, arsenic, and lead), inorganics, and solvents. The sources and primary MCL for many contaminants found in the 'mixed constituents' classification have been discussed throughout Section 2.2.4.

2.2.4.4.5 Emerging Contaminants

Many chemical and microbial constituents that have not historically been considered as contaminants are occasionally, and in some cases with increasing frequency, detected in groundwater. These newly recognized (or emerging) contaminants are commonly derived from municipal, agricultural, industrial wastewater, and domestic wastewater sources and pathways. These newly recognized contaminants are dispersed to the environment from domestic, commercial, and industrial uses of common household products and include caffeine, artificial sweeteners, pharmaceuticals, cleaning products, and other personal care products. Residual waste products of genetically modified organisms are also of potential concern. Several studies, such as by Watanabe et al. in 2010, have recently been published or are underway regarding the potential link between dairies and the occurrence of pharmaceuticals in shallow groundwater in the San Joaquin Valley.

Perfluorooctanesulfonic acid (PFOS) and perfluorooctantoic acid (PFOA) are organic chemicals synthesized for water and lipid resistance, used in a wide variety of consumer products as well as fire-retarding foam and various industrial processes. These chemicals tend to accumulate in groundwater, though typically in a localized area in association with a specific facility, such as a factory or airfield (California Water Boards, 2018). There are currently no MCLs for PFOS or PFOA; however, the USEPA is moving forward with establishing the MCL and is recommending municipalities notify customers at levels at or greater than 70 parts per trillion in water supplies (USEPA, 2019). California's DDW has established notification levels at 6.5 parts per trillion for PFOS and 5.1 parts per trillion for PFOA (SWRCB, 2019).

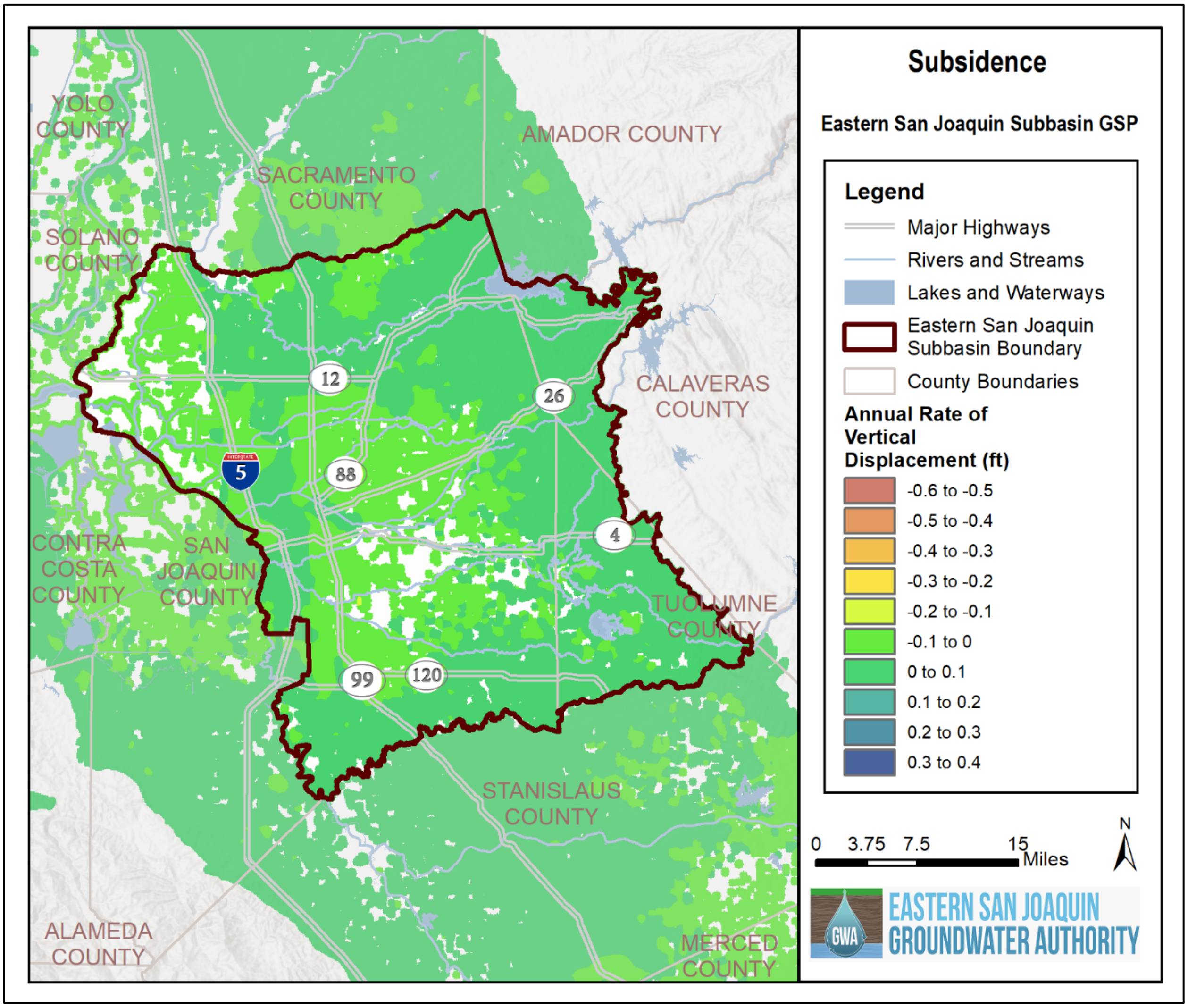
1,2,3-Trichloropropane (1,2,3-TCP) is a solvent is typically found in industrial or hazardous waste sites. Along with an industrial solvent, 1,2,3-TCP is a cleaning and degreasing agent and associated with pesticide products. Though there is currently no federal MCL, the MCL for 1,2,3-TCP in California is 0.005 µg/L (SWRCB, 2019).

Currently, data on PFOS, PFOA, and 1,2,3-TCP are limited in the Eastern San Joaquin Subbasin since these are emerging contaminants.

2.2.5 Land Subsidence

Despite long-term declining groundwater levels, there are no historical records of significant and unreasonable impacts from subsidence in the Eastern San Joaquin Subbasin. Figure 2-70 shows regional subsidence produced from TRE Altamira Interferometric Synthetic Aperture Radar (InSAR) data, provided by DWR for SGMA application. InSAR is a satellite-based method for showing ground-surface displacement over time. This figure illustrates that subsidence has historically been minimal in the Subbasin and surrounding areas (ranging from -0.1 to 0.1 feet of vertical displacement annually). The error range of a single InSAR measurement is +/- 5 millimeters (TRE Altamira, 2019). See Section 2.1.5 for a discussion of the soils and clays within the Subbasin, including the extent of Corcoran Clay.

Figure 2-70: Subsidence (Annual Rate of Vertical Displacement)



Note: This dataset represents measurements of vertical ground surface displacement in between spring 2015 and summer 2017 (TRE Altamira, 2019).

2.2.6 Interconnected Surface Water Systems

Interconnected surface waters are surface water features that are hydraulically connected by a saturated zone to the groundwater system. In these systems, the water table and surface water features intersect at the same elevations and locations. Interconnected surface waters may be either gaining or losing, wherein the surface water feature itself is either gaining water from the aquifer system or losing water to the aquifer system.

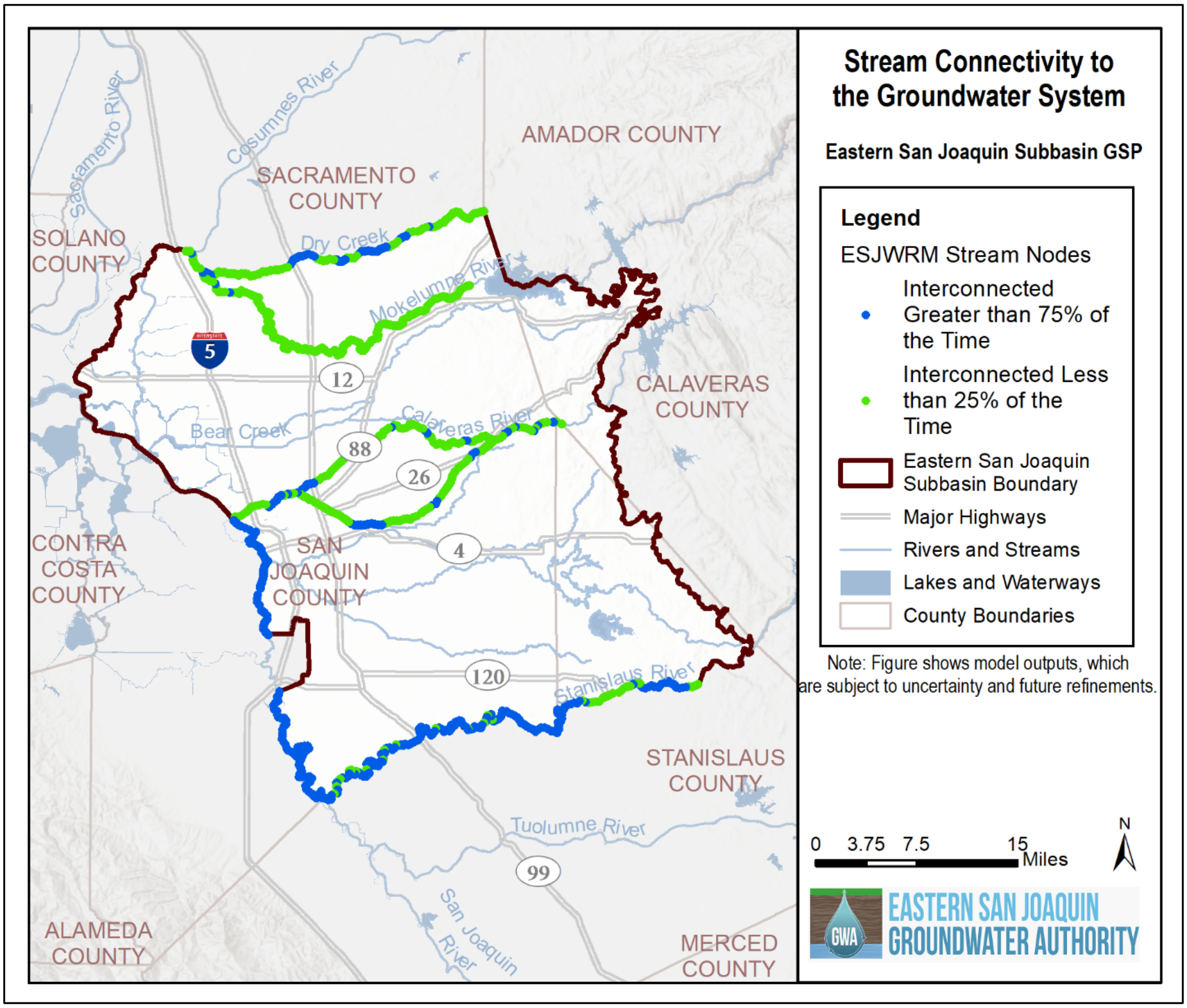
In the Eastern San Joaquin Subbasin, stream connectivity was analyzed by comparing monthly groundwater elevations from the historical calibration of the ESJWRM to streambed elevations along the streams represented in ESJWRM. This analysis was based on modeling results from the historical calibration of the ESJWRM for approximately 900 stream nodes in the Eastern San Joaquin Subbasin, which represents that best available information for current and historical conditions related to interconnected surface water systems. Figure 2-71 shows locations where streams are interconnected at least 75 percent of the time (shown in blue) or interconnected less than 25 percent of the time (shown in green).

Disconnected streams will always be losing streams, but interconnected streams may be either losing or gaining, depending on the surface water and groundwater conditions. Groundwater discharge from the aquifer is primarily through groundwater pumping, however, groundwater also discharges to streams where groundwater elevations are higher than the streambed elevations. Figure 2-72 shows mostly gaining streams in blue where groundwater discharges to rivers more than 75 percent of the time, mostly losing streams in red where streams lose water to the groundwater system more than 75 percent of the time, and mixed streams (gaining or losing less than 75 percent of the time) in orange.

Due to limited model calibration based on insufficient calibration information, stream nodes in the Delta area and along stretches of streams near the foothill boundary of the Subbasin are not shown on Figure 2-71 and Figure 2-72. Interconnected surface water is highlighted as a data gap in Section 4.7.3 due to a lack of data from shallow monitoring wells near streams. Future improvements to the understanding of interconnected surface water include proposed monitoring wells in Section 4.7.5 that are largely located along streams or in areas of the foothills where current monitoring coverage is lacking and a specific project in Section 6.2.7 to improve understanding of losses along Mokelumne River. Section 7.4.1 discusses model refinements over the next five years in order to improve calibration of the model and its use in analysis of GSP water budgets and sustainability criteria.

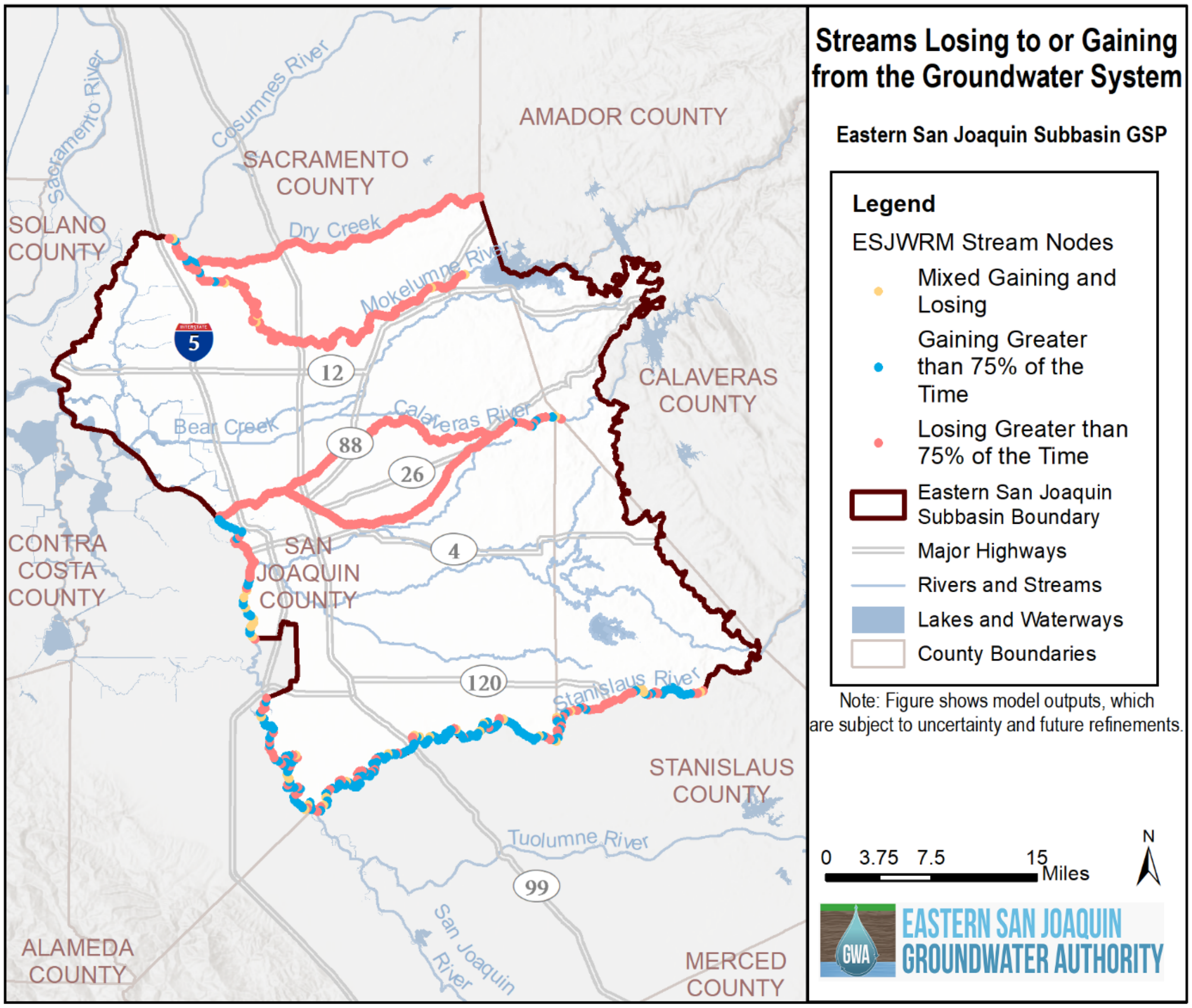
Figure 2-71 and Figure 2-72 are illustrations to describe model outputs, which are subject to uncertainty and future refinements and are not intended for regulatory purposes beyond the use in this Plan.

Figure 2-71: Stream Connectivity to the Groundwater System



Note: Analysis is based on limited data recognized to have significant gaps. Interconnected surface water is a recognized data gap in the GSP as discussed in Section 4.7.

Figure 2-72: Losing and Gaining Streams



Note: Analysis is based on limited data recognized to have significant gaps. Interconnected surface water is a recognized data gap in the GSP as discussed in Section 4.7.

2.2.7 Groundwater-Dependent Ecosystems

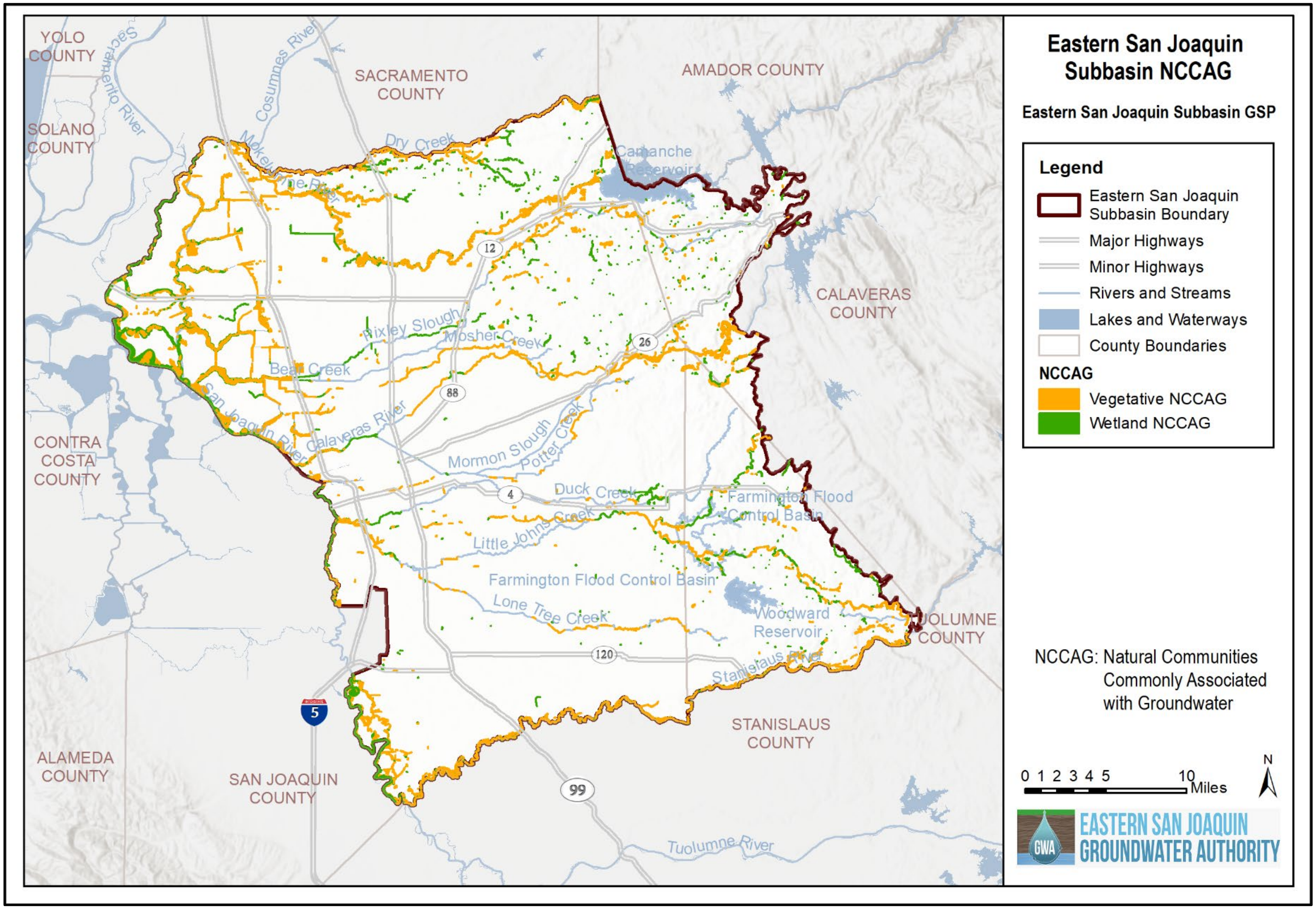
Groundwater-dependent ecosystems (GDEs) are defined in the GSP regulations as "ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface." SGMA requires the identification of GDEs. SGMA does not require that additional sustainable management criteria be established to specifically manage these areas, but rather includes GDEs as a beneficial user of water to be considered when developing other sustainable management criteria.

GDEs exist where vegetation accesses shallow groundwater for survival. This Plan identifies GDEs within the Eastern San Joaquin Subbasin based on determining the areas where vegetation is dependent on groundwater.

2.2.7.1 Methodology for GDE Identification

The Natural Communities Commonly Associated with Groundwater (NCCAG) database was used as a starting point to identify GDEs within the Subbasin. The NCCAG database was developed by a working group comprised of DWR, California Department of Fish and Wildlife (CDFW), and The Nature Conservancy (TNC). The working group reviewed publicly available datasets which mapped California vegetation, wetlands, springs, and seeps and conducted a screening process to retain communities known to be commonly associated with groundwater. The NCCAG database defines two habitat classes: wetland and vegetative. The wetland class includes wetland features commonly associated with the surface expression of groundwater under natural, unmodified conditions. The vegetative class includes vegetation types commonly associated with the shallow subsurface presence of groundwater (phreatophytes). Figure 2-73 shows the location of the two NCCAG classes within the Eastern San Joaquin Subbasin. The distribution of freshwater fish and wildlife species that may be dependent on GDEs is not well known and is not included in this analysis. A list of freshwater species in the Eastern San Joaquin Subbasin is provided in Appendix 1-F. Instream flows for rivers and streams interconnected with groundwater are evaluated through the Depletions of Interconnected Surface Water sustainability indicator (see Section 3.2.6).

Figure 2-73: Natural Communities Commonly Associated with Groundwater (NCCAGs)



Source: NC Dataset Viewer, CADWR Sustainable Groundwater Management (https://gis.water.ca.gov/app/NCDatasetViewer/)

This Plan uses the NCCAG database as a starting point for identifying GDEs. To identify NCCAG areas that are GDEs, the analysis identified communities in areas where groundwater levels are shallower than 30 feet bgs, as these areas are thought to be reachable by the root zone of vegetation.[1] Oak trees are considered the deepest-rooted plant in the region with a root zone of roughly 25 feet.[2] This value is considered conservative, as this depth is unlikely to support recruitment of new oak seedlings. NCCAG-identified communities in areas with groundwater shallower than 30 feet were considered as potential GDEs. Communities in areas deeper than 30 feet were identified as data gap areas for future refinement and are labeled on Figure 2-74 as "Depth to Water > 30 ft". These areas will be refined in future analyses to identify potential existing GDEs that may have been misclassified through this screening process. Additional information regarding plans to fill GDE-related data gaps can be found in Section 4.7.4.

The NCCAG database was then further refined to identify communities without access to alternate water supplies, as those communities would not be dependent on groundwater. This was done by screening for the following: 1) areas not close to managed wetlands, 2) areas not adjacent to irrigated agriculture, and 3) areas not near perennial surface water bodies. NCCAG-identified communities with access to shallow water (less than 30 feet bgs) and without access to alternate water supplies were classified as GDEs. Communities with access to alternate water supplies were identified as data gap areas requiring additional investigation to determine the reliability of the alternate supply.

- **Proximity to Managed Wetlands –** Managed wetlands receive supplemental water to support wildlife habitat. Managed wetlands, and areas within 150 feet of a managed wetland, are assumed to be able to access this supplemental delivered water regardless of the condition of the underlying aquifer. Areas farther than 150 feet from a managed wetland that meet the other GDE criteria in this section are assumed to be dependent on groundwater and were identified as GDEs. A criterion of 150 feet was used to reflect ponded conditions at the wetlands. Identified wetlands were reviewed with local water managers to verify supplemental water deliveries.

  NCCAG-identified communities not identified as GDEs through this analysis are identified as data gap areas for future refinement and are labeled on Figure 2-74 as "Managed Wetland". These areas will be refined in future analyses to determine if the alternate source of surface water is reliable over time and to identify potential existing GDEs that may have been misclassified through this screening process.

- **Adjacent to Irrigated Agriculture –** Irrigated agricultural lands are dependent on regular irrigation. This irrigation benefits not only the crops, but also the surrounding vegetation. Irrigated lands, and areas within 50 feet of irrigated lands, are assumed to be able to access this supplemental delivered water regardless of the condition of the underlying aquifer. Areas farther than 50 feet from irrigated lands that meet the other GDE criteria in this section are assumed to be dependent on groundwater and were identified as GDEs. A criterion of 50 feet was used to reflect non-ponded conditions in the fields.

  NCCAG-identified communities not identified as GDEs through this analysis are identified as data gap areas for future refinement and are labeled on Figure 2-74 as "Adjacent to Agriculture". These areas will be refined in future analyses to determine if the alternate source of surface water is reliable over time and to identify potential existing GDEs that may have been misclassified through this screening process.

- **Proximity to Perennial Surface Water Bodies –** Perennial surface water bodies provide year-round water supplies that can be accessed by adjacent vegetation. These water bodies include much of the Delta; large, managed rivers; and smaller water bodies that flow throughout the summer due to agricultural deliveries or

[1] This analysis uses 2015 groundwater levels (winter, spring, summer, and fall), which may be deeper than representative levels due to drought conditions, a factor which will be considered in future GDEs analyses.

[2] *Quercus chrysolepis* (canyon live oak) has a maximum rooting depth of 7.3 meters (23.95 feet) (Canadell et al., 1996). *Quercus lobata* (valley oak) has a maximum rooting depth of 7.41 meters (24.31 feet), although available data are from fractured rock aquifers (Lewis & Burgy 1964 and Schenk, H. J. and Jackson, R. B. 2002, as cited in TNC, 2019).

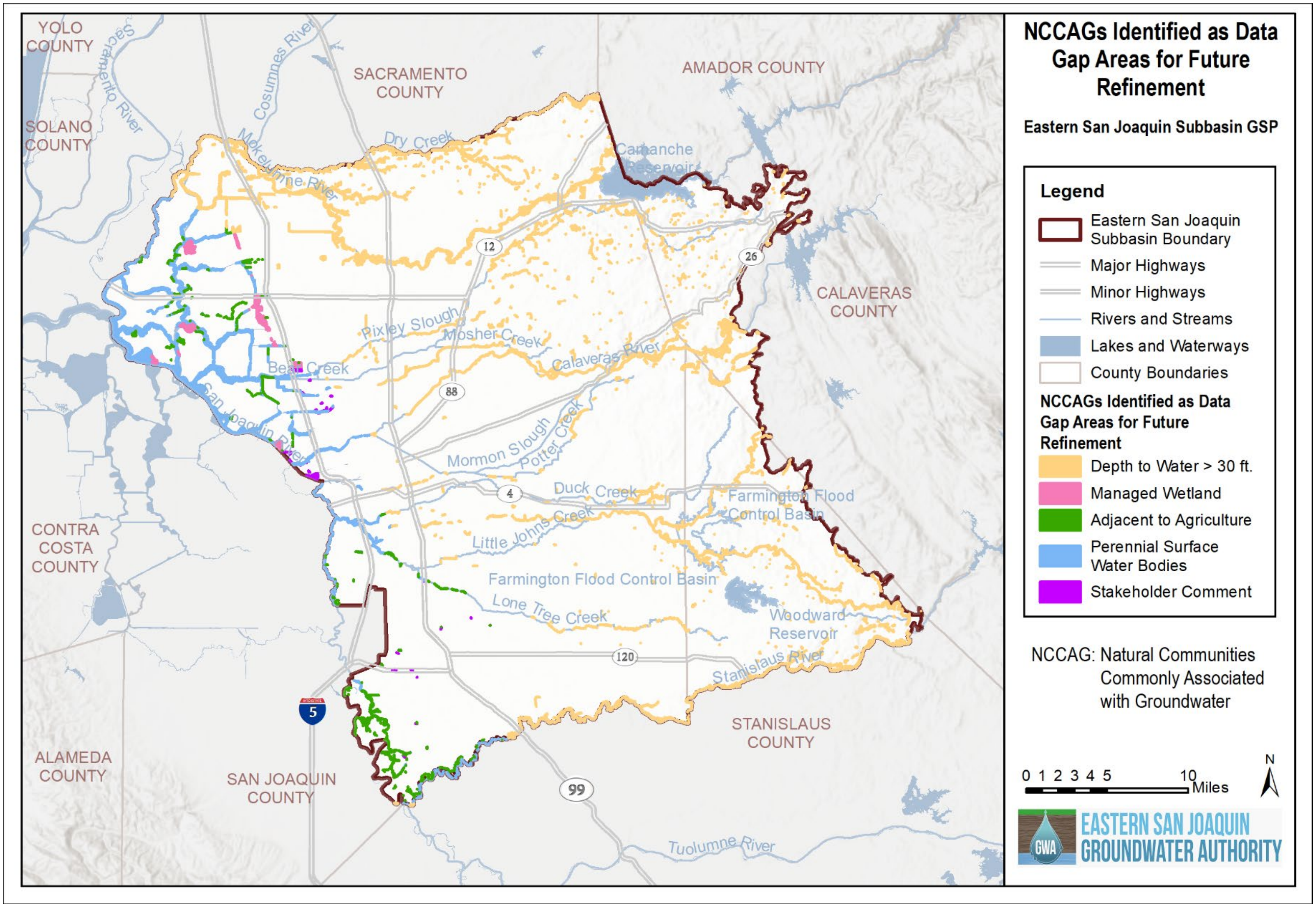
tailwater. Areas within 150 feet of such surface water bodies are assumed to be able to access that surface water regardless of the condition of the underlying aquifer. Areas father than 150 feet from such surface water bodies that meet the other GDE criteria in this section are assumed to be dependent on groundwater and were identified as GDEs. A criterion of 150 feet was used to reflect open water conditions in the surface water bodies.

NCCAG-identified communities not identified as GDEs through this analysis are identified as data gap areas for future refinement and are labeled on Figure 2-74 as “Perennial Surface Water Bodies”. These areas will be refined in future analyses to determine if the alternate source of surface water is reliable over time and to identify potential existing GDEs that may have been misclassified through this screening process.

Next, areas identified as GDEs were ground-truthed with GSA staff and Groundwater Sustainability Workgroup (Workgroup) members. Through this process, areas identified GDEs were investigated, and areas identified as known irrigated parcels such as parks were reclassified. These areas are labels on Figure 2-74 as “Stakeholder Comment.”

This methodology was developed to focus groundwater management activities on the most appropriate areas. The distinction between GDEs and other wetland or vegetative areas is important from a management perspective, as GDEs are expected to be more responsive to changes in groundwater management. Management of communities that access alternate supplies, on the other hand, may require greater focus on land use protection or irrigation activities, for which the GSAs have limited authority to manage through SGMA.

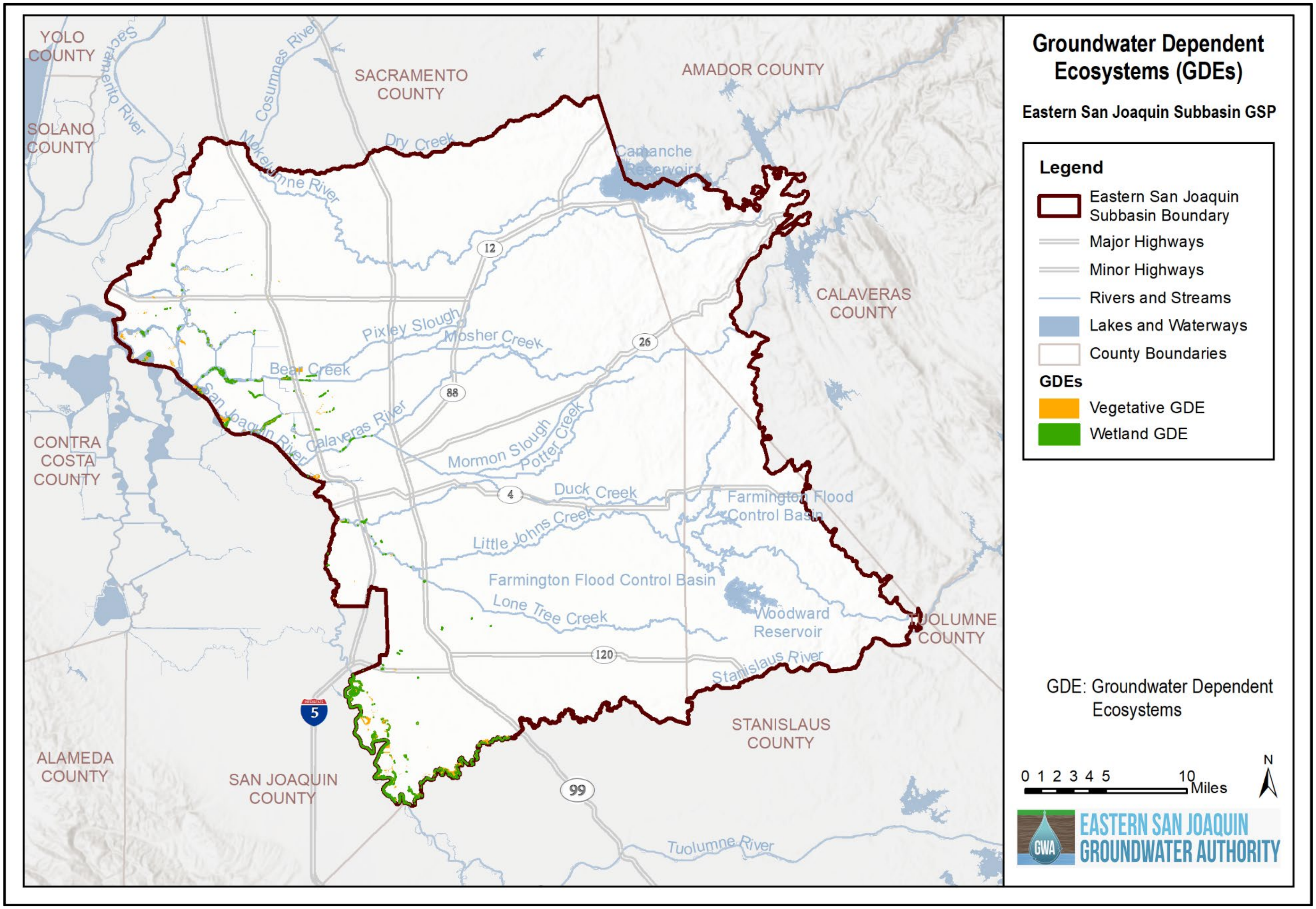
Figure 2-74: NCCAGs Identified as Data Gap Areas for Future Refinement, Likely to Access Non-groundwater Water Supplies



2.2.7.2 Areas Identified as GDEs

Following the methodology presented above, this Plan identifies several GDEs, primarily located along the western boundary of the Subbasin and in the Delta areas where groundwater is typically shallow. These areas are divided into two categories: Vegetative GDEs and Wetland GDEs, as shown in Figure 2-81.

Figure 2-75: Areas Identified as GDEs

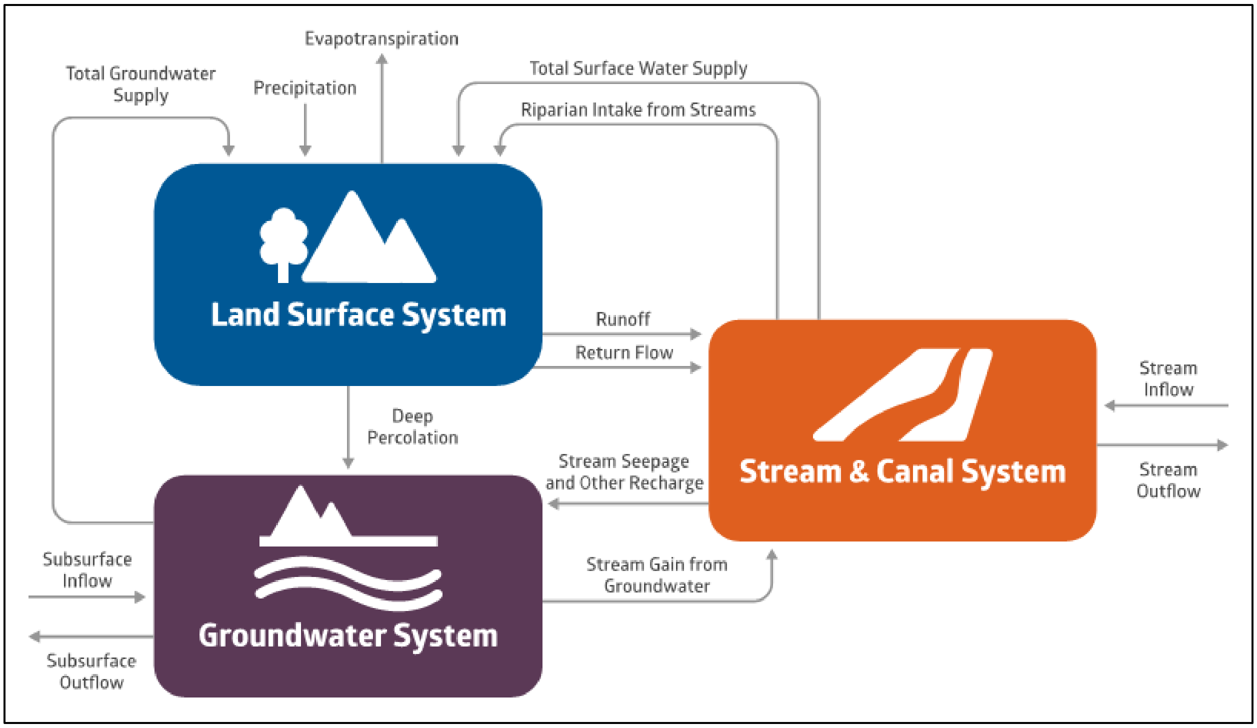


2.3 WATER BUDGETS

2.3.1 Water Budget Background Information

Water budgets are developed to provide a quantitative account of water entering and leaving the Eastern San Joaquin Subbasin. Water entering and leaving the Subbasin includes flows at the surface and in the subsurface environment. Water enters and leaves due to natural conditions, such as precipitation and streamflow, and/or through human activities, such as groundwater pumping or recharge from applied water. Additionally, interconnection between the groundwater system and rivers/streams accounts for other components of the water budget. Figure 2-76 depicts the major components of a water budget and their interconnection as presented in the context of stream, land surface, and groundwater systems.

Figure 2-76: Generalized Water Budget Diagram



Quantities presented for the water budget components of the Eastern San Joaquin Subbasin provide information on historical, current, and projected conditions as they relate to hydrology, water demand, water supply, land use, population, climate variability, groundwater and surface water interaction, and groundwater flow. This information can assist in the management of the Subbasin by identifying the relationship between different components affecting the water budget in the Subbasin, which provides context in the development and implementation of strategies and policies to achieve Subbasin groundwater sustainability conditions. Water budget quantities presented are based on the simulation results from the ESJWRM.

The ESJWRM was developed to be the main analysis tool supporting the development of the GSP for the Subbasin. The ESJWRM is a quasi-three-dimensional finite element model developed using the Integrated Water Flow Model (IWFM) simulation code (Dogrul et al., 2017). Using data from federal, state, and local resources, the ESJWRM was calibrated for the 20-year hydrologic period of October 1995 to September 2015 (water years 1996 through 2015) by comparing simulated groundwater levels and streamflow records with historical observed records. Development of the model involved the study and analysis of hydrogeologic conditions, agricultural and urban water demands, agricultural and urban water supplies, and an evaluation of regional water quality conditions. ESJWRM development is documented in a report, "Eastern San Joaquin Water Resources Model (ESJWRM) Final Report," published in August 2018 and available in Appendix 2-A.

Consistent with CCR Title 23 § 354.18, the water budgets presented in this document encompass the combined surface and groundwater system of the Eastern San Joaquin Subbasin. The Subbasin water budget focuses on the full water year (12 months spanning October 1 of the previous year to September 30 of the year in question), with some consideration of monthly variability.

The Regulations require that the annual water budget quantify three different conditions: historical, current, and projected. Budgets are developed to capture typical conditions during these time periods. Typical conditions are developed through selecting historical hydrologic periods that incorporate droughts, wet periods, and normal periods. By incorporating these varied conditions within the budgets, the Subbasin is analyzed under certain hydrologic conditions, such as drought or very wet events, along with long-term averages. This Plan relies on historical hydrology to identify time periods for water budget analysis and uses the ESJWRM and associated data to develop the water budget and resulting budget estimates. The water budget components developed for the Eastern San Joaquin Subbasin are based upon estimates developed from historical and projected data as well as modeling assumptions. This process is new and has been developed under time constraints; the water budget assumptions will be refined in the future, the water budget may change, and the conclusions and recommendations derived from the water budget may also change.

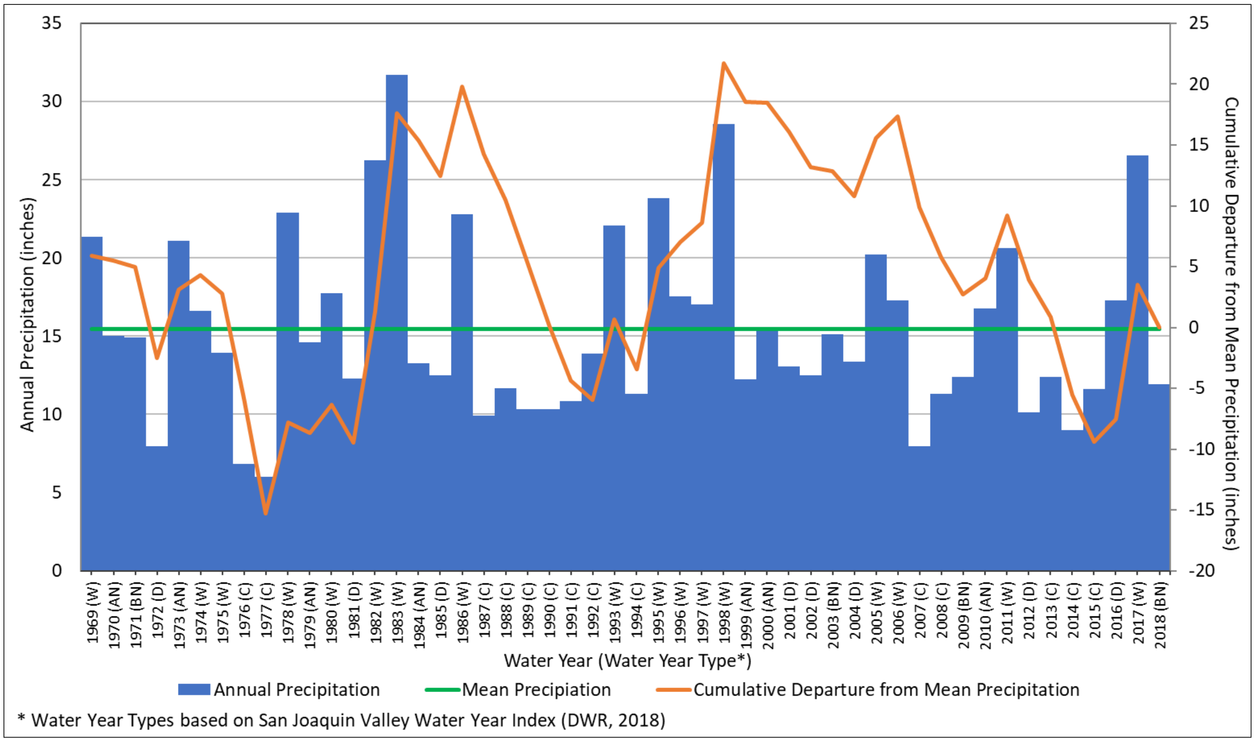
2.3.2 Identification of Hydrologic Periods

The historical hydrologic periods used in this Plan were selected to meet the requirements of developing historical, current, and projected water budgets. The Regulations require that the projected water budget reflect a 50-year hydrologic period in order to project how the Subbasin's land and groundwater systems may react under long-term average hydrologic conditions. Consistent with the Regulations, the 50-year historical record characterizes future conditions with respect to precipitation, evapotranspiration, and streamflow. Historical precipitation or rainfall in the Eastern San Joaquin Subbasin was used to identify a hydrologic period that would provide a representation of wet and dry periods and long-term average conditions needed for water budget analyses. Rainfall data for the Subbasin are derived from the PRISM (Precipitation-Elevation Regressions on Independent Slopes Model) dataset of the DWR's California Simulation of Evapotranspiration of Applied Water (CALSIMETAW) model. Precipitation-Elevation Regressions on Independent Slopes Model (PRISM) is a spatial estimation of rainfall data developed using monitoring network point data and interpolated using a variety of factors (Oregon State University, 2019).

Wet and dry hydrologic periods were identified by evaluating the cumulative departure from mean precipitation. Under this method, the long-term average precipitation is subtracted from annual precipitation within each water year to develop the departure from mean precipitation for each water year. Wet years have a positive departure and dry years have a negative departure; a year with exactly average precipitation would have zero departure. Starting at the first year analyzed, the departures are added cumulatively for each year. So, if the departure for Year 1 is 5 inches and the departure for Year 2 is -2 inches, the cumulative departure would be 5 inches for Year 1 and 3 inches (5 plus -2) for Year 2. Figure 2-77 graphically illustrates the cumulative departure of the spatially averaged rainfall within the Eastern San Joaquin Subbasin. The figure includes bars displaying annual precipitation for each water year from 1969 through 2018 and a horizontal line representing the mean precipitation of 15.4 inches. The cumulative departure from mean precipitation is based on these data sets and is displayed as a line that highlights wet periods with upward slopes (positive departure) and dry periods with downward slopes (negative departure). More severe events are shown by steeper slopes and greater changes. For example, the period from 1975 to 1977 illustrates a short period with dramatically dry conditions (6-inch decline per year in cumulative departure).

The PRISM estimates for rainfall in the Subbasin were confirmed by comparing the cumulative departure from mean precipitation results to the water year types in the San Joaquin Valley Water Year Hydrologic Classification (CA DWR, 2018), which classifies water years 1901 through 2018 as wet, above normal, below normal, dry, and critical based on inflows to major reservoirs or lakes. Wet (W) or Above Normal (AN) years generally show upward sloping cumulative departures, while Below Normal (BN), Dry (D), or Critical (C) water year types show downward trending cumulative departures (Figure 2-77). As the San Joaquin Valley Water Year Hydrologic Classification determines water year types based on inflows for streams throughout the entire San Joaquin Valley, a more locally relevant index to the Subbasin may be developed in the future.

Figure 2-77: 50-Year Historical Precipitation and Cumulative Departure from Mean Precipitation



2.3.3 Use of the ESJWRM and Associated Data in Water Budget Development

This Plan developed water budgets utilizing the ESJWRM, a fully integrated surface and groundwater flow model covering the Eastern San Joaquin Subbasin, as well as the Cosumnes Subbasin to the north and the Modesto Subbasin to the south. The adjacent subbasins were included in the ESJWRM boundaries to be consistent with past local modeling efforts and to better simulate boundary flows to/from the north and south of the Subbasin. This Plan provides a water budget for the Eastern San Joaquin Subbasin portion of the ESJWRM.

With the ESJWRM as the underlying framework, three model scenarios were developed representing historical, current, and projected conditions in the Eastern San Joaquin Subbasin, as discussed below:

- **Historical water budget** represents the historical model calibration period, which covers water years 1996 through 2015 (20 years).
- **Current water budget** represents estimated long-term average conditions of the Subbasin assuming that the current level of development and agricultural demand persists over a long-term period of hydrologic conditions (the 50-year period represented by water years 1969 through 2018).
- **Projected water budget** represents estimated long-term conditions of the Subbasin under the foreseeable future level of development over a long-term period of hydrologic conditions (the 50-year period represented by water years 1969 through 2018).

2.3.4 Water Budget Definitions and Assumptions

Definitions and assumptions for the historical, current, and projected water budgets are provided in the sections below and summarized in Table 2-12.

Table 2-12: Summary of Water Budget Assumptions (Historical, Current, and Projected Periods)

Water Budget Type	Historical	Current	Projected
Tool	ESJWRM	ESJWRM	ESJWRM
Scenario	Historical Calibration	Current Conditions	Projected Conditions
Hydrologic Years	Water Years 1996-2015	Water Years 1969-2018	Water Years 1969-2018
Level of Development[1]	Historical[5]	Current	General Plan or Sphere of Influence Buildout
Agricultural Demand[2]	Historical[5]	Current (2014)	Current (2014), less urban expansion
Urban Demand[3]	Historical[5]	Current (pre-drought)	Projected based on UWMP data
Water Supplies[4]	Historical[5]	Current	Projected based on local information

Notes:

1 The level of development describes the footprint of the urban areas. Historical is the footprint in the historical model period (water years 1996-2015), current is the footprint at the end of the historical model period (water year 2015), and projected reflects the footprint after general plan or sphere of influence urban buildout (approximately water year 2040).

2 Agricultural demand is based on historical cropping patterns and evapotranspiration rates. Current and projected agricultural cropping patterns are assumed to be consistent with DWR's statewide crop mapping of 2014, less any urban buildout in the projected conditions. For the current and projected water budgets, future evapotranspiration rates are assumed to remain the same as historical. The impact of climate change on evapotranspiration is evaluated separately in Section 2.3.7.

3 Historical urban demand includes actual demand and population from Urban Water Management Plans (UWMPs) or other planning efforts. Current demand is assumed to represent demands at a pre-drought level (assumed water year 2013) and water year 2015 population. Projected demand uses projected demand and population from UWMPs or other planning efforts and uses numbers for a buildout level of development (approximately water year 2040).

4 Historical water supplies rely on local district information and records. Projected water supplies were assumed for approximately water year 2040 and may include projects or expansions of supplies currently begun or with funding secured. Current water supplies represent water supplies averaging approximately water years 2012-2015 in the historical records.

5 For more information on historical assumptions, see the published model report (Appendix 2-A).

2.3.4.1 Assumptions Used in the Historical Water Budget

The historical water budget is intended to evaluate availability and reliability of past surface water supply deliveries, aquifer response to water supply, and demand trends relative to water year type. The historical calibration of the ESJWRM reflects the historical conditions in the Eastern San Joaquin Subbasin over water years 1996-2015. The hydrologic period has an average annual precipitation of approximately 14.7 inches and includes the recent 2012-2015 drought, the wetter years of 1996-2000, and periods of normal precipitation. Regulations require the use of a minimum of 10 years to develop the historical water budget. The entire historical calibration period of the ESJWRM was used to be inclusive of all the data used in developing the ESJWRM and to average over a broader range of different hydrologic conditions. The historical water budget applied an evolving level of development and agricultural demand throughout a 20-year historical hydrology.

Additional details of the data used in the development of the historical calibration can be found in the published model report (Appendix 2-A).

The historical calibration includes the following:

- Hydrologic period: Water Years 1996-2015 (20-year hydrology)
- Stream Flows for Water Years 1996-2015:
  - Dry Creek: No streamflow gaging stations were available for Dry Creek; as such, flow estimates from the DWR's California Central Valley surface and groundwater Model (C2VSim) were used (C2VSim-Fg Beta Release, CA DWR, May 2018)
  - Mokelumne River: Historical records from USGS (Mokelumne River below Camanche Dam, CA)
  - Calaveras River: New Hogan Dam releases
  - Stanislaus River: Historical records from USGS (Stanislaus River below Goodwin Dam near Knights Ferry, CA)
  - San Joaquin River: Historical records from USGS (San Joaquin River near Vernalis, CA)
- Reservoir Operations: Upstream reservoirs regulating streamflows into the Subbasin include Pardee Reservoir and Camanche Reservoir on the Mokelumne River; New Hogan Reservoir on the Calaveras River; and New Melones Reservoir, Tulloch Reservoir, and Goodwin Reservoir on the Stanislaus River. As reservoir releases are regulated, no changes to the historical operations of the reservoirs are assumed. In addition, two other local reservoirs are included in the model: Woodward and Farmington. The model estimates seepage contributions from these reservoirs to the groundwater system. Water supply deliveries from these reservoirs are based on records provided by the agencies responsible for operation of these reservoirs.
- Land use and cropping patterns are based on the DWR land use surveys (assumed to represent water year 1995), USDA's remote sensing data from the CropScape library for 2007-2015, and the recent, comprehensive, and Subbasin-wide land use survey from DWR as prepared by Land IQ (CA DWR, 2014). Local data and information were also utilized to refine and update the cropping patterns, as needed. To fill the gap between 1995 and 2007, all land use and crop categories were interpolated at the spatial resolution level of the model elements to simulate the geographic distribution of various crops.
- Urban water demand is calculated for all the urban areas in the model. Urban centers in Eastern San Joaquin Subbasin are City of Escalon, Linden, Lockeford, City of Lodi, City of Manteca, City of Ripon, and City of Stockton. Demands for other domestic areas are estimated based on rural population. Urban water demand is based on:
  - Urban water use from 2015 Urban Water Management Plans (Cal Water; Calaveras County Water District [CCWD], Cities of Lodi, Manteca, Ripon, and Stockton; Stockton East Water District [SEWD]; and South San Joaquin Irrigation District [SSJID]) or municipal pumping records, used to calculate the per capita water use for each urban center.
  - Urban center population from Urban Water Management Plans (UWMPs), United States Census Bureau, or the California Department of Finance.
- Surface Water Deliveries:
  - Deliveries to agricultural areas: Obtained from agricultural entities in the Subbasin, including Central San Joaquin Water Conservation District (CSJWCD), North San Joaquin Water Conservation District (NSJWCD), Oakdale Irrigation District (OID), SEWD, SSJID, and Woodbridge Irrigation District (WID)

- Deliveries to urban areas: Cities of Lodi, Manteca, and Stockton (including Cal Water and City of Stockton service areas, and unincorporated San Joaquin County areas)
- Recharge projects: SEWD's Farmington Groundwater Recharge Program
- Riparian diversions: CCWD, Delta areas, and data from the California Central Valley Surface and Groundwater Model (C2VSim) for riparian diversions off major streams (Dry Creek, Mokelumne River, Calaveras River and related streams, Stanislaus River, San Joaquin River) (C2VSim-Fg Beta Release, CA DWR, May 2018)

- Groundwater Pumping:
  - District pumping for agricultural/landscape uses: City of Manteca, OID, City of Ripon, and SSJID
  - District pumping for urban uses: Cal Water, City of Escalon, Linden County WD, Lockeford CSD, City of Lodi, City of Manteca, City of Ripon, SEWD, and City of Stockton
  - Data on private pumping was not available on a consistent basis across the model, so private pumping was estimated as that which would be required to meet agricultural and rural residential water needs as calculated by the ESJWRM model based on consumptive use methodology (Refer to the ESJWRM documentation for details).

2.3.4.2 Assumptions Used in the Current Water Budget

To analyze the long-term effects of the current level of development on groundwater and surface water conditions and to most appropriately estimate current inflows and outflows for the Subbasin, a current conditions scenario using the ESJWRM was developed for use in estimating the current water budget. The current conditions scenario applies the recent level of development and agricultural demand to a 50-year historical hydrology. As discussed below, current conditions are not necessarily indicative of one year and are instead a compilation of data assumed representative of average recent conditions.

The current conditions scenario includes the following assumptions:

- Hydrologic Period: Water Years 1969-2018 (50-year hydrology)
- Stream Flows for Water Years 1969-2018:
  - Dry Creek: No streamflow gaging stations were available for Dry Creek, as such, flow estimates from the DWR's C2VSim was used (C2VSim-Fg Beta Release, CA DWR, May 2018)
  - Mokelumne River: Historical records from USGS (Mokelumne River below Camanche Dam, CA)
  - Calaveras River: Historical records from USGS (Calaveras River below New Hogan Dam near Valley Springs, CA) and New Hogan Dam releases
  - Stanislaus River: Historical records from USGS (Stanislaus River below Goodwin Dam near Knights Ferry, CA)
  - San Joaquin River: Historical records from USGS (San Joaquin River near Vernalis, CA)
- Reservoir Operations: Upstream reservoirs regulating streamflows into the Subbasin include Pardee Reservoir and Camanche Reservoir on the Mokelumne River; New Hogan Reservoir on the Calaveras River; and New Melones Reservoir, Tulloch Reservoir, and Goodwin Reservoir on the Stanislaus River. The current

conditions scenario assumes that the historical operations of the reservoirs over the 50-year hydrologic records were in place and no changes are made.

- Land use and cropping patterns are based on the most recent, comprehensive, and Subbasin-wide land use survey from DWR as prepared by Land IQ (CA DWR, 2014), with adjustments based on local information and input.
- Urban water demands are calculated for all the urban areas in the model. Urban centers in Eastern San Joaquin Subbasin are City of Escalon, Linden, Lockeford, City of Lodi, City of Manteca, City of Ripon, and City of Stockton. Demands for other domestic areas are estimated based on rural population. Urban water demand is based on:
    - Urban water use for 2013 from 2015 Urban Water Management Plans (Cal Water; CCWD, Cities of Lodi, Manteca, Ripon, and Stockton; SEWD; and SSJID) or municipal pumping records, used to calculate the per capita water use for each urban center under normal (pre-drought) water use conditions.
    - Urban center population from the 2015 Urban Water Management Plans, United States Census Bureau, or the California Department of Finance for 2015. No growth is assumed during this scenario.
- Surface water delivery data for the 50-year hydrologic period were estimated based on average values for similar water year types from the historical calibration, taking into consideration any changes to delivery volumes that occurred within the historical model. Diversion points and delivery areas were assumed to remain the same as the historical calibration. Surface water deliveries include:
    - <u>Deliveries to agricultural areas</u>: CSJWCD, NSJWCD, OID, SEWD, SSJID, and WID
    - <u>Deliveries to urban areas</u>: Cities of Lodi, Manteca, and Stockton (including Cal Water and City of Stockton service areas, and unincorporated San Joaquin County areas)
    - <u>Recycling or recharge projects</u>: Recycled water for the Cities of Lodi and Manteca; SEWD's Farmington Groundwater Recharge Program; and NSJWCD's Tracy Lakes Recharge Project
    - <u>Riparian</u>: CCWD, Delta areas, and data from C2VSim for riparian diversions off major streams (Dry Creek, Mokelumne River, Calaveras River, Stanislaus River, and San Joaquin River)
- As private groundwater pumping was estimated by ESJWRM in the historical calibration, there is no local estimate of current private groundwater pumping available on a consistent basis across the model. Therefore, groundwater pumping to meet agricultural and rural residential needs is calculated by the model based on meeting remaining demands after surface water deliveries are made. Demand in areas with no access to surface water is completely met by groundwater pumping. Additional details on the estimation of private groundwater pumping in ESJWRM can be found in the published model report (Appendix 2-A).

2.3.4.3 Assumptions Used in the Projected Water Budget

The projected water budget is intended to assess the conditions of the Subbasin under future conditions of water supply and agricultural and urban demand, including quantification of uncertainties in the components. The projected conditions scenario applies future land and water use conditions and uses the 50-year hydrologic period of water years 1969-2018. Projections are assumed to represent a buildout level of development (approximately year 2040) and are represented using projected population, land use, and water demand and supply projections. Results of the projected conditions scenario under potential climate change conditions (changes to precipitation, stream flows, and evapotranspiration) are presented in Section 2.3.7.4.

The projected conditions scenario includes the following conditions:

- Hydrologic Period: Water Years 1969-2018 (50-year hydrology)
- Stream Flows for Water Years 1969-2018:
  - Dry Creek: No streamflow gaging stations were available for Dry Creek; as such, flow estimates from the DWR's C2VSim were used (C2VSim-Fg Beta Release, CA DWR, May 2018)
  - Mokelumne River: Historical records from USGS (Mokelumne River below Camanche Dam, CA)
  - Calaveras River: Historical records from USGS (Calaveras River below New Hogan Dam near Valley Springs, CA) and New Hogan Dam releases
  - Stanislaus River: Historical records from USGS (Stanislaus River below Goodwin Dam near Knights Ferry, CA)
  - San Joaquin River: Historical records from USGS (San Joaquin River near Vernalis, CA)
- Reservoir Operations: Upstream reservoirs regulating streamflows into the Subbasin include Pardee Reservoir and Camanche Reservoir on the Mokelumne River; New Hogan Reservoir on the Calaveras River; and New Melones Reservoir, Tulloch Reservoir, and Goodwin Reservoir on the Stanislaus River. The projected conditions scenario assumes that the historical operations of the reservoirs over the 50-year hydrologic records were in place and no changes are made.
- Land use and cropping patterns are based on the most recent, comprehensive, and Subbasin-wide land use survey from DWR as prepared by Land IQ (CA DWR, 2014), with adjustments based on local information and input. Urban areas expand to either the sphere of influence or general plan boundaries and are held constant during the simulation. Cropping acreage is reduced only where urban expansion occurs.
- Urban water demands are calculated for all the urban areas in the model. Urban centers in Eastern San Joaquin Subbasin are City of Escalon, Linden, Lockeford, City of Lodi, City of Manteca, City of Ripon, and City of Stockton. Demands for other domestic areas are estimated based on rural population. Urban water demand is based on:
  - Urban water use estimated from projections in the 2015 Urban Water Management Plans (Cal Water; CCWD, Cities of Lodi, Manteca, Ripon, and Stockton; SEWD; and SSJID) or municipal pumping records, used to calculate the per capita water use for each urban center in the future (approximately 2040).
  - Urban center population projections from the San Joaquin Council of Governments.
- Surface water delivery projections for the 50-year period were estimated based on the historical records of diversions by water year type, surface water rights or agreements, and potential planned changes/upgrades to the surface water diversion facilities. Surface water diversion estimates reflecting projected conditions using currently available information and knowledge were provided to each GSA for review and comment, and appropriate adjustments were made to the estimated record to reflect the surface water diversion projections for each entity. Surface water deliveries include:
  - Deliveries to agricultural areas: CSJWCD, NSJWCD, OID, SEWD, SSJID, and WID
  - Deliveries to urban areas: Cities of Lodi, Manteca, and Stockton (including Cal Water and City of Stockton service areas, and unincorporated San Joaquin County areas)

  - Recycling or recharge projects: Recycled water for Cities of Lodi and Manteca; SEWD's Farmington Groundwater Recharge Program; NSJWCD's Tracy Lakes Recharge Project; and NSJWCD's CALFED groundwater recharge project
  - Riparian: CCWD, Delta areas, and data from C2VSim for riparian diversions off major streams (Dry Creek, Mokelumne River, Calaveras River, Stanislaus River, and San Joaquin River)
- As private groundwater pumping was estimated by ESJWRM in the historical calibration, there is no local estimate of projected private groundwater pumping available on a consistent basis across the model. Therefore, groundwater pumping to meet agricultural and rural residential needs is calculated by the model based on meeting remaining demands after surface water deliveries are made. Demand in areas with no access to surface water is completely met by groundwater pumping. Additional details on the estimation of private groundwater pumping in ESJWRM can be found in the published model report (Appendix 2-A).

2.3.4.4 Updates to Water Budgets

Following submittal of the Eastern San Joaquin Subbasin GSP in January of 2020, the ESJWRM was revised to correct data relating to historical surface water deliveries and to include additional data for Water Year (WY) 2016 through WY 2020. Specifically, the following data sets were updated in ESJWRM:

- The hydrologic period was extended to include WY 2016-2020 with the precipitation data mapped accordingly.
- Minor changes to land use were made with the simulated land uses mapped to the statewide crop mapping released by DWR in 2016.
- Stream inflows were extended through WY 2020 using the same data sources as in the original version.
- Populations were updated for WY 2016 through 2020, and urban demands revised accordingly.
- Surface water deliveries were extended to WY 2020 and additional surface water deliveries that were not previously simulated were added to the model.
- Groundwater pumping volumes were extended to WY 2020 and the Modesto Subbasin wells and two additional OID wells added to the model.
- Agricultural water operations were updated to extend through WY 2020.

The ESJWRM simulation period was extended to simulate Water Years 1995 through 2020 and the model recalibrated for the extended period. As a result of the model update, both the historical and projected water budgets were revised in 2021 to reflect the new data sets used in the model. See Attachment 3 to Technical Memorandum 1 (included herein as Appendix 2-B) for additional details on the updates made to the ESJWRM.

2.3.5 Water Budget Estimates

The ESJWRM simulates the major hydrologic processes that affect the land surface, stream, and groundwater systems in the Eastern San Joaquin Subbasin. The major hydrologic processes can be represented by separate water budgets which detail inflows and outflows occurring at the stream scale (budget on surface water flows occurring in the Subbasin), land surface scale (budget balancing how demands on urban, agricultural, and native lands are met by rainfall, surface water deliveries, or groundwater pumping), and groundwater scale (budget detailing flows occurring within the groundwater aquifers of the Subbasin).

The primary components of the stream system are:

- Inflows:
  - Stream inflows
  - Stream gain from the groundwater system
  - Runoff to the stream system from precipitation
  - Return flow to the stream system from irrigation water
- Outflows:
  - Stream outflows
  - Stream seepage (i.e., losses to the groundwater system)
  - Surface water diversions
  - Riparian intake from streams

The primary components of the land surface system are:

- Inflows:
  - Precipitation
  - Surface water supplies to meet agricultural or urban and industrial uses
  - Groundwater pumping (i.e., groundwater supplies to meet agricultural or urban and industrial uses)
  - Riparian intake from streams
- Outflows:
  - Evapotranspiration
  - Runoff to the stream system
  - Return flow to the stream system
  - Deep percolation from precipitation, applied water (surface water and groundwater) for agricultural lands, and applied water (surface water and groundwater) for outdoor use in the urban areas or industrial purposes

The primary components of the groundwater system are:

- Inflows:
  - Deep percolation from precipitation, applied water (surface water and groundwater) for agricultural lands, and applied water (surface water and groundwater) for outdoor use in the urban areas or industrial purposes
  - Stream seepage (i.e., losses to the groundwater system)

- Other recharge (including unlined canals/reservoir seepage, local tributaries seepage, and Managed Aquifer Recharge [MAR] projects)
- Subsurface inflow

- Outflows:
  - Groundwater outflow to streams (i.e., stream gain from the groundwater system)
  - Groundwater pumping
  - Subsurface outflow

- Change in Groundwater Storage (Inflows Minus Outflows): This reflects average annual change in groundwater storage

The estimated water budgets for the historical, current conditions, and projected conditions scenarios are provided below, with results summarized in Table 2-13 through Table 2-15. The revised model results, utilizing the updated ESJWRM and data through Water Year 2020, is included in Appendix 2-B. Revised water budgets for historical, projected conditions, and projected conditions with climate change scenarios are included in Table 2-16 through Table 2-18 and were prepared using the same methodology. Differences between the original and revised scenarios are discussed further in the documentation in Appendix 2-B. The current conditions water budget was not updated as part of the model updates described in Appendix 2-B and are not included in the revised water budget tables that formed the basis of updated analysis of projects and management actions described in Section 2.3.8 and Chapter 6, Projects and Management Actions, of this GSP. Hydrology under climate change projections was evaluated in a separate ESJWRM scenario and results are discussed separately in Section 2.3.7.4 with updated results discussed in Appendix 2-B.

Table 2-13: Average Annual Water Budget – Stream System (AF/year)

Component	Historical Calibration (AF/year)	Current Conditions (AF/year)	Projected Conditions (AF/year)
Hydrologic Period	**Water Years 1996-2015 (20-Year period)**	**Water Years 1969- 2018 (50-Year period)**	**Water Years 1969- 2018 (50-Year period)**
Inflows			
Stream Inflows[1]	4,066,000	3,949,000	3,952,000
Stream Gain from Groundwater[2]	202,000	209,000	212,000
Eastern San Joaquin Subbasin	107,000	109,000	114,000
Dry Creek[11]	-	1,000	1,000
Mokelumne River	14,000	22,000	24,000
Calaveras River	14,000	15,000	16,000
Stanislaus River	41,000	31,000	29,000
San Joaquin River	29,000	30,000	30,000
Local Tributaries[3]	8,000	11,000	14,000
Other Subbasins[4]	95,000	100,000	98,000
Dry Creek	28,000	39,000	40,000
Mokelumne River	1,000	1,000	1,000
Stanislaus River	49,000	42,000	40,000
San Joaquin River	17,000	18,000	17,000
Runoff to the Stream System[5]	471,000	533,000	542,000
Return Flow to Stream System[6]	74,000	75,000	127,000
Total Inflow[10]	***4,812,000***	***4,766,000***	***4,833,000***
Outflows			
Stream Outflows[7]	4,168,000	4,037,000	4,050,000
Stream Seepage[2]	303,000	375,000	381,000
Eastern San Joaquin Subbasin	262,000	317,000	318,000
Dry Creek	12,000	14,000	14,000
Mokelumne River	114,000	124,000	122,000
Calaveras River	91,000	105,000	102,000
Stanislaus River	13,000	35,000	39,000
San Joaquin River	28,000	36,000	36,000
Local Tributaries[3]	3,000	3,000	3,000
Other Subbasins[4]	41,000	58,000	63,000
Dry Creek	14,000	15,000	16,000
Mokelumne River	2,000	2,000	2,000
Stanislaus River	18,000	32,000	36,000
San Joaquin River	8,000	9,000	9,000
Surface Water Diversions[8]	301,000	323,000	370,000
Riparian Intake from Streams[9]	40,000	31,000	32,000
Total Outflow[10]	***4,812,000***	***4,766,000***	***4,833,000***

Notes:

1 Stream inflows into Eastern San Joaquin Subbasin include flows from Dry Creek, Mokelumne River, Calaveras River, Stanislaus River, San Joaquin River, and estimated tributary flows. Differences between historical and current/projected flows are due to differing hydrologic periods. Differences between current and projected flows are due to differences in flows simulated at Subbasin boundaries (such as from Dry Creek) and estimated tributary flows.

2 Stream gain from groundwater and stream seepage represent the interaction of surface water and groundwater. Differences between the scenarios are related to differences in streamflows and long-term average groundwater elevations.

3 Local tributaries include Bear Creek and related streams, Little Johns Creek, Duck Creek, and Lone Tree Creek.

4 Other subbasins include the Cosumnes, Modesto, South American, Solano, East Contra Costa, and Tracy Subbasins. Stream-aquifer interaction with the other subbasins was included for streams on the boundaries of the Eastern San Joaquin Subbasin.

5 Runoff to the stream system is due to precipitation. As urban areas are assumed to have greater runoff of precipitation (due to more paved areas), the changes in runoff between the model scenarios are due to differences in the urban areas in the scenarios, as well as the amount of precipitation occurring. The historical calibration, with both less precipitation (due to more dry years than wet in the 20-year period) and smaller urban areas, has a corresponding smaller runoff. The current conditions scenario uses urban areas at the end of the historical calibration, while the projected scenario includes urban buildout to sphere of influence or general plan boundaries and therefore has more runoff.

6 Return flow to the stream system is due to applied water, either surface water or groundwater used for agricultural or municipal purposes. Differences between the scenarios is primarily related to the urban growth in the projected conditions scenario causing higher urban demand and therefore correspondingly higher applied water to meet that demand resulting in greater urban return flows (i.e., discharge of treated wastewater).

7 Stream outflows occur at the edge of Eastern San Joaquin Subbasin at the confluence of the San Joaquin and Mokelumne Rivers.

8 Surface water diversions shown in this table are the volumes of water taken directly off the river prior to any losses due to evaporation or canal seepage. These numbers do not include surface water directly diverted from simulated stream nodes (i.e., water taken off Stanislaus River occurs just upstream in the Subbasin). Differences between scenarios are due to differences in current and planned surface water diversions.

9 Riparian intake from streams is the portion of the riparian vegetation evapotranspiration met by streamflows. Differences between scenarios may be due to availability of streamflows or extent of riparian vegetation, which may be affected by growth in urban areas.

10 Summations in table may not match the numbers in the table. This is due to the rounding of model results.

11 Values smaller than 500 AF/year are represented by a dash (-).

Table 2-14: Average Annual Water Budget – Land Surface System (AF/year)

Component	Historical Calibration (AF/year)	Current Conditions (AF/year)	Projected Conditions (AF/year)
Hydrologic Period	**Water Years 1996-2015 (20-Year period)**	**Water Years 1969- 2018 (50-Year period)**	**Water Years 1969- 2018 (50-Year period)**
Inflows			
Precipitation[1] (Precipitation, inches)	938,000 (14.7)	984,000 (15.4)	984,000 (15.4)
Total Surface Water Supply[2]	502,000	493,000	529,000
Agricultural	451,000	426,000	426,000
Urban and Industrial	51,000	67,000	103,000
Total Groundwater Supply[3]	692,000	851,000	801,000
Agricultural	624,000	788,000	680,000
Urban and Industrial	68,000	63,000	121,000
Riparian Intake from Streams[4]	28,000	23,000	24,000
Total Inflow[10]	***2,161,000***	***2,352,000***	***2,338,000***
Outflows			
Evapotranspiration[5]	1,351,000	1,449,000	1,394,000
Agricultural	969,000	1,077,000	976,000
Municipal and Domestic	66,000	73,000	123,000
Refuge, Native, and Riparian	316,000	300,000	296,000
Runoff to the Stream System[6]	471,000	533,000	542,000
Return Flow to the Stream System[7]	74,000	75,000	127,000
Agricultural	2,000	2,000	2,000
Municipal and Domestic	72,000	73,000	125,000
Deep Percolation[8]	218,000	272,000	266,000
Precipitation	61,000	68,000	66,000
Applied Surface Water – Agricultural	59,000	65,000	64,000
Applied Surface Water – Urban and Industrial	7,000	10,000	15,000
Applied Groundwater – Agricultural	82,000	119,000	102,000
Applied Groundwater – Urban and Industrial	9,000	10,000	18,000
Other Flows[9]	47,000	23,000	8,000
Total Outflow[10]	***2,161,000***	***2,352,000***	***2,338,000***

Notes:

1 Precipitation is discussed in the identification of the hydrologic periods in 2.3.2. The current and projected conditions scenarios utilize the same 50 years of hydrology (water years 1969-2018) and have the same overall Subbasin precipitation, whereas the historical calibration has a shorter hydrologic period (20 years from 1996-2015) with less precipitation on average.

2 Total surface water supply shown in this table is the volume of surface water diverted or transported to meet agricultural and urban demands minus estimated losses due to evaporation or canal seepage. Differences between scenarios are due to differences in current and planned surface water deliveries.

3 Total groundwater supply in the scenarios is calculated based on meeting remaining demands after surface water deliveries occur. Differences in demand largely drive the amount of groundwater pumped.

4 Riparian intake from streams is the portion of the riparian vegetation evapotranspiration met by streamflows. Differences between scenarios may be due to availability of streamflows or extent of riparian vegetation, which may be affected by growth in urban areas.

5 Evapotranspiration is the demand required by agricultural land (i.e., crops); municipal and domestic areas (i.e., industrial and urban demands); and refuge, native and riparian areas. Differences in evapotranspiration are largely related to differences in urban areas between the scenarios and the loss of agricultural or native/riparian land as urban growth occurs.

[6] Runoff to the stream system is due to precipitation. As urban areas are assumed to have greater runoff (e.g., more paved areas), the changes in runoff between the model scenarios are due to differences in the urban areas in the scenarios, as well as the amount of precipitation occurring. The historical calibration, with both less precipitation and smaller urban areas, has a corresponding smaller runoff. The current conditions scenario uses urban areas at the end of the historical calibration, while the projected scenario includes urban buildout to sphere of influence or general plan boundaries and therefore has more runoff.

[7] Return flow to the stream system is due to applied water, either surface water or groundwater used for agricultural or municipal purposes. Differences between the scenarios is primarily related to the urban growth in the projected conditions scenario causing higher urban demand and therefore correspondingly higher applied water to meet that demand.

[8] Deep percolation is the amount of infiltrated water ultimately reaching the groundwater aquifer. The source of the water may be from precipitation or either applied surface water or groundwater used for agricultural or urban and industrial purposes. Differences between scenarios are related to differences between these sources of water and differences in the infiltration parameters related to land use.

[9] Other Flows captures the gains and losses due to land expansion and temporary storage in the root-zone and unsaturated (vadose) zones.

[10] Summations in table may not match the numbers in the table. This is due to the rounding of model results.

Table 2-15: Average Annual Water Budget – Groundwater System (AF/year)

Component	Historical Calibration (AF/year)	Current Conditions (AF/year)	Projected Conditions (AF/year)
Hydrologic Period	**Water Years 1996-2015 (20-Year period)**	**Water Years 1969- 2018 (50-Year period)**	**Water Years 1969- 2018 (50-Year period)**
Inflows			
Deep Percolation[1]	218,000	272,000	266,000
Precipitation	61,000	68,000	66,000
Applied Surface Water – Agricultural	59,000	65,000	64,000
Applied Surface Water – Urban and Industrial	7,000	10,000	15,000
Applied Groundwater – Agricultural	82,000	119,000	102,000
Applied Groundwater – Urban and Industrial	9,000	10,000	18,000
Stream Seepage[2]	262,000	317,000	317,000
Dry Creek	12,000	14,000	14,000
Mokelumne River	114,000	124,000	122,000
Calaveras River	91,000	105,000	102,000
Stanislaus River	13,000	35,000	39,000
San Joaquin River	28,000	36,000	36,000
Local Tributaries[3]	3,000	3,000	2,000
Other Recharge[4]	160,000	158,000	164,000
Subsurface Inflow[5]	171,000	212,000	192,000
Cosumnes Subbasin	32,000	38,000	37,000
Sierra Nevada Mountains	55,000	58,000	59,000
Modesto Subbasin	25,000	41,000	33,000
South American Subbasin	4,000	4,000	3,000
Solano Subbasin	15,000	15,000	13,000
East Contra Costa Subbasin	6,000	7,000	7,000
Tracy Subbasin	35,000	48,000	41,000
Total Inflow[7]	***811,000***	***959,000***	***939,000***
Outflows			
Groundwater Outflow to Streams[2]	107,000	109,000	114,000
Dry Creek[8]	-	1,000	1,000
Mokelumne River	14,000	22,000	24,000
Calaveras River	14,000	15,000	16,000
Stanislaus River	41,000	31,000	29,000
San Joaquin River	29,000	30,000	30,000
Local Tributaries[3]	8,000	11,000	14,000
Groundwater Pumping[6]	692,000	851,000	801,000
Agricultural	624,000	788,000	680,000
Urban and Industrial	68,000	63,000	121,000
Subsurface Outflow[5]	53,000	47,000	58,000
Cosumnes Subbasin	18,000	15,000	18,000
Modesto Subbasin	19,000	18,000	25,000
South American Subbasin[8]	-	-	-
Solano Subbasin	4,000	4,000	4,000
East Contra Costa Subbasin	2,000	2,000	2,000
Tracy Subbasin	9,000	8,000	8,000
Total Outflow[7]	***852,000***	***1,007,000***	***973,000***
Change in Groundwater Storage (Inflows Minus Outflows)			
Change in Groundwater Storage[7]	***(41,000)***	***(48,000)***	***(34,000)***

Notes:

[1] Deep percolation is the amount of infiltrated water ultimately reaching the groundwater aquifer. The source of the water may be from precipitation, as well as either applied surface water or groundwater used for agricultural or urban and industrial purposes. Differences between scenarios are related to differences between these sources of water and differences in urban versus agricultural land use totals.

[2] Stream gain from groundwater and stream seepage represent the interaction of surface water and groundwater. Differences between the scenarios are related to differences in streamflows and long-term average groundwater elevations.

[3] Local Tributaries include Bear Creek and related streams, Little Johns Creek, Duck Creek, and Lone Tree Creek.

[4] Other Recharge includes unlined canals/reservoir seepage, local tributaries seepage, and MAR projects.

[5] The goal of projecting inter-basin flows is to maintain a reasonable balance between the neighboring groundwater subbasins. The resulting projected conditions scenario flows are within 10-15% of historical calibration flows, considered a reasonable range given the availability of projected land use, population, surface water delivery, and groundwater production data from areas outside of the Eastern San Joaquin Subbasin. Continuing inter-basin coordination may refine these numbers.

[6] Groundwater pumping is estimated by the ESJWRM based on the need for additional water to meet remaining demands after surface water deliveries occur. Differences in demand largely drive the amount of groundwater pumped.

[7] Summations in table may not match the numbers in the table. This is due to the rounding of model results.

[8] Values smaller than 500 AF/year are represented by a dash (-).

Table 2-16: Average Annual Water Budget for Revised ESJWRM – Stream System (AF/year)

Component	Historical Calibration (AF/year)	Projected Conditions (AF/year)	Projected Conditions with Climate Change (AF/year)
Hydrologic Period	**Water Years 1996-2020 (25-Year period)**	**Water Years 1969- 2020 (52-Year period)**	**Water Years 1969- 2020 (52-Year period)**
Inflows			
Stream Inflows[1]	4,585,000	4,680,000	5,073,000
Stream Gain from Groundwater[2]	220,000	179,000	169,000
Eastern San Joaquin Subbasin	131,000	108,000	103,000
Dry Creek[11]	-	-	-
Mokelumne River	22,000	20,000	18,000
Calaveras River	3,000	3,000	3,000
Stanislaus River	43,000	24,000	22,000
San Joaquin River	51,000	47,000	46,000
Local Tributaries[3]	10,000	13,000	3,000
Other Subbasins[4]	90,000	71,000	67,000
Dry Creek	22,000	23,000	22,000
Mokelumne River	-	-	-
Stanislaus River	42,000	25,000	23,000
San Joaquin River	25,000	22,000	22,000
Runoff to the Stream System[5]	616,000	549,000	644,000
Return Flow to Stream System[6]	91,000	117,000	118,000
Total Inflow[10]	**5,511,000**	**5,525,000**	**6,006,000**
Outflows			
Stream Outflows[7]	4,817,000	4,792,000	5,222,000
Stream Seepage[2]	312,000	359,000	409,000
Eastern San Joaquin Subbasin	259,000	289,000	329,000
Dry Creek	2,000	2,000	2,000
Mokelumne River	129,000	136,000	147,000
Calaveras River	45,000	42,000	46,000
Stanislaus River	31,000	50,000	60,000
San Joaquin River	51,000	56,000	60,000
Local Tributaries[3]	2,000	3,000	11,000
Other Subbasins[4]	53,000	70,000	80,000
Dry Creek	2,000	2,000	2,000
Mokelumne River	2,000	2,000	3,000
Stanislaus River	29,000	45,000	53,000
San Joaquin River	19,000	21,000	22,000
Surface Water Diversions[8]	336,000	328,000	327,000
Riparian Intake from Streams[9]	46,000	45,000	48,000
Total Outflow[10]	**5,511,000**	**5,525,000**	**6,006,000**

Notes:

1 Stream inflows into Eastern San Joaquin Subbasin include flows from Dry Creek, Mokelumne River, Calaveras River, Stanislaus River, San Joaquin River, and estimated tributary flows. Differences between historical and current/projected flows are due to differing hydrologic periods. Differences between current and projected flows are due to differences in flows simulated at Subbasin boundaries (such as from Dry Creek) and estimated tributary flows.

2 Stream gain from groundwater and stream seepage represent the interaction of surface water and groundwater. Differences between the scenarios are related to differences in streamflows and long-term average groundwater elevations.

[3] Local tributaries include Bear Creek and related streams, Little Johns Creek, Duck Creek, and Lone Tree Creek.

[4] Other subbasins include the Cosumnes, Modesto, South American, Solano, East Contra Costa, and Tracy Subbasins. Stream-aquifer interaction with the other subbasins was included for streams on the boundaries of the Eastern San Joaquin Subbasin.

[5] Runoff to the stream system is due to precipitation. As urban areas are assumed to have greater runoff of precipitation (due to more paved areas), the changes in runoff between the model scenarios are due to differences in the urban areas in the scenarios, as well as the amount of precipitation occurring. The historical calibration, with both less precipitation (due to more dry years than wet in the 20-year period) and smaller urban areas, has a corresponding smaller runoff. The current conditions scenario uses urban areas at the end of the historical calibration, while the projected scenario includes urban buildout to sphere of influence or general plan boundaries and therefore has more runoff.

[6] Return flow to the stream system is due to applied water, either surface water or groundwater used for agricultural or municipal purposes. Differences between the scenarios is primarily related to the urban growth in the projected conditions scenario causing higher urban demand and therefore correspondingly higher applied water to meet that demand resulting in greater urban return flows (i.e., discharge of treated wastewater).

[7] Stream outflows occur at the edge of Eastern San Joaquin Subbasin at the confluence of the San Joaquin and Mokelumne Rivers.

[8] Surface water diversions shown in this table are the volumes of water taken directly off the river prior to any losses due to evaporation or canal seepage. These numbers do not include surface water directly diverted from simulated stream nodes (i.e., water taken off Stanislaus River occurs just upstream in the Subbasin). Differences between scenarios are due to differences in current and planned surface water diversions.

[9] Riparian intake from streams is the portion of the riparian vegetation evapotranspiration met by streamflows. Differences between scenarios may be due to availability of streamflows or extent of riparian vegetation, which may be affected by growth in urban areas.

[10] Summations in table may not match the numbers in the table. This is due to the rounding of model results.

[11] Values smaller than 500 AF/year are represented by a dash (-).

Table 2-17: Average Annual Water Budget for Revised ESJWRM – Land Surface System (AF/year)

Component	Historical Calibration (AF/year)	Projected Conditions (AF/year)	Projected Conditions with Climate Change (AF/year)
Hydrologic Period	**Water Years 1996-2020 (25-Year period)**	**Water Years 1969- 2020 (52-Year period)**	**Water Years 1969- 2020 (52-Year period)**
Inflows			
Precipitation[1] (Precipitation, inches)	972,000 (15.3)	985,000 (15.5)	1,082,000 (17.0)
Total Surface Water Supply[2]	567,000	528,000	528,000
Agricultural	512,000	453,000	452,000
Urban and Industrial	55,000	76,000	75,000
Total Groundwater Supply[3]	709,000	751,000	833,000
Agricultural	647,000	669,000	751,000
Urban and Industrial	62,000	82,000	82,000
Riparian Intake from Streams[4]	33,000	32,000	34,000
Total Inflow[10]	**2,282,000**	**2,296,000**	**2,477,000**
Outflows			
Evapotranspiration[5]	1,295,000	1,340,000	1,416,000
Agricultural	994,000	960,000	1,034,000
Municipal and Domestic	66,000	95,000	95,000
Refuge, Native, and Riparian	235,000	285,000	288,000
Runoff to the Stream System[6]	616,000	549,000	644,000
Return Flow to the Stream System[7]	91,000	117,000	118,000
Agricultural	21,000	22,000	23,000
Municipal and Domestic	70,000	95,000	95,000
Deep Percolation[8]	262,000	282,000	286,000
Precipitation	57,000	72,000	70,000
Applied Surface Water – Agricultural	82,000	74,000	72,000
Applied Surface Water – Urban and Industrial	9,000	12,000	12,000
Applied Groundwater – Agricultural	104,000	110,000	119,000
Applied Groundwater – Urban and Industrial	10,000	14,000	13,000
Other Flows[9]	19,000	8,000	12,000
Total Outflow[10]	**2,282,000**	**2,296,000**	**2,477,000**

Notes:

1. Precipitation is discussed in the identification of the hydrologic periods in 2.3.2. The current and projected conditions scenarios utilize the same 50 years of hydrology (water years 1969-2018) and have the same overall Subbasin precipitation, whereas the historical calibration has a shorter hydrologic period (20 years from 1996-2015) with less precipitation on average.
2. Total surface water supply shown in this table is the volume of surface water diverted or transported to meet agricultural and urban demands minus estimated losses due to evaporation or canal seepage. Differences between scenarios are due to differences in current and planned surface water deliveries.
3. Total groundwater supply in the scenarios is calculated based on meeting remaining demands after surface water deliveries occur. Differences in demand largely drive the amount of groundwater pumped.
4. Riparian intake from streams is the portion of the riparian vegetation evapotranspiration met by streamflows. Differences between scenarios may be due to availability of streamflows or extent of riparian vegetation, which may be affected by growth in urban areas.

[5] Evapotranspiration is the demand required by agricultural land (i.e., crops); municipal and domestic areas (i.e., industrial and urban demands); and refuge, native and riparian areas. Differences in evapotranspiration are largely related to differences in urban areas between the scenarios and the loss of agricultural or native/riparian land as urban growth occurs.
[6] Runoff to the stream system is due to precipitation. As urban areas are assumed to have greater runoff (e.g., more paved areas), the changes in runoff between the model scenarios are due to differences in the urban areas in the scenarios, as well as the amount of precipitation occurring. The historical calibration, with both less precipitation and smaller urban areas, has a corresponding smaller runoff. The current conditions scenario uses urban areas at the end of the historical calibration, while the projected scenario includes urban buildout to sphere of influence or general plan boundaries and therefore has more runoff.
[7] Return flow to the stream system is due to applied water, either surface water or groundwater used for agricultural or municipal purposes. Differences between the scenarios is primarily related to the urban growth in the projected conditions scenario causing higher urban demand and therefore correspondingly higher applied water to meet that demand.
[8] Deep percolation is the amount of infiltrated water ultimately reaching the groundwater aquifer. The source of the water may be from precipitation or either applied surface water or groundwater used for agricultural or urban and industrial purposes. Differences between scenarios are related to differences between these sources of water and differences in the infiltration parameters related to land use.
[9] Other Flows captures the gains and losses due to land expansion and temporary storage in the root-zone and unsaturated (vadose) zones.
[10] Summations in table may not match the numbers in the table. This is due to the rounding of model results.

Table 2-18: Average Annual Water Budget for Revised ESJWRM – Groundwater System (AF/year)

Component	Historical Calibration (AF/year)	Projected Conditions (AF/year)	Projected Conditions with Climate Change (AF/year)
Hydrologic Period	**Water Years 1996-2020 (25-Year period)**	**Water Years 1969- 2020 (52-Year period)**	**Water Years 1969- 2020 (52-Year period)**
Inflows			
Deep Percolation[1]	262,000	282,000	286,000
Precipitation	57,000	72,000	70,000
Applied Surface Water – Agricultural	82,000	74,000	72,000
Applied Surface Water – Urban and Industrial	9,000	12,000	12,000
Applied Groundwater – Agricultural	104,000	110,000	119,000
Applied Groundwater – Urban and Industrial	10,000	14,000	13,000
Stream Seepage[2]	259,000	289,000	318,000
Dry Creek	2,000	2,000	2,000
Mokelumne River	129,000	136,000	147,000
Calaveras River	45,000	42,000	46,000
Stanislaus River	31,000	50,000	60,000
San Joaquin River	51,000	56,000	60,000
Local Tributaries[3]	2,000	3,000	3,000
Other Recharge[4]	169,000	162,000	165,000
Subsurface Inflow[5]	193,000	202,000	217,000
Cosumnes Subbasin	39,000	41,000	41,000
Sierra Nevada Mountains	56,000	57,000	56,000
Modesto Subbasin	34,000	37,000	41,000
South American Subbasin	3,000	4,000	5,000
Solano Subbasin	19,000	19,000	23,000
East Contra Costa Subbasin	10,000	11,000	12,000
Tracy Subbasin	33,000	33,000	40,000
Total Inflow[7]	**883,000**	**934,000**	**986,000**
Outflows			
Groundwater Outflow to Streams[2]	131,000	108,000	100,000
Dry Creek[8]	-	-	-
Mokelumne River	22,000	20,000	18,000
Calaveras River	3,000	3,000	3,000
Stanislaus River	43,000	24,000	22,000
San Joaquin River	51,000	47,000	46,000
Local Tributaries[3]	10,000	13,000	11,000
Groundwater Pumping[6]	709,000	751,000	833,000
Agricultural	647,000	669,000	751,000
Urban and Industrial	62,000	82,000	82,000
Subsurface Outflow[5]	80,000	91,000	91,000
Cosumnes Subbasin	27,000	32,000	33,000
Modesto Subbasin	32,000	35,000	36,000
South American Subbasin[8]	1,000	1,000	-
Solano Subbasin	7,000	7,000	6,000
East Contra Costa Subbasin	2,000	2,000	2,000
Tracy Subbasin	11,000	14,000	14,000
Total Outflow[7]	**920,000**	**951,000**	**1,024,000**
Change in Groundwater Storage (Inflows Minus Outflows)			
Change in Groundwater Storage[7]	**(37,000)**	**(16,000)**	**(38,000)**

Notes:

1 Deep percolation is the amount of infiltrated water ultimately reaching the groundwater aquifer. The source of the water may be from precipitation, as well as either applied surface water or groundwater used for agricultural or urban and industrial purposes. Differences between scenarios are related to differences between these sources of water and differences in urban versus agricultural land use totals.

2 Stream gain from groundwater and stream seepage represent the interaction of surface water and groundwater. Differences between the scenarios are related to differences in streamflows and long-term average groundwater elevations.

3 Local Tributaries include Bear Creek and related streams, Little Johns Creek, Duck Creek, and Lone Tree Creek.

4 Other Recharge includes unlined canals/reservoir seepage, local tributaries seepage, and MAR projects.

5 The goal of projecting inter-basin flows is to maintain a reasonable balance between the neighboring groundwater subbasins. The resulting projected conditions scenario flows are within 10-15% of historical calibration flows, considered a reasonable range given the availability of projected land use, population, surface water delivery, and groundwater production data from areas outside of the Eastern San Joaquin Subbasin. Continuing inter-basin coordination may refine these numbers.

6 Groundwater pumping is estimated by the ESJWRM based on the need for additional water to meet remaining demands after surface water deliveries occur. Differences in demand largely drive the amount of groundwater pumped.

7 Summations in table may not match the numbers in the table. This is due to the rounding of model results.

8 Values smaller than 500 AF/year are represented by a dash (-).

2.3.5.1 Historical Water Budget Estimates

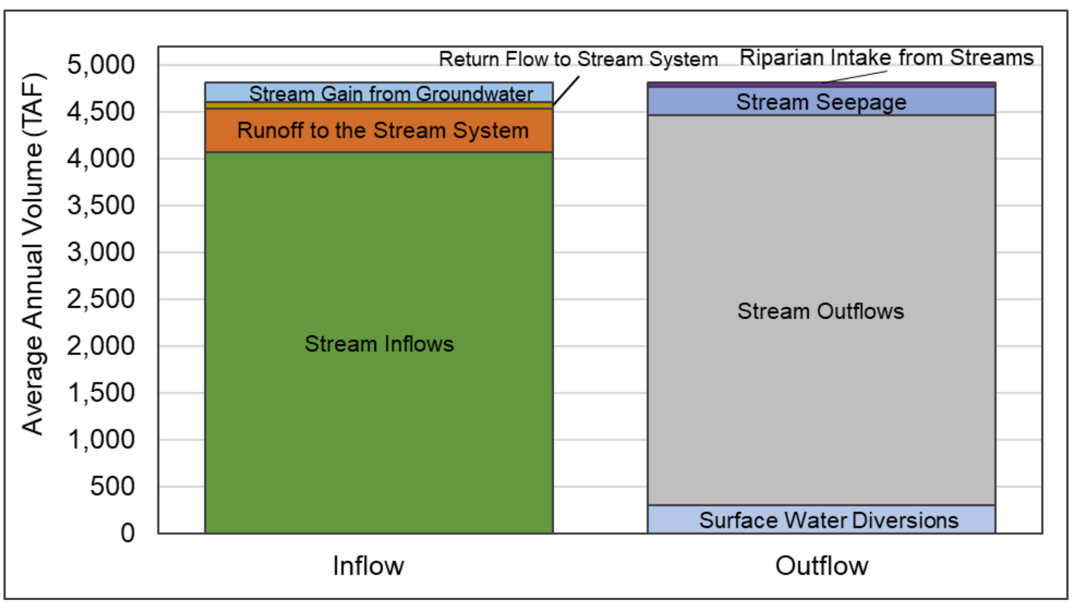
The historical water budget is a quantitative tabulation of the historical surface and groundwater supply represented in the historical calibration of the ESJWRM covering the 20-year period of water years 1996-2015. The ESJGWA selected this period as the representative hydrologic period to calibrate and reduce the uncertainty of the ESJWRM. Proper analysis and calibration of water budgets using the ESJWRM assures the hydrologic characteristics of the groundwater basin are well simulated. The historical calibration is discussed in detail in the historical model documentation (Appendix 2-A). CCR Title 23 § 354.18, the water budget includes estimates for supply and demand, while summarizing flows within the Subbasin, including the movement of all primary sources of water such as precipitation, agricultural water supplies, streamflow, and subsurface flows.

Subsequent to completion and submittal of the GSP in January of 2020, the ESJWRM was updated to include new data sets extending the simulation period to encompass WY 1995 through 2020. This model update and recalibration and the associated results are documented in Appendix 2-B of this revised GSP.

The existing stream network supplies water to multiple agricultural water users and municipalities in the Eastern San Joaquin Subbasin. When analyzing the water budget for the stream system, it is important to note potentially significant effects due to the interactions and managed operations of adjacent groundwater subbasins on streams coinciding with the boundaries of the Subbasin (i.e., Dry Creek, portions of the Mokelumne River, San Joaquin River, and Stanislaus River). The summary of water budget assumptions presented in Table 2-12 and Figure 2-78 not only quantifies the surface water system within the Subbasin, but also estimates contributions from adjoining subbasins.

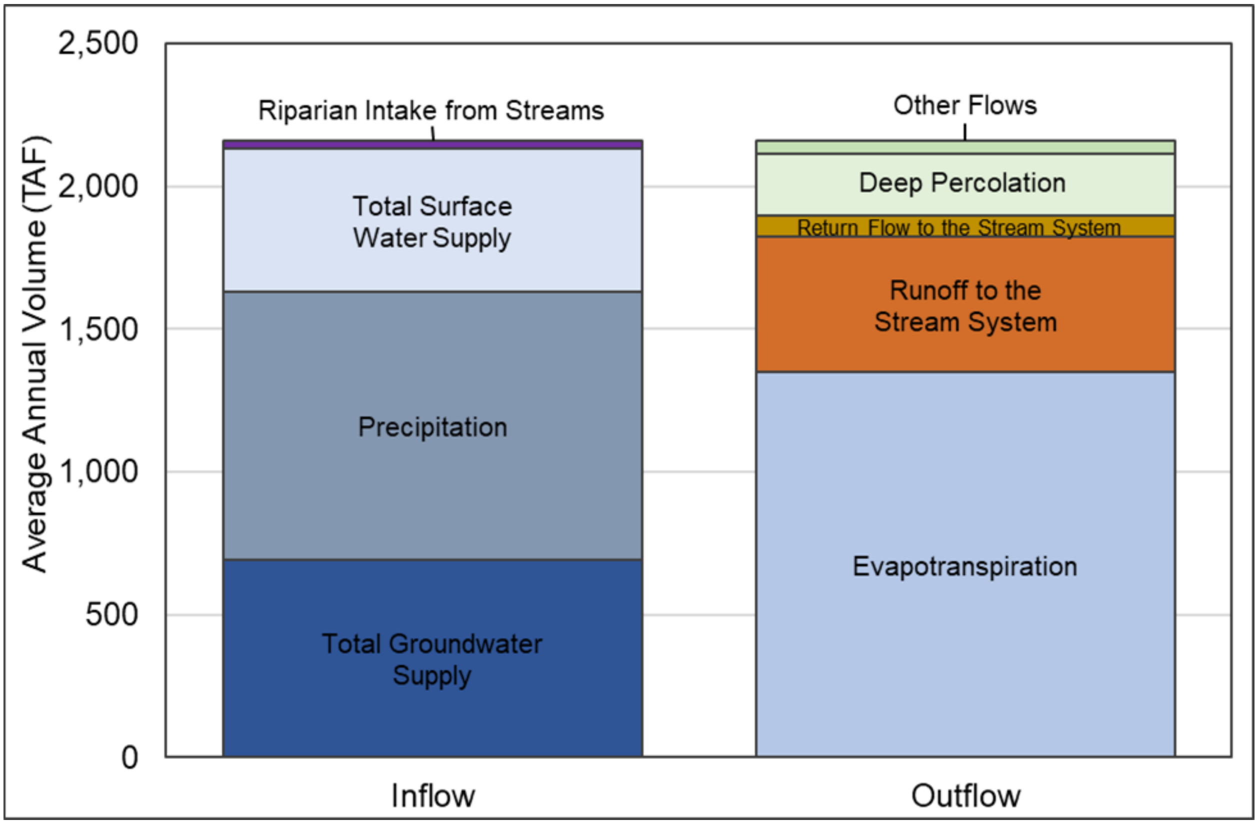
The stream system inflows through or along the Subbasin boundary simulated in the historical calibration average 4.8 MAF/year. The majority of these flows, almost 4.1 MAF/year, enter the Subbasin as stream inflows to the Subbasin. Three other surface water inflows are estimated stream gains from the groundwater system (202,000 AF/year), runoff of precipitation to the stream system (471,000 AF/year), and return flow of applied water to the stream system (74,000 AF/year). Outflows of the Eastern San Joaquin Subbasin stream system total 4.8 MAF/year and include downstream outflows leaving the Subbasin (almost 4.2 MAF/year), stream seepage to the groundwater system (303,000 AF/year), surface water diversions (301,000 AF/year), and riparian vegetation intake from streams (40,000 AF/year).

Figure 2-78: Historical Average Annual Water Budget – Stream System



The land surface system water budget in the historical calibration of the Eastern San Joaquin Subbasin, shown below in Figure 2-79, estimates almost 2.2 MAF/year of inflows, a combination of precipitation (938,000 AF/year), surface water supply (502,000 AF/year), groundwater supply (692,000 AF/year), and riparian intake from streams (28,000 AF/year). The outflow from the land surface system in the historical calibration estimates evapotranspiration (close to 1.4 MAF/year), runoff of precipitation to the stream system (471,000 AF/year), return flow of applied water to the stream system (74,000 AF/year), deep percolation of precipitation or applied water (218,000 AF/year), and a small component representing other flows (47,000 AF/year), which includes uncertainties in other components due to land expansion and temporary storage in the root-zone and unsaturated (vadose) zones.

Figure 2-79: Historical Average Annual Water Budget – Land Surface System

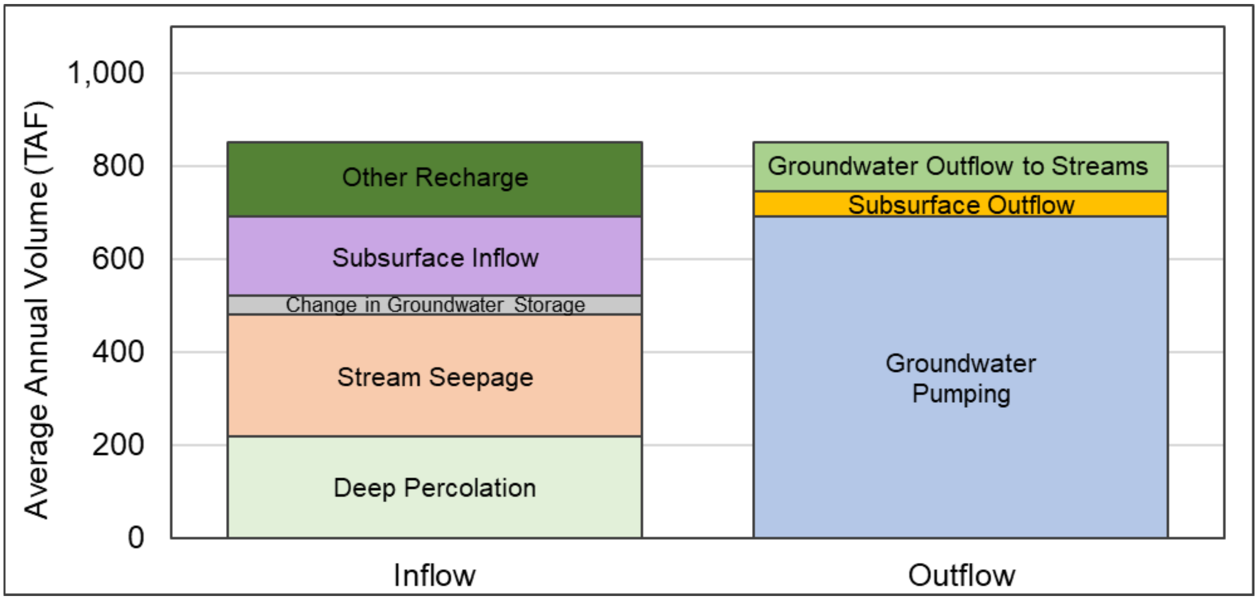


The groundwater system of the Eastern San Joaquin Subbasin includes 811,000 AF/year of inflows in the historical calibration (not including change in groundwater storage), of which 218,000 AF/year is deep percolation of precipitation or applied water. There is also stream seepage (262,000 AF/year), other recharge (160,000 AF/year), and subsurface inflows (171,000 AF/year) from the Sierra Nevada Mountains and the neighboring groundwater subbasins of Cosumnes, Modesto, South American, Solano, East Contra Costa, and Tracy. On average, the inflows do not meet the entire groundwater demand. The primary outflow from the groundwater system is pumping (692,000 AF/year), followed by groundwater outflow to streams (107,000 AF/year), and subsurface outflow to the neighboring groundwater subbasins (53,000 AF/year).

The Eastern San Joaquin Subbasin average historical groundwater budget has greater outflows than inflows, leading to an estimated average annual decrease in groundwater storage of approximately 41,000 AF/year. Figure 2-80 summarizes the average historical calibration groundwater inflows and outflows of the Eastern San Joaquin Subbasin.

A groundwater change in storage, or overdraft, estimate of 41,000 AF/year represents a refinement over previous efforts which have estimated levels of overdraft for the Subbasin to be between 70,000 AF and 150,000 AF annually. Such previous efforts include the DWR's 2003 Bulletin 118 study (CA DWR, 2003) and modeling conducting as part of the SJCFCWCD's 2001 Water Management Plan (SJCFCWCD, 2001) and presented in the 2004 Eastern San Joaquin Groundwater Basin Groundwater Management Plan (NSJCGBA, 2004). The analysis presented in this Plan represents the best available information to date. These estimates, which are the result of several years of collaboration between agencies prior to Plan development, utilize new data and modeling capabilities not captured in prior modeling efforts. A portion of the reduction seen in the overdraft estimate is also the result of converting from groundwater use to surface water supplies that has occurred since the development of previous estimates. For additional discussion of refinements that occurred in the development of the ESJWRM (Woodard & Curran, 2018), see Appendix 2-A.

Figure 2-80: Historical Average Annual Water Budget Estimates – Groundwater System



Historical inflows and outflows change by water year type as defined by the San Joaquin Valley Water Year Hydrologic Classification (CA DWR, 2018a). In wet years, precipitation meets more of the water demand and greater availability of surface water reduces the need for groundwater pumping. However, in dry years, more groundwater is pumped to meet the demand not met by surface water or precipitation. This may lead to an increase in groundwater storage in wet years and a decrease in dry years. Table 2-19 breaks down the average historical water supply and demand by water year type.

The historical calibration focuses on representing changing conditions and operations, such as new agricultural land or crop types, new surface water diversions, and population growth. The timing of these changes is often independent of the hydrologic conditions of the year in question; therefore, looking at supplies and demands averaged by water year type does not necessarily present clear results. Furthermore, the 20 years represented in the historical calibration do not include an equal number of each water year type, making averages less reliable to gather historical trends. As the projected conditions scenario considered the water year type in some of the model inputs and the 50-year hydrologic period allows for greater repetition of the water year types, the projected conditions results presented later in Table 2-20 in Section 2.3.5.3 are more consistent with the trends expected when averaging by water year type.

Table 2-19: Average Annual Values for Key Components of Historical Water Budget by Year Type

Component	Water Year Type (San Joaquin River Index)					
	Wet	Above Normal	Below Normal[1]	Dry	Critical	20-Year
Number of Years[2]	**6**	**3**	**1**	**5**	**5**	**20**
Precipitation, AF/year (Precipitation, inches)	**1,287,000 (20.2)**	**944,000 (14.8)**	**963,000 (15.1)**	**784,000 (12.3)**	**666,000 (10.5)**	**938,000 (14.7)**
Water Demand (AF/year)						
Ag Demand[3]	1,030,000	1,060,000	1,054,000	1,072,000	1,142,000	1,074,000
Urban Demand[4]	115,000	118,000	123,000	126,000	124,000	120,000
Total Demand[7]	***1,145,000***	***1,178,000***	***1,177,000***	***1,198,000***	***1,266,000***	***1,194,000***
Water Supply (AF/year)						
Total Surface Water Supply[5]	491,000	518,000	479,000	510,000	504,000	502,000
Agricultural	446,000	466,000	435,000	458,000	445,000	451,000
Urban and Industrial	46,000	51,000	44,000	52,000	59,000	51,000
Total Groundwater Supply[6]	654,000	660,000	698,000	688,000	762,000	692,000
Agricultural	585,000	595,000	620,000	615,000	698,000	624,000
Urban and Industrial	68,000	65,000	78,000	73,000	64,000	68,000
Total Supply (AF/year)[7]	***1,145,000***	***1,178,000***	***1,177,000***	***1,198,000***	***1,266,000***	***1,194,000***
Change in Groundwater Storage (AF/year)[7]	***137,000***	***-3,000***	***-106,000***	***-120,000***	***-184,000***	***-41,000***

Notes:

1 There was only one below normal water year in the historical calibration (water year 2003), so averages are just based on model results for that single water year. Since there weren't any more below normal years to use in the average, results for the below normal water year type do not follow expected trends.

2 List of historical water budget water years by water year type:
Wet: 1996, 1997, 1998, 2005, 2006, 2011
Above Normal: 1999, 2000, 2010
Below Normal: 2003
Dry: 2001, 2002, 2004, 2009, 2012
Critical: 2007, 2008, 2013, 2014, 2015

3 Agricultural demand is based on evapotranspiration by crop and acreages by crop. As agricultural land use changes over the historical calibration through changes in crop types and urbanization, averaging of the resulting agricultural demand is less a function of water year type than of the time in the simulation when that year type fell.

4 Urban demands in the historical water budget are reported values from cited sources. Averaging urban demands by water year type may not explicitly depict urban growth patterns during the historical calibration period.

5 Total surface water supply is based on information received from local entities and varied historically based on when surface water rights or agreements occurred. As some entities received new surface water sources during the historical calibration period, averaging by water year type depends more on when the water year types occurred in the simulation.

6 Total groundwater supply is pumping as estimated by the ESJWRM is a function of demand, precipitation, and surface water. Differences between water year types for groundwater pumping are more related to differences in these components.

7 Summations in table may not match the numbers in the table. This is due to the rounding of model results.

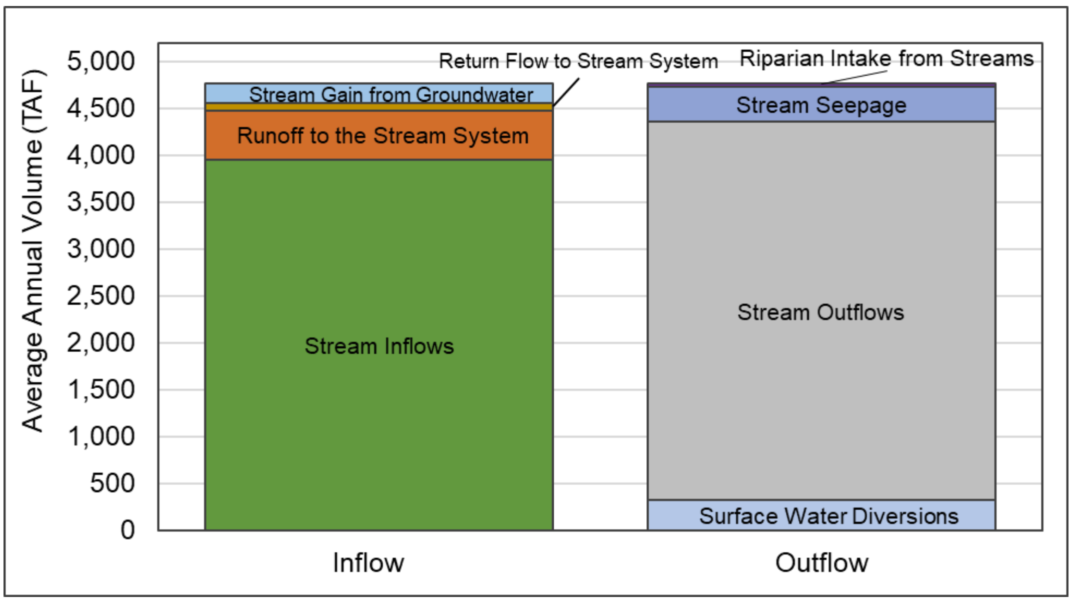
2.3.5.2 Current Water Budget Estimates

The current water budget quantifies inflows to and outflows from the Subbasin using the most recent 50 years of hydrology, water supply, water demand, and land use information. By using a baseline approach with the ESJWRM, long-term hydrology is applied to the most recent water supply, water demand, and land use information to provide a robust estimate of the current water budget. These conditions are incorporated in the current conditions scenario of the ESJWRM.

The outflows from the stream system in the current conditions scenario include 323,000 AF/year of surface water diversions occurring in the Subbasin from simulated streams. In addition, on average, over 4.0 MAF/year leaves the Subbasin's stream system as downstream outflow of the San Joaquin River and Mokelumne River, 375,000 AF/year is lost as stream seepage to the groundwater system, and 31,000 AF/year is used by riparian vegetation as riparian intake from streams.

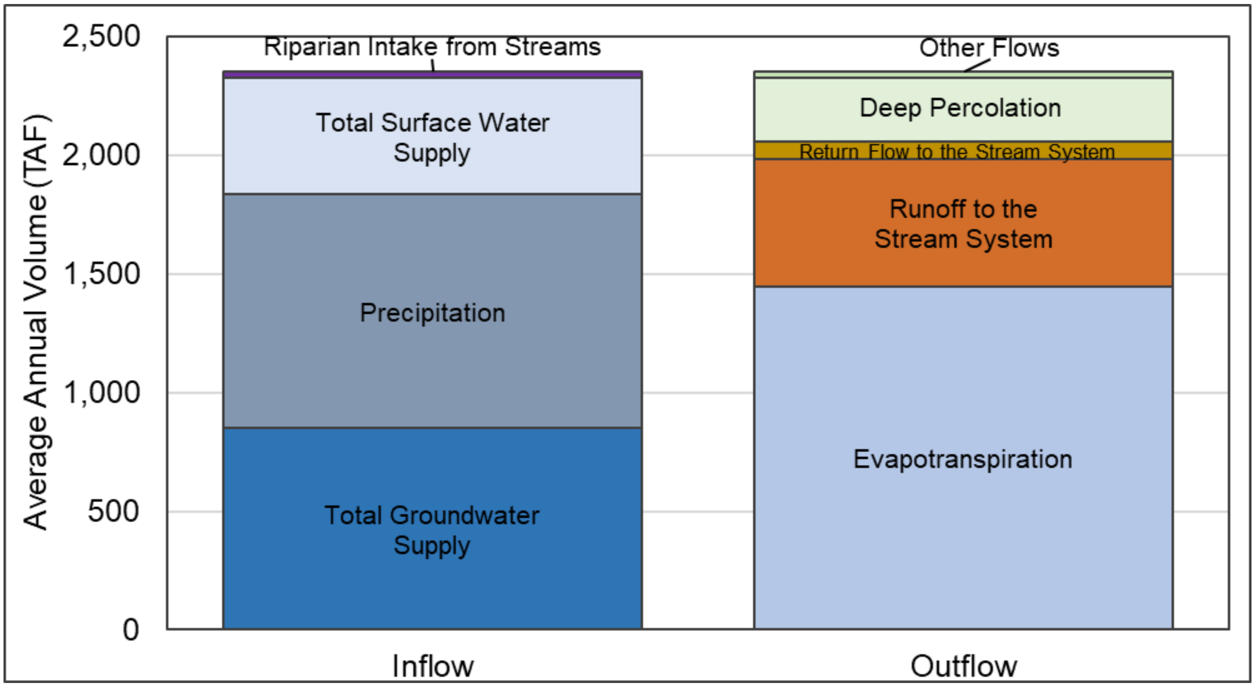
These demands are met by an estimated 3.9 MAF/year of stream inflows, 533,000 AF/year of runoff of precipitation to the stream system, 75,000 AF/year of return flow of applied water to the stream system, and 209,000 AF/year of stream gain from the groundwater system. Figure 2-81 summarizes the average annual inflows and outflow of the current conditions scenario in the Eastern San Joaquin Subbasin stream network.

Figure 2-81: Current Average Annual Water Budget Estimates – Stream System



The current conditions scenario fixes land use to current conditions based on 2014 cropping patterns and calculates urban demands using 2015 population and pre-drought (assumed 2013) per capita water use. Over the 50-year hydrologic period, the current conditions land surface water budget simulates annual inflows of almost 2.4 MAF/year, including 984,000 AF/year of precipitation, 1.3 MAF/year of applied water (493,000 AF/year of surface water supply and 851,000 AF/year of groundwater supply), and 23,000 AF/year of riparian intake from the stream system. Approximately 2.4 MAF/year of outflows include evapotranspiration (1.4 MAF/year), runoff to the stream system of precipitation (533,000 AF/year), return flow to the stream system of applied water (75,000 AF/year), deep percolation (272,000 AF/year), and other flows due to land expansion and temporary storage in the root-zone and vadose zones (23,000 AF/year). Figure 2-82 summarizes the average annual current conditions inflows and outflows in the land surface budget for the Eastern San Joaquin Subbasin.

Figure 2-82: Current Average Annual Water Budget Estimates – Land Surface System

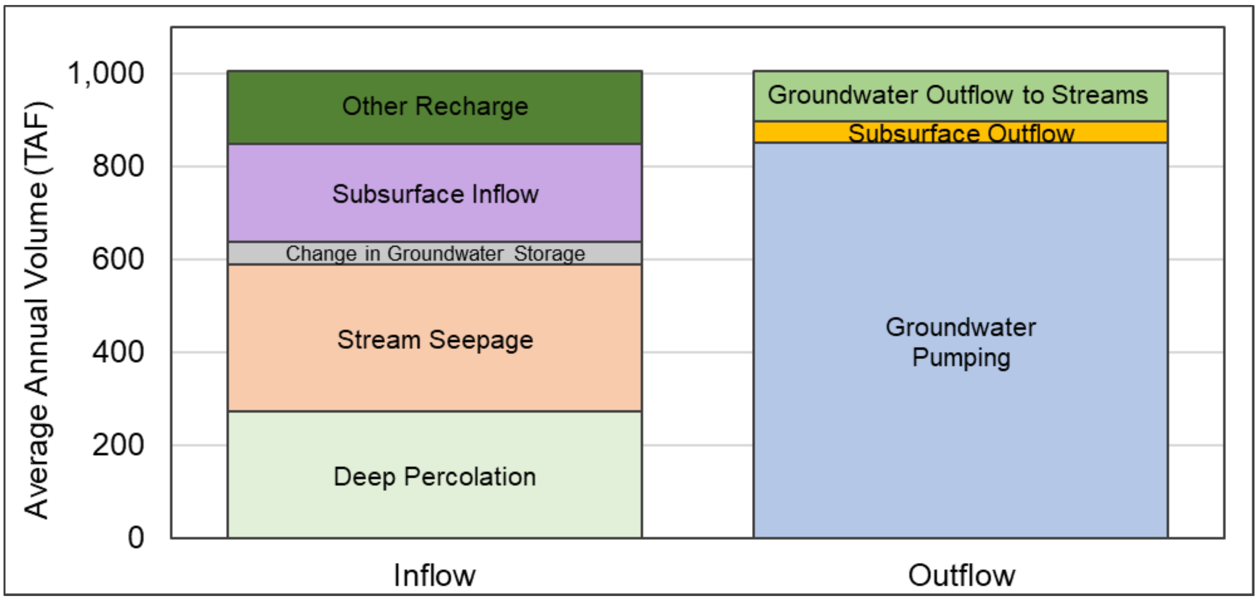


The current conditions scenario simulates 50 years of hydrology with conditions approximately reflective of current Subbasin management and activities. Over the simulation, the current conditions groundwater system water budget simulates annual inflows of 959,000 AF/year, including 272,000 AF/year of deep percolation, 317,000 AF/year of stream seepage, 158,000 AF/year of other recharge (including canal and reservoir seepage and MAR projects), and subsurface inflows from surrounding subbasins and the Sierra Nevada Mountains totaling 212,000 AF/year.

Similar to the historical water budget, average groundwater system outflows exceed the inflows under current conditions. Groundwater pumping (851,000 AF/year) remains the largest portion of aquifer discharge, with subsurface outflows to surrounding subbasins (47,000 AF/year) and groundwater outflow or losses to the stream system (109,000 AF/year), bringing the total system outflows to over 1 MAF/year.

The Eastern San Joaquin Subbasin's current conditions groundwater budget has greater outflows than inflows, resulting in an average annual decline in groundwater storage of 48,000 AF/year. Figure 2-83 summarizes the average current conditions groundwater inflows and outflows in the Eastern San Joaquin Subbasin.

Figure 2-83: Current Average Annual Water Budget Estimates – Groundwater System



2.3.5.3 Projected Water Budget Estimates

The projected water budget is used to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation. The projected conditions scenario of the ESJWRM is used to evaluate the projected conditions water budget assuming a 2040 level of development and using hydrology from water years 1969-2018. Results of the projected conditions scenario under potential climate change conditions (changes to precipitation, stream flows, and evapotranspiration) are presented in Section 2.3.7.4.

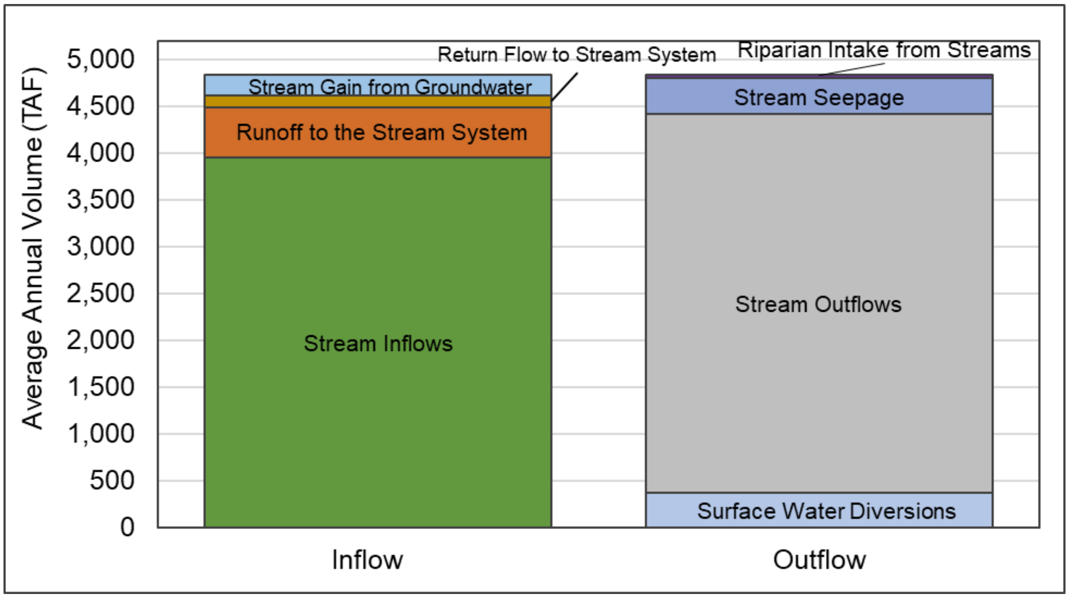
Subsequent to completion and submittal of the GSP in January of 2020, refinements and enhancements were made to the historical data for the updated historical ESJWRM, which in turn, required an update to the projected conditions baseline ESJWRM. The updated version of the Projected Conditions Baseline (PCBL) used the extended dataset and calibration results, along with updated data sources and assumptions for projected conditions, representing approximately WY 2040 conditions. This projected water budget update and the associated results are documented in Appendix 2-B of this revised GSP.

Development of the projected water demand is based on population growth trends reported by the San Joaquin Council of Governments, urban per capita water use consistent with projections in 2015 UWMPs, and urban area expansion from general plans or sphere of influence boundaries. An important assumption made in the projected water budget analysis is that due to projected urban growth, agricultural acreage is expected to decrease by approximately 40,000 acres. While there is agricultural growth anticipated in the eastern areas of the Subbasin and potential conversion of existing agricultural land to permanent irrigated crops, no reliable projections were available to include in the simulation; therefore, no additional agricultural land growth was added to the projected conditions scenario. An analysis of county agricultural reports can be performed to assess agricultural trends in future scenarios of the ESJWRM.

Average annual surface water inflows to the Eastern San Joaquin Subbasin's stream system total an average of over 4.8 MAF/year in the projected conditions scenario. Under projected conditions, stream inflows of almost 4.0 MAF/year are augmented by stream gains from groundwater of 212,000 AF/year and runoff of precipitation to the stream system (542,000 AF/year) and return flow of applied water to the stream system (127,000 AF/year). Of these inflows, it is anticipated that 370,000 AF/year will be distributed to local growers to meet agricultural demand as surface water diversions and the remaining amount will leave the system in the form of San Joaquin River and Mokelumne River outflows (over 4.0 MAF/year), stream seepage (380,000 AF/year), and riparian intake from streams (32,000 AF/year).

Figure 2-84 summarizes the average projected inflows and outflows in the Eastern San Joaquin Subbasin stream system.

Figure 2-84: Projected Average Annual Water Budget Estimates – Stream System



The land surface water budget for the projected conditions scenario has annual average inflows and outflows of 2,338,000 AF/year. Inflows consist of precipitation (984,000 AF/year), surface water supply (529,000 AF/year), groundwater supply (801,000 AF/year), and riparian intake from streams (24,000 AF/year). The balance of this is the summation of average annual evapotranspiration (1,394,000 AF/year), runoff of precipitation to the stream system (542,000 AF/year), return flow of applied water to the stream system (127,000 AF/year), deep percolation (266,000 AF/year), and other flows due to land expansion and temporary storage in the root-zone and unsaturated (vadose) zones (8,000 AF/year). A summary of these flows can be seen below in Figure 2-85.

Figure 2-85: Projected Average Annual Water Budget Estimates – Land Surface System

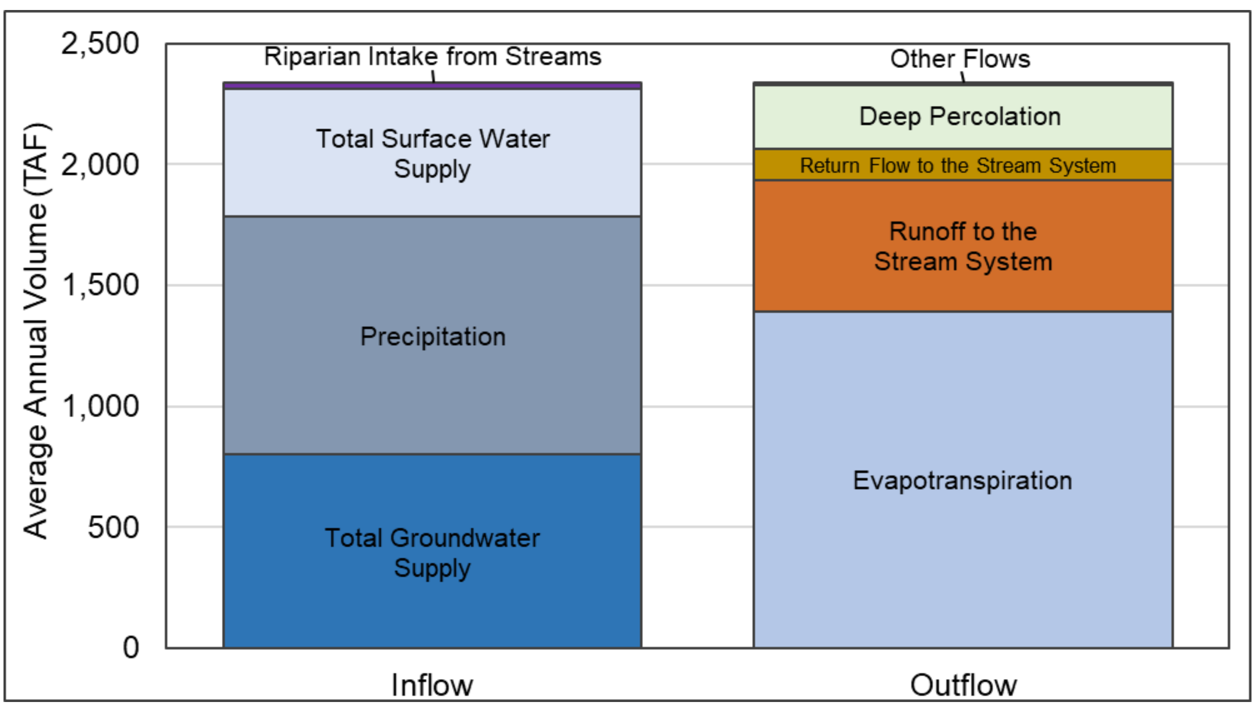
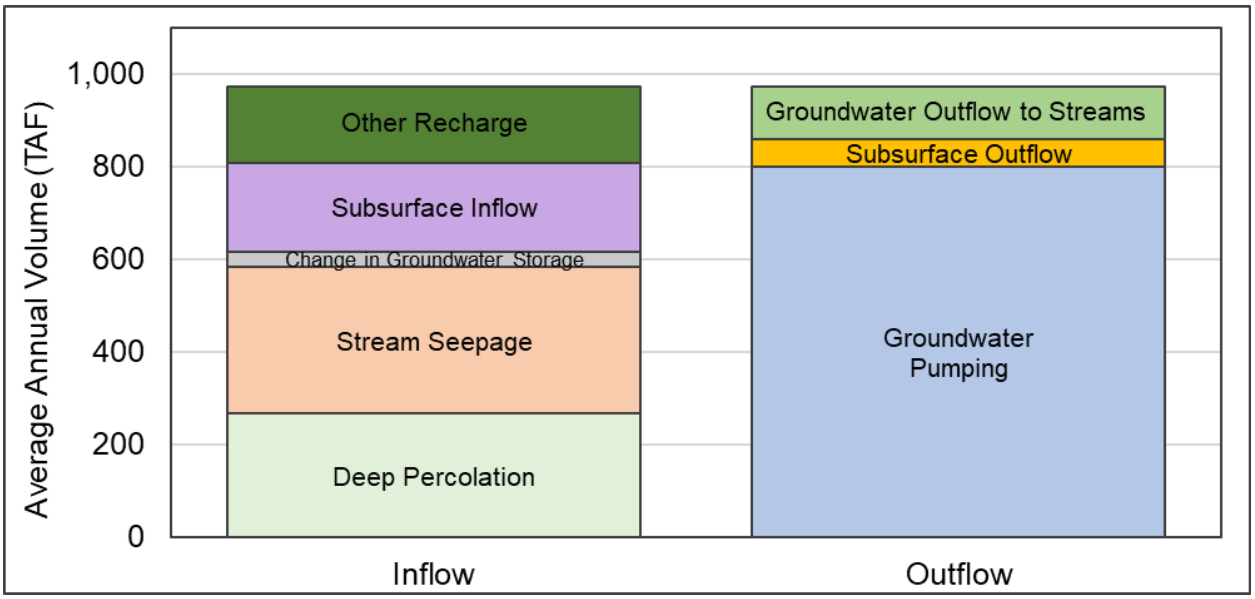


Figure 2-86 below shows how anticipated expansion in surface water supplies is reflected by decreases to groundwater pumping (801,000 AF/year) relative to current conditions estimates. Subsurface outflow to neighboring subbasins (58,000 AF/year) and stream gain from groundwater (114,000 AF/year) bring the total Subbasin discharges to 973,000 AF/year.

Under projected conditions, the groundwater system of the Eastern San Joaquin Subbasin experiences an average of 939,000 AF/year of inflows each year, of which 266,000 AF/year is deep percolation. There is also stream seepage (317,000 AF/year), as well as other recharge which includes recharge from canals, reservoirs, and MAR projects (164,00 AF/year), and subsurface inflows (192,000 AF/year) from the Sierra Nevada Mountains and the neighboring subbasins of Cosumnes, Modesto, South American, Solano, East Contra Costa, and Tracy.

The projected water budget has greater outflows than inflows, resulting in an average annual decline in groundwater storage of 34,000 AF/year. Figure 2-86 summarizes the average projected groundwater inflows and outflows in the Eastern San Joaquin Subbasin.

Figure 2-86: Projected Average Annual Water Budget Estimates – Groundwater System



As seen previously in Table 2-19 for the historical calibration, Table 2-20 shows the projected conditions water demands, supplies, and change in groundwater storage averaged based on the San Joaquin Valley Water Year Hydrologic Classification or water year type. As expected, in wet years there is more precipitation and surface water to meet more of the water demand, reducing the need for groundwater pumping and increasing groundwater storage. However, in dry years, more groundwater is pumped to meet the demand not met by surface water or precipitation, which leads to a decrease of groundwater storage. Unlike the historical calibration, the 50-year period allows for enough of each water year type to calculate meaningful averages, and the changes in supplies and demands are consistent with expectations for each water year type.

Table 2-20: Average Annual Values for Key Components of Projected Water Budget by Year Type

Component	Water Year Type (San Joaquin River Index)					
	Wet	Above Normal	Below Normal	Dry	Critical	50-Year
Number of Years[1]	**17**	**7**	**4**	**8**	**14**	**50**
Precipitation, AF/year (Precipitation, inches)	**1,376,000 (21.6)**	**987,000 (15.5)**	**866,000 (13.6)**	**790,000 (12.4)**	**652,000 (10.2)**	**984,000 (15.4)**
Water Demand (AF/year)						
Ag Demand	1,088,000	1,107,000	1,108,000	1,112,000	1,117,000	1,104,000
Urban Demand	230,000	228,000	225,000	225,000	222,000	226,000
Total Demand[2]	***1,318,000***	***1,335,000***	***1,333,000***	***1,337,000***	***1,339,000***	***1,330,000***
Water Supply (AF/year)						
Total Surface Water Supply	565,000	559,000	518,000	507,000	488,000	529,000
Agricultural	450,000	446,000	416,000	408,000	395,000	426,000
Urban and Industrial	114,000	113,000	102,000	98,000	93,000	103,000
Total Groundwater Supply	753,000	776,000	815,000	830,000	851,000	801,000
Agricultural	639,000	662,000	693,000	705,000	725,000	681,000
Urban and Industrial	115,000	116,000	124,000	126,000	128,000	121,000
Total Supply (AF/year)[2]	***1,318,000***	***1,335,000***	***1,333,000***	***1,337,000***	***1,339,000***	***1,330,000***
Change in Groundwater Storage (AF/year)[2]	***185,000***	***20,000***	***-113,000***	***-164,000***	***-223,000***	***-34,000***

Notes:

1 List of projected water budget water years by water year type:
Wet: 1969, 1974, 1975, 1978, 1980, 1982, 1983, 1986, 1993, 1995, 1996, 1997, 1998, 2005, 2006, 2011, 2017
Above Normal: 1970, 1973, 1979, 1984, 1999, 2000, 2010
Below Normal: 1971, 2003, 2009, 2018
Dry: 1972, 1981, 1985, 2001, 2002, 2004, 2012, 2016
Critical: 1976, 1977, 1987, 1988, 1989, 1990, 1991, 1992, 1994, 2007, 2008, 2013, 2014, 2015

2 Summations in table may not match the numbers in the table. This is due to the rounding of model results.

2.3.6 Sustainable Yield Estimate

Sustainable yield is defined for SGMA purposes as "the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result." (CWC §10721(w)). Sustainable yield for the Eastern San Joaquin Subbasin was calculated through development of an ESJWRM sustainable conditions scenario (model run) in which the goal was to generate a long-term (50-year) change in Subbasin groundwater storage of zero, a conservative approach, as a change in storage of greater than zero could occur without causing undesirable results. In order to account for the challenges of implementing the GSP, this Plan assumes future operations include a slow ramping up of demand reduction actions (e.g., projects that reduce groundwater pumping or increase recharge) for a 20-year period, so groundwater levels will continue to decline until 2040. From 2040, the 50 years of long-term hydrology was applied and various scenarios were run to see what level of groundwater production resulted in a long-term change in storage of, or very close to, zero. The sustainable conditions scenario is based on the projected conditions scenario (see Section 2.3.4.3, Table 2-15, and Figure 2-86) modified by lowering groundwater production across the model domain. In practice, Subbasin overdraft could be addressed through reduced groundwater production, increased recharge, or a combination of the two; focusing on groundwater production is just for simulation purposes to calculate the Subbasin sustainable yield. The sustainable conditions scenario, building off the projected conditions scenario, does not include climate change discussed in Section 2.3.7. Due to the uncertainty around DWR's climate projections for a 2070 timeframe, the ESJGWA Board determined the projected conditions scenario was most appropriate for analyzing sustainable yield in the GSP implementation time period beginning in 2040. The sustainable conditions scenario estimates future conditions of supply, demand, and the resulting aquifer response to implementation of sustainable conditions in the Subbasin. Under sustainable conditions, groundwater pumping activities in the Subbasin are not anticipated to create changes in groundwater inflow that could impact GSP implementation in neighboring subbasins.

There are uncertainties associated with projections in the ESJWRM scenarios due to the sequence of the hydrologic period, population projections, future cropping patterns, and irrigation practices and technologies, as well as uncertainties inherent in the representation of the physical groundwater and surface water system by the model. Therefore, to account for these uncertainties, a range of assumptions (from high-end estimates to low-end estimates) are used in running model scenarios to estimate the sustainable yield and an initial estimate of the adjustment that would be required to achieve the sustainable yield over the 50-year planning period. These assumptions will be honed over time in updates to this Plan and refinements to the ESJWRM as described in Section 7.4.1.

The sustainable conditions scenario results in groundwater outflows almost equal to groundwater inflows, bringing the long-term (50-year) average change in groundwater storage to close to zero. Based on this analysis, the sustainable yield of the Subbasin is 715,000 AF/year ± 10 percent.

In order to achieve a net-zero change in groundwater storage over a 50-year planning period, approximately 78,000 AF/year of direct or in lieu groundwater recharge and/or reduction in agricultural and urban groundwater pumping would need to be implemented in the Eastern San Joaquin Subbasin to reduce the projected groundwater pumping to the sustainable yield. This number (78,000 AF/year) is larger than the estimated annual overdraft of the projected conditions scenario (34,000 AF/year) due to the integrated nature of a groundwater subbasin. As efforts are made to reach sustainability in a subbasin, flows to and from neighboring basins and flows to and from streams may vary due to proposed management actions resulting in increased groundwater levels, creating the need for additional recharge or pumping reduction greater than the overdrafted amount.

2.3.7 Climate Change Analysis

2.3.7.1 Regulatory Background

SGMA requires taking into consideration uncertainties associated with climate change in the development of GSPs.

Consistent with Section 354.18(d)(3) and Section 354.18(e) of the GSP Regulations, an analysis was performed for the Subbasin evaluating the projected water budget with and without climate change conditions.

Section 354.18(d)(3) of the GSP Regulations states:

"(d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:

(1) Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.

(2) Current water budget information for temperature, water year type, evapotranspiration, and land use.

(3) Projected water budget information for population, population growth, ***climate change*** *[emphasis added]**,** and sea level rise."*

Section 354.18(e) states:

"*(e) Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population,* ***climate change*** *[emphasis added], sea level rise, groundwater and surface water interaction, and subsurface groundwater flow. If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater, the Plan shall identify and describe an equally effective method, tool, or analytical model to evaluate projected water budget conditions.****"***

2.3.7.2 DWR Guidance

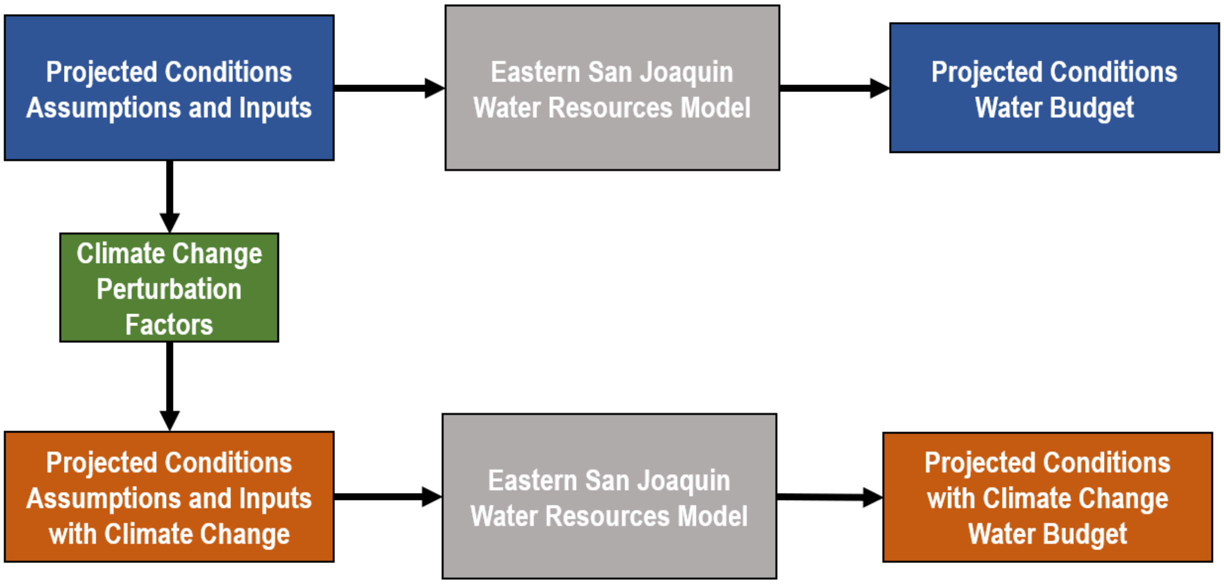
Climate change analysis is an area of continued evolution in terms of methods, tools, forecasted datasets, and the predictions of greenhouse gas concentrations in the atmosphere. The approach developed for this GSP is based on the methodology in DWR's guidance document (CA DWR, 2018b). The "best available information" related to climate change in the Eastern San Joaquin Subbasin was deemed to be the information provided by DWR combined with basin-specific modeling tools. The following resources from DWR were used in the climate change analysis:

- SGMA Data Viewer
- Guidance for Climate Change Data Use During Sustainability Plan Development and Appendices (Guidance Document)
- Water Budget BMP
- Climate Change Desktop IWFM Tools

The SGMA Data Viewer contains climate change forecast datasets for download (CA DWR, 2018c). The guidance document details the approach, development, applications, and limitations of the datasets available from the SGMA Data Viewer (CA DWR, 2018c). The Water Budget BMP describes in greater detail how DWR recommends projected water budgets with climate change be estimated (CA DWR, 2016). The Desktop IWFM Tools are available to estimate the projected precipitation and evapotranspiration inputs under climate change conditions (CA DWR, 2018b).

The methods suggested by DWR in the above resources were used, with modifications where needed, to ensure the results would be reasonable for the Eastern San Joaquin Subbasin and align with the assumptions of the ESJWRM. Figure 2-87 shows the overall process developed for the Subbasin consistent with the Climate Change Resource Guide (CA DWR, 2018b) and describes workflow beginning with projected conditions inputs and assumptions to perturbed 2070 conditions for the projected conditions.

Figure 2-87: Eastern San Joaquin Climate Change Analysis Process



The process described in Figure 2-87 of developing a projected water budget with and without climate change was discussed with DWR staff and is consistent with the regulations. Further, it enables the analysis to account for variability in demand and supply separate from the uncertainty associated with climate change forecasts.

Table 2-21 summarizes the forecasted variable datasets provided by DWR that were used to carry out the climate change analysis (CA DWR, 2018b). The Variable Infiltration Capacity (VIC) model referred to in Table 2-21 is the fully mechanistic hydrologic model used by DWR to derive hydrographs under standard and climate change conditions. Section 1.2.2 includes further description of the model and other tools and datasets.

Table 2-21: DWR-Provided Datasets

Input Variable	DWR-Provided Dataset
Unimpaired Streamflow	Combined VIC model runoff and baseflow to generate change factors, provided by HUC 8 watershed geometry
Impaired Streamflow (Ongoing Operations)	CalSim II time series outputs
Precipitation	VIC model-generated GIS grid with associated change factor time series for each cell
Reference ETo	VIC model-generated GIS grid with associated change factor time series for each cell

2.3.7.3 Climate Change Methodology

Accepted methods for estimating climate change impacts on groundwater are based on the assessment of impacts on the individual water resource system elements that directly link to groundwater. These elements include precipitation, streamflow, evapotranspiration and, for coastal aquifers, sea level rise as a boundary condition. For the Eastern San Joaquin Subbasin, sea level rise was not included.

The method for perturbing the streamflow, precipitation, and evapotranspiration input files is described in the following sections. A future scenario of 2070 climate forecasts was evaluated in this analysis, consistent with DWR guidance (CA DWR, 2018b). DWR combined 10 global climate models (GCMs) for two different representative climate pathways

(RCPs) to generate the central tendency scenarios in the datasets used in this analysis. The “local analogs” method (LOCA) was used to downscale these 20 different climate projections to a scale usable for California (CA DWR, 2018b). The 2070 central tendency among these projections serves to assess impacts of climate change over the long-term planning and implementation period.

With the updated PCBL, the potential impact of climate change on the Subbasin in the future was also updated. The updated version of the Projected Conditions Baseline with Climate Change (PCBL-CC) largely used the same perturbation factors (2070 Central Tendency climate change conditions) as the prior runs, but the updated PCBL-CC extends the simulation time period by two years. This projected water budget with climate change impacts update, and the associated results, are documented in Appendix 2-B of this revised GSP.

2.3.7.3.1 Streamflow under Climate Change

Hydrologic forecasts for streamflow under various climate change scenarios are available from DWR as either a flow-based timeseries or a series of perturbation factors applicable to local data. DWR simulates volumetric flow in most regional surface water bodies by utilizing the Water Resource Integrated Modeling System (WRIMS, formally named CalSim II). While river flows and surface water diversions in the Calaveras, San Joaquin, and Stanislaus Rivers are simulated in CalSim II, there are significant variations when compared to local historical data. Due to the uncertainty in reservoir operations, flows from CalSim II provided by the state are not used directly. Instead, relative perturbation factors were used to derive surface water inflows and diversions for use in ESJWRM.

Local tributaries and smaller streams within Eastern San Joaquin Subbasin are not simulated in CalSim II and must be simulated using adjustment factors developed by DWR for unregulated stream systems. Dry Creek flows were perturbed using this method. The resolution of these perturbation factors is at the Hydrologic Unit Code 8 watershed scale. CalSim II model runs are not available for the Mokelumne River, according to Appendix B, Table B-2 of DWR’s Climate Change Document (CA DWR, 2018b). Therefore, Mokelumne River flows used the perturbation factor method for consistency with the methodology applied to smaller streams. The remaining streams simulated in the ESJWRM utilize the IWFM small watershed package, whose climate change impacts are calculated internally dependent on both precipitation and evapotranspiration refinement. Table 2-22 presents the impaired and unimpaired streams in the ESJWRM model for the Eastern San Joaquin Subbasin.

Table 2-22: Eastern San Joaquin Stream Inflows

Stream	Impaired	Unimpaired
Dry Creek		X
Mokelumne River		X
Calaveras River	X	
San Joaquin River	X	
Stanislaus River	X	

2.3.7.3.1.1 Unimpaired Flows

Change factors for unimpaired streams (Dry Creek and Mokelumne River) were downloaded from SGMA Data Viewer and multiplied by the projected conditions input streamflow data to calculated perturbed flows. DWR change factors are available through 2011; however, the model hydrologic period runs from Water Year 1969-2018. Flows for the remaining model years beyond 2011 were synthesized using the change factor from the most recent matching water year type in the available dataset. Water Year types are designated for each year based on the San Joaquin Valley Runoff WY year type index (CA DWR, 2018a). DWR uses five designations ranging from driest to wettest conditions: Critical, Dry, Below Normal, Above Normal, and Wet. Table 2-23 below shows the year type designations used to synthesize the remaining years (2011-2018).

Table 2-23: San Joaquin Valley Water Year Type Designations

Water Year	Year Type
2003	Below Normal
2004	Dry
2005	Wet
2006	Wet
2007	Critical
2008	Critical
2009	Below Normal
2010	Above Normal
2011	Wet
2012	Dry
2013	Critical
2014	Critical
2015	Critical
2016	Dry
2017	Wet
2018	Below Normal

Figure 2-88 shows the perturbed time series against the projected conditions scenario time series for Dry Creek and Figure 2-89 presents the exceedance probability curve. Figure 2-90 and Figure 2-91 show perturbed time series and exceedance curves for Mokelumne River. The exceedance curves are provided because they more clearly show the differences between the projected conditions scenario and the with-climate-change scenario. Generally, flows under the climate change scenario are slightly higher.

Figure 2-88: Dry Creek Hydrograph

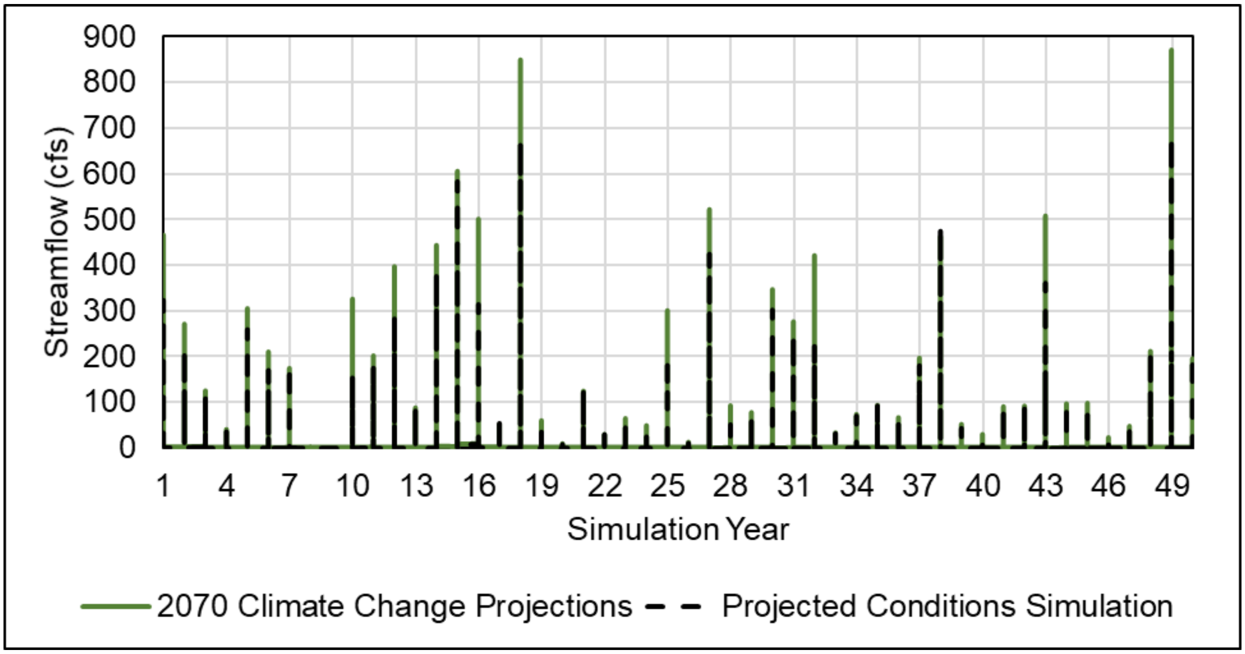


Figure 2-89: Dry Creek Exceedance Curve

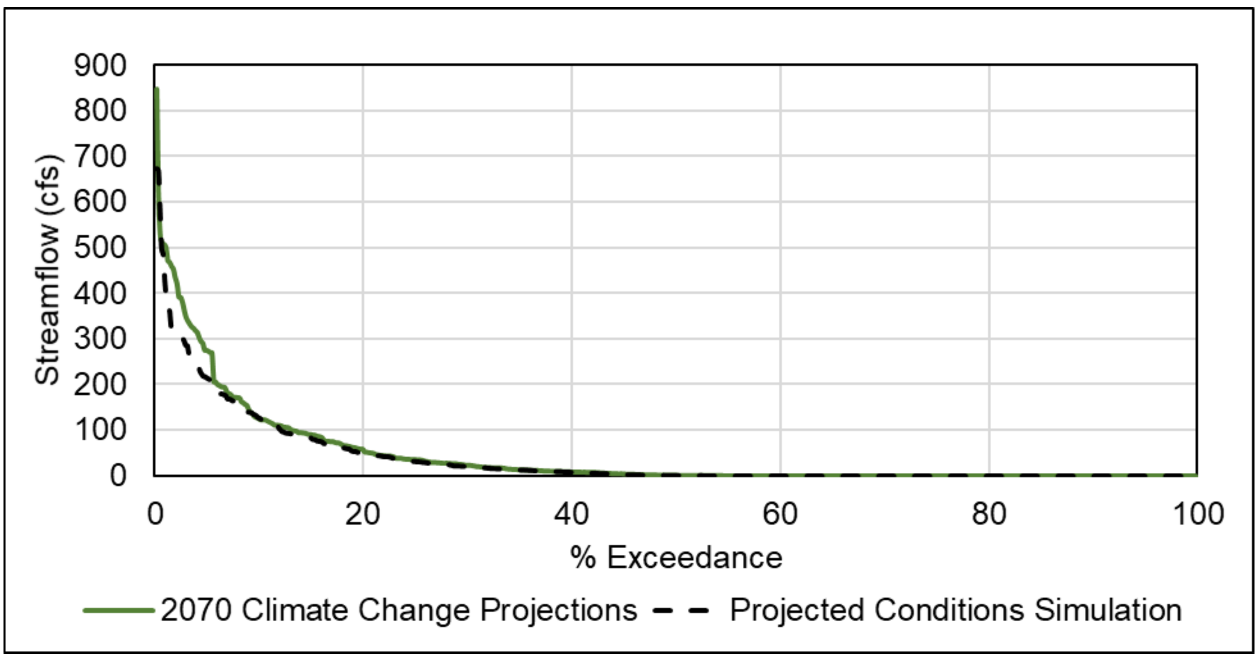


Figure 2-90: Mokelumne River Hydrograph

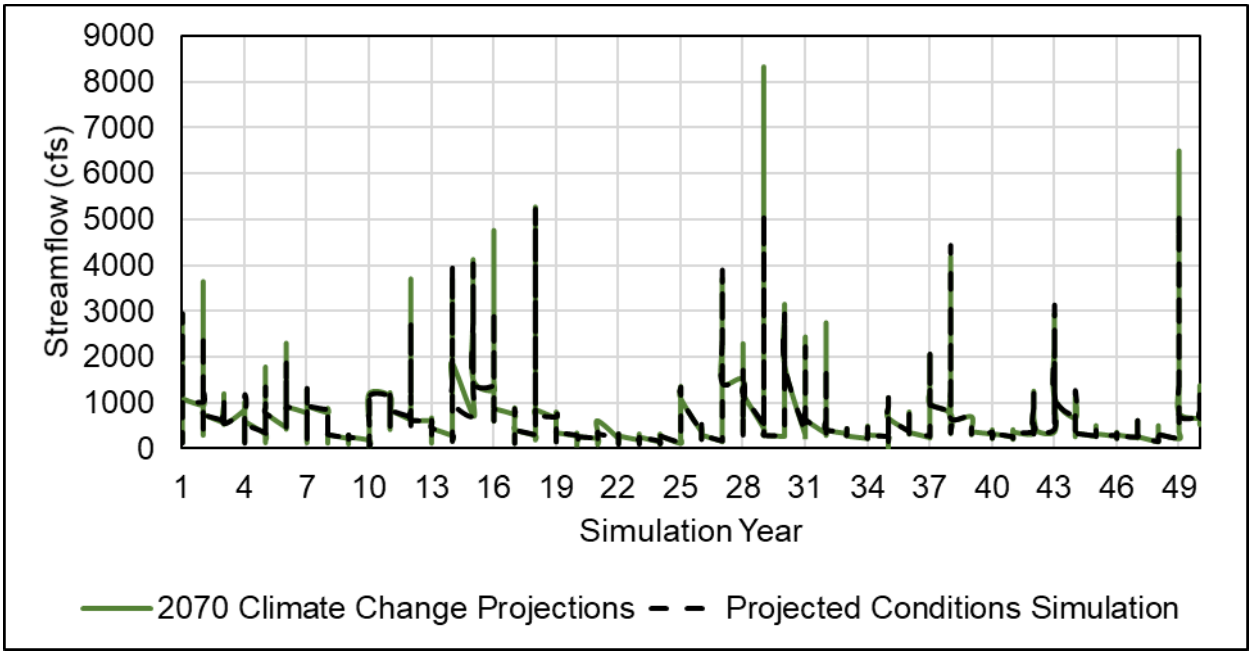
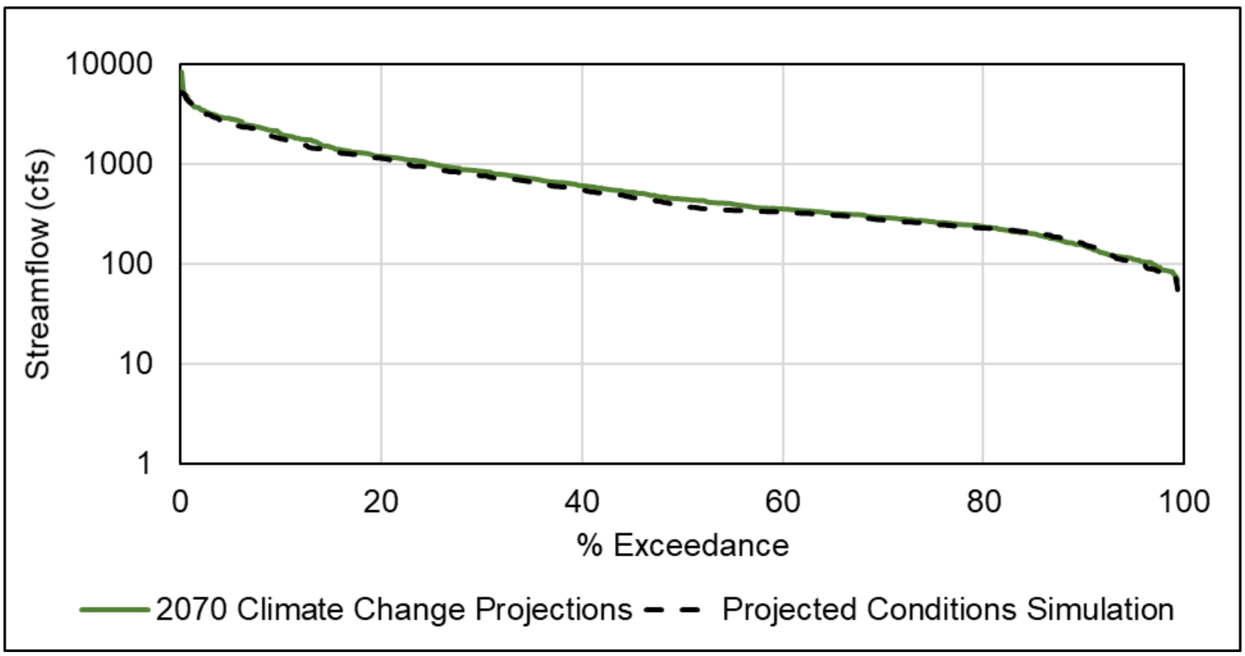


Figure 2-91: Mokelumne River Exceedance Curve



2.3.7.3.1.2 Impaired Flows

CalSim II-estimated flows for point locations on the Calaveras River, San Joaquin River, and Stanislaus River were downloaded from DWR. These points obtained from CalSim II include:

- Calaveras River: New Hogan Reservoir Outflow
- San Joaquin River: San Joaquin River at Vernalis
- Stanislaus River: New Melones Reservoir Outflow

These flows represent projected hydrology based on reservoir outflow, operational constraints, and diversions and deliveries of water for the State Water Project and the Central Valley Project. CalSim II data from WY 1969-2003 were available. For the years 2003-2018, streamflow was synthesized based on flows from WY 1969-2003 and the DWR year type index shown in Table 3 (CA DWR, 2018a). For example, the total monthly streamflow for October 2003 was calculated as the average of the monthly streamflows from October 1966 and October 1971 because they are the same water year type.

CalSim II simulated flows were compared with flows generated using the DWR-provided unimpaired perturbation factors. Streamflows simulated in CalSim II and those derived using the unimpaired adjustment factors did not present similar trends, particularly in dry years, due to CalSim II's simulation of reservoir operations. DWR-provided unimpaired change factors do not account for variations in the operation of the reservoirs that would result from climate change conditions. Therefore, CalSim II outputs were considered a more appropriate starting dataset for regulated streams given that downstream flow is driven by surface water demand rather than natural flow.

The team explored a hybrid approach to improve upon the discrepancy between flows produced using CalSim II and perturbation factors, while accounting for some change in reservoir operations. In this approach, change factors are generated from the difference between the simulated future climate change CalSim II scenario for 2070 climate conditions and a "without climate change" CalSim II run. This "without climate change" run is the CalSim II 1995 Historical Detrended simulation run. The generated change factors from these two runs were then used to perturb the regulated river inflows simulated in the ESJWRM projected conditions scenario. For the purposes of simplicity, this method is referred to throughout the rest of the document as CalSim II Generated Perturbation Factors (CGPF). The CGPF method presents limitations given that the resulting flows are not directly obtained from an operations model. The actual mass balance on the reservoirs is not tracked in the estimates of the flows and, instead, the method relies on CalSim II tracking storage and managing the reservoir based on the appropriate rule curves.

Figure 2-92 through Figure 2-97 provide a comparison of project baseline condition and the results of the CGPF method described above. Exceedance curves are included for each of the CGPF flows against the project baseline flows.

Figure 2-92: Calaveras River Perturbed Hydrograph

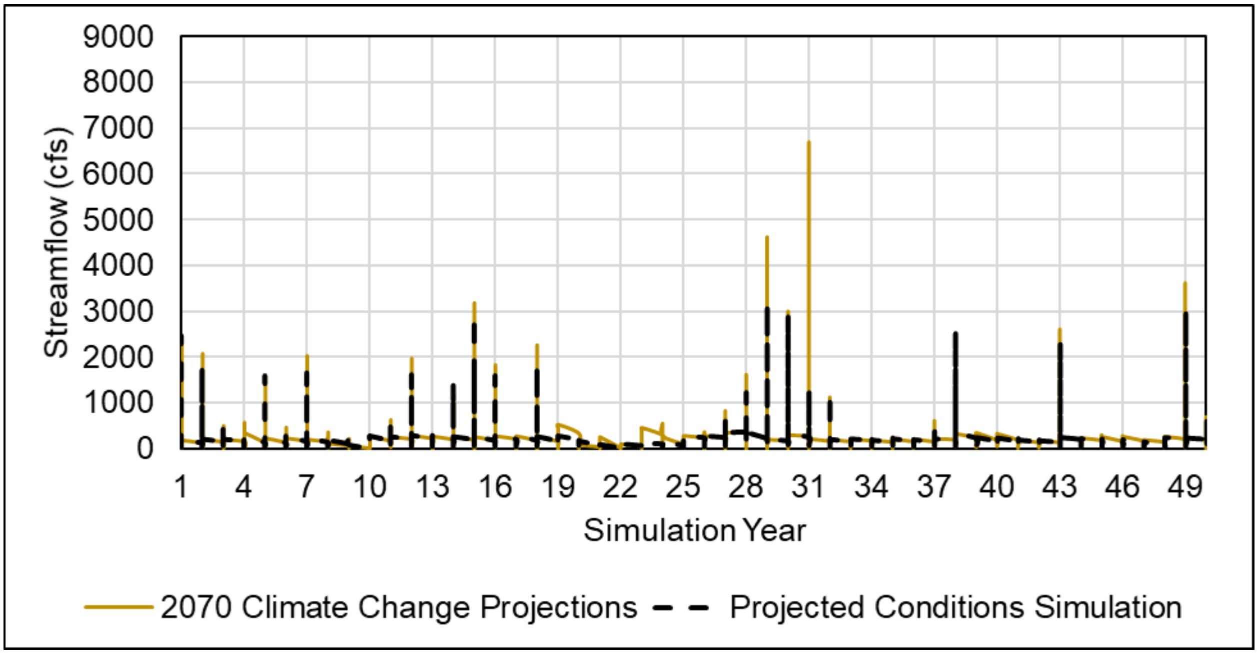


Figure 2-93: Calaveras River Exceedance Curve

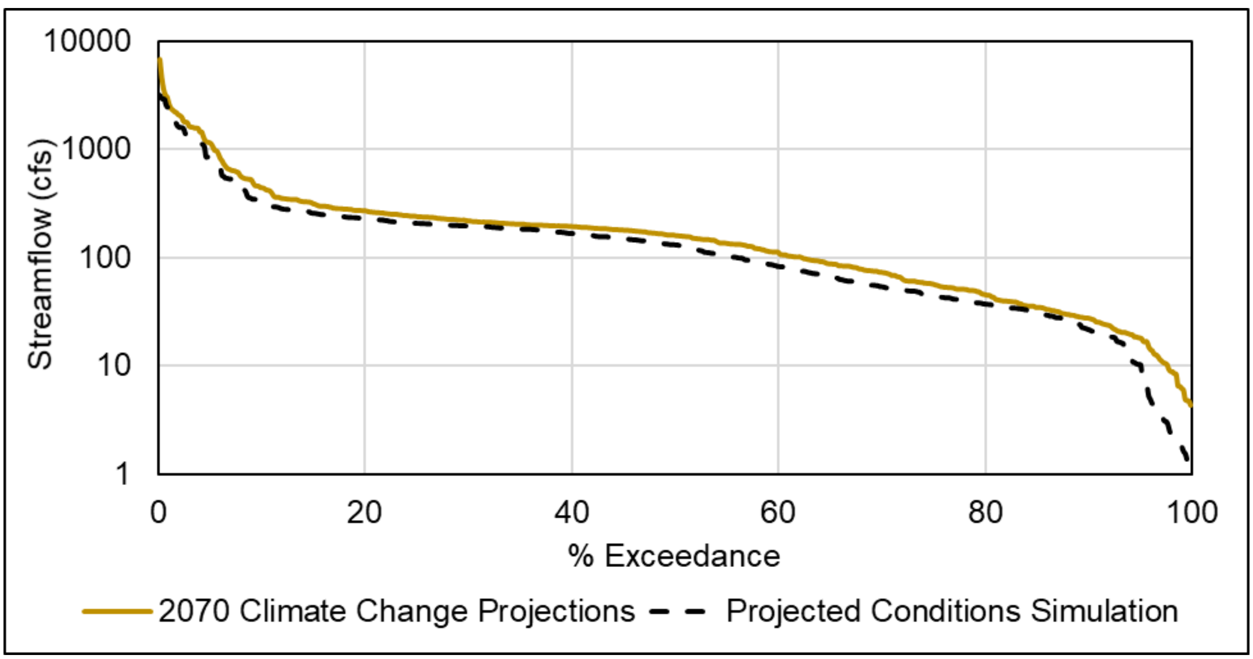


Figure 2-94: Stanislaus River Hydrograph

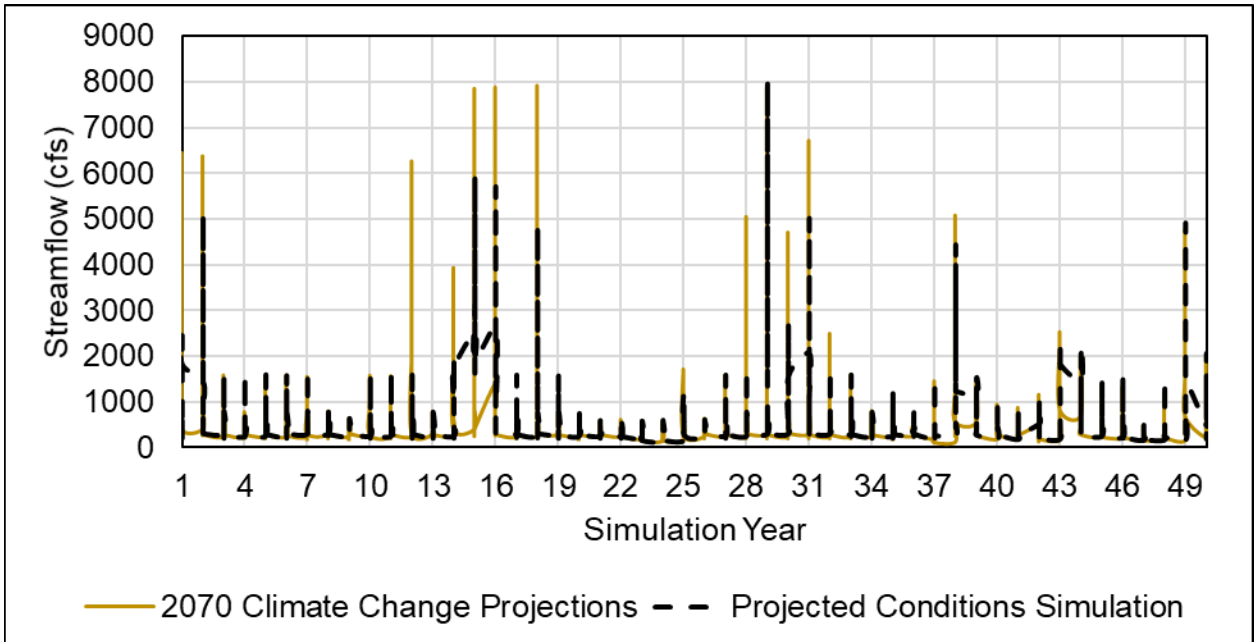


Figure 2-95: Stanislaus River Exceedance Curve

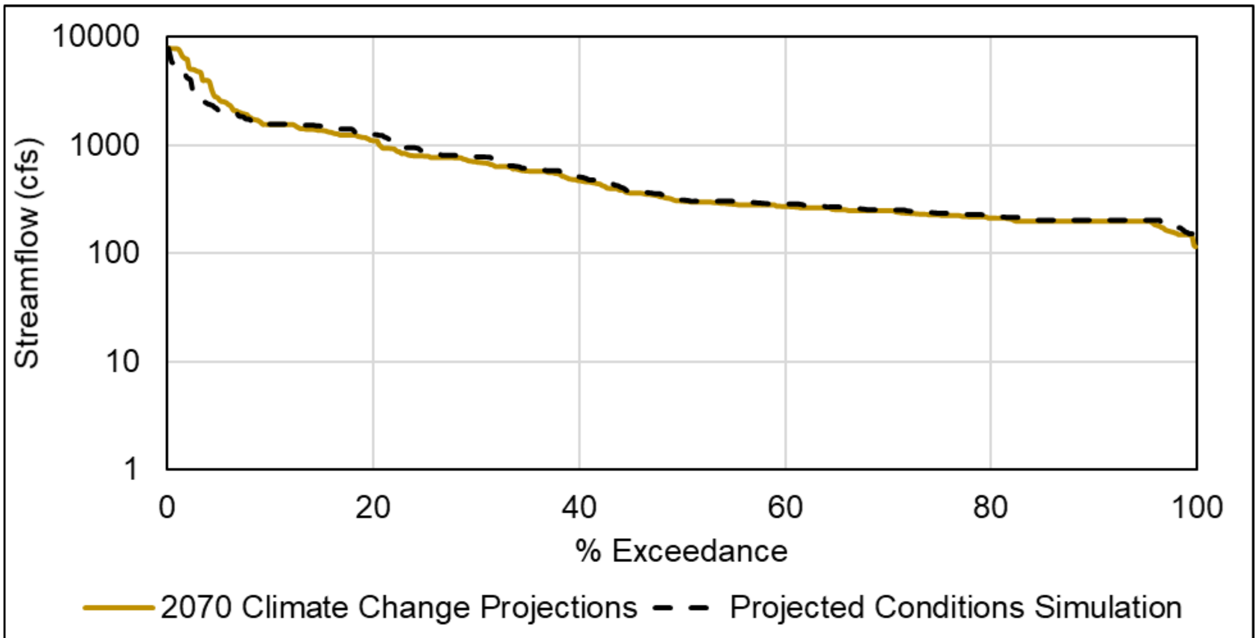


Figure 2-96: San Joaquin River Hydrograph

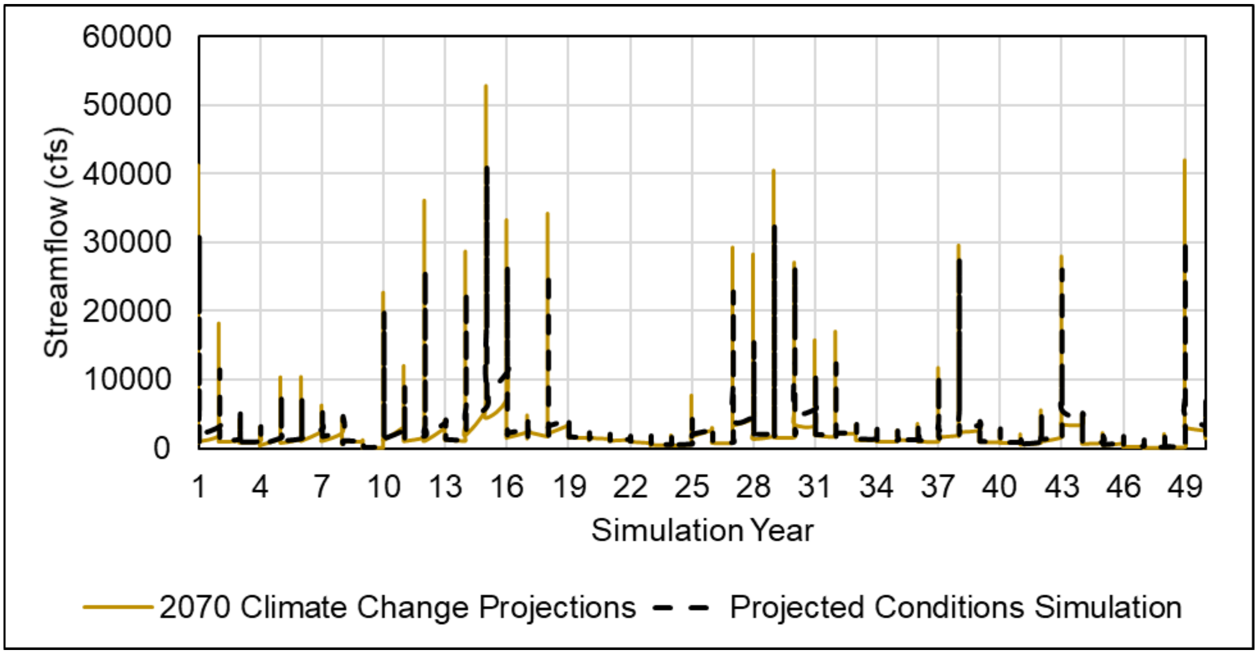
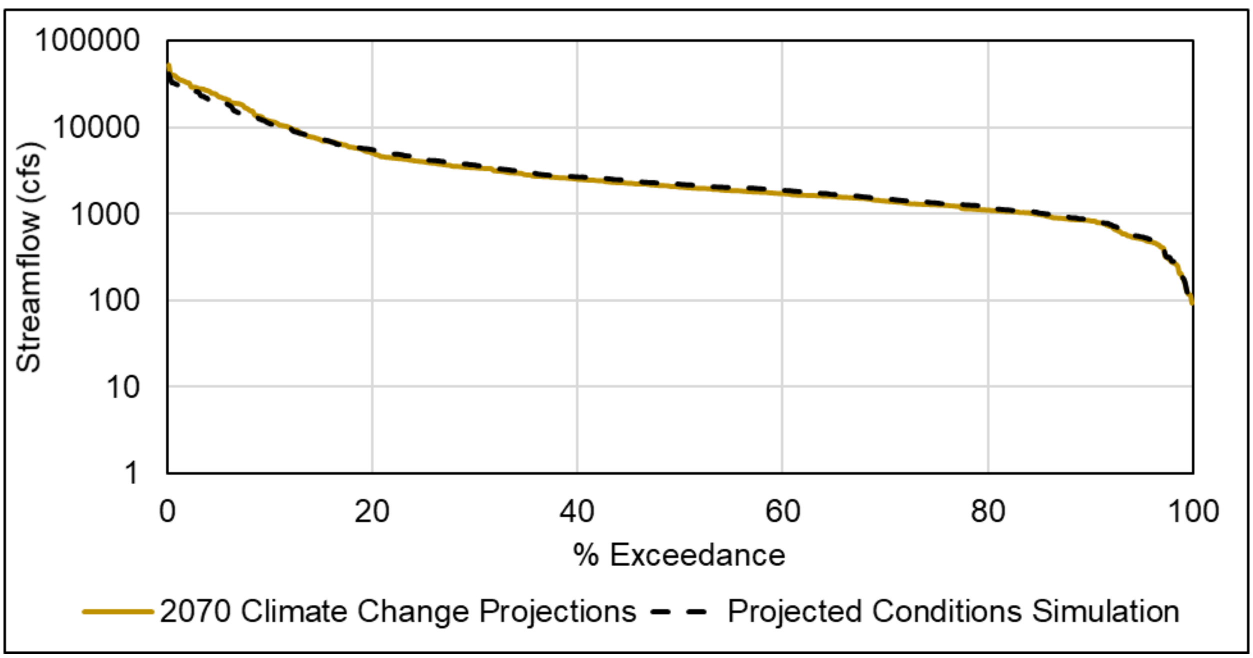


Figure 2-97: San Joaquin River Exceedance Curve



2.3.7.3.2 Precipitation and Evapotranspiration under Climate Change

Projected precipitation and evapotranspiration (ETo) change factors were calculated using a climate period analysis based on historical precipitation and ETo from January 1915 to December 2011 (CA DWR, 2018b). DWR used a macroscale hydrologic model that solves the water balance of a watershed, called the VIC Model. Change factors provided by DWR were calculated as a ratio of the value of a variable under a "future scenario" divided by a baseline. That baseline data is the 1995 Historical Temperature Detrended scenario downscaled from GCM climate data. The "future scenario" corresponds to VIC outputs of the simulation of future conditions using GCM forecasted hydroclimatic variables as inputs. These change factors are thus a simple perturbation factor that corresponds to the ratio of a future with climate change divided by the past without it. Change factors are available on a monthly time step and are spatially defined by the VIC model grid. Supplemental tables with the time series of perturbation factors are available from DWR for each grid cell. DWR has made accessible a Desktop GIS tool for both IWFM and MODFLOW to process these change factors (CA DWR, 2018c).

2.3.7.3.2.1 Applying Change Factors to Precipitation

DWR change factors were multiplied by historical precipitation to generate projected precipitation under the 2070 central tendency future scenario using the Desktop IWFM GIS tool (CA DWR, 2018c). The tool calculates an area weighted precipitation change factor for each model grid geometry. This model grid geometry was based on polygons generated around the PRISM nodes within the model region used to specify rainfall depths.

However, the DWR tool only includes change factors through 2011. The remaining 6 years of the time series were synthesized according to historically comparable water years. The perturbation factor from the corresponding month of the comparable year was applied to the baseline of the missing years (2012-2018) to generate projected values. Months with no precipitation in the baseline were assumed to have a monthly precipitation of 1 mm under climate change to account for increased precipitation that cannot be calculated from a baseline of 0 mm for these synthesized years. The comparable years that were used can be found in Table 2-24. These comparable years were determined by comparing total San Joaquin Valley runoff, DWR year type index, and total annual Subbasin precipitation.

Table 2-24: Comparable Water Years (Precipitation)

Water Year Not Available in DWR Tool	Comparable Water Year
2012	2001
2013	1991
2014	1987
2015	1977
2016	2002
2017	1983
2018	1983

The resulting perturbed precipitation values and the baseline precipitation values for the representative historical period can be found in Figure 2-98. The exceedance plot for these two times series can be found in Figure 2-99.

Figure 2-98: Perturbed Precipitation Under Climate Change

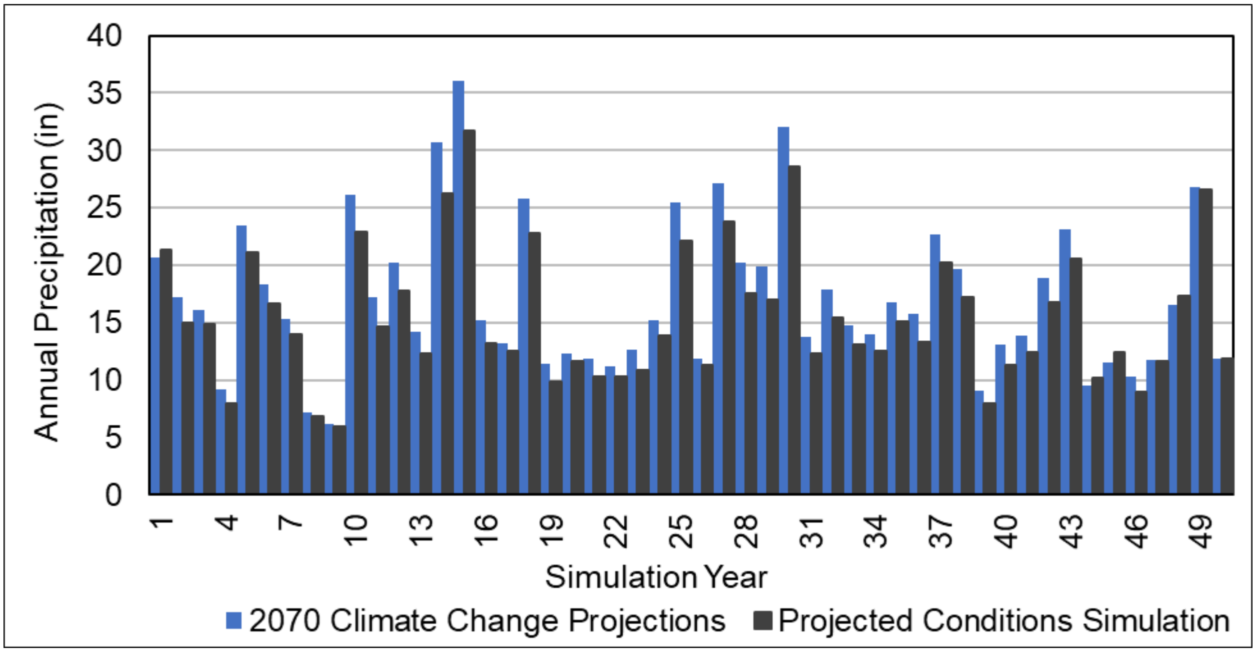
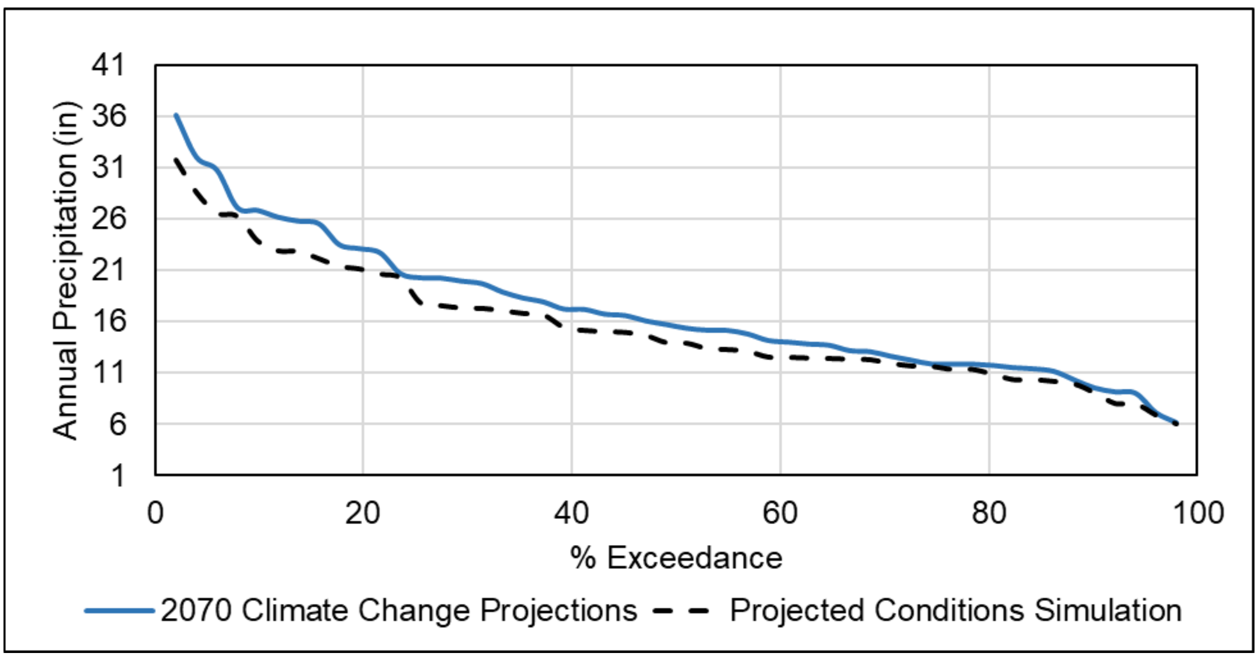


Figure 2-99: Perturbed Precipitation Exceedance Curve



2.3.7.3.2.2 Applying Change Factors to Evapotranspiration

Potential ETo in the Subbasin varies geographically and by land use. The tool provided by DWR to process ETo was not used because of the minimal spatial variation in ETo in the Subbasin. DWR provides change factors for ETo that vary spatially based on the VIC model grid as described above. Change factors for November 1, 1964 through December 1, 2011 were averaged. For the purposes of this analysis, a localized averaged change factor of 1.082 or 1.084 was used depending on the crop type.

This average ETo change factor was then applied to the historical ETo time series for each crop type. Because there is currently no interannual variability in ETo in ESJWRM, the same perturbed time series was applied across all simulation years. Refinement to the simulated evapotranspiration of almonds, walnuts, and cherries under 2070 climate conditions is shown in Figure 2-100 through Figure 2-103.

Figure 2-100: Monthly Evapotranspiration Variability for Almonds

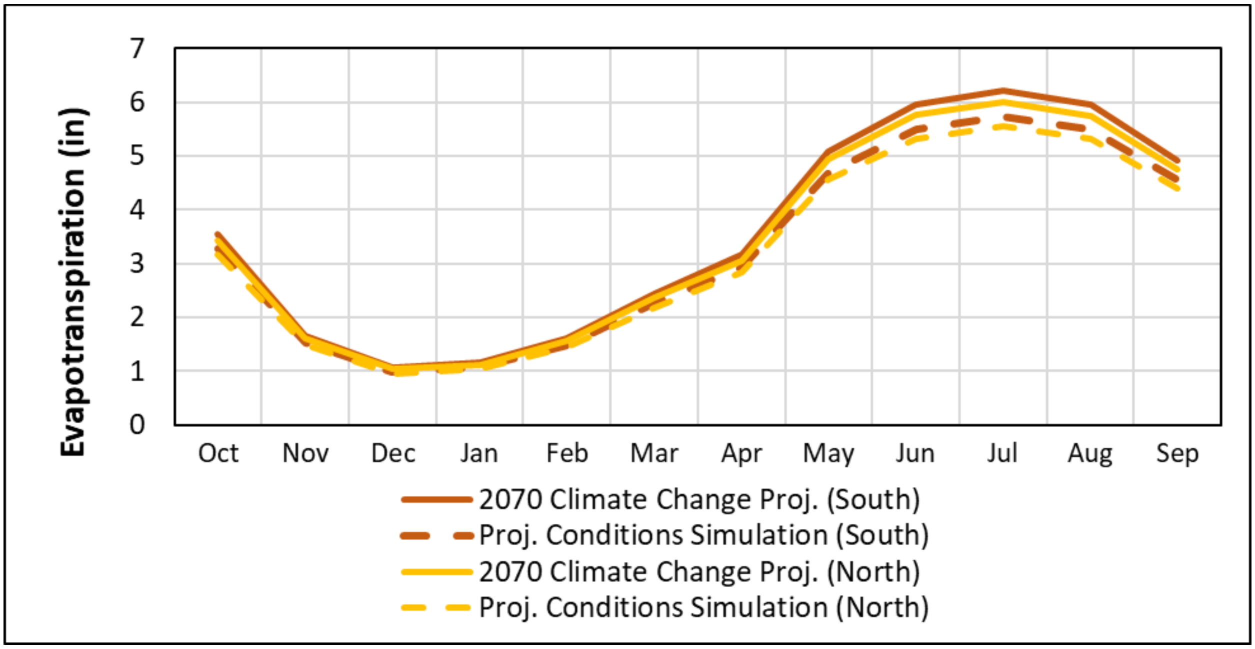


Figure 2-101: Monthly Evapotranspiration Variability for Walnuts

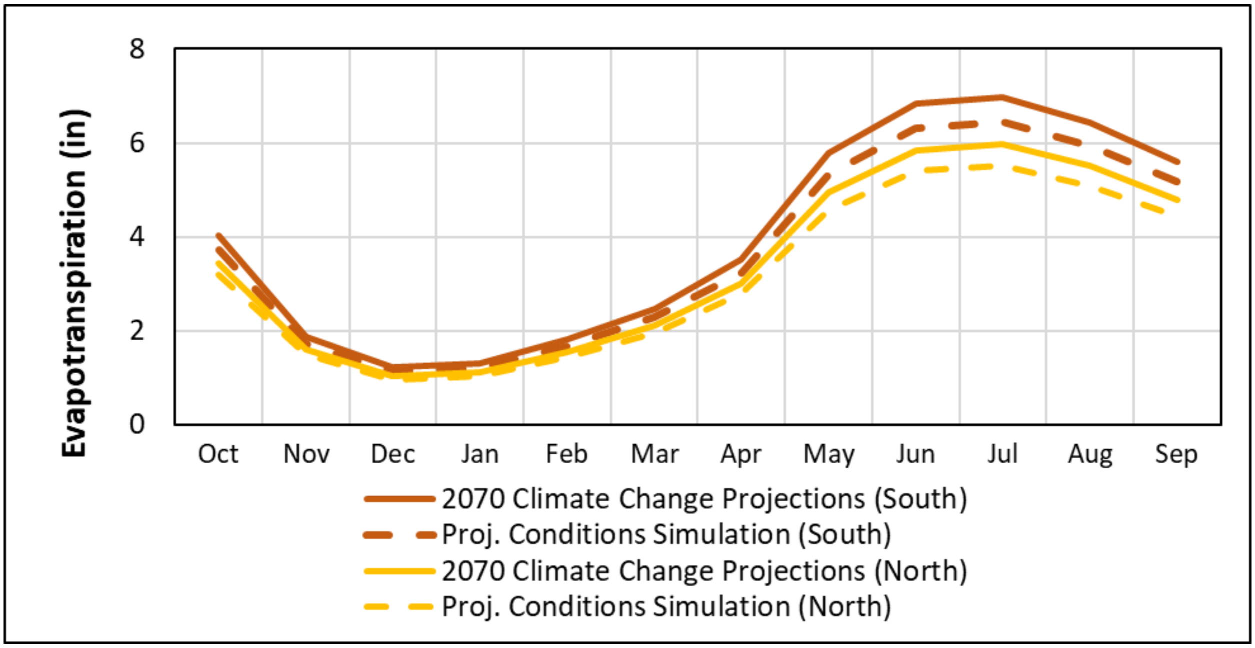


Figure 2-102: Monthly Evapotranspiration Variability for Cherries

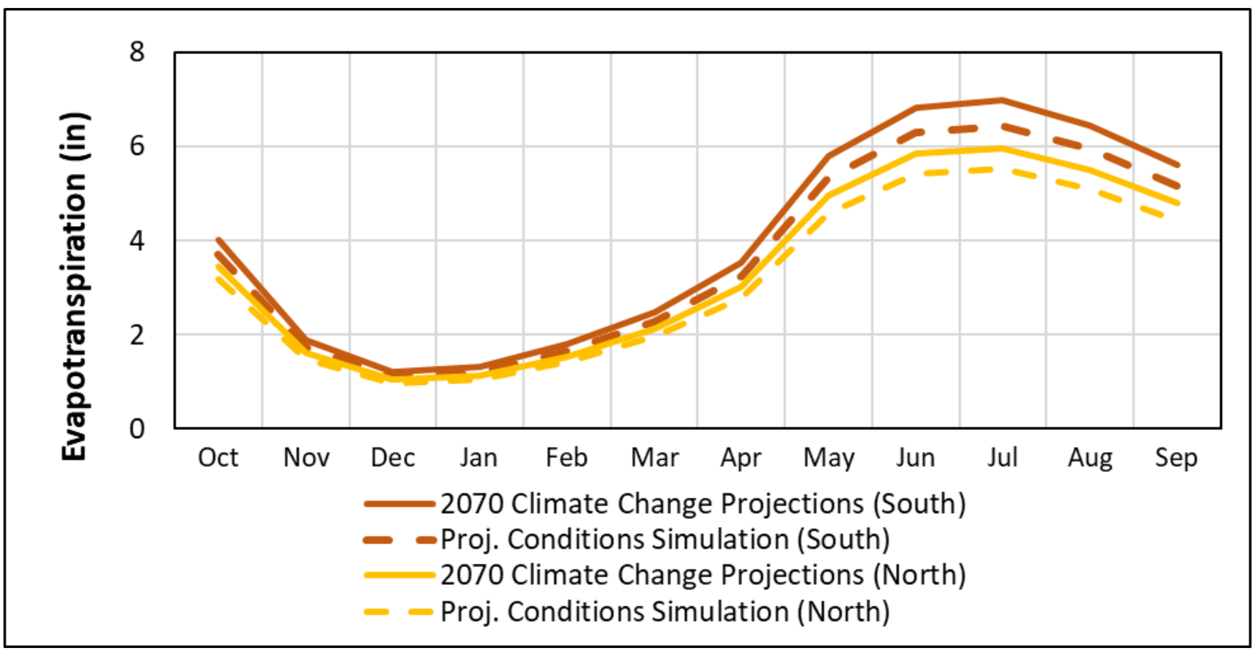
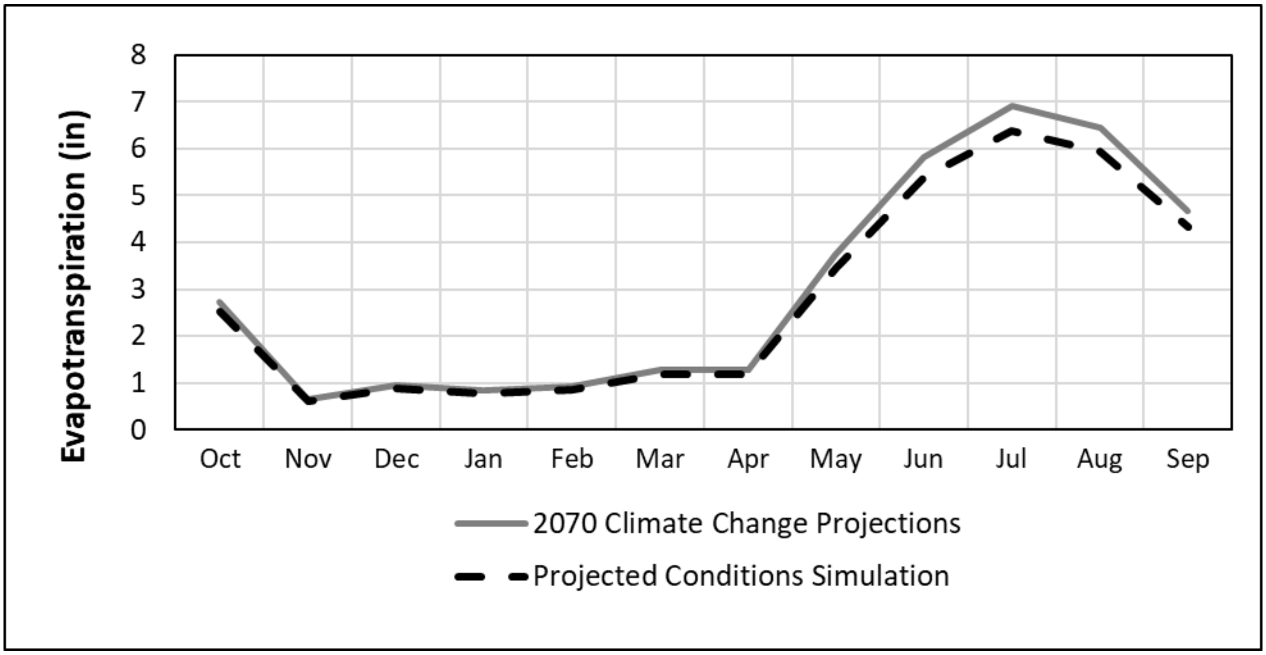


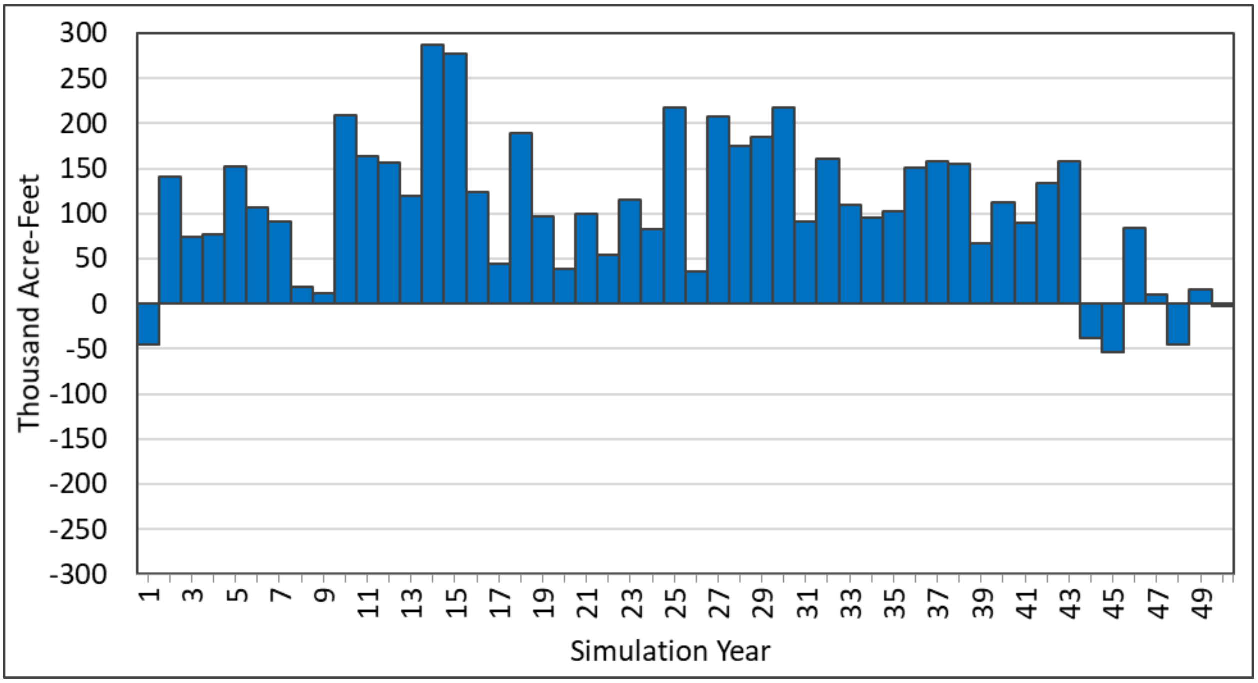
Figure 2-103: Monthly Evapotranspiration Variability for Vineyards



2.3.7.4 Eastern San Joaquin Water Budget Under Climate Change

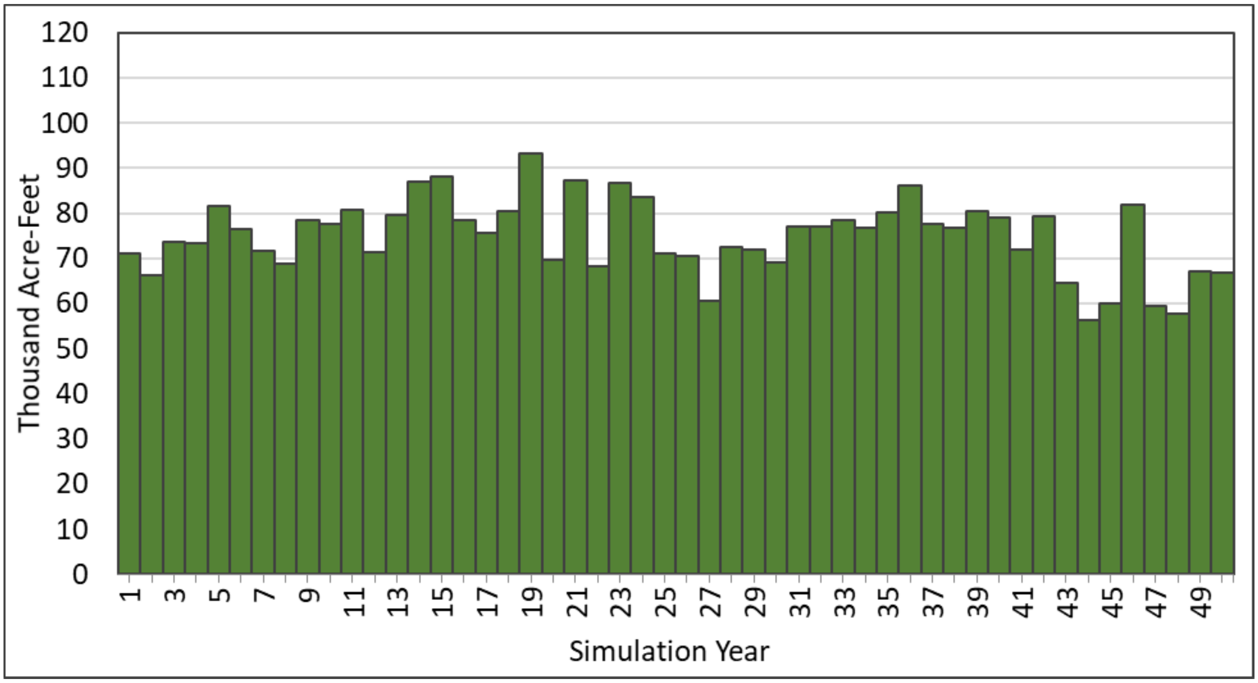
A climate change scenario was developed for the ESJWRM to evaluate the hydrological impacts under these climate change conditions. The analysis was based on the projected conditions scenario with climate change perturbed inputs for streamflow, precipitation, and ETo. Under the climate change scenario, the average annual precipitation is 11 percent higher than the projected conditions scenario, increasing from 984,000 AF/year to 1,090,000 AF/year. Similarly, the average annual volume of evapotranspiration is 6 percent higher than the projected conditions scenario, increasing to 1,476,000 AF/year from 1,394,000 AF/year. Despite there being higher flows in streams, the monthly timing of the flows meant that surface water diversions were not expected to change due to both availability of water in the stream and water rights agreements limiting diversion months. With a similar surface water supply and increased water demands under the climate change scenario, private groundwater production is simulated to increase approximately 11 percent, from 801,000 AF/year to 887,000 AF/year. Under climate change conditions, the depletion in aquifer storage is expected to increase by about 68 percent to an average annual storage change of 57,000 AF/year, from 34,000 AF/year in the projected conditions scenario. A graphical representation of simulated changes to precipitation, evapotranspiration, and groundwater pumping are presented in Figure 2-104 though Figure 2-106, and complete water budgets for the climate change scenario are shown in Figure 2-107 and Figure 2-108.

Figure 2-104: Simulated Changes in Precipitation due to Climate Change



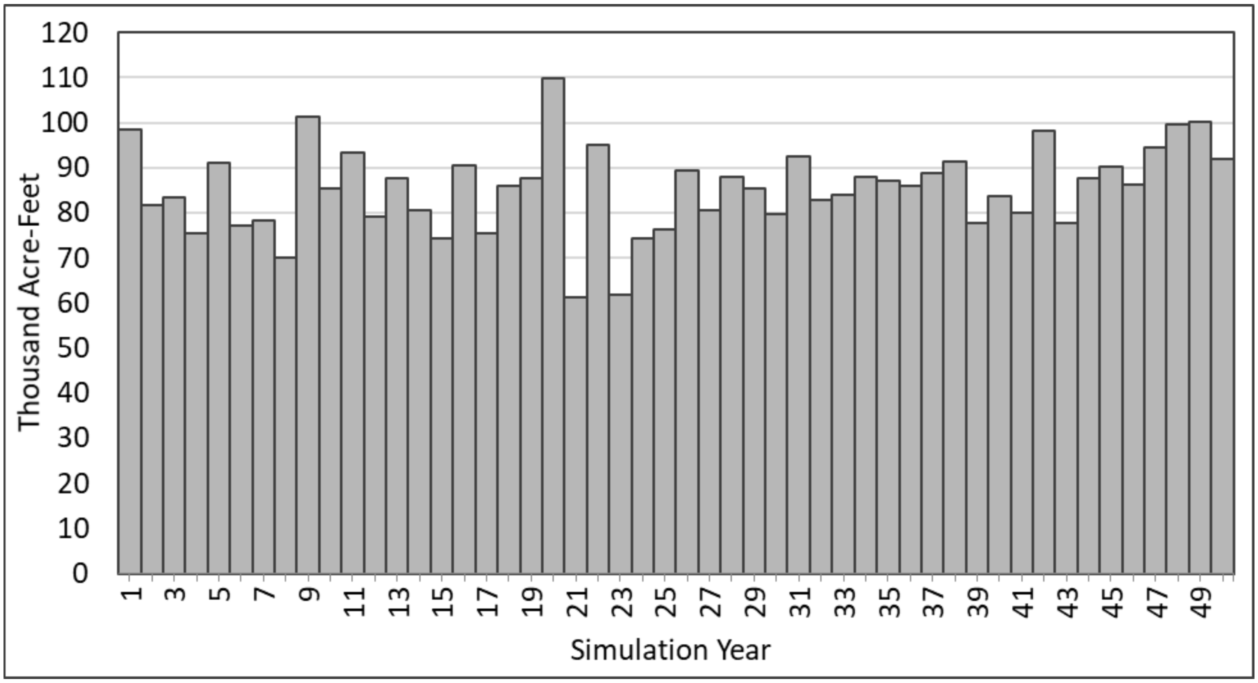
Note: Negative indicates projected conditions scenario value was larger and positive indicates climate change scenario was larger. The climate change scenario largely has more precipitation than the projected conditions scenario.

Figure 2-105: Simulated Changes in Evapotranspiration due to Climate Change



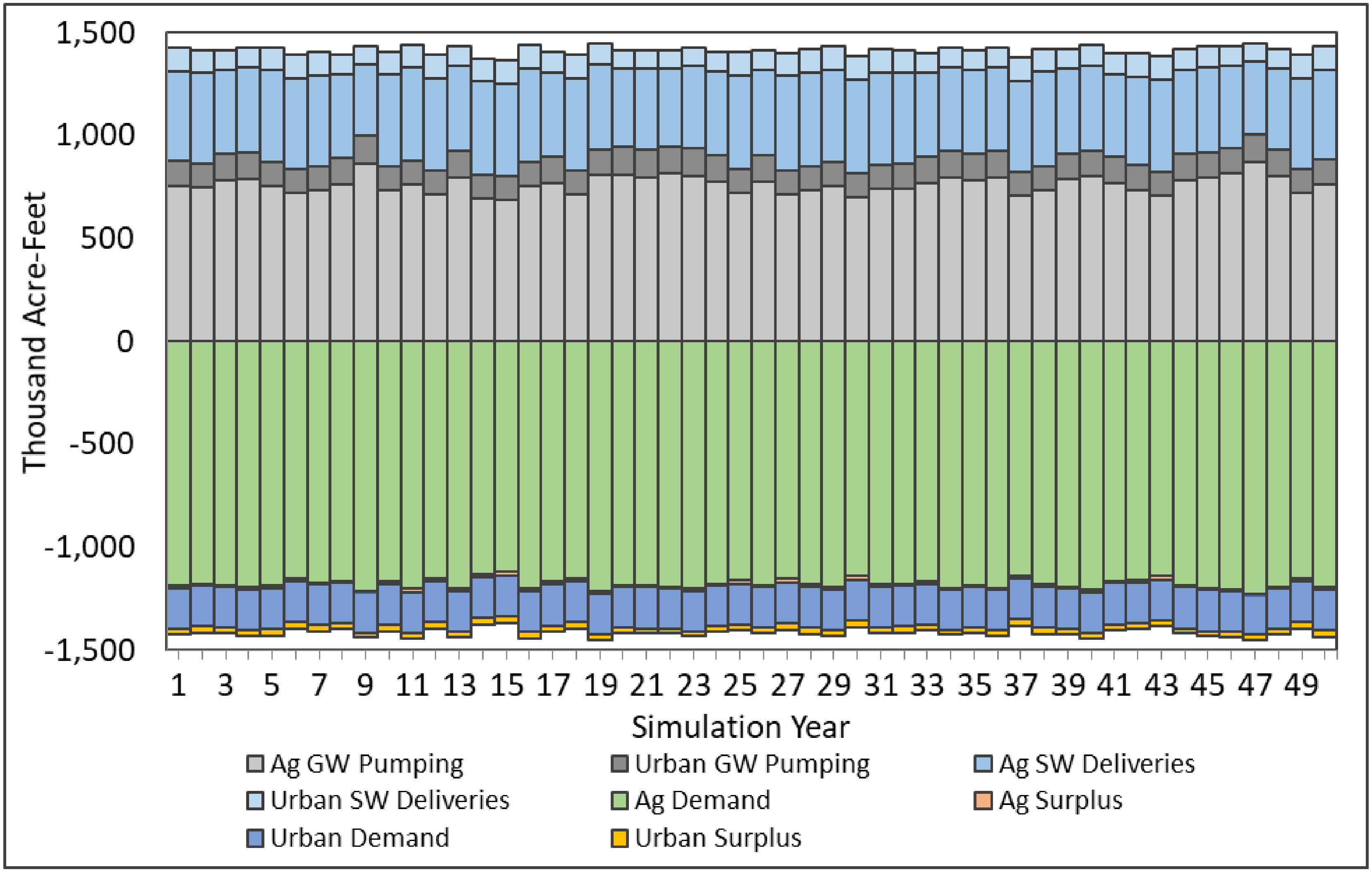
Note: Climate change scenario evapotranspiration is always larger than the projected conditions scenario for all simulated years.

Figure 2-106: Simulated Changes in Groundwater Pumping due to Climate Change



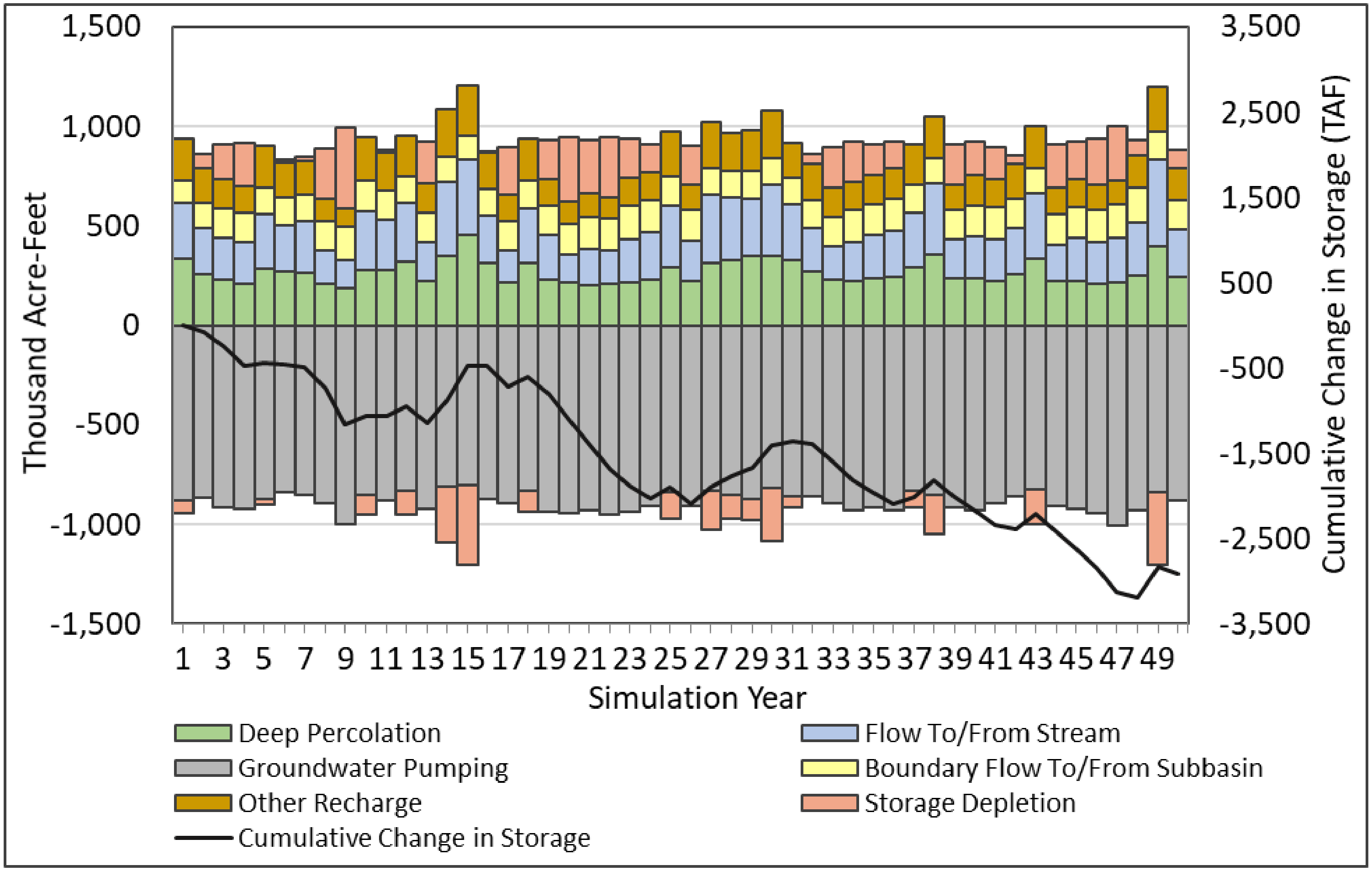
Note: Climate change scenario groundwater pumping is always larger than the projected conditions scenario for all simulated years.

Figure 2-107: Land and Water Use Budget – Climate Change Scenario



Note: Figure shows simplified annual climate change scenario land and water use budget results for the 50 years of the simulation. Water supplies are positive and are balanced by negative water demands and any water supply in excess of the demand.

Figure 2-108: Groundwater Budget – Climate Change Scenario



Notes:

1. Figure shows annual climate change scenario groundwater budget results for the 50 years of the simulation
2. "Other Recharge" includes managed aquifer recharge, recharge from unlined canals and/or reservoirs, and recharge from ungauged watersheds.
3. "Storage Depletion" is placed to balance the water budget. For instance, if annual outflows (-) are greater than inflows (+), there is a decrease in storage, but this would be shown on the positive side of the bar chart to balance out the increased outflows on the negative side of the bar chart.

2.3.7.5 Opportunities for Future Refinement

The approach developed for this GSP is based on the methodology in DWR's guidance document (CA DWR, 2018b) and uses "best available information" related to climate change in the Eastern San Joaquin Subbasin. There are limitations and uncertainties associated with the analysis. One important limitation is that CalSim II does not fully simulate local surface water operations. Thus, the analysis conducted for this GSP may not fully reflect how surface and groundwater basin operations would respond to the changes in water demand and availability caused by climate change. Mokelumne River flows are simulated under climate change as unimpaired in this analysis despite the influence of operations from Pardee and Camanche Reservoirs. This presents an opportunity in future efforts to improve the analysis to better project streamflow. However, for this GSP, use of a local model and the perturbation factor approach were deemed appropriate given the uncertainties in the climate change analysis.Projects and Management Actions Analysis

The ESJGWA received a Consultation Initiation Letter (Letter) from DWR on November 18, 2021 that identified two potential deficiencies with the GSP which may preclude DWR's approval, as well as potential corrective actions to address each potential deficiency. Potential Deficiency 1 related to the GSP's requirement of two consecutive non-dry (i.e., below normal, above normal, or wet) water year types and the exclusion of dry and critically dry water-year types in the identification of undesirable results. (Please see Chapter 3, Sustainable Management Criteria, for revisions that address this deficiency). Potential Deficiency 1 also requests additional detail on how projects and management actions, in conjunction with the proposed chronic lowering of groundwater levels sustainable management criteria, will offset drought related groundwater reductions and avoid significant and unreasonable impacts. Specifically, Potential Correction Action 1(b) stated that the GSP "fails to identify specific extraction and groundwater recharge management actions the GSAs would implement or otherwise describe how the Subbasin would be managed to offset...dry year reductions of groundwater storage". As a Potential Corrective Action, the following is suggested: "The GSP should be revised to include specific projects and management actions the GSAs would implement to offset drought year groundwater level declines." To address this corrective action, the PCBL and PCBL-CC were revised to include some of the projects and management actions (PMAs) included in Chapter 6, Projects and Management Actions, of this GSP.

As part of the process to respond to the identified deficiency, the ESJGWA worked with each GSA individually to update GSP project descriptions with new information that has become available in the past two years since the GSP was first adopted in 2020. These revised projects were then divided into two categories: Category A projects (projects that are likely to advance in the next five years and have existing water rights or agreements) and Category B projects (projects that are not anticipated to advance in the next five years, but could be leveraged in the future, particularly if Category A projects do not fully achieve stated recharge and/or offset targets or do not produce a response as simulated in the model). Category B projects may be elevated to a Category A project should feasibility studies demonstrate a viable project, if water rights or contracts are firmly identified, if partnerships are formed, and if economic evaluation demonstrate that the projects are cost effective.

The analysis conducted to address the Potential Corrective Action 1(b) focused on the simulation of implementing Category A projects, which includes in lieu and direct recharge projects. In total, 11 Category A projects were identified and simulated in the PCBL and PCBL-CC models (with simulations named PCBL-PMA and PCBL-CC-PMA, respectively). Six of the Category A projects are in-lieu recharge projects, three are direct recharge projects, and two are a combination of in-lieu recharge and direct recharge. Overall, the total additional surface water provided by Category A projects (either by in lieu or direct recharge) varies by water year type and ranges from 36,300 to 96,700 acre-feet per year (AFY) and is a mixture of deliveries to agricultural customers (including assumptions on evaporation and delivery losses), deliveries to urban customers, and direct recharge projects. A summary of the total additional water supply (excluding assumed losses) anticipated from Category A projects is below; detailed assumptions for the 11 Category A projects are summarized in Chapter 6, Projects and Management Actions, of this revised GSP and are documented in Appendix 2-B of this revised GSP.

- Additional surface water delivered to the Subbasin for agricultural uses: average of 39,700 AFY (range of 9,500-56,300 AFY)
- Additional surface water delivered to the Subbasin for urban uses: 5,000 AFY or 20,000 AFY in only dry and drought years, respectively
- Additional groundwater stored via direct groundwater recharge: average of 21,200 AFY (range of 6,500-32,000 AFY)

2.3.7.6 Projected Water Budget with PMAs Estimates

The results of the Subbasin ESJWRM Projected Condition BaseLine with Category A Projects and Management Actions (PCBL-PMA) are summarized below. Detailed results for the PCBL-PMA are included in Appendix 2-B of this revised GSP. As with the PCBL, the projected conditions with projects and management actions scenario of the ESJWRM assumes a 2040 level of development and hydrology from water years 1969-2020. A summary of the 11 Category A PMAs simulated as additional diversions in the PCBL-PMA model is provided in Table 2-25, along with fractions for recoverable loss (i.e., percolation or canal seepage), non-recoverable loss (i.e., evaporation), and delivery (i.e., amount delivered is equal to the total amount minus the recoverable and non-recoverable losses). The remaining 66 PCBL diversions are summarized in a separate document (Woodard & Curran, 2022).

2.3.7.6.1 Land and Water Use Water Budget

The land and water use budget for the PCBL-PMA includes two different versions, agricultural and urban, and represents the balance of the model-calculated water demands with the water supplied. Both the agricultural and urban versions include the same components that make up the water balance:

- Inflows:
  - Groundwater pumping
  - Surface water deliveries
  - Shortage (if applicable)
- Outflows:
  - Demand (either agricultural or urban)
  - Surplus (if applicable)

The average annual PCBL-PMA water demand for the Subbasin within the 52-year simulation period is 1,256,100 acre-feet per year (AFY), consisting of approximately 1,098,000 AFY of agricultural demand and 158,100 AFY of urban demand. This demand is met by an annual average of 571,100 AFY of surface water deliveries (490,400 AFY of agricultural and 80,700 AFY of urban deliveries) and is supplemented by 704,400 AFY of groundwater production (627,200 AFY of agricultural and 77,200 AFY of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is 19,600 AFY of surplus in the Subbasin-scale agricultural water supply, which is insignificant relative to the total volume of water use. Shortage and surplus represent a misalignment between the reported, estimated, or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus. These annual averages are shown in Table 2-26. The annual land and water use budgets across the ESJ Subbasin are shown in Figure Figure 2-109 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands plotted with water supplies.

Table 2-26 also includes the PCBL results and a Category A projects benefit calculated as the PCBL-PMA results minus the PCBL results. The PCBL-PMA has an average of 37,600 AFY more surface water for agricultural purposes and 5,100 AFY more surface water for urban areas compared to the PCBL. For urban areas, this represents a comparable reduction in groundwater pumping of 5,000 AFY. For agricultural areas, the increased surface water results in 33,400 AFY less groundwater pumping, a number smaller than the amount of surface water provided due to a mismatch between the Category A water supplied and model-calculated agricultural demand on a monthly basis.

Table 2-25: Summary of ESJWRM Category A Projects Surface Water Deliveries

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Average Annual Diversion*** (acre-feet)
					RL*	NL**	Delivery	
67	Stockton East WD Lake Grupe In-Lieu Recharge	Calaveras River	Approximately 1,750 acres of orchards surrounding Lake Grupe in SEWD	Ag	0%	0%	100%	4,300
68	Stockton East WD Surface Water Implementation Expansion	Import (outside of ESJWRM)	Approximately 6,750 acres adjacent to surface water conveyance systems in SEWD	Ag	0%	0%	100%	13,400
69	Stockton East WD West Groundwater Recharge Basin	Import (outside of ESJWRM)	Recharge basin near SEWD water treatment plant	Recharge	100%	0%	0%	10,200
70	Central San Joaquin WCD Capital improvement Program	Import (outside of ESJWRM)	CSJWCD	Ag	15%	2%	83%	20,300
71	Long-term Water Transfer to Stockton East WD for M&I	Import (outside of ESJWRM)	City of Stockton area urban users	Urban	0%	0%	100%	11,500
72	City of Lodi White Slough Water Pollution Control Facility Expansion	Import (outside of ESJWRM)	890 acres of agricultural land surrounding White Slough Pollution Control Facility	Ag	4%	2%	100%	3,700
73	North San Joaquin WCD South System Modernization	Mokelumne River	NSJWCD South System	Ag	50%	0%	50%	5,500
74	North San Joaquin WCD Tecklenburg Recharge Project	Mokelumne River	Recharge basin located in NSJWCD South System	Recharge	100%	0%	0%	4,100

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Average Annual Diversion*** (acre-feet)
					RL*	NL**	Delivery	
75	North San Joaquin WCD South System Groundwater Banking with EBMUD	Mokelumne River	NSJWCD South System	Ag	50%	0%	50%	5,600
76	North San Joaquin WCD North System Modernization/Lasko Recharge	Mokelumne River	NSJWCD North System	Ag	50%	0%	50%	2,600
77	City of Stockton Delta Water Treatment Plant Groundwater Recharge Improvements Project Geotechnical Investigation	Import (outside of ESJWRM)	Recharge basin adjacent to Delta Water Treatment Plant	Recharge	100%	0%	0%	5,000

*RL = Recoverable Loss (canal seepage or recharge)

**NL = Non-Recoverable Loss (evaporation)

*** Averages calculated only for years with diversions occurring (i.e., non-zero average)

Table 2-26: Eastern San Joaquin Subbasin Land and Water Use Budget Annual Average Comparison Between the PCBL (Version 2.0) and the PCBL-PMA

Land and Water Use Budget Component	Annual Average		
	PCBL (Version 2.0)	PCBL-PMA	PMA Benefit (PCBL-PMA minus PCBL)
Agricultural Area (thousand acres)	359	359	0
Agricultural Demand (AFY)	1,099,900	1,098,000	-1,900
Agricultural Groundwater Pumping (AFY)	660,600	627,200	-33,400
Agricultural Surface Water Deliveries (AFY)	452,800	490,400	37,600
Agricultural Shortage (AFY)[1]	-13,500	-19,600	-6,100
Urban Area (thousand acres)	153	153	0
Urban Demand (AFY)	158,100	158,100	0
Urban Groundwater Pumping (AFY)	82,200	77,200	-5,000
Urban Surface Water Deliveries (AFY)	75,600	80,700	5,100
Urban Shortage (AFY)[1]	300	200	-100

1 Shortage and surplus represent a misalignment between the reported, estimated or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the historical model, this can occur when there are inaccuracies in the reported water supplies or uncertainties in the methodology and/or parameters used to calculate the demand. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus.

Figure 2-109: Eastern San Joaquin Subbasin Projected Agricultural Demand in the PCBL-PMA

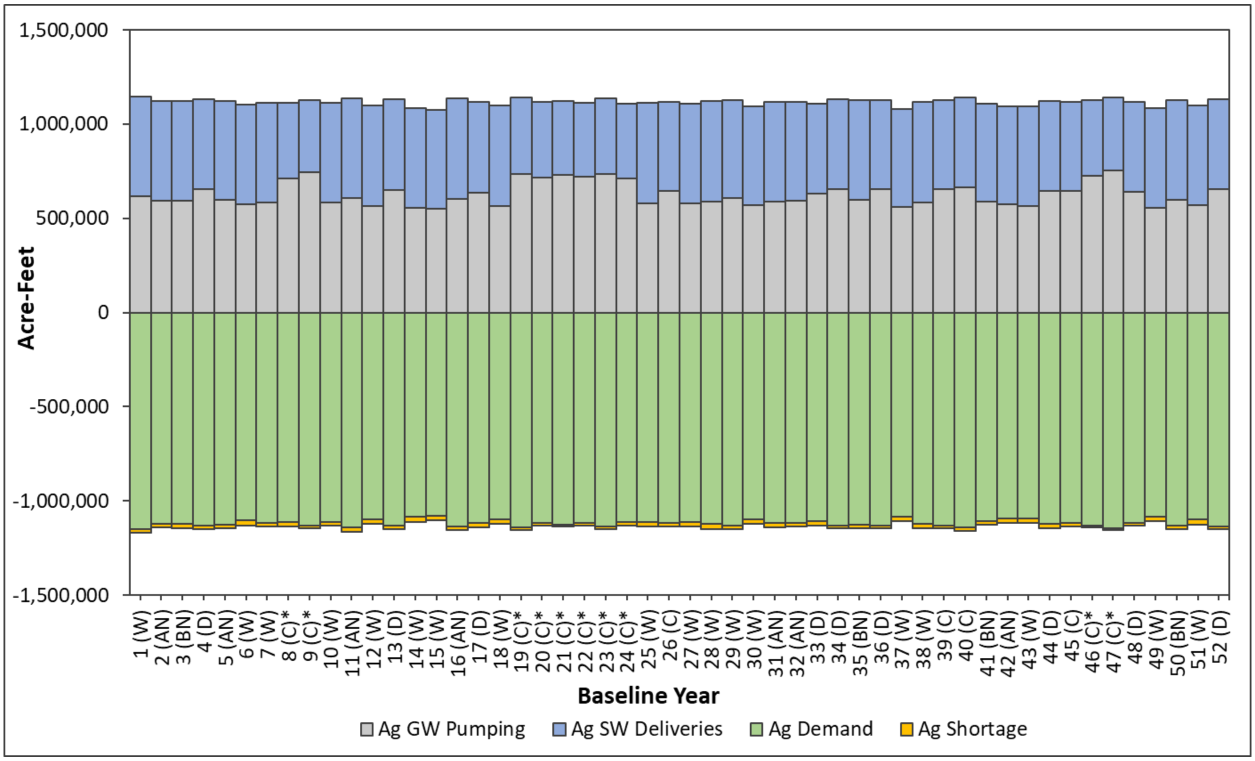
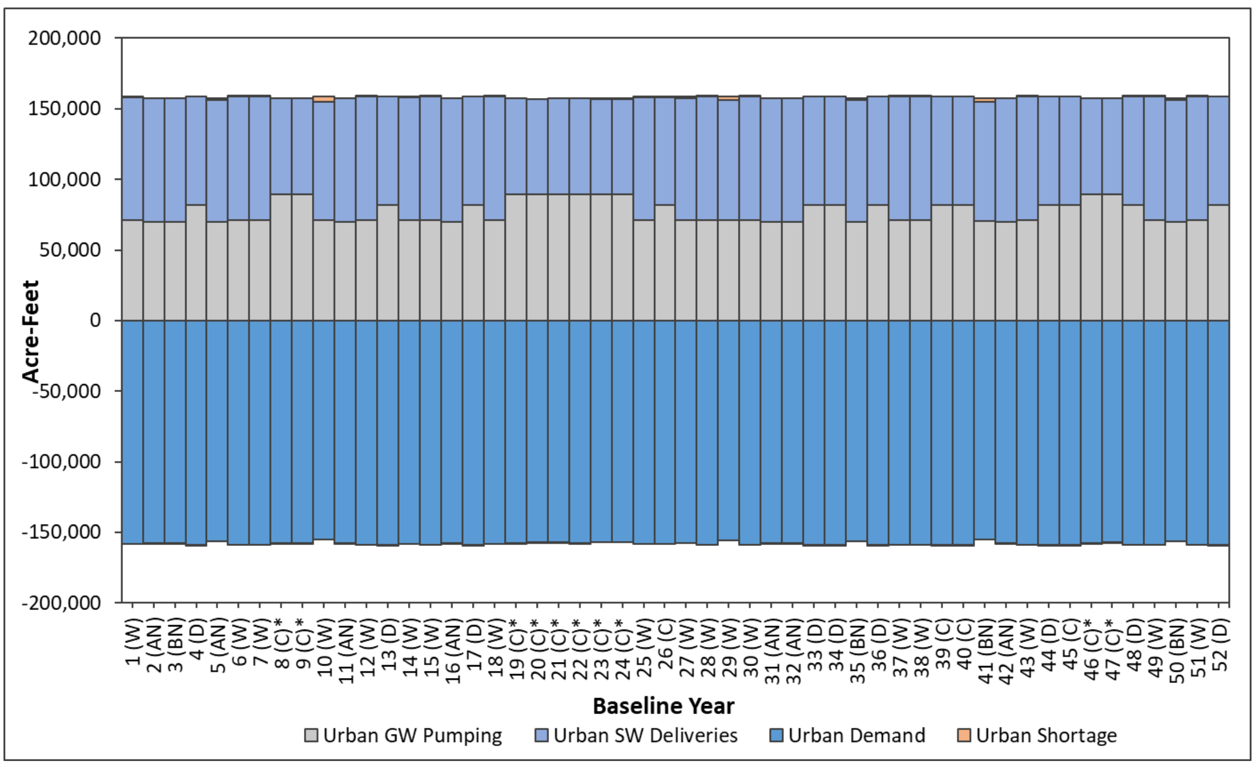


Figure 2-110: Eastern San Joaquin Subbasin Projected Urban Demand in the PCBL-PMA



2.3.7.6.2 Hydrologic Groundwater Budget

The primary components of the groundwater budget are the same as represented in the historical model. Corresponding to the major hydrologic processes affecting groundwater flow in the Subbasin, these are:

- Inflows:
    - Deep percolation (from rainfall and irrigation applied water)
    - Gain from stream (or recharge due to stream seepage)
    - Boundary inflow (from surrounding groundwater subbasins and the Sierra Nevada Mountains)
    - Other Recharge (from other sources such as irrigation canal seepage, managed aquifer recharge projects, and reservoir seepage)
- Outflows:
    - Groundwater pumping
    - Loss to stream (or outflow to streams and rivers)
    - Boundary outflow (to surrounding groundwater subbasins)
    - Change in groundwater storage (can be either an inflow or outflow)

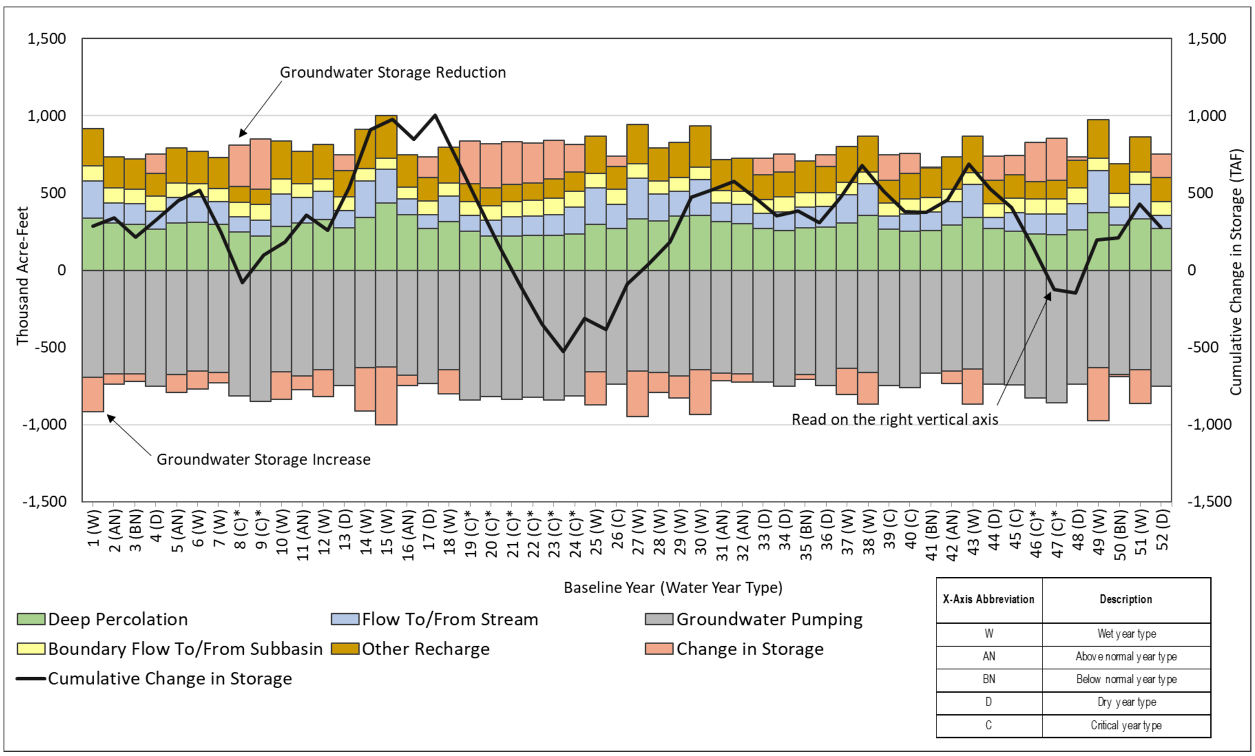
Pumping in the PCBL-PMA remains the largest component in the groundwater budget with an annual average 712,900 AFY. The PCBL-PMA offsets this pumping with 290,100 AFY of deep percolation, a net gain from stream of 151,800 AFY, 186,200 AFY of other recharge, and a total subsurface inflow of 90,100 AFY. The cumulative change in groundwater storage can be calculated from the annual change in groundwater storage. Due to inherent uncertainties in model input data, calculations, and calibration, all budget components have a degree of uncertainty. Given this uncertainty, the projected long-term average annual the groundwater storage deficit in ESJ Subbasin in the PCBL-PMA is -5,300 AFY, with the negative sign actually indicating an absence of groundwater overdraft and an increase in storage over the 52 years of the PCBL-PMA. These annual averages are shown in Table 2-27 The groundwater budgets, with average cumulative change in storage, are shown for the ESJ Subbasin in Figure 2-111.

Table 2-27 also includes the PCBL results and a Category A projects benefit calculated as the PCBL-PMA results minus the PCBL results. The results indicate that the Category A projects will resolve the PCBL Subbasin overdraft condition when impacts due to climate change are not included. Without projects, the modeling shows an average overdraft of 16,300 AFY over the 52 years of the PCBL simulation. With Category A projects in place, the modelling shows a projected overdraft of -5,300 AFY on average in the PCBL-PMA. The PCBL-PMA shows an average increase of 21,600 AFY of groundwater in storage when compared to the PCBL. Compared to the PCBL, with Category A projects modeled, the PCBL-PMA has 38,400 AFY less groundwater pumping due to the new in-lieu recharge projects, 24,500 AFY more recharge (both direct recharge projects and canal seepage losses for the in-lieu recharge projects), and 28,900 AFY less stream seepage into the groundwater system due to higher groundwater levels. Other hydrologic groundwater budget component differences are small between the PCBL and PCBL-PMA simulations.

Table 2-27: Eastern San Joaquin Subbasin Hydrologic Groundwater Budget Annual Average Comparison Between the PCBL (Version 2.0) and the PCBL-PMA

Hydrologic Groundwater Budget Component	Annual Average		
	PCBL (Version 2.0)	PCBL-PMA	PMA Benefit (PCBL-PMA minus PCBL)
Deep Percolation (AF)	282,100	290,100	8,000
Other Recharge (AF)	161,700	186,200	24,500
Net Stream Seepage (AF)	180,700	151,800	-28,900
Net Boundary Inflow (AF)	110,400	90,100	-20,300
Groundwater Pumping (AF)	751,300	712,900	-38,400
Change in Groundwater Storage (AF)	16,300	-5,300	-21,600

Figure 2-111: Eastern San Joaquin Subbasin Projected Hydrologic Groundwater Budget in the PCBL-PMA



2.3.7.7 Projected Water Budget with Climate Change and PMAs Estimates

The results of the Subbasin ESJWRM Projected Condition BaseLine with Climate Change and Category A Projects and Management Actions (PCBL-CC-PMA) are summarized below. Detailed results for the PCBL-CC- PMA are included in Appendix 2-B of this revised GSP. As with the PCBL-CC, the projected conditions with climate change and projects and management actions scenario of the ESJWRM assumes a 2040 level of development and hydrology from water years 1969-2020 with the 2070 Central Tendency climate change dataset. A summary of the 11 Category A PMAs simulated as additional diversions in the PCBL-CC- PMA model is provided in Table 2-25, along with fractions for recoverable loss (i.e., percolation or canal seepage), non-recoverable loss (i.e., evaporation), and delivery (i.e., amount delivered is equal to the total amount minus the recoverable and non-recoverable losses). The remaining 66 PCBL diversions are summarized in a separate document (Woodard & Curran, 2022).

2.3.7.7.1 Land and Water Use Water Budget

The land and water use budget includes two different versions, agricultural and urban, and represents the balance of the model-calculated water demands with the water supplied. Both the agricultural and urban versions include the same components that make up the water balance:

- Inflows:
  - Groundwater pumping
  - Surface water deliveries
  - Shortage (if applicable)
- Outflows:
  - Demand (either agricultural or urban)
  - Surplus (if applicable)

The average annual PCBL-CC-PMA water demand for the Subbasin within the 52-year simulation period is 1,337,800 AFY, consisting of approximately 1,179,700 AFY of agricultural demand and 158,100 AFY of urban demand. This demand is met by an annual average of 570,700 AFY of surface water deliveries (490,200 AFY of agricultural and 80,500 AFY of urban deliveries) and is supplemented by 785,600 AFY of groundwater production (708,400 AFY of agricultural and 77,200 AFY of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is about 19,000 AFY of surplus in the Subbasin scale agricultural water use budget, which is insignificant relative to the total volume of water use. Shortage and surplus represent a misalignment between the reported, estimated, or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus. These annual averages are shown in Table 2-28. The annual land and water use budgets across the ESJ Subbasin are shown in Figure 2-112 and Figure 2-113 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands plotted with water supplies.

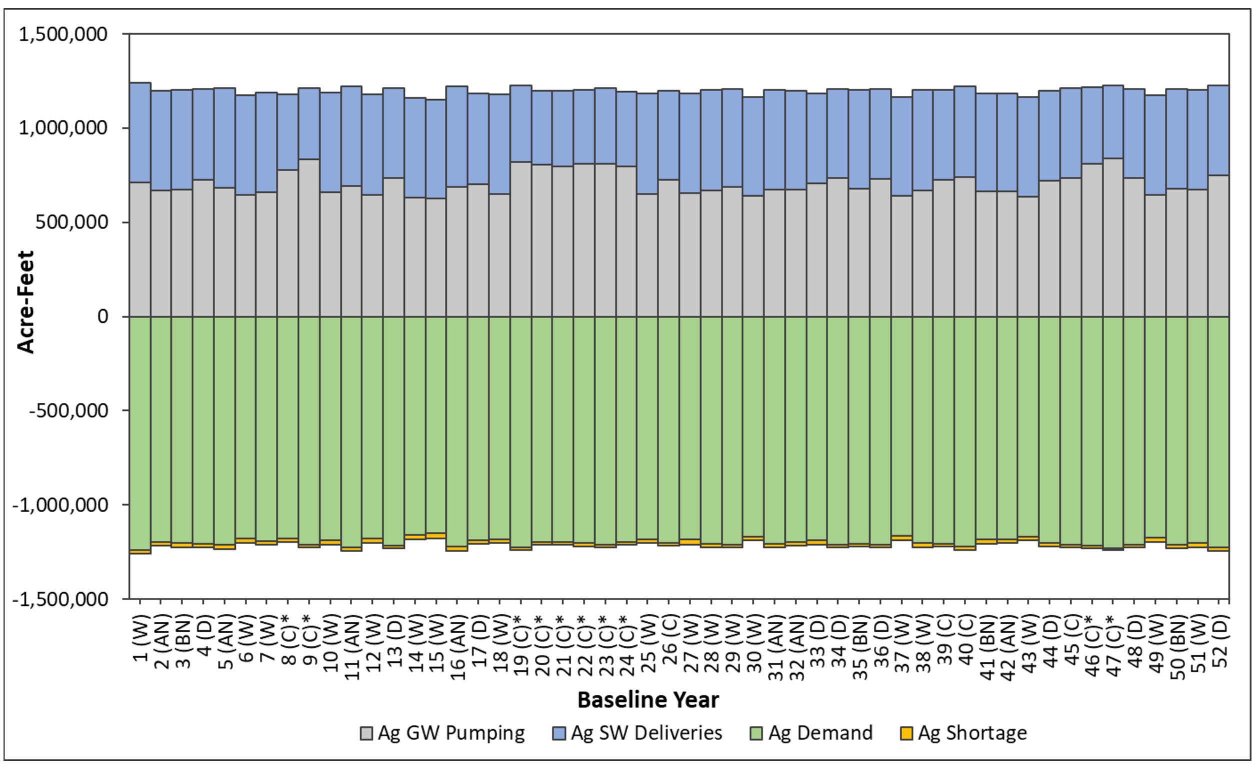
Table 2-28 also includes the PCBL-CC results and a Category A projects benefit calculated as the PCBL-CC-PMA results minus the PCBL-CC results. The PCBL-CC-PMA has an average of 37,800 AFY more surface water for agricultural purposes and 5,000 AFY more surface water for urban areas compared to the PCBL-CC. For urban areas, this represents an equivalent reduction in groundwater pumping of 5,000 AFY. For agricultural areas, the increased surface water results in 34,000 AFY less groundwater pumping, a number smaller than the amount of surface water provided due to a mismatch between the Category A water supplied and model-calculated agricultural demand on a monthly basis.

Differences between the amount of surface water supplied for PCBL-PMA and PCBL-CC-PMA are due to differences in the amount of surface water available in streams impacted by climate change. These differences are small (less than 200 AFY) between results in Table 2-26 and Table 2-28.

Table 2-28: Eastern San Joaquin Subbasin Land and Water Use Budget Annual Average Comparison Between the PCBL-CC and the PCBL-CC-PMA

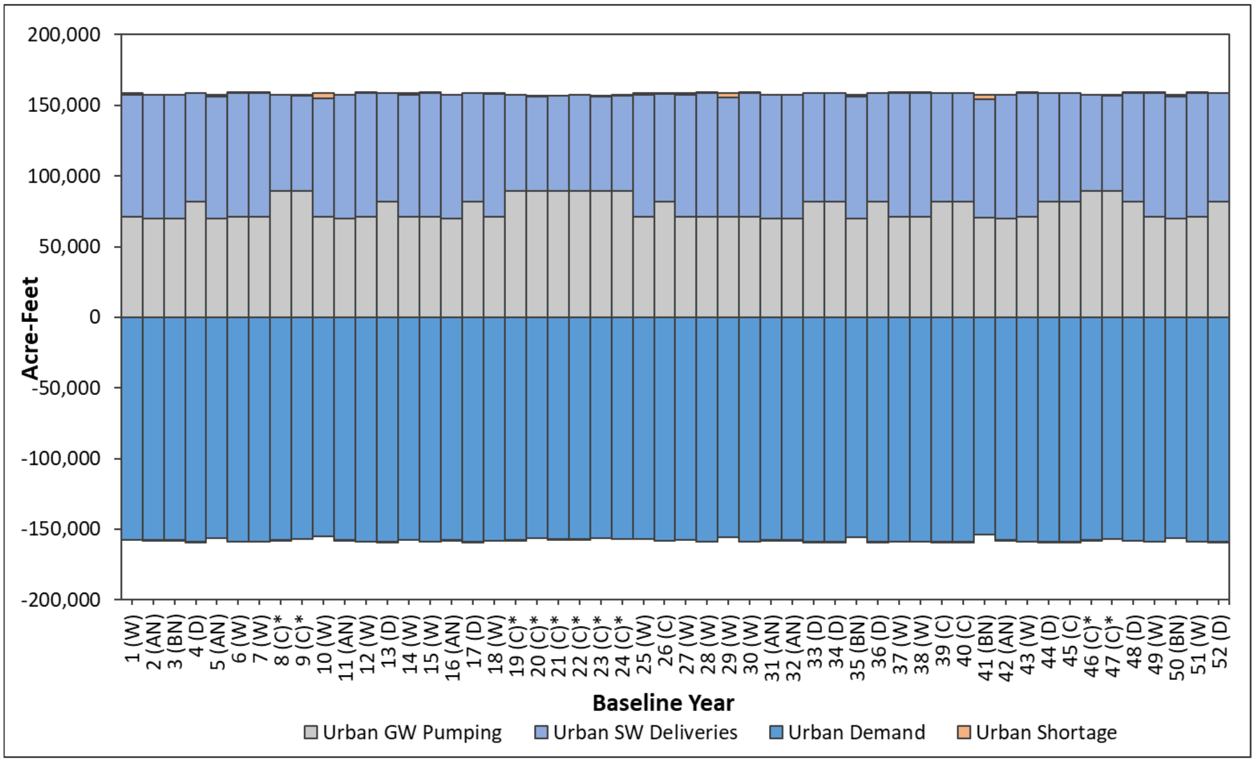
Land and Water Use Budget Component	Annual Average		
	PCBL-CC	PCBL-CC-PMA	PMA Benefit (PCBL-CC-PMA minus PCBL-CC)
Agricultural Area (thousand acres)	359	359	0
Agricultural Demand (AF)	1,181,300	1,179,700	-1,600
Agricultural Groundwater Pumping (AF)	742,400	708,400	-34,000
Agricultural Surface Water Deliveries (AF)	452,400	490,200	37,800
Agricultural Shortage (AF)[1]	-13,500	-18,900	-5,500
Urban Area (thousand acres)	153	153	0
Urban Demand (AF)	158,100	158,100	0
Urban Groundwater Pumping (AF)	82,200	77,200	-5,000
Urban Surface Water Deliveries (AF)	75,500	80,500	5,000
Urban Shortage (AF)[1]	400	400	0

Figure 2-112: Eastern San Joaquin Subbasin Projected Agricultural Demand in the PCBL-CC-PMA



[1] Shortage and surplus represent a misalignment between the reported, estimated or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the historical model, this can occur when there are inaccuracies in the reported water supplies or uncertainties in the methodology and/or parameters used to calculate the demand. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus.

Figure 2-113: Eastern San Joaquin Subbasin Projected Urban Demand in the PCBL-CC-PMA



2.3.7.7.2 Hydrologic Groundwater Budget

The primary components of the groundwater budget are the same as represented in the historical model. Corresponding to the major hydrologic processes affecting groundwater flow in the Subbasin, these are:

- Inflows:
  - Deep percolation (from rainfall and irrigation applied water)
  - Gain from stream (or recharge due to stream seepage)
  - Boundary inflow (from surrounding groundwater subbasins and the Sierra Nevada Mountains)
  - Other Recharge (from other sources such as irrigation canal seepage, managed aquifer recharge projects, and reservoir seepage)
- Outflows:
  - Groundwater pumping
  - Loss to stream (or outflow to streams and rivers)
  - Boundary outflow (to surrounding groundwater subbasins)
  - Change in groundwater storage (can be either an inflow or outflow)

Pumping in the PCBL-CC-PMA remains the largest component in the groundwater budget with an annual average 794,100 AFY. The PCBL-CC-PMA offsets this pumping with 293,000 AFY of deep percolation, a net gain from stream of 189,800 AFY, 189,900 AFY of other recharge, and a total subsurface inflow of 105,700 AFY annually. The cumulative change in groundwater storage can be calculated from the annual change in groundwater storage. Due to inherent uncertainties in model input data, calculations, and calibration, all budget components have a degree of uncertainty.

Given this uncertainty, the projected long-term average annual the groundwater storage deficit in ESJ Subbasin in the PCBL-CC-PMA is 15,700 AFY, indicating that groundwater overdraft is still occurring even with the Category A projects due to the impacts climate change on the Subbasin. These annual averages are shown in Table 2-29 The groundwater budgets, with average cumulative change in storage, are shown for the ESJ Subbasin in Figure 2-114

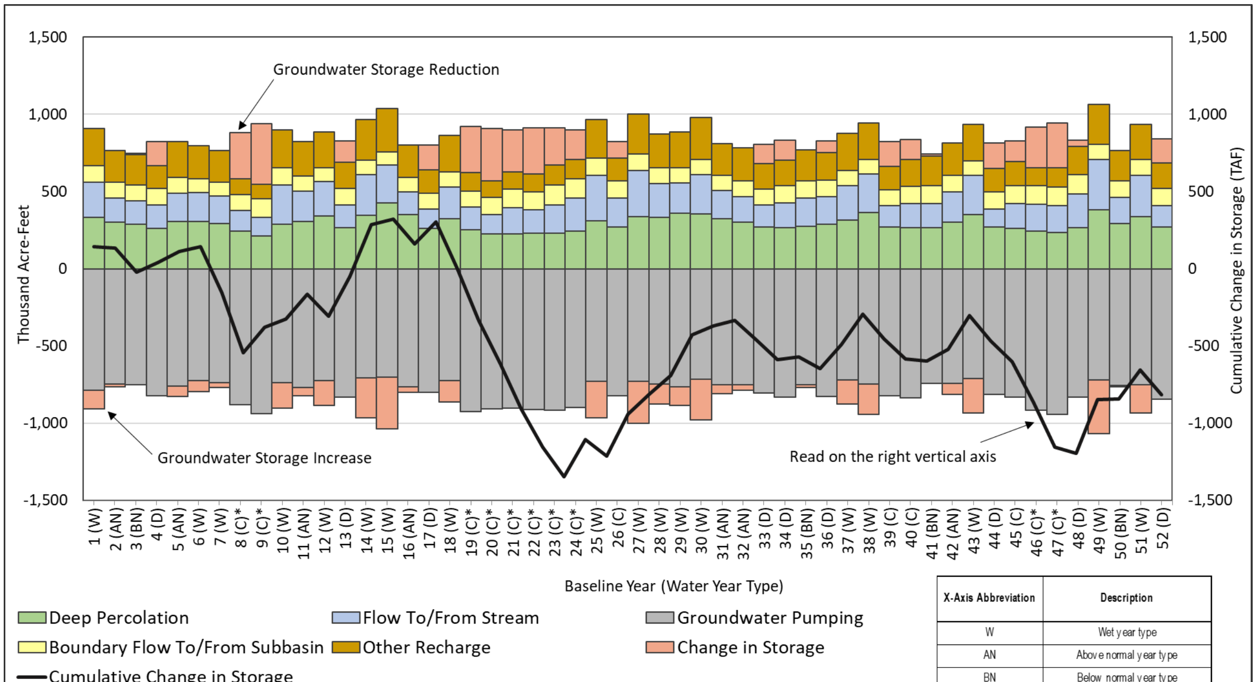
Table 2-29 also includes the PCBL results and a Category A projects benefit calculated as the PCBL-PMA results minus the PCBL results. While the groundwater storage deficit in the PCBL is projected to be corrected through the implementation of Category A projects as seen in PCBL-PMA, the modeling shows that when climate change is factored in for the PCBL-CC-PMA, there is still additional work (e.g., projects and/or management actions) that may need to be done to maintain subbasin sustainability. The PCBL-CC has a projected overdraft of 38,100 AFY. When projects are added in, as simulated in PCBL-CC-PMA, this overdraft amount is reduced to 15,700 AFY, but still represents continuing groundwater overdraft in the Subbasin that is not sustainable.

Compared to the PCBL-CC, with Category A projects modeled, the PCBL-CC-PMA has 39,000 AFY less groundwater pumping due to the new in-lieu recharge projects, 24,600 AFY more recharge (both direct recharge projects and canal seepage losses for the in-lieu recharge projects), and 28,300 AFY less stream seepage into the groundwater system due to higher groundwater levels. Other hydrologic groundwater budget component differences are small between the PCBL-CC and PCBL-CC-PMA simulations.

Table 2-29: Eastern San Joaquin Subbasin Hydrologic Groundwater Budget Annual Average Comparison Between the PCBL-CC and the PCBL-CC-PMA

Hydrologic Groundwater Budget Component	Annual Average		
	PCBL-CC	PCBL-CC-PMA	PMA Benefit (PCBL-CC-PMA minus PCBL-CC)
Deep Percolation (AF)	285,600	293,000	7,400
Other Recharge (AF)	165,300	189,900	24,600
Net Stream Seepage (AF)	218,100	189,800	-28,300
Net Boundary Inflow (AF)	126,000	105,700	-20,300
Groundwater Pumping (AF)	833,100	794,100	-39,000
Change in Groundwater Storage (AF)	38,100	15,700	-22,400

Figure 2-114: Eastern San Joaquin Subbasin Projected Hydrologic Groundwater Budget in the PCBL-CC-PMA



X-Axis Abbreviation	Description
W	Wet year type
AN	Above normal year type
BN	Below normal year type
D	Dry year type
C	Critical year type

For a comparison of the PCBL water budget results with and without PMAs and with and without climate change, please see Appendix 2-B of this revised GSP.

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3. SUSTAINABLE MANAGEMENT CRITERIA

Several requirements of Groundwater Sustainability Plans (GSPs) fall under the heading of "Sustainable Management Criteria". These criteria include:

- Sustainability Goal
- Undesirable Results
- Minimum Thresholds
- Measurable Objectives

The Eastern San Joaquin GSP developed these criteria based on information about the Subbasin developed in the hydrogeologic conceptual model (Section 2.1), the descriptions of current and historical groundwater conditions (Section 2.2), the water budget (Section 2.3), and input from stakeholders during the GSP development process (Section 1.3.4). The sustainable management criteria were developed by working with the Eastern San Joaquin Groundwater Authority Board of Directors (ESJGWA Board), Advisory Committee, and Groundwater Sustainability Workgroup (Workgroup) over several months in 2018 and into 2019.

This GSP considers the six sustainability indicators defined by the Sustainable Groundwater Management Act (SGMA) in the development of sustainable management criteria. SGMA allows several pathways to meet the distinct local needs of each groundwater basin, including development of sustainable management criteria, usage of other sustainability indicators as a proxy, and identification of indicators as not being applicable to the basin. This GSP relies on groundwater levels as a proxy for minimum thresholds and measurable objectives for reduction in groundwater storage, land subsidence, and depletions of interconnected surface water.

3.1 SUSTAINABILITY GOAL

The California Water Code (Water Code) defines sustainable groundwater management as "the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results" (CA Water Code §10721). The planning and implementation horizon includes a 20-year implementation period until 2040 where sustainability is achieved and a 50-year planning period where pumping is maintained within the sustainable yield. The sustainability goal reflects this requirement and succinctly states the Groundwater Sustainability Agencies' (GSAs') objectives and desired conditions of the Subbasin.

The sustainability goal description for the Eastern San Joaquin Subbasin is *to maintain an economically-viable groundwater resource for the beneficial use of the people of the Eastern San Joaquin Subbasin by operating the Subbasin within its sustainable yield or by modification of existing management to address future conditions. This goal will be achieved through the implementation of a mix of supply and demand type projects consistent with the GSP implementation plan* (see Chapter 6: Projects and Management Actions and Chapter 7: Plan Implementation).

Groundwater levels in the Subbasin may continue to decline during the implementation period. However, as projects are implemented and basin operations are modified, sustainable groundwater management will be achieved, and levels will stabilize on a long-term average basis. The Subbasin will be managed to prevent undesirable results throughout the implementation period, despite the possible decline of groundwater elevations. This sustainability goal is supported by locally-defined minimum thresholds that will avoid undesirable results. Demonstration of stable groundwater levels on a long-term average basis combined with the absence of undesirable results will ensure the Subbasin is operating within its sustainable yield (see Section 2.3.6) and the sustainability goal will be achieved.

An explanation of how the goal will be achieved is included in Chapter 6: Projects and Management Actions.

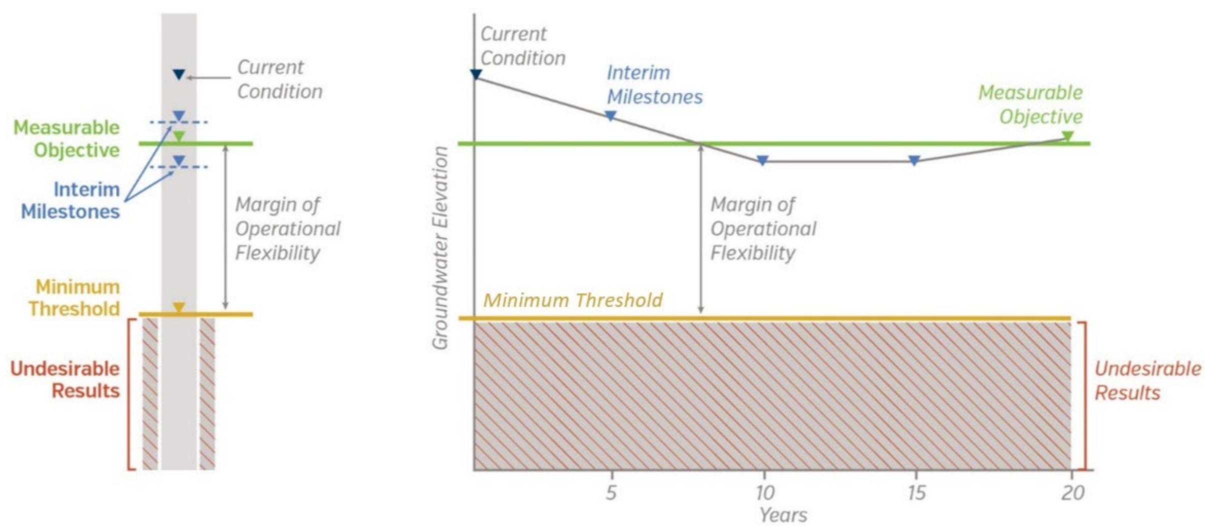
EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

Sustainable Management Criteria Definitions

- **Undesirable Results** – Significant and unreasonable negative impacts associated with each sustainability indicator, avoidance of which is used to guide development of GSP components
- **Minimum Threshold –** Quantitative threshold for each sustainability indicator used to define the point at which undesirable results may begin to occur
- **Measurable Objective** – Quantitative target that establishes a point above the minimum threshold that allows for a range of active management in order to prevent undesirable results
- **Interim Milestones –** Targets set in increments of 5 years over the implementation period of the GSP to put the basin on a path to sustainability
- **Margin of Operational Flexibility –** The range of active management between the measurable objective and the minimum threshold

See Figure 3-1 for a graphic that demonstrates the relationship between the Sustainable Management Criteria terms.

Figure 3-1: Sustainable Management Criteria Definitions Graphic (Groundwater Levels Example)



3.2 UPDATES TO SUSTAINABILITY INDICATORS

The Eastern San Joaquin Groundwater Authority (ESJGWA) received a Consultation Initiation Letter (Letter) on November 18, 2021 (Appendix 3-C) from the California Department of Water Resources (DWR). The Letter identified two potential deficiencies with the Eastern San Joaquin Groundwater Subbasin (Subbasin) Groundwater Sustainability Plan (GSP) which may preclude DWR's approval, as well as potential corrective actions to address each potential deficiency. The Letter thus initiated consultation between DWR, the Plan Manager, and the Subbasin's GSAs regarding the amount of time needed to address the potential deficiencies and corrective actions. A subsequent meeting with DWR was held on April 4, 2022 to discuss the Subbasin's proposed approach to addressing the identified deficiencies. The revisions to the sustainability indicators and sustainability management criteria, as shown in this revised chapter, represent the response to the Letter based on direction provided by the ESJGWA, the Subbasin GSAs, and DWR. This revised GSP chapter, and new Appendices 2-B and 3-C through 3-F, are intended to address deficiencies in the 2020 Eastern San Joaquin GSP as identified by DWR, and fill potential gaps identified in the Letter.

In their Letter, DWR identified the following two deficiencies:

Potential Deficiency 1 – The GSP lacks sufficient justification for determining that undesirable results for chronic lowering of groundwater levels, subsidence, and depletion of interconnected surface waters can only occur in consecutive non-dry water year types. The GSP also lacks sufficient explanation for its minimum thresholds and undesirable results for chronic lowering of groundwater levels.

Potential Deficiency 2 - The GSP does not provide enough information to support the use of the chronic lowering of groundwater level sustainable management criteria and representative monitoring network as a proxy for land subsidence.

The Letter also provided Potential Corrective Actions. Six potential corrective actions were identified for Deficiency 1, and three potential corrective actions were identified for Deficiency 2. The revisions to this chapter, and to Chapters 2 and 6 of this revised GSP, reflect changes made to the Subbasin sustainability indicators and sustainable management criteria resulting from analyses and decisions made to address these deficiencies. Documentation of modifications made to Subbasin sustainability indicators and sustainable management criteria and additional explanation as to how the Subbasin sustainability indicators and sustainable management criteria were determined can be found in the appendices, with Potential Corrective Actions 1(a) through 1(c) addressed in Appendix 2-B, Potential Corrective Actions 1(d) and 1(e) addressed in Appendix 3-D, Potential Corrective Action 1(f) addressed in Appendix 3-E, and Potential Corrective Actions 2(a) through 2(c) addressed in Appendix 3-F.

3.3 REVISED SUSTAINABILITY INDICATORS

3.3.1 Chronic Lowering of Groundwater Levels

3.3.1.1 Undesirable Results

3.3.1.1.1 Description of Undesirable Results

SGMA defines undesirable results related to chronic lowering of groundwater as:

> *Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.*

An undesirable result for chronic lowering of groundwater levels in the Eastern San Joaquin Subbasin is experienced if sustained groundwater levels are too low to satisfy beneficial uses within the Subbasin over the planning and implementation horizon of this GSP (see Section 1.3.1 for a discussion of beneficial uses and users). Potential impacts and the extent to which they are considered significant and unreasonable were determined by the ESJGWA Board with input by the Advisory Committee, Workgroup, and members of the public. During development of the GSP, potential undesirable results identified by stakeholders included a significant and unreasonable:

- Number of wells going dry
- Reduction in the pumping capacity of existing wells
- Increase in pumping costs due to greater lift
- Need for deeper well installations or lowering of pumps
- Adverse impacts to environmental uses and users, including interconnected surface waters and groundwater-dependent ecosystems (GDEs)

3.3.1.1.2 Identification of Undesirable Results

An undesirable result is considered to occur during GSP implementation when at least 25 percent of representative monitoring wells used to monitor groundwater levels (5 of 20 wells in the Subbasin) fall below their minimum level thresholds for two consecutive years.

Two consecutive years of minimum threshold exceedances are used to determine if an undesirable result has occurred and to establish a pattern rather than indicate an isolated event. The lowering of groundwater levels during dry or critically-dry years is not considered to be unreasonable unless the levels do not rebound to above the thresholds following wet conditions or are otherwise mitigated through adaptive management or implementation of projects and management actions. While statistically, three data points are required to establish a trend, three years of exceedances was felt to be too extreme, whereas a single exceedance was not sufficient to establish a trend. Therefore, the two consecutive years was selected as part of this definition.

At least 25 percent of representative monitoring wells used to monitor groundwater levels falling below their minimum thresholds for two consecutive years was presented to the Eastern San Joaquin Technical Advisory Committee (ESJ TAC) during the April 10, 2019 meeting and was approved by the Eastern San Joaquin Groundwater Authority (ESJGWA) Board during the May 8, 2019 meeting. The Eastern San Joaquin Water Resources Model (ESJWRM) results under the projected conditions baseline scenario were used to evaluate minimum threshold exceedances, and the model results considered in determining that a 25 percent exceedance threshold was sufficient to determine that undesirable results would occur subbasin-wide (e.g., were not a localized event).

3.3.1.1.3 Potential Causes of Undesirable Results

The Eastern San Joaquin Subbasin is currently designated as a critically overdrafted subbasin by DWR, a designation originally placed on the subbasin in 1980 (CA DWR, 1980). The Subbasin has experienced undesirable results related to chronic lowering of groundwater levels in the past, which resulted in the deepening of wells. These historical undesirable results, as well as the widespread deepening of Subbasin wells, were identified through anecdotal data provided by GSAs and through review of prior planning documents, including the 2014 Eastern San Joaquin Integrated Regional Water Management Plan (ESJ IRWMP), which indicates that water levels fell to "unprecedented levels" in the fall of 1992, and that "many private groundwater users were forced to modify or deepen wells during the prolonged 1986-1992 drought period." Due to these prior efforts to mitigate low groundwater levels, undesirable results in the Subbasin were remedied. Each ESJGWA member GSA indicated, through multiple meetings, that no current undesirable results exist in their GSA, largely citing these prior large-scale well-deepening efforts and significant undertakings to augment surface water supplies.

Future undesirable results could result from insufficient groundwater recharge and/or offset or delays in implementation of GSP programs or projects due to increased demand or regulatory, permitting, or funding obstacles.

3.3.1.1.4 Potential Effects of Undesirable Results

If groundwater levels were to cause undesirable results, effects could include de-watering of a subset of the existing groundwater infrastructure, starting with the shallowest wells, which are generally domestic wells, and adverse effects on GDEs, to the extent connected with the production aquifer. Lowering levels to this degree could necessitate changes in irrigation practices and crops grown and could cause adverse effects to property values and the regional economy. Additionally, undesirable results due to declining groundwater levels could adversely affect current and projected municipal uses translating into increased costs for potable water supplies.

Potential effects of undesirable results related to GDEs is an area that has been identified as a data gap requiring further study, including through future shallow groundwater monitoring efforts discussed in Section 4.7.

3.3.1.2 Minimum Thresholds

The minimum thresholds for chronic lowering of groundwater levels are the shallower at each representative monitoring well site of the following:

- The deeper of 1992 and 2015-2016 historical groundwater levels with a buffer of 100 percent of historical range applied, *or*
- The 10th percentile domestic well total depth of wells within a 3-mile radius of the monitoring well.[1,2]

To develop these thresholds, members of the ESJGWA Board, Advisory Committee, and Workgroup evaluated the potential for undesirable results based on past, present, and future conditions. In addition to anecdotal on-the-ground data, data from DWR and GSAs, as well as information from reports and planning documents, were used to identify how a given area falls into any one of three general conditions: 1) Areas with significant and unreasonable existing issues, 2) Areas that previously had issues, and 3) Areas that have never had issues. Each of the three conditions correspond to a different pathway to setting minimum thresholds. Areas were considered without undesirable results if no significant and unreasonable issues were identified based on input from GSAs and stakeholders and review of prior planning documents.

- <u>Areas with significant and unreasonable existing issues</u>: these areas are considered to have undesirable results, and minimum thresholds are set to 2015 in accordance with SGMA legislation. No areas were identified by the ESJGWA Board or other stakeholders under this condition within the Subbasin.
- <u>Areas that previously had significant and unreasonable issues</u>: for areas with historical but not current significant and unreasonable results (as identified by GSAs, stakeholders, and prior planning documents), historical levels were considered in the development of minimum thresholds in addition to existing basin management criteria.
- <u>Areas that have never had significant and unreasonable issues</u>: in areas that have never had issues, discussions on what the ESJGWA would consider to be significant and unreasonable drove identification of potential thresholds, and minimum thresholds were developed based on the preservation of future beneficial uses.

The ESJGWA Board and Advisory Committee reviewed previously adopted groundwater-related planning documents including the 2014 ESJ IRWMP, the 2004 Groundwater Management Plan (GMP), Agricultural Water Management

[1] A radius of 2 miles was used for well 03N07E21L003 to reflect domestic well depths in close proximity to the Mokelumne River.

[2] In municipalities with ordinances requiring the use of City water (water provided by the City's municipal wells), the 10th percentile municipal well depth is used in place of the 10th percentile domestic well depth criteria.

Plans (AWMPs), and the Mokelumne Watershed Interregional Sustainability Evaluation (MokeWISE) Water Program. These documents provided a starting point for setting minimum thresholds. The ESJ IRWMP indicates fall 1992 groundwater elevation levels as a historical low benchmark for the Subbasin, stating "The Eastern San Joaquin Groundwater Basin contour measured in 1992 is proposed as the basin management framework baseline. Groundwater fell to its lowest recorded elevation in 1992 following a significant drought period and it is considered undesirable to drop below this level" (Eastern San Joaquin County GBA, 2014). This language, although not developed within the SGMA framework, has served as a starting point for developing minimum thresholds under SGMA.

Fall 1992 groundwater levels were examined and compared to levels following the recent drought (fall 2015-2016) using groundwater elevation data from officially monitored California Statewide Groundwater Elevation Monitoring (CASGEM) wells, voluntarily monitored CASGEM wells, clustered and nested wells, and San Joaquin County database wells (see Section 2.1.1.1). This examination showed that groundwater levels in some areas of the Subbasin have recovered since 1992, with much of the central portion of the Subbasin showing an increase of greater than 10 feet. However, groundwater levels in other portions of the Subbasin have further decreased below 1992 levels without undesirable effects, such as a significant and unreasonable number of wells going dry or impact to GDEs, being observed by GSAs and other stakeholders. In many cases, areas that experienced undesirable effects in 1992 put mitigation measures in place, often deepening wells, meaning that 1992 groundwater levels would no longer trigger undesirable effects.

The deepest conditions between fourth quarter 1992 and 2015-2016 groundwater levels were examined to develop a greater understanding of potential impacts to beneficial uses experienced under historical low groundwater levels. These years were chosen based on the threshold language in the ESJ IRWMP and also to capture the end of the two most recent droughts. Fourth quarter 2014 data were used in the northwest corner of the Subbasin, where data are limited.

Individual GSAs confirmed understanding of the historical lows based on their experience and data, provided feedback on groundwater conditions for their GSAs, and indicated if undesirable results could occur if the minimum threshold was set deeper than the deeper of 1992 and 2015-2016 based on their understanding. GSAs then identified potential wells to be included in the representative monitoring network for the groundwater level sustainability indicator based on the adequate spatial coverage, availability of historical data, and reliability of the monitoring well. For the majority of the Subbasin, GSA representatives identified no undesirable results, even if groundwater were to reach historical low groundwater levels. As a starting point, a potential minimum threshold was considered for each representative monitoring well based on the lower of 1992 or 2015-2016 values unless otherwise indicated. A buffer was subtracted from the minimum 1992 or 2015 groundwater elevation. The buffer was calculated by finding the difference between the minimum and maximum groundwater level over the historical record for each representative monitoring well. The subtraction of the buffer provides a range in which groundwater levels may continue to decline during implementation of projects and management actions until sustainable yield is reached. The buffer allows for flexibility to account for natural fluctuations in groundwater levels but would avoid significant and unreasonable impacts to groundwater levels.

The ESJGWA Board determined that dewatering of domestic wells and impacts to drinking water may be a potential undesirable result that could potentially be used to confirm the adequacy of the minimum threshold methodology. Domestic wells are generally shallower than agricultural and municipal wells and thus more sensitive to undesirable effects such as wells going dry. Additionally, the loss of a domestic well usually results in a loss of water for consumption, cooking, and sanitary purposes, which can often have substantial impacts on the users of the water and can be financially difficult for the well owner to replace. The 10th percentile domestic well depth (i.e., the depth of the top 10th percent most shallow well) was examined within a radius around the monitoring well representative of local conditions. A radius of 3 miles around each representative monitoring well was used to identify the 10th percentile domestic well construction depth. For representative monitoring well 03N07E21L003, a 2-mile radius was used due to variations in groundwater levels due to its proximity to the Mokelumne River. The 3-mile radius of each representative monitoring well (including the 2-mile radius of monitoring well 03N07E21L003), includes an average of 400 domestic wells each, collectively capturing approximately 76 percent of the domestic wells in the Subbasin. In cases where the

10th percentile domestic well depth was shallower than the historical drought low with the buffer, that value was developed as the minimum threshold to prevent undesirable results associated with dewatering wells in the Subbasin.

Domestic well data were retrieved from the Online System for Well Completion Reports (OSWCR) database, which is sparsely populated with information on total casing depth, screening intervals, and the age of the well. The 10th percentile well depth was chosen due to the uncertainty in the database and to account for the fact that domestic wells may have been drilled to a very shallow depth prior to the current well drilling standards enforced by local jurisdictions and/or have reached the end of their lifecycle. The 10th percentile domestic well depth for groundwater levels is protective of approximately 90 percent of the domestic wells in the OSWCR dataset and is used as a criterion for determining if a decline in groundwater levels is significant and unreasonable under SGMA. In municipalities with ordinances requiring the use of City water (water provided by the City's municipal wells), the 10th percentile municipal well depth is used in place of the 10th percentile domestic well depth criteria.

Figure 3-2 shows the location of groundwater level representative monitoring wells throughout the Eastern San Joaquin Subbasin. Table 3-1 lists the corresponding numeric minimum thresholds at each representative monitoring well and the basis. Additional data on the monitoring wells and minimum thresholds, including hydrographs of historical observed data and domestic well analysis, are provided in Appendix 3-A and 3-B.

The basis for design and selection of the sustainable management criteria (SMCs) is the lowest drought-related groundwater conditions observed. The ESJGWA and GSAs focused the GSP goals on the long-term sustainability of the Subbasin and implementation of projects that would help all beneficial users to have a reliable and resilient water supply, even in time of drought, and provide the ability to respond to climate change. The ESJGWA and GSAs are supportive of ongoing agricultural, urban, and industrial water conservation efforts and to achieving the highest levels of water use efficiency technically achievable. It should be noted that water conservation programs have been successful in reducing urban and agricultural water demands such that those demands have become "hardened" and are less able to be reduced in time of drought without real impacts to the quality of life or economy. GSP projects and management actions are designed to reduce overdraft, and to provide sustainable supplies through a drought without severe impacts to quality of life or the economy.

The GSP was not targeted toward emergency responses to drought or the short-term impacts associated with drought since this is the focus of the County Office of Emergency Services (OES) and a requirement for the water purveyors. In addition, the prevailing urban water management plans (UWMPs) and agricultural water management plans (AWMPs) identify water conservation goals and demand reduction targets, including water shortage contingency plans, and the ESJGWA and GSAs are supportive of those plans (and the drought contingency responses) and will encourage the lead agencies for those plans to implement actions and programs consistent with local and state requirements. The ESJGWA will work to better coordinate with the OES and urban purveyors to support emergency drought response efforts. The ESJGWA and GSP development has included representatives from the urban suppliers and will continue to seek opportunities to engage with OES, the urban purveyors and to work to identify mutual goals, objectives and project opportunities.

Additionally, the ESJGWA and GSAs will evaluate other programs as part of an adaptive management strategy, and along with an annual evaluation of Subbasin conditions, will continue outreach efforts to domestic well owners and small water systems regarding information related to forecasted water levels with and without project implementation to inform subsequent investments decisions for well improvement and replacement; produce and distribute current and forecasted groundwater level information to well permit applicants to inform the permitting process; review well standards to evaluate opportunities to establish standards to better reflect current and forecasted groundwater level conditions; and actively promote small systems interties and/or consolidation of their systems to achieve supply reliability.

If drinking water impacts are observed during GSP implementation as a result of the established minimum thresholds, the ESJGWA will evaluate the need to revise the minimum threshold methodology and/or implement additional projects or management actions to mitigate such impacts (as described in Appendix 2-B *Technical Memorandum No. 1 – Undesirable Result Definition and Projects and Management Actions*). The ESJGWA and GSAs will evaluate other programs as part of the adaptive management strategy, and annual program evaluation and reporting.

The future five-year update to the GSP will more closely evaluate and include information on UWMP water shortage contingency plans, and the ESJGWA will coordinate with the County OES to support emergency drought responses and plans.

Figure 3-2: Location of Representative Monitoring Wells for Groundwater Levels

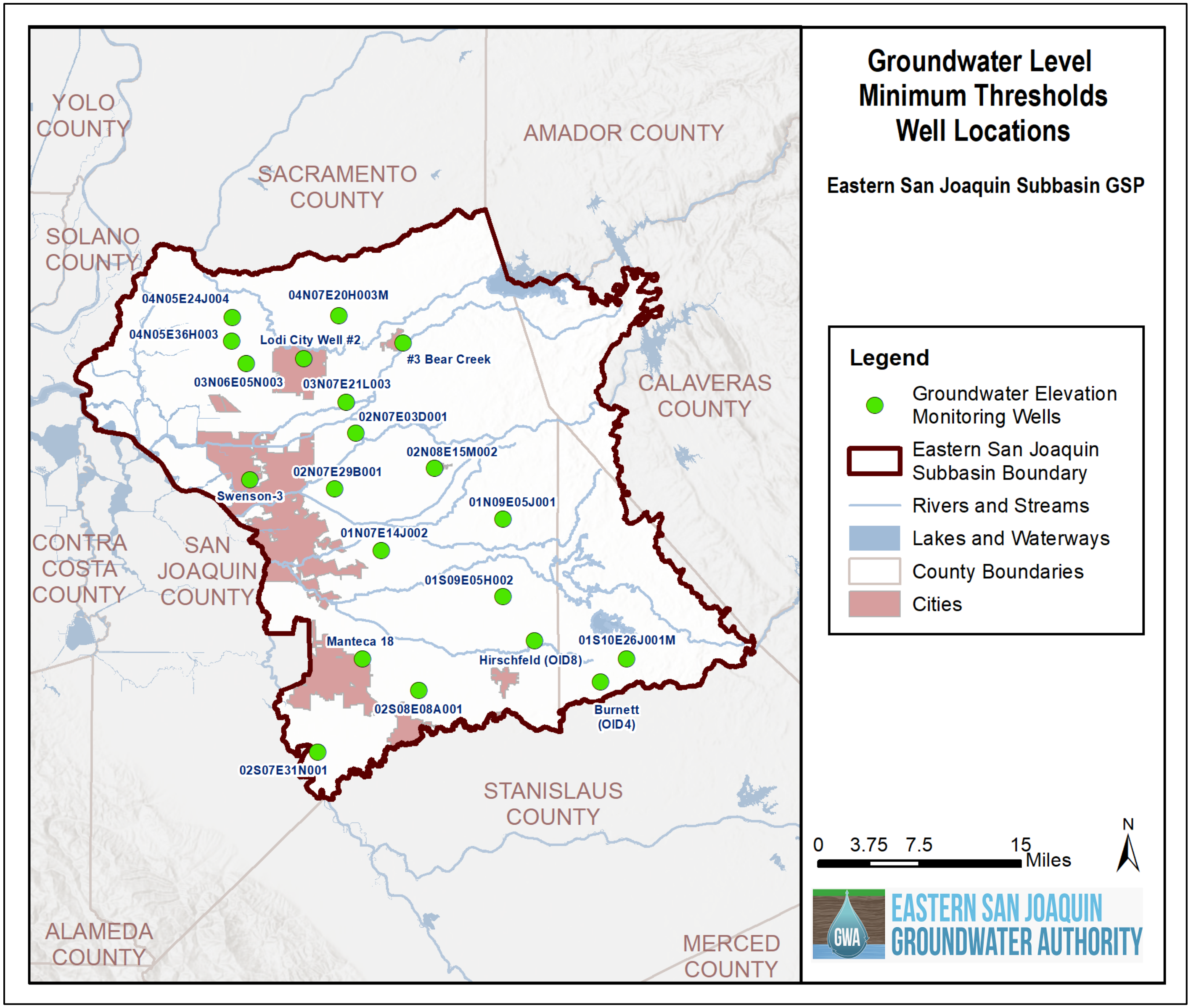


Table 3-1: Minimum Thresholds for Chronic Lowering of Groundwater Levels

Narrative Description			
The minimum threshold is set at the deeper of 1992 and 2015-2016 groundwater levels with a buffer of 100 percent of historical range applied, *or* the 10th percentile domestic well depth, whichever is shallower. In municipalities with ordinances requiring the use of City water, the 10th percentile municipal well depth is used in place of the 10th percentile domestic well depth criteria.			
Numeric Minimum Thresholds			
GSA Well is Located in[1]	**Well ID**	**Minimum Threshold (feet mean sea level [MSL])**	**Basis for Threshold**
CSJWCD	01S09E05H002	-49.8	10th percentile domestic well depth
CSJWCD	01N07E14J002	-114.4	1992 groundwater level with a buffer of 100 percent of historical range
City of Lodi	Lodi City Well #2	-38.5	1992 groundwater level with a buffer of 100 percent of historical range
City of Manteca	Manteca 18	-16.0	2016 groundwater level with a buffer of 100 percent of historical range
City of Stockton	Swenson-3	-26.6	2015 groundwater level with a buffer of 100 percent of historical range
Eastside GSA	01S10E26J001M	43.7	2015 groundwater level with a buffer of 100 percent of historical range
LCWD	02N08E15M002	-124.1	10th percentile domestic well depth
LCSD	#3 Bear Creek	-72.3	2016 groundwater level with a buffer of 100 percent of historical range
NSJWCD	04N07E20H003M	-81.7	2016 groundwater level with a buffer of 100 percent of historical range
NSJWCD	03N07E21L003	-100.0	1992 groundwater level with a buffer of 100 percent of historical range
OID	Hirschfeld (OID-8)	8.0	2015 groundwater level with a buffer of 100 percent of historical range
OID	Burnett (OID-4)	60.7	2015 groundwater level with a buffer of 100 percent of historical range
SDWA	02S07E31N001	1.5	1992 groundwater level with a buffer of 100 percent of historical range
SSJ GSA	02S08E08A001	0.6	2016 groundwater level with a buffer of 100 percent of historical range
SEWD	02N07E03D001	-122.8	10th percentile domestic well depth
SEWD	01N09E05J001	-86.8	10th percentile domestic well depth
SEWD	02N07E29B001	-130.1	10th percentile domestic well depth
WID	04N05E36H003	-31.1	2015 groundwater level with a buffer of 100 percent of historical range
WID	03N06E05N003	-35.1	2015 groundwater level with a buffer of 100 percent of historical range
WID	04N05E24J004	-31.2	2015 groundwater level with a buffer of 100 percent of historical range

[1] Acronyms defined: Central San Joaquin Water Conservation District (CSJWCD), Eastside San Joaquin GSA (Eastside GSA), Linden County Water District (LCWD), Lockeford Community Services District (LCSD), North San Joaquin Water Conservation District (NSJWCD), Oakdale Irrigation District (OID), South Delta Water Agency (SDWA), South San Joaquin GSA (SSJ GSA), Stockton East Water District (SEWD), Woodbridge Irrigation District (WID).

3.3.1.3 Measurable Objectives and Interim Milestones

Measurable objectives are quantitative goals that reflect the desired Subbasin condition and allow the Subbasin to achieve its sustainability goal. The measurable objective is set to allow a reasonable margin of operational flexibility between minimum thresholds to allow for active management of the Subbasin during dry periods without reaching the minimum threshold. The margin of operational flexibility is intended to accommodate droughts, climate change, conjunctive use operations, or other groundwater management activities. The margin of operational flexibility is defined as the difference between the minimum threshold and the measurable objective.

The measurable objective for chronic lowering of groundwater levels is defined as the deeper of 1992 or 2015-2016 groundwater level values.

Table 3-2 lists the measurable objectives for each representative monitoring well. The margin of operational flexibility is defined at each well as the difference between the minimum and maximum groundwater level over the historical record for that well.

Table 3-2: Measurable Objective for Chronic Lowering of Groundwater Levels

Narrative Description		
The measurable objective is set at the deeper of 1992 and 2015-2016 groundwater levels.		
Numeric Measurable Objectives		
GSA Well is Located in	**Well ID**	**Measurable Objective (feet MSL)**
CSJWCD	01S09E05H002	-19.6
CSJWCD	01N07E14J002	-70.4
City of Lodi	Lodi City Well #2	-3.5
City of Manteca	Manteca 18	5.8
City of Stockton	Swenson-3	-19.3
Eastside GSA	01S10E26J001M	81.7
LCWD	02N08E15M002	-69.7
LCSD	#3 Bear Creek	-50.3
NSJWCD	04N07E20H003M	-36.7
NSJWCD	03N07E21L003	-57.5
OID	Hirschfeld (OID-8)	31.5
OID	Burnett (OID-4)	79.7
SDWA	02S07E31N001	13.0
SSJ GSA	02S08E08A001	24.0
SEWD	02N07E03D001	-79.7
SEWD	01N09E05J001	-51.1
SEWD	02N07E29B001	-80.4
WID	04N05E36H003	-5.1
WID	03N06E05N003	-14.1
WID	04N05E24J004	-6.2

To assist the Subbasin in reaching the measurable objective for groundwater levels, interim milestones for 2025, 2030, and 2035 were developed to keep implementation on track. Interim milestones are based on achieving the sustainability goal within the 20-year time period provided by SGMA. Table 3-3 shows the 5-year milestones, which follow a stepwise trend between the current condition and the measurable objective. Fall 2015 groundwater levels were used to define current conditions where data were available. The average of fall 2013, fall 2014, and fall 2016 were used where fall 2015 data were not available.

Table 3-3: Interim Milestones for Chronic Lowering of Groundwater Levels

Narrative Description						
5-year milestones are assumed to remain similar to current for the first 10 years and then follow along a linear trend between the current condition and the measurable objective.						
Numeric Interim Milestones						
GSA Well is Located in	**Well ID**	**Current Condition (feet MSL)**	**Measurable Objective (feet MSL)**	**Interim Milestones**		
				2025	**2030**	**2035**
CSJWCD	01S09E05H002	-8.7	-19.6	-8.7	-8.7	-14.2
CSJWCD	01N07E14J002	-49.9	-70.4	-49.9	-49.9	-60.2
City of Lodi	Lodi City Well #2	0.6**	-3.5	0.6	0.6	-1.5
City of Manteca	Manteca 18	9.1	5.8	9.1	9.1	7.5
City of Stockton	Swenson-3	-19.3	-19.3	-19.3	-19.3	-19.3
Eastside GSA	01S10E26J001M	81.7	81.7	81.7	81.7	81.7
LCWD	02N08E15M002	-63.2	-69.7	-63.2	-63.2	-66.5
LCSD	#3 Bear Creek	-49.3	-50.3	-49.3	-49.3	-49.8
NSJWCD	04N07E20H003M	-35.5	-36.7	-35.5	-35.5	-36.1
NSJWCD	03N07E21L003	-51.5	-57.5	-51.5	-51.5	-54.5
OID	Hirschfeld (OID-8)	31.5	31.5	31.5	31.5	31.5
OID	Burnett (OID-4)	79.7	79.7	79.7	79.7	79.7
SDWA	02S07E31N001	13.8**	13	13.8	13.8	13.4
SSJ GSA	02S08E08A001	22.2**	24	22.2	22.2	23.1
SEWD	02N07E03D001	-61.7	-79.7	-61.7	-61.7	-70.7
SEWD	01N09E05J001	-20.2	-51.1	-20.2	-20.2	-35.7
SEWD	02N07E29B001	-49.8**	-80.4	-49.8	-49.8	-65.1
WID	04N05E36H003	-5.1	-5.1	-5.1	-5.1	-5.1
WID	03N06E05N003	-14.1	-14.1	-14.1	-14.1	-14.1
WID	04N05E24J004	-6.2	-6.2	-6.2	-6.2	-6.2

** Current Condition is the average of fall groundwater levels for 2013-2016

3.3.2 Reduction in Groundwater Storage

3.3.2.1 Undesirable Results

3.3.2.1.1 Description of Undesirable Results

The ESJGWA has determined that an undesirable result for the reduction of groundwater storage is experienced if sustained groundwater storage volumes are insufficient to satisfy beneficial uses within the Subbasin over the planning and implementation horizon of this GSP (see Section 1.3.1 for a discussion of beneficial uses and users).

Undesirable results related to groundwater storage in the Subbasin have not occurred historically, are not currently occurring, and are not likely to occur in the future. As discussed in the current and historical groundwater conditions section of this GSP (Section 2.2), there is a large volume (approximately 53 million acre-feet [MAF]) of freshwater in storage. An analysis of groundwater storage using the Eastern San Joaquin Water Resources Model (ESJWRM) was conducted to evaluate groundwater storage conditions between 1996 and 2015. The results of this analysis showed a range of fluctuation from 1996 to 2015 of approximately 0.01 percent per year. See Section 2.2.2 for additional quantification of groundwater storage. A discussion of the geology of the Subbasin can be found in Section 2.1.

3.3.2.1.2 Identification of Undesirable Results

An undesirable result occurs when groundwater storage volumes are insufficient to satisfy beneficial uses within the Subbasin. To identify a volume associated with undesirable results, the ESJWRM was run to estimate the volume of groundwater storage needed to meet beneficial uses. The analysis determined that groundwater demand for beneficial use occurs within the shallowest 23 MAF of the Subbasin, as this is roughly the zone corresponding to the depth at which pumping occurs and is reasonably expected to occur in the future. Based on this analysis, it is estimated that overlying pumpers have limited access equating to approximately the shallowest 23 MAF of groundwater storage in the Subbasin; therefore, an undesirable result would occur if groundwater storage levels were depleted by 23 MAF. Therefore, undesirable results would occur if groundwater storage were reduced by 23 MAF, to a total volume of 30 MAF.

3.3.2.1.3 Potential Causes of Undesirable Results

While reduction of 23 MAF within the SGMA planning horizon of 2040 is highly unlikely, an event of a catastrophic nature or prolonged and exaggerated increases in the mining of groundwater due to extreme and severe drought or major changes in groundwater management over time could cause a reduction of groundwater storage to a significant and unreasonable level.

Section 7.4.4 references factors that could affect the availability of surface water, including State Water Resources Control Board (SWRCB) plans to reduce flows available for use by 40-60 percent as part of the Water Quality Control Plan for the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan).

3.3.2.1.4 Potential Effects of Undesirable Results

If groundwater levels were to reach levels causing undesirable results, significant and unreasonable effects could include degradation of produced water quality from groundwater sources; insufficient fresh groundwater to access in drought years; increased cost of access; and reduction in beneficial uses, such as domestic supply and changes to agriculture.

3.3.2.2 Minimum Thresholds

This GSP uses groundwater level minimum thresholds as a proxy for the reduction in groundwater storage sustainability indicator.

GSP regulations allow GSAs to use groundwater levels as a proxy metric for any sustainability indicator, provided the GSP demonstrates that there is a significant correlation between groundwater levels and the other metrics. In order to rely on groundwater levels as a proxy, one approach suggested by DWR is to:

> *Demonstrate that the minimum thresholds and measurable objectives for chronic declines of groundwater levels are sufficiently protective to ensure significant and unreasonable occurrences of other sustainability indicators will be prevented. In other words, demonstrate that setting a groundwater level minimum threshold satisfies the minimum threshold requirements for not only chronic lowering of groundwater levels but other sustainability indicators at a given site* (CA DWR, 2017).

Minimum thresholds for groundwater levels will effectively avoid undesirable results for reduction of groundwater storage. As noted above, the amount of groundwater in storage in the Subbasin is approximately 53 MAF and the undesirable results of reducing beneficial uses would not occur until storage is reduced by 23 MAF, to a total of 30 MAF.

The ESJWRM was run to estimate the reduction in groundwater storage that would occur if every representative monitoring well in the Subbasin were to operate at the minimum threshold for the chronic lowering of groundwater levels sustainability indicator. The results of this analysis showed that this scenario would result in a reduction of approximately 1.2 MAF of storage.[3] Because undesirable results are anticipated to occur following a reduction of 23 MAF, the minimum thresholds for groundwater levels are protective of beneficial uses. Minimum thresholds and measurable objectives for groundwater levels can therefore be used as a proxy for reduction in groundwater storage, as groundwater levels are sufficiently protective against occurrences of significant and unreasonable reduction in groundwater storage.

3.3.2.3 Measurable Objectives and Interim Milestones

As chronic lowering of groundwater levels is used as a proxy for reduction in groundwater storage, the measurable objectives and interim milestones for the reduction in groundwater storage sustainability indicator are the same measurable objectives and interim milestones as for the chronic lowering of groundwater levels sustainability indicator as set forth in Section 3.2.1.3.

3.3.3 Degraded Water Quality

3.3.3.1 Undesirable Results: Degraded Water Quality

3.3.3.1.1 Description of Undesirable Results

The undesirable result related to degraded water quality is defined in SGMA as:

> *Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.*

An undesirable result for degraded water quality in the Eastern San Joaquin Subbasin is experienced if SGMA-related groundwater management activities cause significant and unreasonable impacts to the long-term viability of domestic, agricultural, municipal, environmental, or other beneficial uses over the planning and implementation horizon of this GSP.

Salinity is the only water quality constituent for which minimum thresholds are established in the Eastern San Joaquin Subbasin. High salinity in the western portion of the Subbasin has been an area of historical concern, as described in Section 2.2. There is potential for pumping to contribute to the movement of high saline water from the three sources noted by O'Leary et al. (2015): Sacramento-San Joaquin River Delta (Delta) sediments, deep deposits, and irrigation

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[3] Volumes based on ESJWRM estimates calculated assuming all representative monitoring wells for groundwater levels reached their minimum thresholds across the Subbasin for a conservative estimate of Subbasin storage reduction.

return water (see Section 2.2.4.1). Other constituents, including arsenic and nitrate are evaluated in Section 2.2**,** with monitoring efforts described in Section 4.3. These constituents are managed through existing management and regulatory programs within the Subbasin, such as the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) and the Irrigated Lands Regulatory Program (ILRP), which focus on improving water quality by managing septic and agricultural sources of salinity and nutrients. Additionally, point-source contaminants are managed and regulated through a variety of programs by the Regional Water Quality Control Board (RWQCB), Department of Toxic Substances Control (DTSC), and the U.S. Environmental Protection Agency (EPA). Through new monitoring efforts, the GSP will document trends in these constituents and identify opportunities for coordination with existing programs. A description of existing regulations and requirements for these constituents is provided in Section 2.2.4. Through coordination with existing agencies and through additional monitoring, the ESJGWA will know if existing regulations are being met or groundwater pumping activities in the Subbasin are contributing to significant and unreasonable undesirable effects related to degraded water quality (see Section 3.2.3.4 for additional information).

Total dissolved solids (TDS) was selected for the evaluation of sustainable management criteria for salinity under this sustainability indicator, as historical data for TDS are more widely available in the Eastern San Joaquin Subbasin than other constituents used to measure salinity, such as electrical conductivity (EC) or chloride. This decision was made by the ESJGWA Board based on the greater availability of TDS data in the Subbasin. TDS data are available through existing monitoring programs such as the CV-SALTS program and Groundwater Ambient Monitoring and Assessment (GAMA) Program or through monitoring or regulatory agencies such as United States Geological Survey (USGS), DWR, SWRCB, and the Central Valley Regional Water Quality Control Board (CVRWQCB) Waste Discharge Requirement (WDR) Dairy program. Additionally, GSA members and their affiliates including Cal Water, SJCFCWCD, and the cities of Stockton, Lodi, and Manteca, provided TDS data from existing production wells.

3.3.3.1.2 Identification of Undesirable Results

Undesirable results occur during GSP implementation when more than 25 percent of representative monitoring wells (3 of 10 sites) exceed the minimum thresholds for water quality for two consecutive years and where these concentrations are the result of groundwater management activities.

In addition to the monitoring of changes in groundwater elevations and the potential for those changes to result in undesirable results relative to groundwater quality, the ESJGWA and GSAs will collaborate and share data with other programs monitoring water quality data to observe both ambient and regulated conditions. Programs for coordination include, but are not limited to, the Irrigated Lands Regulatory Program (ILRP) and Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS), two existing regulatory programs for the monitoring and regulation of nitrate and salts. The GWA, in coordination with the GSAs, will evaluate changes in groundwater quality on an annual basis to determine if groundwater management has the potential to be a contributing factor to declines in groundwater quality. If so, the GSA(s) will coordinate with responsible regulatory agency(ies) to establish a plan to alleviate or prevent further degradation. Please see Appendix 3-E for additional information as to how the ESJGWA and Subbasin GSAs will coordinate to identify undesirable results and the potential causes of the decline in groundwater quality, and to develop and implement appropriate management actions to address that degradation.

3.3.3.1.3 Potential Causes of Undesirable Results

Elevated TDS concentrations in the Subbasin are the result of natural processes and overlying land use activities (O'Leary et al., 2015). Pumping in excess of recharge has resulted in declining aquifer water levels and led to an increase of salinity in groundwater wells since the 1950s (O'Leary et al., 2015). Within the Subbasin, there are localized concerns related to salinity along with three primary sources of salinity, as discussed in Section 2.2.4 of this GSP. To this end, potential mechanisms for causes of undesirable results include human-induced contamination and changes in water levels that may influence water quality, including:

- Falling groundwater levels which may cause migration of already-contaminated groundwater from natural sources, nonpoint sources (salt, nitrate), or a plume from a point source.

- Rising groundwater levels creating changes in oxidation potential and mobilization of arsenic.
- Rising groundwater levels from recharge operations or reduced pumping that could mobilize nitrates or salts in the vadose zone.

3.3.3.1.4 Potential Effects of Undesirable Results

The potential effects of undesirable results related to degraded groundwater quality include: reduction in usable supply of groundwater, increased treatment costs, and required access to alternate supplies, which can be unaffordable for small users. Some water quality issues could potentially cause more impact to agricultural uses than municipal or domestic uses, depending on the impact of the contaminant to these water use sectors. Water quality degradation may cause potential changes in irrigation practices or crops grown, adverse effects to property values, and other economic effects.

3.3.3.2 Minimum Thresholds

The minimum threshold for degraded water quality is 1,000 milligrams per liter (mg/L) TDS at all representative monitoring well locations, shown in Figure 3-3.

Minimum thresholds for this sustainability indicator are focused on addressing the major groundwater quality issue of salinity by monitoring TDS as a representative constituent of salinity and preventing future water quality degradation due to pumping. Additional constituents, including nitrate and arsenic, will be monitored for informational purposes through the water quality monitoring network to identify trends and fill data gaps (see Section 3.3.3.4).

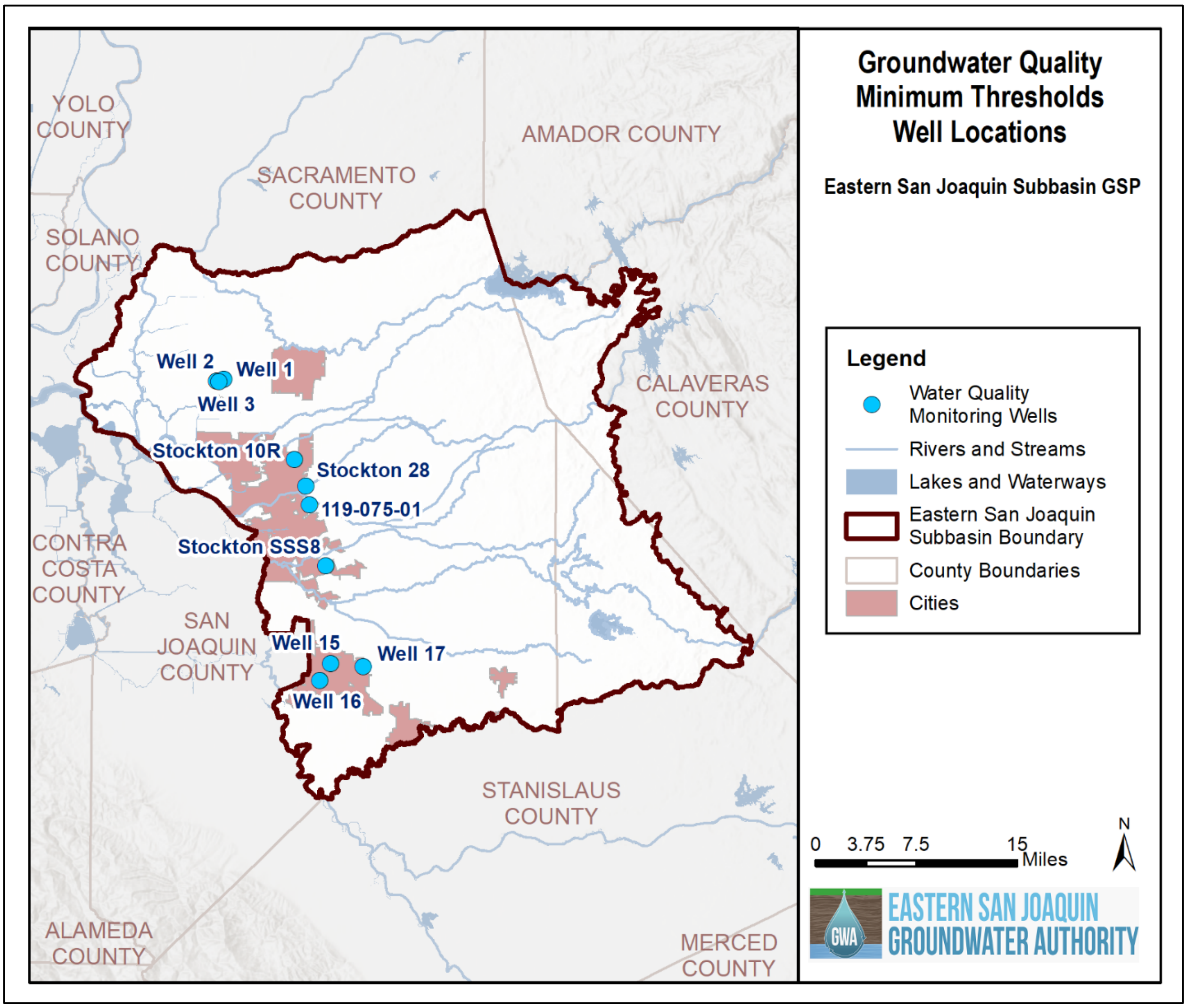
The ESJGWA Board selected a minimum threshold of 1,000 mg/L based on stakeholder concerns for drinking water and agricultural beneficial uses. The minimum threshold reflects input from agricultural and municipal stakeholders, including local drinking water purveyors and the local agricultural community. A meeting was held in fall 2018 with GSA representatives in areas impacted by high salinity. Representatives from San Joaquin County, City of Lodi, City of Manteca, City of Stockton, and Cal Water were in attendance. Additionally, members of the Workgroup who represent agribusiness interests provided input on the salinity levels at which crops begin to become impacted by salinity.

In the development of minimum thresholds, beneficial uses of groundwater as a drinking water supply and as an agricultural supply were considered. For drinking water, the TDS secondary maximum contaminant level (SMCL) was considered. As noted in Section 2.2, the SWRCB Division of Drinking Water (DDW) has established SMCLs for TDS in drinking water supplies. SMCLs are established for aesthetic reasons such as taste, odor, and color and are not based on public health concerns. For TDS, the SMCL is 500 mg/L (recommended) and the upper limit SMCL is 1,000 mg/L (SWRCB, 2017). The SWRCB has set a short-term limit of 1,500 mg/L (SWRCB, 2017). For agricultural uses, salinity tolerances of major Subbasin crops were considered. As previously stated in Section 1.2.1, dominant Subbasin crops are fruit and nut trees (primarily almonds, cherries, and walnuts), grapes, and alfalfa (USDA, 2015). Salinity tolerances for Subbasin crops range from 900 mg/L TDS (for almonds) to 4,000 mg/L TDS (for wheat) (Texas A&M AgriLife Extension, 2003, adapted from Ayers and Westcott, 1976; Hoffman, 2010). Salinity tolerances of major Subbasin crops are shown in Table 3-4. Because fruit and nut trees and vineyards collectively cover more than half of the acreage of the Subbasin, the minimum threshold was centered on the salinity impact of these crop types. These crop types have lower salinity tolerances, in the range of 900 to 1,000 mg/L TDS. Standards in this range are considered protective of these crop types and therefore the majority of Subbasin crops. TDS values are estimated based on applied irrigation water electrical conductivity values for a 90 percent crop yield potential (Texas A&M AgriLife Extension, 2003, adapted from Ayers and Westcott, 1976).

Table 3-4: Salinity Tolerances of Major Subbasin Crops

Crop Type	Salinity Tolerance (mg/L TDS)
Fruit & Nut Trees - Almonds	900
Fruit & Nut Trees - Apples	1,000
Vineyards - Grapes	1,100
Alfalfa	1,400
Grain - Wheat	4,000
Field Crops - Corn	1,100
Truck Crops - Tomatoes	1,500
Rice	1,700

Figure 3-3: Location of Representative Monitoring Wells for Water Quality



Should an existing groundwater quality impairment or new groundwater quality impact be identified as having a direct impact on groundwater users, the GWA and/or GSAs will coordinate with the appropriate regulatory agency(ies) to communicate the situation to those impacted, and will adaptively work with the regulatory agency(ies) to manage the situation. Additionally, the ESJGWA proposes the following program management actions for the Subbasin GSAs to be coordinated through the ESJGWA:

1. Regular Process for coordination
    a. The ESJGWA will hold an annual "groundwater water quality state of the basin" meeting or workshop in January and invite the members of the San Joaquin County & Delta Water Quality Coalition (Coalition) to present the results of the monitoring program.
    b. The ESJ Technical Advisory Committee (TAC) will invite participation and ex officio representation from the CVRWQCB staff to receive regular information regarding ILRP, CV-SALTS and any planned updates or amendments to the Central Valley *Water Quality Control Plan* (Basin Plan).

2. Monitoring
    a. The ESJGWA will seek to develop monitoring and data sharing agreements with the Coalition.
    b. ESJGWA staff will work with the local Environmental Health Division and SWRCB Division of Drinking to identify drinking water wells which are nearing or have exceeded MCLs or SMCLs, noting the location, number of wells and the constituents of concern.

3. Data Management. . Where possible, the ESJGWA will include the assessment of water quality data collected via other monitoring networks in their annual assessments, and will use this information to further evaluate trends and any correlations between groundwater levels, the groundwater level MTs, and observed water quality conditions.

4. Annual Report. Beyond the reporting of data from the GSP groundwater level and water quality monitoring network, the ESJ Annual Report will include an expanded groundwater quality discussion to document:
    a. The annual results of the Coalition's monitoring program
    b. Known impairments identified by the CVRWQCB pursuant to the Basin Plan
    c. Wells and locations where MCLs have been exceeded as identified by the SWRCB Division of Drinking Water, consumer confidence reports, or the local Environmental Health Department

3.3.3.3 Measurable Objectives and Interim Milestones

The measurable objective for degraded water quality is 600 mg/L TDS at all representative monitoring well locations.

600 mg/L was developed based on the TDS recommended SMCL for drinking water of 500 mg/L and adding a 100 mg/L buffer. 600 mg/L TDS is close to the recommended SMCL of 500 mg/L and significantly below the upper limit SMCL of 1,000 mg/L, and is considered adequate for drinking water and agricultural uses.

Interim milestones for 2025, 2030, and 2035 were developed to keep implementation on track to allow the Subbasin to meet the measurable objective for groundwater quality.

Table 3-5 shows the 5-year milestones, which follow along a linear trend between the current condition and the measurable objective. Interim milestones are based on the measurable objective and will be coordinated with projects and management actions. Current conditions were calculated by averaging TDS values collected from 2015-2018 where data were available. In two cases (for Well 16 and Well 17), current conditions were calculated by averaging TDS values collected from 2012-2018.

Table 3-5: Interim Milestones for Degraded Water Quality

Narrative Description					
5-year milestones follow along a linear trend between the current condition and the measurable objective.					
Numeric Interim Milestones					
Well ID	**Current Condition (mg/L TDS)**	**Measurable Objective (mg/L TDS)**	**Interim Milestones**		
			2025	**2030**	**2035**
Well 1	500	600	525	550	575
Well 2	510	600	532.5	555	577.5
Well 3	510	600	532.5	555	577.5
Stockton 10R	322	600	391.5	461	530.5
Stockton 26	350	600	412.5	475	537.5
Stockton SSS8	370	600	427.5	485	542.5
Well 15	300	600	375	450	525
Well 16	280*	600	360	440	520
Well 17	300*	600	375	450	525
119=075-01	300	600	375	450	525

* Current Condition is the average TDS value for 2012-2018

3.3.3.4 Monitoring for Additional Constituents

Increased monitoring is needed to identify water quality trends related to additional constituents including arsenic and nitrate. Arsenic, as well as cations and anions (which include nitrate), will be monitored for informational purposes through the water quality monitoring network (see Section 4.3.2) to identify trends and fill data gaps. Additionally, these constituents are currently regulated in the Subbasin through existing water resources monitoring and management programs, as described in Section 1.2.2. If water quality conditions violate those regulations, or if monitoring efforts indicate concerning trends, the ESJGWA will take steps to coordinate with regulatory agencies and will evaluate establishing minimum thresholds and measurable objectives for these constituents.

Many of the GSAs are drinking water suppliers and are required to provide a consumer confidence report each year. The ESJGWA will consider requiring GSAs that are drinking water supplies to notify the ESJGWA if constituents of concern exceed their maximum contaminant level (MCL) to assist in identifying potential trends of concern. While these reports do not reflect the water quality of private well owners, it would provide a basin-wide screen to inform basin groundwater quality conditions.

3.3.4 Seawater Intrusion

3.3.4.1 Undesirable Results

3.3.4.1.1 Description of Undesirable Results

The undesirable result related to seawater intrusion is defined in SGMA as:

Significant and unreasonable seawater intrusion

An undesirable result for seawater intrusion in the Eastern San Joaquin Subbasin is experienced if sustained groundwater salinity levels caused by seawater intrusion and due to groundwater management practices are too high to satisfy beneficial uses within the basin over the planning and implementation horizon of this GSP.

The Eastern San Joaquin Subbasin is not in a coastal area and seawater intrusion is not currently present. Undesirable results related to seawater intrusion are not currently occurring and are not reasonably expected to occur (see Section 2.2.3). However, this GSP establishes monitoring protocols for the early detection of seawater intrusion, were it ever to occur, so that the ESJGWA can take action to address undesirable results.

There is the possibility of future seawater intrusion due to potential future changes in the Delta that could be caused by sea level rise. This GSP develops minimum thresholds and measurable objectives that include monitoring for chloride and an analysis of isotopic ratios to identify the source of high salinity (see Section 2.2.4.1).

3.3.4.1.2 Identification of Undesirable Results

Undesirable results are considered to occur during GSP implementation when 2,000 mg/L chloride reaches an established isocontour line and where these concentrations are caused by intrusion of a seawater source as a result of groundwater management activity.

3.3.4.1.3 Potential Causes of Undesirable Results

If seawater intrusion does become an issue in the future, the cause of undesirable results would be seawater coming from surface waters in the Delta either due to climate change and associated sea level rise or significant changes in Delta management practices.

3.3.4.1.4 Potential Effects of Undesirable Results

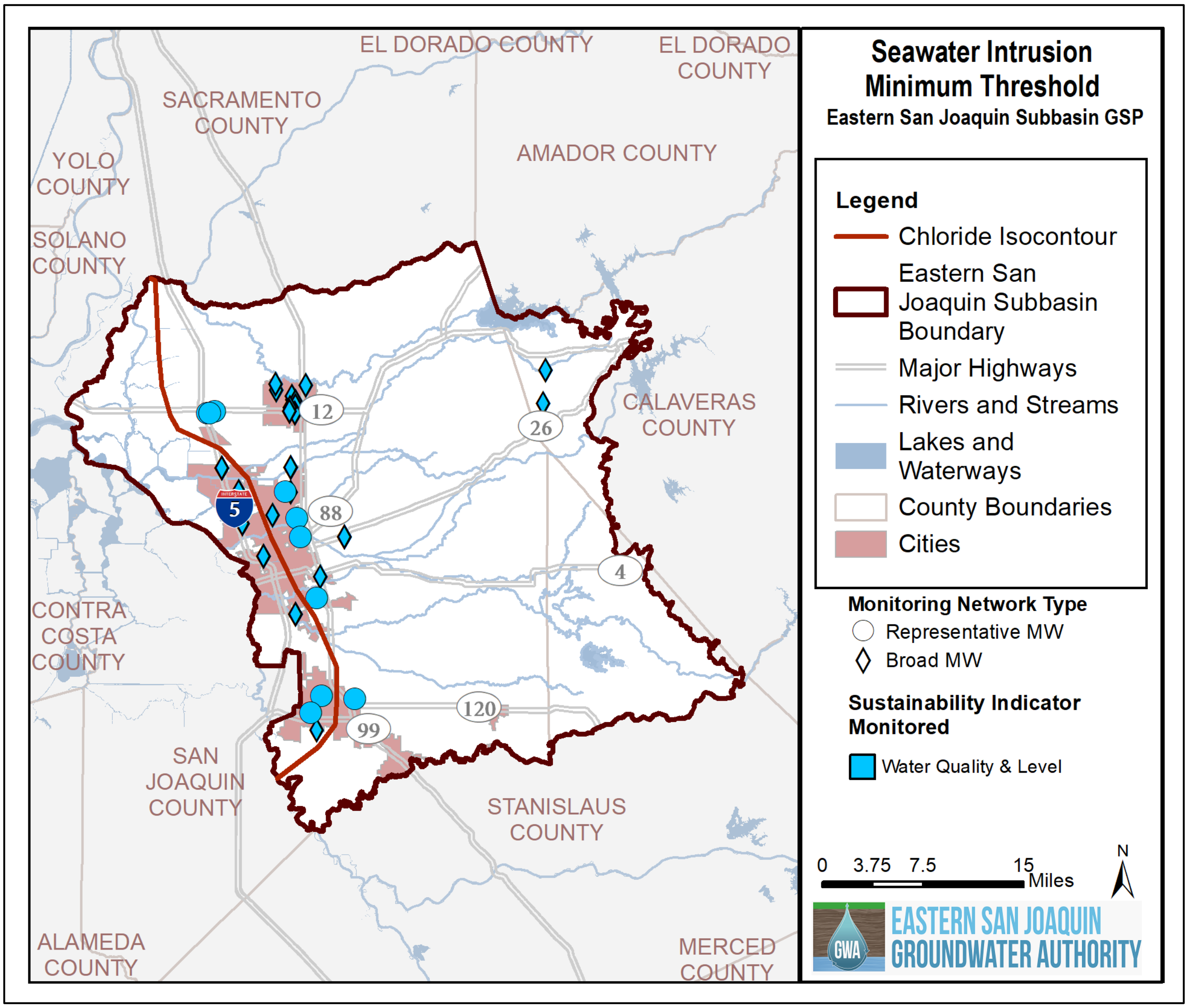
Similar to the effects of undesirable results for degraded water quality, increased salinity due to seawater intrusion could potentially cause a reduction in usable supply to groundwater users, with domestic wells being most vulnerable, as treatment costs or access to alternate supplies can be high for small users. Water quality degradation due to seawater intrusion could cause potential changes in irrigation practices or crops grown, adverse impacts to property values, and other economic effects. It could also adversely affect current and projected municipal uses, and users could have to install treatment systems or seek alternate supplies.

3.3.4.2 Minimum Thresholds

The minimum threshold for seawater intrusion is a 2,000 mg/L chloride isocontour line. 2,000 mg/L chloride is approximately 10 percent of seawater chloride concentrations (19,500 mg/L) and was developed as a minimum threshold based on consideration of existing management practices in other areas of the state including Monterey County and Fox Canyon. This threshold incorporates input from stakeholders from multiple meetings and was reviewed by the ESJGWA Board and Advisory Committee.

The 2,000 mg/L chloride isocontour line depicted in Figure 3-4 is a demarcation of where the ESJGWA would consider seawater intrusion has created an undesirable result. As data are collected from wells within the water quality monitoring network (see Section 4.4), an isocontour line can be drawn with the most current data. If the drawn isocontour line representing current data crosses the minimum threshold isocontour line in Figure 3-4 at chloride concentrations 2,000 mg/L or higher, the ESJGWA would consider that an undesirable result had occurred. It is unlikely that the Subbasin will experience an undesirable result due to seawater intrusion during the SGMA planning horizon.

Figure 3-4: Seawater Intrusion Minimum Threshold Chloride Isocontour Line



3.3.4.3 Measurable Objectives and Interim Milestones

The measurable objective for seawater intrusion is 500 mg/L chloride concentrations at the contour line indicated for the minimum threshold.

The 5-year interim milestones follow along a linear trend between the current conditions and the measurable objective. Interim milestones are based on the measurable objective and will be further developed through water quality monitoring identified in Chapter 4: Monitoring Networks, and coordinated with projects and management actions.

3.3.4.4 Trigger and Actions

An action plan is in place as part of this GSP to trigger additional monitoring and analysis at detections of 1,000 mg/L chloride in the monitoring network to confirm seawater source. Assessing high-chloride water sources to determine origin involves determining water type from major-ions, and evaluating stable isotope concentrations (O'Leary et al., 2015). The ratio of chloride to iodide is also used to differentiate high-chloride water sources besides seawater (O'Leary et al., 2015). These assessment tools would be used to provide the GSAs adequate time to develop groundwater management strategies to address any seawater intrusion before the 2,000 mg/L chloride minimum threshold is reached.

3.3.5 Land Subsidence

3.3.5.1 Undesirable Results

3.3.5.1.1 Description of Undesirable Results

The undesirable result related to land subsidence is defined in SGMA as:

> *Significant and unreasonable land subsidence that substantially interferes with surface land uses.*

An undesirable result for land subsidence in the Eastern San Joaquin Subbasin is experienced if the occurrence of land subsidence substantially interferes with beneficial uses of groundwater and infrastructure within the Subbasin over the planning and implementation horizon of this GSP. Critical infrastructure in the Eastern San Joaquin Subbasin has been defined in coordination with the San Joaquin County Department of Public Works and the San Joaquin County Office of Emergency Services as the following infrastructure potentially at risk for interference from land subsidence:

- Major highways, roadways, and bridges
- Canals, pipelines, and levees
- Electrical transmission lines
- Schools
- Fire stations
- Hospitals and other medical facilities
- Law enforcement facilities (police stations, jails, correctional facilities)
- Water and wastewater treatment, distribution, and storage facilities
- Communication facilities

The Subbasin is served by an extensive road network, including major interstate highways. The San Joaquin County Department of Public Works maintains the County's 120-mile network of underground facilities, over 1,600 miles of roadway, 265 bridges, and 364 minor structures. In addition, San Joaquin County supports air service, a deep water port, transcontinental rail, and commuter trains. Major roadways located within the Subbasin boundary include Interstate 5 (I-5) and multiple State Routes (4, 12, 26, 88, 99, 120). Major bridges in the Subbasin serve both automobile and railroad transport. Major bridges in the subbasin include the San Joaquin River Bridge, Littlejohns Creek Bridge, Mormon Slough Bridge, and the Union Pacific Mossdale Bridge East.

Service buildings within the Subbasin include fire stations, hospitals, jails and correction facilities, police stations, and wastewater plants. The County also maintains 30 water systems with 52 wells, 3 sewage treatment plants, 9 sewage pumping stations, 68 storm drain pumping stations, and over 300 miles of levees and flood channels. In general, major pipelines that run through the County are in areas south of Lodi and southwest of Tracy along the foothills (outside of the Subbasin boundary).

In addition to identifying critical infrastructure at risk for subsidence impacts, the ESJGWA has worked with OES to identify the total subsidence load that critical infrastructure in the Subbasin can tolerate during GSP implementation, and what would be considered an undesirable result. Through input from OES, the critical infrastructure in the Subbasin can generally tolerate a significant amount of uniform settlement due to subsidence across the Subbasin, though the total amount of settlement that can be tolerated is dependent on the design of the specific infrastructure. Differential settlement across facilities in a locale, on the other hand, will result in more damage. However, it is worth noting that it is less common for subsidence to cause significant local differential sediment. In addition, the San Joaquin County *2017 Local Hazard Mitigation Plan* identifies land subsidence as a potential cause for levee breakage; however, the hazard of subsidence is ranked "not likely" to occur.

There are no historical records of significant and unreasonable impacts from subsidence in the Eastern San Joaquin Subbasin (see Figure 2-64). If land subsidence becomes an area of concern, the ESJGWA will take action to consider monitoring protocols and next steps for understanding potential for undesirable results.

3.3.5.1.2 Identification of Undesirable Results

An undesirable result occurs when subsidence substantially interferes with beneficial uses of groundwater and surface land uses. Subsidence occurs as a result of compaction of subsurface materials due to the dewatering of subsurface materials. Undesirable results would occur when substantial interference with land use occurs, including significant damage to canals, pipes, or other water conveyance facilities.

Undesirable results related to inelastic land subsidence will be identified through data collected from the Subbasin's representative monitoring network supplemented with land subsidence data collection efforts conducted by individual GSAs, continuous global positioning system (CGPS) data collected and posted by the United States Geological Survey, InSAR datasets collected and posted by DWR, UNAVCO monitoring data collected and posted by UNAVCO's Plate Boundary Observatory Program, and other publicly available datasets.

3.3.5.1.3 Potential Causes of Undesirable Results

Potential causes of future undesirable results for land subsidence would include significant increases in groundwater production beyond what is currently projected, resulting in dewatering of compressible clays in the subsurface, which are not known to be common in the Eastern San Joaquin Subbasin, as indicated by historical absence of subsidence. Corcoran Clay is one type of subsurface material that is potentially predisposed to compression. See Section 2.1.5 for a description of Corcoran Clay extent in the Subbasin.

3.3.5.1.4 Potential Effects of Undesirable Results

If land subsidence conditions were to reach undesirable results, the adverse effects could potentially cause an irrecoverable loss of groundwater storage and damage to infrastructure, including water conveyance facilities and flood control facilities. This could impact the ability to deliver surface water, resulting in increased groundwater use, or could impact the ability to store and convey flood water. These could have adverse effects to property values or public safety.

3.3.5.2 Minimum Thresholds

This GSP uses groundwater level minimum thresholds as a proxy for the land subsidence sustainability indicator. As such, the minimum thresholds for the land subsidence sustainability indicator are the same as the minimum thresholds for the chronic lowering of groundwater levels sustainability indicator.

GSP regulations allow GSAs to use groundwater levels as a proxy metric for any sustainability indicator, provided the GSP demonstrates that there is a significant correlation between groundwater levels and the other metrics. DWR requires the GSP (CA DWR, 2017):

> *Demonstrate that the minimum thresholds and measurable objectives for chronic declines of groundwater levels are sufficiently protective to ensure significant and unreasonable occurrences of other sustainability indicators will be prevented. In other words, demonstrate that setting a groundwater level minimum threshold*

satisfies the minimum threshold requirements for not only chronic lowering of groundwater levels but other sustainability indicators at a given site.

There is significant correlation between groundwater levels and land subsidence, with land subsidence being driven by a lowering of groundwater levels in the aquifer. Further, the use of groundwater levels as a proxy is necessary, given the relative lack of direct monitoring for land subsidence in the Subbasin.

Land subsidence as a result of groundwater extractions can only occur if two conditions are met: 1) subsurface materials are dewatered, and 2) those dewatered subsurface materials are compressible. Historical declines in groundwater levels in the Eastern San Joaquin Subbasin have not resulted in subsidence (see Section 2.2.5), suggesting that subsurface materials in the geologic units historically affected by groundwater elevation fluctuations are not compressible. If the Subbasin were to operate within the margin of operational flexibility for groundwater levels, future dewatering would continue to occur in the same geologic units historically affected by groundwater elevation fluctuations. Because the deepest groundwater level minimum threshold is 205 feet depth-to-water (well 02N08E15M002), additional declines in groundwater levels are not anticipated to affect dewatered materials at a depth deeper than 205 feet. Geologic materials at this depth are consistent with historical dewatering (see Section 2.1.7 for the five geologic cross sections of the Subbasin), which resulted in no known subsidence. As a result, projected elevation declines are not expected to result in subsidence, and groundwater level minimum thresholds are protective.

The decision to use the groundwater levels representative monitoring network as a proxy for land subsidence was based on the information as discussed above. The GSAs recognize that additional land subsidence data collection and monitoring in the Subbasin over the first few years of GSP implementation will be an important indicator in assessing if the groundwater levels representative monitoring network alone will be sufficient to evaluate potential movement towards significant and unreasonable impacts to infrastructure due to inelastic land subsidence, particularly given that the Subbasin has not historically experienced issues related to land subsidence. For this reason, the Subbasin GSAs have committed to annual collection and evaluation of land subsidence data from publicly available sources, including CGPS, InSAR and other data sources, for assessment with data collected from its representative monitoring network. Data will be evaluated annually, and if subsidence is apparent, projects and management actions in that area will be triggered. The ESJGWA will establish a trigger value of 0.25 feet (annual rate of vertical displacement) at which point an analysis will occur to determine if the subsidence is directly related to groundwater management, and if deemed so, additional projects and management actions will be triggered. Measurable Objectives and Interim Milestones

As chronic lowering of groundwater levels is used as a proxy for land subsidence, the measurable objectives and interim milestones for the land subsidence sustainability indicator are the same measurable objectives and interim milestones as the chronic lowering of groundwater levels sustainability indicator found in Section 3.3.1.3. However, as an additional 5-year interim milestone for this sustainability indicator, the ESJGWA will revisit the Hydrogeologic Conceptual Model (HCM) presented in this GSP after DWR's Airborne Electromagnetic (AEM) data become available in order to incorporate those results and other new hydrogeologic data into an updated HCM. At that time, the ESJGWA will review and adjust the representative monitoring network and monitoring protocols as needed based on improved basin understanding to refine the Subbasin monitoring for inelastic land subsidence. This analysis, and any subsequent revisions, will be incorporated in the GSP five-year update. In time and as subsequent interim milestones, the ESJGWA will improve the correlation between groundwater levels and subsidence for its representative monitoring networks.

Additionally, in coordination with updates as described above for the 5-year interim milestone and as previously stated, as part of the Subbasin's annual reporting process and to further supplement the land subsidence data collection efforts put forward in the GSP, CGPS data, InSAR data, and other subsidence data have been, and will continue to be, evaluated annually by the ESJGWA in coordination with the planned use of chronic lowering of groundwater level minimum thresholds as a proxy for land subsidence. These data will be compiled and evaluated each year as part of the data assessment and production of the Annual Report, submitted to DWR each year by April 1st.

3.3.6 Depletions of Interconnected Surface Water

Depletions of interconnected surface water are a reduction in flow or levels of surface water caused by groundwater extraction. This reduction in surface water flow or levels, at certain magnitudes or timing, may have adverse impacts on beneficial uses of surface water and may lead to undesirable results. Quantification of depletions is relatively challenging and requires significant data on both groundwater levels near streams and stage information supported by groundwater modeling.

3.3.6.1 Undesirable Results

3.3.6.1.1 Description of Undesirable Results

The undesirable result related to *depletions of interconnected surface water* is defined in SGMA as:

> *Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.*

Major rivers and streams that potentially have a hydraulic connection to the groundwater system in certain reaches are the Calaveras River, Dry Creek, the Mokelumne River, the San Joaquin River, and the Stanislaus River. Many of the smaller creeks and streams are substantially used for the conveyance of irrigation water and these systems have not been considered in the analysis of depletions.

3.3.6.1.2 Identification of Undesirable Results

The undesirable result for depletions of interconnected surface water in the Eastern San Joaquin Subbasin is depletions that result in reductions in flow or levels of major rivers and streams that are hydrologically connected to the basin such that the reduced surface water flow or levels have a significant and unreasonable adverse impact on beneficial uses and users of the surface water within the Subbasin over the planning and implementation horizon of this GSP. Beneficial uses and users were identified previously in Section 1.3.1.

3.3.6.1.3 Potential Causes of Undesirable Results

Potential causes of undesirable results would include increased regional groundwater extractions, reduced recharge due to drought, reduced availability of surface water supplies, and increased groundwater extraction along interconnected stream reaches.

3.3.6.1.4 Potential Effects of Undesirable Results

If depletions of interconnected surface water were to reach levels causing undesirable results, effects could include reduced flow and stage within rivers and streams in the Subbasin to the extent that insufficient surface water would be available to support diversions for agricultural or urban uses or to support regulatory environmental requirements. This could result in increased groundwater production, changes in irrigation practices and crops grown, and could cause adverse effects to property values and the regional economy. Reduced flows and stage, along with potential associated changes in water temperature, could also negatively impact aquatic species in the rivers and streams. Such impacts are tied to the inability to meet minimum flow requirements, which are defined for the Mokelumne, Stanislaus, and San Joaquin Rivers, which, in turn, are managed through operations at Camanche Reservoir, Woodbridge Dam, New Melones Reservoir, and other reservoirs.

3.3.6.2 Minimum Thresholds

This GSP uses groundwater level minimum thresholds as a proxy for the depletions of interconnected surface water sustainability indicator. As such, the minimum thresholds for the interconnected surface water sustainability indicator are the same as the minimum thresholds for the chronic lowering of groundwater levels sustainability indicator.

GSP regulations allow GSAs to use groundwater levels as a proxy metric for any sustainability indicator, provided the GSP demonstrates that there is a significant correlation between groundwater levels and the other metrics. The following approach from DWR is used to justify the proxy metric (CA DWR, 2017):

> *Demonstrate that the minimum thresholds and measurable objectives for chronic declines of groundwater levels are sufficiently protective to ensure significant and unreasonable occurrences of other sustainability indicators will be prevented. In other words, demonstrate that setting a groundwater level minimum threshold satisfies the minimum threshold requirements for not only chronic lowering of groundwater levels but other sustainability indicators at a given site.*

To use the minimum thresholds for chronic lowering of groundwater levels as a proxy for interconnected surface water, the stream depletions which would occur when undesirable results for groundwater levels are reached must not be significant and unreasonable.

In discussions of interconnected surface water, the ESJGWA Board, Advisory Committee, Workgroup members, and GSA staff did not indicate any current or historical significant and unreasonable depletions. Based on this input, this Plan assumes that historical conditions are protective of beneficial uses related to interconnected surface water. Therefore, the historical depletions simulated by ESJWRM's historical calibration (documentation in Appendix 3-A) are assumed to have no associated undesirable results. However, if groundwater levels were to fall lower than historical levels, there is an associated level of additional depletions that would occur, quantified below.

The ESJWRM was used to estimate the volume of additional depletions associated with groundwater levels that would be classified as undesirable results (non-dry year pairings where 25 percent or more wells fall below their minimum thresholds). The sustainable conditions scenario (see Section 2.3.6) does not result in groundwater level undesirable results, but the projected conditions scenario (see Section 2.3.4.3) does result in groundwater level undesirable results. The additional stream losses that occurred in the projected conditions scenario compared to the historical calibration are estimates of additional depletions as they can be linked directly to simulated increases in groundwater pumping. The additional depletions in the projected conditions scenario are 50,000 acre-feet per year (AF/year), which is approximately 1 percent of total stream outflows from the Eastern San Joaquin Subbasin. As the reduction in total stream flows is small, no impact is expected to the beneficial users of interconnected surface water in the Subbasin. Depletions greater than an increase of 50,000 AF/year would not occur because at this point the sustainability indicators for groundwater levels would be triggered and would be protective of any further depletions. Therefore, groundwater level thresholds are protective of the depletions of interconnected surface water.

3.3.6.3 Measurable Objectives and Interim Milestones

As chronic lowering of groundwater levels is used as a proxy for depletions of interconnected surface water, the measurable objectives and interim milestones for the depletions of interconnected surface water sustainability indicator are the same as the measurable objectives and interim milestones for the chronic lowering of groundwater levels sustainability indicator.

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4. MONITORING NETWORKS

Monitoring networks in the Eastern San Joaquin Subbasin are dedicated to monitoring short-term, seasonal, and long-term trends in sustainability indicators. There are four networks: a broad network for water levels, a representative network for water levels, a broad network for water quality, and a representative network for water quality. These monitoring networks are tools for the Eastern San Joaquin Groundwater Authority (ESJGWA) and will allow the ESJGWA to compile data on key sustainability indicators and monitor groundwater trends on a variety of temporal and spatial scales. The objective of these monitoring networks is to detect undesirable results in the Subbasin as described in Chapter 3: Sustainable Management Criteria of this Groundwater Sustainability Plan (GSP). The data and trends will allow the ESJGWA to detect changes in Subbasin conditions, meet sustainability goal, avoid minimum thresholds, and evaluate the effectiveness of projects and management actions implemented. Ultimately, the monitoring network and associated data will guide decisions to prevent undesirable results occurring within the GSP implementation timeframe. Other objectives of the monitoring networks, as defined by the Department of Water Resources (DWR), include:

- Demonstrate progress toward achieving measurable objectives described in the Plan
- Monitor impacts to the beneficial uses or users of groundwater
- Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds
- Quantify annual changes in water budget components

The monitoring networks are intended to monitor for chronic lowering of groundwater levels, degraded water quality, and seawater intrusion. As discussed in Chapter 3: Sustainable Management Criteria, the following sustainability indicators will be evaluated using groundwater levels as a proxy: reduction in groundwater storage, land subsidence, and depletions of interconnected surface water.

The schedule and costs associated with monitoring and implementation will be discussed in Chapter 7: Plan Implementation of the GSP.

4.1 MONITORING NETWORK FOR CHRONIC LOWERING OF GROUNDWATER LEVELS

This section provides information on how the groundwater level monitoring networks were developed, criteria for selecting dedicated monitoring wells, monitoring frequency, spatial density, and summary protocols. The two networks that collect data for groundwater levels include:

- **Representative Monitoring Network** – These wells will be used to monitor sustainability in the Subbasin. These wells are used to determine compliance with minimum thresholds and measurable objectives for the groundwater level sustainability indicator.
- **Broad Monitoring Network** – Additional wells are included as part of the broad monitoring network to collect additional information and to maintain a robust network for evaluation. Wells part of the broad monitoring network are not used to determine compliance with minimum thresholds or measurable objectives.

4.1.1 Representative Monitoring Network for Groundwater Levels

Representative monitoring wells represent overall conditions in the production zone in the Subbasin and are reflective of regional groundwater conditions in the vicinity. Table 4-1 identifies and summarizes the 20 representative monitoring wells for groundwater levels. Well locations were shown previously in Figure 3-2 in Chapter 3: Sustainable Management Criteria.

Table 4-1: Representative Monitoring Wells for Groundwater Levels

Local Well ID	CASGEM Site Code	Monitoring Agency	Well Depth (ft.)	Screen Interval in ft. bgs (ft. MSL)	Measurement Period (years)	Measurement Count
Swenson-3	380067N1213458W003	San Joaquin County (SJC)	204	194–204 (-190 to -200)	2014–2018	10
01S09E05H002	378824N1210000W001	SJC	256	148–256 (-41 to -149)	1991–2018	47
Burnett (OID4)	377909N1208675W001	Stanislaus County	501	168–249 (21 to -60)	2005–2019	26
02N07E03D001	380578N1212017W001	SJC	484	130–484 (-74 to -428)	1990–2018	49
04N07E20H003M	381843N1212261W001	SJC	180	164–180 (-87to -103)	1972–2019	103
02S07E31N001	377136N1212508W001	SJC	Unknown	Unknown	1991–2018	45
02S08E08A001	377810N1211142W001	SJC	180	50–180 (22 to -108)	1991–2018	47
01N07E14J002	379316N1211665W001	SJC	556	168–556 (-116 to -504)	1991–2018	47
01N09E05J001	379661N1210011W001	SJC	750	100–750 (56 to -594)	2011–2018	12
02N07E29B001	379976N1212308W001	SJC	202	130–202 (-88 to -160)	1989–2018	41
02N08E15M002	380206N1210943W001	SJC	Unknown	Unknown	2011–2013	5
03N07E21L003	380909N1212153W001	SJC	Unknown	Unknown	1991–2013	39
03N06E05N003	381317N1213524W001	SJC	292	252–292 (-225 to -265)	1991–2018	44
04N05E36H003	381559N1213727W001	SJC	112	50–112 (-27 to -89)	1971–2018	88
04N05E24J004	381816N1213723W001	SJC	190	150–190 (-128 to -168)	1991–2018	47
#3 Bear Creek	Not Part of CASGEM Program	Lockeford Community Services District (LCSD)	780	0–780 (96 to -684)	2011–2018	23
Lodi City Well #2	Not Part of CASGEM Program	City of Lodi	315	109–310 (-57 to -258)	1927–2015	89
Hirschfeld (OID8)	Not Part of CASGEM Program	Stanislaus County	408	88–179 (44 to -47)	2005–2016	23
Well 18	Not Part of CASGEM Program	City of Manteca	350	109–349 (-65 to -305)	1997–2018	65
01S10E26J001M	378163N1208321W001	California Statewide Groundwater Elevation Monitoring (CASGEM)	Unknown	Unknown	1950–2019	104

Representative groundwater level sites were selected by several different criteria. These include:

1. **Adequate Spatial Distribution –** Representative monitoring does not require the use of all wells that are spatially "clumped" together within a portion of the Subbasin. Adequately spaced wells will provide sufficient coverage with fewer monitoring sites.

2. **Robust and Extensive Historical Data –** Representative monitoring sites with a longer period of record and a greater number of historical measurements will provide insight into long-term trends that can provide information about groundwater conditions through varying climatic periods such as droughts and wet periods. Historical data may also show changes in groundwater conditions through anthropogenic effects as well. While some sites chosen may not have extensive historical data, they may still be selected because there are no wells nearby with longer records.

3. **Increased Density in Heavily Pumped Areas –** Selection of additional wells in heavily pumped areas such as in the central portion of the Subbasin and other agriculturally intensive areas will provide additional data where the most groundwater change may occur.

4. **Increased Density near Areas of Geologic or Hydrologic Uncertainty –** Having a greater density of representative wells in areas of uncertainty, such as around faults or large elevation gradients, may provide insight into groundwater dynamics to improve management practices and strategies.

5. **Wells with Multiple Depths –** The utilization of wells with different screen intervals is important to collect data on the groundwater conditions at different elevations within the aquifer. This can be achieved by using wells with different screen depths that are close to one another, or by using multi-completion wells.

6. **Consistency with BMPs –** Using published Best Management Practices (BMPs) provided by DWR will promote consistency across subbasins and promote compliance with established regulations.

7. **Adequate Well Construction Information –** Well information such as perforation depths, construction date, and well depth was considered and encouraged when considering wells to be included.

8. **Professional Judgement –** Professional judgement is used to make the final decision about each well, particularly when more than one suitable well exists in an area of interest.

9. **Maximum Coverage –** Monitoring network wells were selected to prioritize spatial and vertical density of monitoring.

4.1.2 Broad Monitoring Network for Groundwater Levels

The broad monitoring network includes 107 wells, distinct from the 20 wells in the representative network, which will monitor groundwater levels (see Figure 4-1). These wells are not used to determine compliance with the measurable objectives and minimum thresholds. Wells that are part of the broad monitoring network will collect groundwater level data for informational purposes and will help maintain a robust groundwater level monitoring network. Data from this network will be available through the Data Management System (see Chapter 5: Data Management System) and will be reported in Annual Reports to DWR.

Of the 107 wells in the broad monitoring network, 76 wells included are wells used in CASGEM, a monitoring program that has tracked seasonal long-term groundwater elevation trends in the Subbasin. CASGEM wells were selected to be included in the broad monitoring network for groundwater level monitoring based on the following key qualifications:

1. The wells were previously determined to be representative of Subbasin groundwater level conditions;

2. Agencies have committed to semiannual monitoring of these wells;

3. The wells use an existing data source with a historical data record;
4. The wells provide reliable, consistent data taken with standardized existing monitoring protocols; and
5. The wells are in many cases new, having been constructed within the past 10 years when the CASGEM program was enacted.

The broad monitoring network also includes 16 nested and/or clustered well sites (with more than 45 different screen intervals) monitored as part of the CASGEM program and/or by the United States Geological Survey (USGS). These 16 well sites were selected to be included in the broad monitoring network for groundwater levels for the following reasons:

1. The wells use an existing data source and have a historical data record;
2. Many wells are new, having been constructed within the past 10 years when the CASGEM program was enacted;
3. Construction details, including total depth, hole depth, and screen intervals, for these wells are well documented;
4. Wells are screened at multiple depths and can provide depth-specific data; and
5. Nested and/or clustered wells can be used for the analysis of vertical gradients, which will be valuable in characterizing groundwater conditions

The broad monitoring network also includes 15 identified local water quality wells that are included as part of the groundwater water quality monitoring networks (10 in the representative monitoring network and five in the broad monitoring network). These 15 local water quality wells include San Joaquin County's Flag City wells and wells located near cities of Lodi, Manteca, and Stockton. These wells will be monitored for groundwater levels as part of the broad monitoring network for groundwater levels. See Appendix 4-A for additional information on the wells in the broad monitoring network for groundwater levels.

Figure 4-1: Broad Monitoring Network for Groundwater Levels

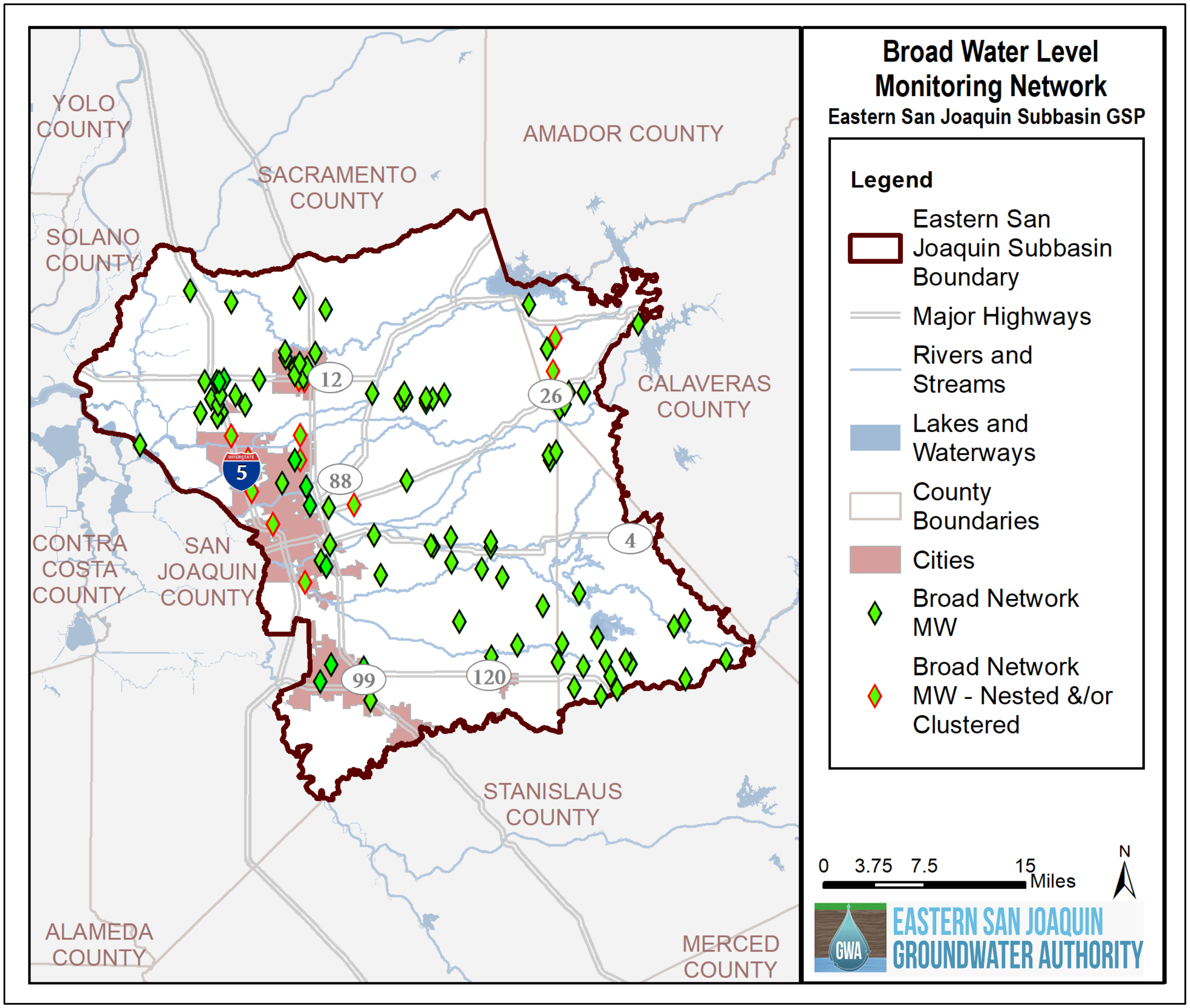


Table 4-2 provides the breakdown on type of wells included in the broad monitoring network for groundwater levels.

Table 4-2: Groundwater Level Monitoring Wells in the Broad Monitoring Well Network

Well Type	Number of Wells Selected for Broad Monitoring Network
CASGEM	76
Existing Nested and/or Clustered Well Site	16
Local Water Quality Wells	15
Total	**107**

4.1.3 Monitoring Protocols for Groundwater Level Data Collection and Monitoring

Groundwater monitoring protocols are essential to producing quality data measurements and protecting the water quality of monitoring wells. Existing protocol resources include DWR's *Groundwater Elevation Monitoring Guidelines* (CA DWR, 2010) and USGS's *National Field Manual for the Collection of Water Quality Data* (USGS, var.). Protocols are established to improve consistency in data and ensure comparable methodologies.

Typical groundwater level measurement equipment used by agencies includes electric sounders, data loggers, steel tapes, and air gauges. Regardless of the instrumentation used in the field, each groundwater level data measurement must include: well identification number, measurement date, reference point and land surface elevation, depth to water, method of measuring water depth, measurement quality codes, any observations on well conditions (i.e., condition of surface seal, accessibility issues, obstructions within the wells, etc.), and measurement to the base of the well (total well depth).

DWR released a BMP for monitoring protocols, in the *Best Management Practices for the Sustainable Management of Groundwater Monitoring Protocols, Standards, and Sites* (CA DWR, 2016a). The monitoring protocols described in DWR's BMP recommend that groundwater level measurements are taken in a manner to ensure data are:

- Taken from the correct location, well ID, and screen interval depth
- Accurate and reproducible
- Representative of conditions that inform appropriate basin management data quality objectives
- Recorded with all salient information to correct, if necessary, and compare data
- Handled in a way that ensures data integrity.
- Taken using a CASGEM-approved water-level measurement method to ensure consistency across measurements. Methods include:
    - Establishing a reference point
    - Using one of four approved methods (steel tape, electric sounding tape, sonic water-level meter, or pressure transducer) to measure groundwater levels

Existing wells, monitored under the CASGEM program, already use these procedures in the collection of groundwater level data. The protocols used for CASGEM groundwater level monitoring will be used when possible in data monitoring and collection in support of this GSP.

4.1.4 Frequency and Timing of Groundwater Level Monitoring

Representative monitoring network wells and broad monitoring network wells for groundwater levels will be monitored semi-annually in March and October to capture the seasonal high and low groundwater levels and to avoid interference from pumping wells during irrigation season.

Frequency of groundwater level monitoring is cited in the *Draft Monitoring Networks and Identification of Data Gaps Best Management Practice* (CA DWR, 2016b) which presents guidance on monitoring frequency based on the type of monitoring, aquifer type, confinement, recharge rate, hydraulic conductivity, and withdrawal rate. While semi-annual monitoring is required for groundwater levels, DWR guidance recommends monthly sampling of groundwater levels for the Eastern San Joaquin Subbasin based on aquifer type, volume of long-term aquifer withdrawals, and recharge potential. Sampling frequencies were developed based on this guidance in combination with a consideration of sampling costs.

A semi-annual monitoring frequency will generate data that is useful for monitoring for the long term, regional trends in groundwater level conditions. These measurements are also valuable for local groundwater management and for investigating local pumping's effects on nearby wells. This frequency meets the goal of a successful monitoring schedule which provides enough data to adequately interpret changes in groundwater levels and fluctuations over short- and long-term periods, as these fluctuations could be the result of storm events, droughts, or other climatic variations, seasons, and anthropogenic activities.

4.1.5 Spatial Density of Groundwater Level Monitoring Network

The goal of the groundwater level monitoring network is to provide adequate spatial coverage within the Subbasin. This includes the ability to monitor and identify groundwater changes across the Subbasin through time. The spatial location of monitoring wells in the networks was based on proximity to other monitoring wells and ensuring adequate coverage near other prominent features such as faults or production wells. Monitoring wells in close proximity to active pumping wells could be influenced by groundwater withdrawals, thus skewing static level monitoring.

To achieve a suitable monitoring network density, DWR recommends selecting existing, dedicated groundwater monitoring wells with known construction information over production wells to incorporate into the network. When deciding on the number of groundwater wells to be monitored in a basin to adequately represent static water levels (and corresponding elevations), the following factors should be considered:

- Known hydrogeology of the basin
- Slope of the groundwater table or potentiometric surface
- Existence of high-volume production wells and the frequency of their use
- Availability of easily accessible monitoring wells

In 2010, DWR released *Groundwater Elevation Monitoring Guidelines*, which discusses the selection and requirements for new wells to be incorporated into groundwater level monitoring networks (CA DWR, 2010). The recommended network density ranges from 0.2 to 10 groundwater monitoring wells per 100 square miles depending on local pumping rates. The Subbasin is approximately 1,195 square miles. Based on the recommendations by DWR, the number of monitoring wells for the Eastern San Joaquin Subbasin should range from 2.4 to 119.5 wells per 100 square miles, as summarized in Table 4-3.

Table 4-3: DWR Monitoring Well Density Recommendations

Reference	Monitoring Well Density (wells per 100 sq. miles)	Recommended No. of Monitoring Wells in the Subbasin
Heath (1976)	0.2 – 10	2.4 – 119.5
Sophocleous (1983)	6.3	75.9
Hopkins (1994)		
Basins pumping more than 10,000 AF/year per 100 miles	4.0	47.8

Spatial density of the groundwater level monitoring network was calculated for both the representative monitoring network and the broad monitoring network, as summarized in Table 4-4. The density of the representative monitoring network is 1.7 wells per 100 square miles, a total of 20 monitoring wells, which falls into the lower to middle range of DWR's recommendations. However, in combination with the broad monitoring network, a total of 127 wells are monitored for groundwater levels (approximately 11 wells per 100 square miles), which exceeds DWR's recommendations.

Table 4-4: Groundwater Level Monitoring Network Density

Monitoring Network	No. of Wells	Well Density (Wells per 100 sq. miles)
Representative Monitoring Network	20	1.7
Broad Monitoring Network	107	9.0
Combined Representative Monitoring Network and Broad Monitoring Network	127	10.6

4.2 MONITORING NETWORK FOR REDUCTION IN GROUNDWATER STORAGE

Groundwater levels will be used as a proxy for the reduction in groundwater storage sustainability indicator as described in Chapter 3: Sustainable Management Criteria. Sustainable management criteria for groundwater storage will be monitored through the groundwater levels monitoring networks, described in Section 4.1. Monitoring data collected by the groundwater level monitoring networks will support future characterization of groundwater in storage.

4.3 MONITORING NETWORKS FOR DEGRADED WATER QUALITY

Groundwater quality monitoring is conducted through both representative and broad groundwater well monitoring networks. This section provides information on how the monitoring networks were developed, criteria for selecting dedicated monitoring wells, monitoring frequency, spatial density, and summary protocols.

The representative monitoring network is used to determine compliance with minimum thresholds and measurable objectives developed for the degraded water quality sustainability indicator. The broad monitoring network includes additional wells to maintain a robust network for evaluation and information collection. Wells that are part of the broad monitoring network are not used to determine compliance with minimum thresholds or measurable objectives.

Monitoring networks monitoring for water quality will test for total dissolved solids (TDS), cations and anions (including chloride and nitrate), arsenic, and field parameters including pH, electrical conductivity (EC), and temperature. Arsenic will be monitored for informational purposes and to track trends in arsenic concentrations. The GSP does not include sustainability goals, measurable objectives, or minimum thresholds for arsenic.

4.3.1 Representative Monitoring Network for Groundwater Quality

Ten representative monitoring wells were selected for monitoring groundwater quality. These wells are currently monitored and managed by City of Manteca, Cal Water, City of Stockton, and San Joaquin County. Table 4-5 identifies and summarizes the agencies with the 10 representative monitoring wells selected for the groundwater quality monitoring network, which was shown previously in Figure 3-3 (Chapter 3: Sustainable Management Criteria).

Table 4-5: Representative Monitoring Network Wells for Water Quality

Well ID	Monitoring Agency	Well Depth (ft. bgs)	Screen Interval (ft. bgs)	Current Condition Average TDS (2015 – 2018) (mg/L)	Monitoring Period (years)	Monitoring Count
Well 1	San Joaquin County (Flag City)	170	120 – 170	500	2008 - 2018	8
Well 2	San Joaquin County (Flag City)	180	130 – 180	510	2008 – 2016	7
Well 3	San Joaquin County (Flag City)	Unknown	Unknown	510	2013 - 2016	3
Stockton 10R	City of Stockton	Unknown	177 – 277	322	1998 - 2018	6
Stockton 28	City of Stockton	Unknown	178 – 278	350	1998 - 2018	6
Stockton SSS8	City of Stockton	Unknown	177 - 277	370	1998 - 2018	4
Well 15	City of Manteca	Unknown	81 – 181	300	1998 - 2018	7
Well 16	City of Manteca	Unknown	80 – 180	-	1998 - 2018	6
Well 17	City of Manteca	Unknown	97 - 197	-	1998 - 2018	6
119-075-01	Cal Water	580	176 – 276	300	1979 - 2018	15

Representative monitoring wells were selected based on their ability to represent conditions in the Subbasin and indicate long-term, regional changes in groundwater quality conditions. Groundwater Sustainability Agencies (GSAs) in areas affected by high TDS levels identified wells to be used as representative monitoring wells that met the following criteria:

1. **Adequate Spatial Distribution** – High TDS concentrations historically have occurred in the western portion of the Subbasin, near the San Joaquin River and urban areas; as such, the majority of representative monitoring wells are located in the western half of the Subbasin. Monitoring wells are located both within areas of high TDS concentrations, to observe and monitor TDS trends, and adjacent to high TDS areas, to observe potential TDS movement.

2. **Extensive Historical Data** – Wells with longer records of TDS monitoring were preferentially selected over wells with short or sporadic records. Monitoring wells with historical TDS records provide insight on long-term trends and the groundwater condition responses to varying climatic periods such as droughts and wet periods and/or anthropogenic effects.

3. **A Range of TDS Concentrations** – Wells with historically low TDS concentrations near areas with high salinity were looked at to alert a change in groundwater quality conditions and a possible migration of salinity.

4. **Known Well Construction Information** – Wells with known construction data, including total depth, screen intervals, and construction date, were preferred. Knowledge of the depth at which water quality measurements are taken would better describe the representative conditions of specific portions of the aquifer.

5. **Current TDS Monitoring Program** – Wells currently monitored for TDS were preferred over wells not currently monitored for water quality constituents. These wells are already equipped for monitoring and have existing protocols to ensure accurate and consistent measurements, and they represent a current asset for the Subbasin that can be further utilized.

6. **Consistency with BMPs** – DWR's published BMPs were used as guidance documents to ensure consistency across all basins and ensure compliance with established regulations.

7. **Professional Judgement** – Professional judgement was used to make the final decision about each well, particularly when more than one suitable well exists in an area of interest.

4.3.2 Broad Monitoring Network for Groundwater Quality

In addition to the representative monitoring network wells, 21 additional wells will monitor groundwater quality as part of the broad monitoring network (see Figure 4-2). The purpose of including these wells in the broad monitoring network is to better monitor for potential spread of salinity and to maintain a robust network for evaluation as part of 5-year GSP updates. These wells are not used to determine compliance with the measurable objectives or minimum thresholds. These 21 wells overlap with the broad monitoring network for groundwater levels. Data from this network will be available through the Data Management System (see Chapter 5: Data Management System) and will be reported in Annual Reports to DWR.

The broad monitoring network for water quality includes 5 identified local water quality wells and 16 nested and/or clustered well sites that are also monitored for groundwater levels in the broad monitoring network for groundwater levels (Section 4.1.2). Table 4-6 identifies the wells included in the broad monitoring network for water quality.

Figure 4-2: Broad Monitoring Network for Groundwater Quality

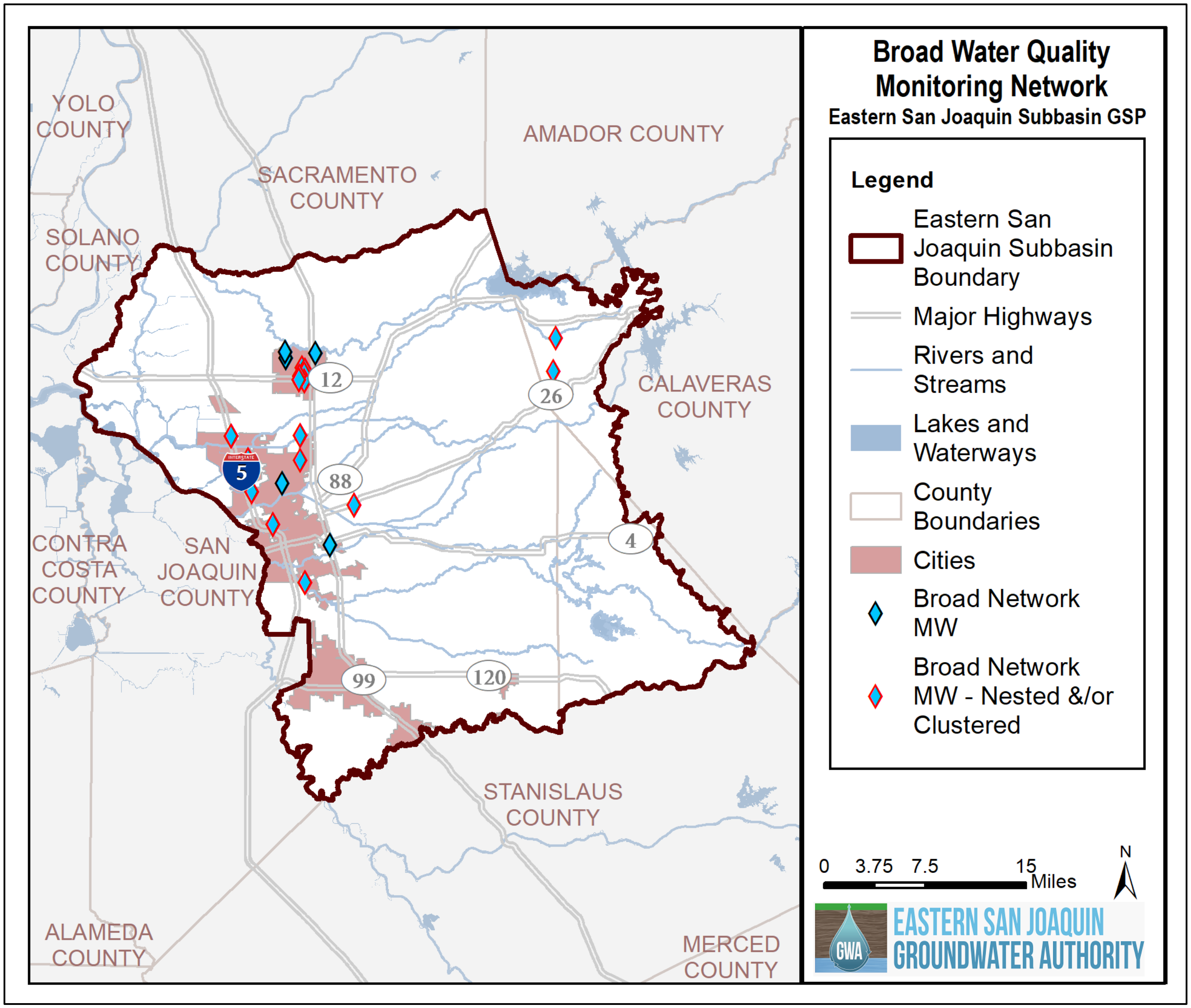


Table 4-6: Wells in the Broad Monitoring Network for Groundwater Quality

Identified Local Water Quality Monitoring Wells			Nested and/or Clustered Wells		
Well ID	**Monitoring Entity**	**Well Depth (ft.)**	**Well ID**	**Monitoring Entity**	**Screen Interval (ft.)**
119-059-01	Cal Water	520	Lodi MW - 21	City of Lodi	(66–76) (92–102) (118–128)
119-069-01	Cal Water	530	Lodi MW – 24	City of Lodi	(95.5–105.5) (60–70) (114–124)
Lodi Well #5	City of Lodi	230	Lodi MW – 25	City of Lodi	(86–96) (148–158)
Lodi Well #7	City of Lodi	422	Lodi SMW – 1	City of Lodi	(105–115) (200–210)
Lodi Well #11R	City of Lodi	465	Lodi WMW – 1	City of Lodi	(195–205) (140–150) (232–242)
			Lodi WMW – 2	City of Lodi	(179–189) (204–214) (231–241) (283–293)
			CCWD 04-06	CCWD	Unknown
			CCWD 010-012	CCWD	Unknown
			Sperry Well	SJCFCWCD	(114–124) (262–282) (440–460)
			STK – 1	SJCFCWCD	(58–68) (220–240) (360–380) (520–540) (860–880)
			STK – 2	SJCFCWCD	(200–220) (280–300) (520–540) (615–635)
			STK – 4	SJCFCWCD	(200–220) (340–360) (540–560)
			STK – 5	SJCFCWCD	(210–230) (410–430) (560–580)
			STK – 6	SJCFCWCD	(240–260) (450–470) (540–560)
			STK – 7	SJCFCWCD	(145–165) (270–295) (415–435) (545–565)
			Swenson Golf Course	SJCFCWCD	(482–502) (294–314) (194–204)

4.3.3 Monitoring Protocols for Groundwater Quality Data Collection and Monitoring

Groundwater quality data sampling protocols are based on DWR's *Best Management Practices for the Sustainable Management of Groundwater Monitoring Protocols, Standards, and Sites* (CA DWR, 2016a), which cites the USGS's 1995 publication *Ground-Water Data-Collection Protocols and Procedures for the National Water-Quality Assessment Program: Collection and Documentation of Water-Quality Samples and Related Data* (USGS, 1995). The BMP recommends groundwater quality monitoring protocols and also recommends using the USGS *National Field Manual for the Collection of Water Quality Data* (USGS, var.) for additional protocols. These publications include protocols for equipment selection, setup, use, field evaluation, sample collection techniques, sample handling, and sample testing.

Groundwater quality sampling protocols recommended in the BMP include ensuring that:

- Groundwater quality data are taken from the correct location
- Groundwater quality data are accurate and reproducible
- Data represents conditions that inform appropriate basin management and are consistent with the data quality objectives
- Data are handled in a way that ensures data integrity
- All salient information is recorded to normalize, if necessary, and compare data

As a quality assurance measure, an operating standard will be developed to ensure data integrity. See Chapter 7: Plan Implementation for additional information on monitoring plan implementation.

4.3.4 Frequency and Timing of Groundwater Quality Monitoring

Groundwater quality measurements will be collected semi-annually for both the representative monitoring network wells and the broad monitoring network wells.

Although DWR does not provide specific recommendations on the frequency of monitoring for TDS, concentrations of groundwater quality, especially salinity, do not typically fluctuate significantly throughout a year to require multiple samples per year. No existing monitoring wells were found to be monitored continuously for groundwater quality (such monitoring is typically performed only for EC and temperature), nor were there agencies that reported ongoing, non-regulatory, regularly scheduled groundwater quality monitoring programs.

Table 4-7 identifies the historical frequency of groundwater quality monitoring conducted for local water quality wells by each monitoring agency. Ten of these wells are the water quality representative network wells, and the remaining five are part of the water quality broad network (two monitored by Cal Water and three monitored by the City of Lodi).

Table 4-7: Historical Groundwater Quality Monitoring Frequency at Identified Local Water Quality Wells

Agency	Data Record	Historical Monitoring Frequency (Approx.)
Cal Water	1979 - 2018	Approx. every 3 years
City of Lodi	2008 - 2018	Approx. every 3 years
City of Manteca	1975 - 2017	Monthly
City of Stockton	1989 - 2016	Quarterly
San Joaquin County – Flag City	2009 - 2017	Annually

4.3.5 Spatial Density of Groundwater Quality Monitoring Wells

DWR's *Monitoring Networks and Identification of Data Gaps BMP* states "The spatial distribution must be adequate to map or supplement mapping of known contaminants" (CA DWR, 2016b). The goal of the groundwater quality monitoring network is to adequately cover the Subbasin to accurately characterize salinity concentrations and trends. This includes both spatial coverage and temporal coverage in order to identify changes in groundwater quality over time.

DWR's *Monitoring Networks and Identification of Data Gaps BMP* identifies different sources and calculations for establishing monitoring network densities on a Subbasin-specific case (CA DWR, 2016b). These density calculations and guidance are summarized in Table 4-3. The spatial density of the groundwater quality monitoring network was calculated for both the representative monitoring network and the broad monitoring network, as summarized in Table 4-8. The representative monitoring network consists of a total of 10 monitoring wells, a density of 0.8 wells per 100 square miles. The density of the broad monitoring network, a total of 21 monitoring wells, is 1.2 wells per 100 square miles.

Table 4-8: Groundwater Quality Monitoring Network Density

Monitoring Network	No. of Wells	Well Density (Wells per 100 sq. miles)
Representative Monitoring Network	10	0.8
Broad Monitoring Network	21	1.2
Combined Representative Monitoring Network and Broad Monitoring Network	31	2.6

4.4 MONITORING NETWORK FOR SEAWATER INTRUSION

The seawater intrusion monitoring network uses the same monitoring wells and monitoring strategies as the groundwater quality representative monitoring network. Chloride concentrations will be monitored at the degraded water quality representative monitoring networks wells to develop a chloride isocontour line (see Section 3.2.4.2 in Chapter 3: Sustainable Management Criteria).

4.5 MONITORING NETWORK FOR LAND SUBSIDENCE

Groundwater levels will be used as a proxy for the land subsidence sustainability indicator as described in Chapter 3: Sustainable Management Criteria. Sustainable management criteria for land subsidence will be monitored through the groundwater levels monitoring network, described in Section 4.1. The ESJGWA will continue to review Interferometric Synthetic Aperture Radar (InSAR) subsidence monitoring data made available by DWR, as well as other data sources as available.

4.6 MONITORING NETWORK FOR DEPLETIONS OF INTERCONNECTED SURFACE WATERS

Groundwater levels will be used as a proxy for the depletions of interconnected surface water sustainability indicator as described in Chapter 3: Sustainable Management Criteria. As such, sustainable management criteria for interconnected surface water will be monitored through the groundwater levels monitoring network, described in Section 4.1. Available stream gage data (stream flows and levels) will also be reviewed for potential impacts to the beneficial uses and users of the surface water within the Subbasin.

4.7 DATA GAPS

4.7.1 Groundwater Level Data Gaps

Groundwater level monitoring data gaps exist in areas where data are limited. Specifically, areas of high data needs include monitoring near streams, Subbasin boundaries, and the groundwater depression in the central part of the Subbasin. Additionally, areas without multiple-completion wells present a limitation for depth-specific information collection. Additional sampling taken within these identified areas will provide more information about groundwater levels and trends in the indicated locations.

4.7.2 Groundwater Quality Data Gaps

Groundwater quality monitoring data gaps have four components:

1. **Spatial distribution:** Monitoring wells are mainly focused in the western portion of the Subbasin, as this area has historically had the highest concentrations of TDS. Additional sampling will provide more information about salinity both to provide more detailed understanding within areas with current monitoring coverage and to expand monitoring to areas without current salinity issues.
2. **Well construction data:** As described in Section 2.2.4, many wells with salinity measurements lack well depth and construction information. Both deeper and shallower groundwater quality monitoring wells are needed to better understand the spatial and depth distribution of salinity concentrations in the Subbasin.
3. **Monitoring frequency:** Temporally, groundwater quality monitoring occurs at different frequencies across the Subbasin, dependent on the monitoring agency responsible (summarized in Table 4-7). The groundwater quality monitoring network under the GSP will utilize a standardized, semi-annual monitoring schedule to facilitate the regular sampling of wells.
4. **Monitoring for additional constituents:** Groundwater quality concerns in the Subbasin are currently focused on salinity. Additional groundwater quality components such as arsenic and cations and anions, including nitrate, are monitored under existing water resources monitoring and management programs. Informational monitoring of these constituents may preempt future groundwater quality issues in the Subbasin.

4.7.3 Interconnected Surface Water System Data Gaps

The ESJGWA recognizes the depletions of interconnected surface water as a data gap area. The ESJGWA has identified a need for future study and refinement of interconnected surface water and will continue coordination efforts to better inform Subbasin conditions. As discussed in Section 7.4.1, future model calibration will be improved by more information on interconnected surface water, including the incorporation of shallow groundwater levels near streams from the proposed wells in Section 4.7.5 and the study of Mokelumne River losses in Section 6.2.7.

4.7.4 Groundwater-Dependent Ecosystem Data Gaps

The Natural Communities Commonly Associated with Groundwater (NCCAG) areas not identified as Groundwater-Dependent Ecosystems (GDEs) through the GDE analysis are data gap areas requiring further evaluation and refinement to determine whether they require classification as a GDE. These areas include NCCAGs that either access co-occurring surface water, were identified as located in an area with groundwater levels deeper than 30 feet bgs, or were located adjacent to irrigated agriculture. The purpose of this data gap is to identify potential existing GDEs that may have been incorrectly not identified as GDEs through the GDE screening process discussed in Section 2.2.7. The ESJGWA will evaluate whether to use GDE Pulse Tool and other tools to monitor GDE areas. Potential impacts to fish and wildlife species associated with GDEs that occur as a result of groundwater pumping under and are not captured under the depletions of interconnected surface water sustainability indicator is also considered a data gap area.

4.7.5 Plan to Fill Data Gaps

Data gaps will be largely filled by leveraging existing wells, constructing new wells, additional water quality monitoring, modeling, and studies of interconnected surface water and GDEs, which are discussed in Chapter 7: Plan Implementation. These efforts will be supported through a combination of funding and financing sources, including through DWR Technical Support Services (TSS) funding, future grant funding, and GSA funding. A description of data collection and analysis efforts to fill data gaps, and information on how these efforts will be funded, is provided in Chapter 7: Plan Implementation.

There are up to 12 proposed new monitoring well sites (shown in Figure 4-3 in orange); these wells will be measured for groundwater levels and groundwater quality. The locations of the proposed monitoring wells are subject to change based on the needs of the Subbasin and well siting feasibility.

Two of these wells will be deep, multi-completion wells, built using support awarded to the Subbasin by DWR's TSS program. The TSS program provides technical support to GSAs during GSP development. The two new wells drilled using DWR's TSS program will improve the density and sampling frequency for both groundwater quality and groundwater level monitoring within data gap areas. Additional multi-completion groundwater level information will assist with better understanding of groundwater-surface water interaction and GDEs. One of the TSS wells is located approximately in the middle of the northern Subbasin boundary (near Dry Creek) and the other well is located along Calaveras River near Highway 88 in the approximate middle of the Subbasin.

The remaining wells will be new shallow groundwater level and quality monitoring wells located near streams, Subbasin boundaries, and the groundwater depression area in the center of the Subbasin. Up to 10 of these wells are funded through the DWR Proposition 1 Sustainable Groundwater Planning Grant. The proposed locations of these wells were selected to be co-located with identified and potential GDE areas and near streams to further understanding of groundwater-surface water connectivity and to refine GDE data gaps. Additionally, groundwater level data collected from these wells will improve the understanding of groundwater flows between subbasins and groundwater quality data will assist in tracking quality in different areas of the Subbasin. Two recommended monitoring locations are adjacent to Dry Creek and are intended to provide data relevant to potential surface water depletions and subsurface flows across the Subbasin boundary to the Cosumnes Subbasin to the north. Relevant data from these and other wells will be shared with GSAs in neighboring subbasins, and parallel efforts will be coordinated.

The USGS *National Field Manual for the Collection of Water Quality Data* (USGS, var.) will be used as a guide for selection of wells, well locations, and collection of reliable data, as recommended by DWR's *Monitoring Protocols, Standards, and Sites* BMP (CA DWR, 2016a). Requirements are summarized in Table 4-9. The DWR's *California Well Standards, Bulletin 74-81 and 74-90* will be used as references for guidance for construction of new monitoring well installation, per DWR's *Best Management Practices for the Sustainable Management of Groundwater Monitoring Protocols, Standards, and Sites* (CA DWR, 2016a). Additionally, procedures will follow applicable San Joaquin County, Calaveras County, or Stanislaus County well standards, including proper permitting and inspection from the applicable county for each well.

Aside from new groundwater monitoring wells, data gaps will also be addressed through additional analysis of interconnected surface water, including additional modeling and refinement of GDEs. Additional activities related to filling data gaps are discussed in Chapter 6: Projects and Management Actions and Chapter 7: Plan Implementation.

Figure 4-3: Proposed New Monitoring Well Locations (Shown in Orange)

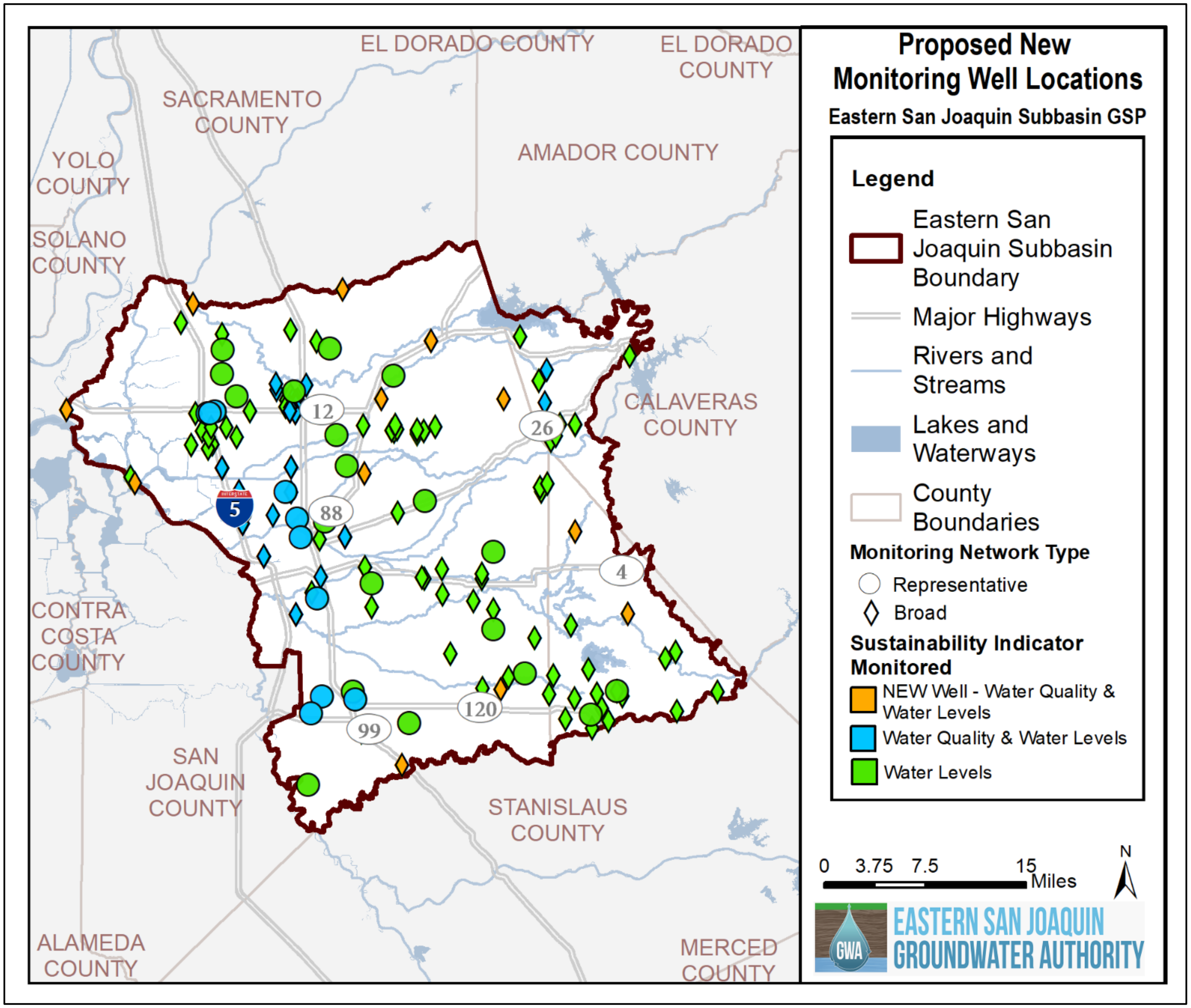


Table 4-9: Considerations for Well Selection and Well Installation

Well Location
• Location conforms to the study's network design for areal and depth distribution. • Land-use/land-cover characteristics, if relevant, are consistent with study objectives. • Site is accessible for equipment needed for well installation and sample collection.
Hydrogeologic Unit(s)
• Hydrogeologic unit(s) that contribute water to the well can be identified. • Depth and thickness of targeted hydrogeologic unit(s) are known or can be determined. • Yield of water is adequate for sampling (typically, a minimum of 1 gallon (3.785 liters) per minute).
Well Records, Description, Design, Materials, and Structure
• Available records (for example, logs of well drilling, completion, and development) have sufficient information to meet the criteria established by the study. • Borehole or casing/screen diameter is adequate for equipment. • Depth to top and bottom of sample-collection (open or screened) interval is known (to determine area contributing water to well). • Length of well screen is proportional to the vertical and areal scale of investigation. • Well has only one screened or open interval in one aquifer, if possible. (Packers can be used to isolate the interval of interest, but packers might not completely isolate zones in unconsolidated or highly fractured aquifers. If packers are used, materials of construction must be compatible with analytes to be studied.) • Top of well screen is several feet below mean annual low-water table to reduce chances of well going dry and to avoid sampling from unsaturated intervals. • Filter pack is of a reasonable length (a long interval compared with length of screened or open interval usually results in uncertainty as to location of the source of water to well). • Well-construction materials do not leach or sorb substances that could alter ambient target-analyte concentrations. • Well-structure integrity and communication with the aquifer are sound. (Checks include annual depth-to-bottom measurements, borehole caliper and downhole-camera video logs, and aquifer tests.)
Pump Type, Materials, Performance, and Location of Sampler Intake
• Supply wells have water-lubricated turbine pumps rather than oil-lubricated turbine pumps. (Avoid suction-lift, jet, or gas-contact pumps, especially for analytes affected by pressure changes, exposure to oxygen, or that partition to a gas phase.) • Pump and riser-pipe materials do not affect target-analyte concentrations. • Effects of pumping rate on measurements and analyses have been or will be evaluated. • Samples intake is ahead of where water enters treatment systems, pressure tanks, or holding tanks.

Source: *National Field Manual for the Collection of Water-Quality Data* (USGS, var.)

5. DATA MANAGEMENT SYSTEM

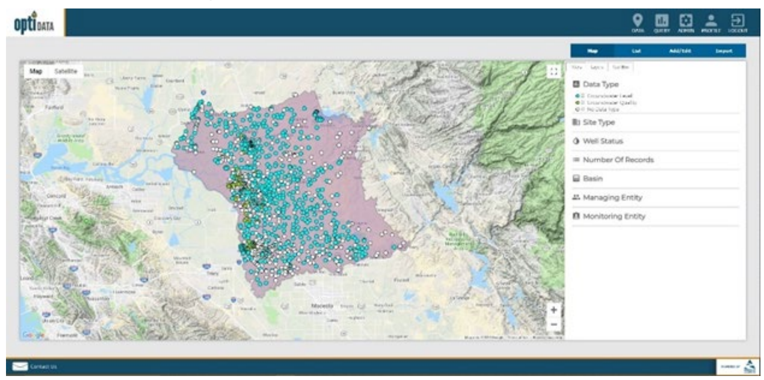
This chapter includes the Data Management System Section that satisfies § 352.6 of the Sustainable Groundwater Management Act Regulations. This section contains three main subsections:

- Overview of the Eastern San Joaquin Subbasin Data Management System
- Functionality of the Data Management System
- Data Included in the Data Management System

5.1 OVERVIEW OF THE EASTERN SAN JOAQUIN SUBBASIN DATA MANAGEMENT SYSTEM

The Eastern San Joaquin Subbasin Data Management System (DMS) is implemented using the Opti platform. The DMS serves as a data sharing portal to enable utilization of the same data and tools for visualization and analysis to support sustainable groundwater management and transparent reporting of data and results.

Figure 5-1: Opti DMS Screenshot



The DMS is web-based and publicly accessible using common web browsers including Google Chrome, Firefox, and Microsoft Edge. It is a flexible and open software platform that utilizes familiar Google maps and charting tools for analysis and visualization. The site may be accessed here: https://opti.woodardcurran.com/esj

5.2 FUNCTIONALITY OF THE DATA MANAGEMENT SYSTEM

The DMS is a modular system that includes numerous tools to support Groundwater Sustainability Plan (GSP) development and ongoing implementation, including:

- User and Data Access Permissions
- Data Entry and Validation
- Visualization and Analysis
- Query and Reporting

The DMS can be configured for additional tools and functionality as the needs of the Eastern San Joaquin Groundwater Authority (ESJGWA) change over time. The following sections briefly describe the currently configured tools. For more detailed instructions on the usage of the DMS, please refer to the Opti Public User Guide (the Opti Public User Guide can be accessed online at https://opti.woodardcurran.com/esj/upload/OptiPublicDMS_Guide.pdf.

5.2.1 User and Data Access Permissions

User access permissions are controlled through several user types that have different roles in the DMS as summarized in Table 5-1 below. These user types are broken into three high-level categories:

- System Administrator users manage information at a system-wide level, with access to all user accounts and entity information. System Administrators can set and modify user access permissions when an entity is unable to do so.
- Managing Entity (Administrator, Power User, User) users are responsible for managing their entity's site/monitoring data and can independently control access to this data. Entity users can view and edit their entity's data and view (not edit) shared or published data of other entities. An entity's site information (wells, gages, etc.) and associated data may only be edited by Administrators and Power Users associated with the entity.
- Public users may view data that are published but may not edit any information. These users may access the DMS using the Guest Login feature on the login screen.

Monitoring sites and their associated datasets are added to the DMS by Managing Entity Administrators or Power Users. In addition to the user permissions, access to the monitoring datasets is controlled through three options:

- Private data are monitoring data that are only available for viewing, depending on user type, by the entity's associated users in the DMS.
- Shared data are monitoring data that are available for viewing by all users in the DMS (excludes Public Users).
- Public data are monitoring data that are available publicly and can be viewed by all user types in the DMS and may be published to other sites or DMSs as needed.

The Managing Entity Administrators have the ability to set and maintain the data access options for each dataset associated with their entity.

Table 5-1: Data Management System User Types

Modules/Submodules	System Administrators	Entity			Public
		Admin	Power User	User	
Data: Map	●	●	●	●	○
Data: List	●	●	●	●	○
Data: Add/Edit	●	●	●		
Data: Import	●	●	●		
Query	●	●	●	●	○
Admin	●				
Profile	●	●	○	○	○

● Indicates access to all functionality, ○ Indicates access to partial functionality (see explanations in following sections)

5.2.2 Data Entry and Validation

To encourage agency and user participation in the DMS, data entry and import tools are easy to use, accessible over the web, and help maintain data consistency and standardization. The DMS allows Entity Administrators and Power Users to enter data either manually via easy-to-use interfaces, or through an import tool utilizing Excel templates, ensuring data may be entered into the DMS as soon as possible after collection. The data are validated by Managing Entity's Administrators or Power Users using a number of quality control checks prior to inclusion in the DMS.

5.2.2.1 Data Collection Sites

Site information is input for groundwater wells, stream gages, and precipitation meters manually either through the Data Entry tool or when prompted in the Import tool. In the Data Entry tool, new sites may be added by clicking on New Site. Existing sites may be updated using the Edit Site tool. During data import, the sites associated with imported data are checked by the system against the existing site list in the DMS. If the site is not in the existing site list, the user is prompted to enter the information via the New Site tool before the data import can proceed.

The information that is collected for sites is shown in Table 5-2. Required fields are indicated with an asterisk.

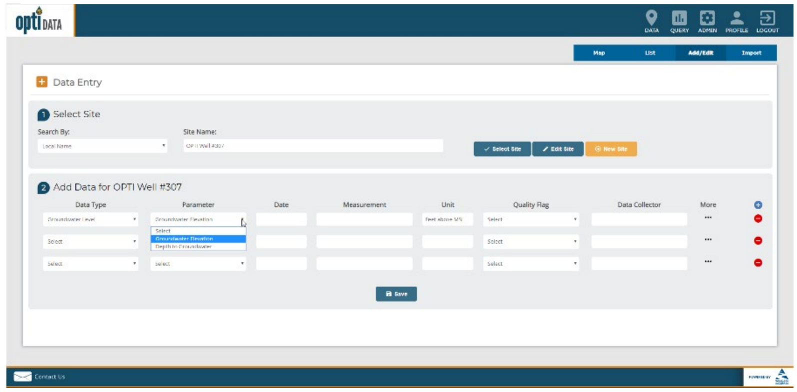
Table 5-2: Data Collection Site Information

Basic Info	Well Info	Construction Info
Site Type*	State Well ID	Total Well Depth
Local Site Name*	CASGEM ID	Borehole Depth
Local Site ID	Ground Surface Elevation	Casing Perforations
Latitude/Longitude*	Reference Point	Casing Diameter
Description	Reference Point Elevation	Casing Modifications
County	Reference Point Location	Well Capacity
Managing Entity*	Reference Point Description	Well Completion Report Number
Monitoring Entity*	Well Use	Comments
Type of Monitoring	Well Status	
Type of Measurement	Well Type	
Monitoring Frequency	Aquifers Monitored	
	Groundwater Subbasin Name/Code	
	Comments	
	Upload File	

* Required fields; all other fields are optional

5.2.2.2 Monitoring Data Entry

Figure 5-2: DMS Data Entry Tool



Monitoring data, including but not limited to groundwater elevation, groundwater quality, streamflow, and precipitation, may be input either manually through the Data Entry tool or using templates in the Import tool. The Data Entry tool allows users to select a site and add data for the site using a web-based tool (see Figure 5-2). The following information is collected:

- Data Type (e.g., groundwater elevation, groundwater quality, streamflow, or precipitation)
- Parameter for selected Data Type, units populate based on selection
- Date of Measurement
- Measurement Value
- Quality Flag (e.g., quality assurance description for the measurement such as "Pumping", "Can't get tape in casing", etc., as documented by the Data Collector)
- Data Collector
- Supplemental Information based on Data Type (e.g., Reference Point Elevation, Ground Surface Elevation, etc.)

Data import templates include the same data entry fields and are available for download from the DMS. The Excel-based templates contain drop-down options and field validation similar to the data entry interface.

5.2.2.3 Data Validation

Quality control helps ensure the integrity of the data added to the DMS. The entities that maintain the monitoring data that were loaded into the DMS may have performed previous validation of that data; no effort was made to check or correct that previous validation and it was assumed that all data provided was valid. While it is nearly impossible to determine complete accuracy of the data added to the DMS since the DMS cannot detect incorrect measurements due to human error or mechanical failure, it is possible to verify that the data input into the DMS meets some data quality standards. This helps promote user confidence in the data stored and published for visualization and analysis.

Upon saving the data in the data entry interface or importing the data using the Excel templates, the following data validation checks are performed by the DMS:

- Duplicate measurements: The database checks for duplicate entries based on the unique combination of site, data type, date, and measurement value.
- Inaccurate measurements: The database compares data measurements against historical data for the site and flags entries that are outside the historical minimum and maximum values.
- Incorrect data entry: Data field entries are checked for correct data type (e.g., number fields do not include text, date fields contain dates, etc.)

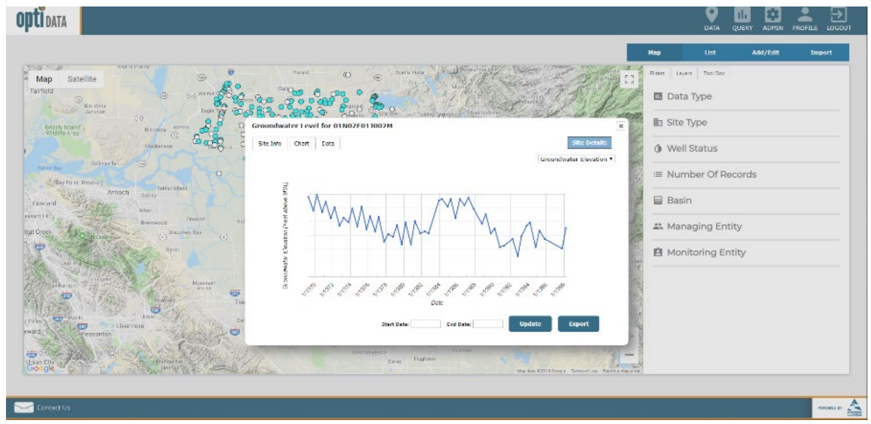
Users are alerted to any validation issues and may either update the data entries or accept the values and continue with the entry/import. Users may access partially completed import validation through the import logs that are saved for each data import. The partially imported data are identified in the Import Log with an incomplete icon under the Status field. This allows a second person to also access the imported data and review prior to inclusion in the DMS.

5.2.3 Visualization and Analysis

Transparent visualization and analysis tools enable utilization of the same data and methodologies, allowing stakeholders and neighboring Groundwater Sustainability Agencies (GSAs) to use the same data and methods for tracking and analysis. In the Eastern San Joaquin Subbasin DMS, data visualization and analysis are performed in both Map and List views.

5.2.3.1 Map View

Figure 5-3: Typical DMS Data Display



The Map view displays all sites (groundwater wells, stream gages, precipitation meters, etc.) in a map-based interface (see Figure 5-3). The sites are color coded based on associated data type and may be filtered by different criteria such as number of records or monitoring entity. Users may click on a site to view the site detail information and associated data. The monitoring data are displayed in both chart and table formats. In these views, the user may select to view different parameters for the data type. The chart and table may be updated to display selected date ranges, and the data may be exported to Excel.

5.2.3.2 List View

The List view displays all sites (groundwater wells, stream gages, precipitation meters, etc.) in a tabular interface. The sites are listed according to site names and associated entities. The list can be sorted and filtered by different criteria such as number of records or monitoring entity. Similar to the Map view, users may click on a site to view the site detail information and associated data. The monitoring data are displayed in both chart and table formats. In these views, the user may select to view different parameters for the data type. The chart and table may be updated to display selected date ranges, and the data may be exported to Excel.

5.2.3.3 Analysis Tools

The Toolbox is available in the Map view and offers Administrative and Entity users access to the Well Tiering tool to support monitoring plan development. The flexibility of the DMS platform allows for future analysis tools, including contouring, total water budget visualization, and management area tracking.

5.2.4 Query and Reporting

The DMS has the ability to format and export data and analysis at different levels of aggregation, and in different formats, to support local decision making and for submission to various statewide and local programs (i.e., the Sustainable Groundwater Management Act [SGMA], California Statewide Groundwater Elevation Monitoring [CASGEM], groundwater ambient monitoring and assessment [GAMA], etc.).

5.2.4.1 Ad-hoc Query

The data in the DMS can be queried and reported using the Query Tool. The Query Tool includes the ability to build ad-hoc queries using simple options. The data can be queried by:

- Monitoring or Managing Entity
- Site Name
- Data Type

Once the type of option is selected, the specific criteria may be selected (e.g., groundwater elevation greater than 100 ft.). Users may also include time periods as part of the query. The query options can build upon each other to create reports that meet specific needs. Queries may be saved and will display in the saved query drop-down menu of the user who created the query for future use.

The query results are displayed in a map format and a list format. In both the Map and List views, the user may click on a well to view the associated data. The resulting data of the query may be exported to Excel.

5.2.4.2 Standard Reports

The DMS can be configured to support wide-ranging reporting needs through the Reports tool. Standard report formats may be generated based on a predetermined format and may be created at the click of a button. These report formats may be configured to match state agency requirements for submittals, including annual reporting of monitoring data that must be submitted electronically on forms provided by the Department of Water Resources (DWR).

5.3 DATA INCLUDED IN THE DATA MANAGEMENT SYSTEM

Many monitoring programs exist at both the local and state/federal levels. A cross-sectional analysis was conducted within the Subbasin to document and assess the availability of data within the Subbasin, as well as statewide or federal databases that provide data relevant to the Subbasin.

The DMS is configured to include a wide variety of monitoring data types and associated parameters. Based on the analysis of existing datasets within the Subbasin and the GSP needs, the data types shown in Table 5-3 below were identified and are currently used in the DMS.

Table 5-3: Data Types and Their Associated Parameters Configured in the DMS

Data Type	Parameter	Units	Currently Has Data in DMS
Groundwater Level	Depth to Groundwater	feet	Yes
	Groundwater Elevation	feet	Yes
Groundwater Quality	Chloride	milligrams per liter	Yes
	Electrical Conductivity	umhos/cm	Yes
	Total Dissolved Solids	milligrams per liter	Yes
	Various Parameters (See Appendix 5-A)	various	
Surface Water Quality	Various Parameters (See Appendix 5-A)	various	
Streamflow	Streamflow	cubic feet per second	
Precipitation	Precipitation	inches	
	Reference Evapotranspiration (ETo)	inches per month	
	Average Air Temperature	ºF	

Additional data types and parameters can be added and modified as the DMS grows over time.

The data were collected from a variety of sources, as shown in Table 5-4 below. Each dataset was reviewed for overall quality and consistency prior to consolidation and inclusion in the database.

The groundwater wells shown in the DMS are those that are included datasets provided by the monitoring data sources shown below for groundwater elevation and quality. These do not include all wells currently used for production and may include wells historically used for monitoring that do not currently exist. Care was taken to minimize duplicative wells in the DMS. As datasets were consolidated, sites were evaluated based on different criteria (e.g., naming conventions, location, etc.) to determine if the well was included in a different dataset. Datasets for the wells were then associated with the same well, where necessary.

After the data were consolidated and reviewed for consistency, it was loaded into the DMS. Using the DMS data viewing capabilities, the data were reviewed for completeness and consistency to ensure the imports were successful.

Table 5-4: Sources of Data Included in the Data Management System

Data Source	Datasets Collected	Date Collected	Activities Performed
Central Valley Salinity Alternatives for Long-Term Sustainability (CVSALTS)	Well Location Well Type (Limited) Well Depth (Limited) Groundwater Quality	8/13/2018	• Removed duplicate records • Matched existing records with other data sources (GAMA, DWR)
DWR CASGEM	Groundwater Elevation Well Type (Limited) Well Depth (Limited) Well Location	4/18/2018	• Removed duplicate records
EnviroStor	Groundwater Quality	7/23/2018	• Removed duplicate records
GeoTracker	Groundwater Quality	7/23/2018	• Removed duplicate records
GAMA	Well Type Well Depth (Limited) Well Location Groundwater Quality	8/2/2018	• Removed duplicate records
Local Data	Groundwater Elevation (Limited) Well Type (Limited) Well Depth Well Location Groundwater Quality	2/2017-10/2018	• Removed duplicate records
San Joaquin County Flood Control and Water Conservation District	Groundwater Elevation Well Type (Limited) Well Depth (Limited) Well Location	9/19/2017	• Removed duplicate records

6. PROJECTS AND MANAGEMENT ACTIONS

This chapter includes relevant projects and management actions information to satisfy California Code of Regulations (CCR) Title 23 § 354.42 and 354.44. The projects and management actions described in this chapter will help achieve the Eastern San Joaquin Subbasin's sustainability goal.

6.1 PROJECTS, MANAGEMENT ACTIONS, AND ADAPTIVE MANAGEMENT STRATEGIES

Achieving sustainability in the Subbasin requires implementation of projects and management actions. The Eastern San Joaquin Subbasin will achieve sustainability by implementing water supply projects that either replace (offset) or supplement (recharge) groundwater to achieve the estimated pumping offset and/or recharge need of 78,000 acre-feet per year (AF/year), identified as the sustainable yield estimate presented in Section 2.3.6. In addition, three projects have been identified that support demand conservation activities, including water use efficiency upgrades. Currently, no pumping restrictions have been proposed for the Subbasin; however, Groundwater Sustainability Agencies (GSAs) maintain the flexibility to implement such demand-side management actions in the future if need is determined.

6.2 PROJECTS

6.2.1 Project Identification

Projects were identified by the Eastern San Joaquin GSAs through a several-month process involving the Eastern San Joaquin Groundwater Authority Board of Directors (ESJGWA Board), Advisory Committee, Workgroup, and the general public. This process included a public polling and feedback solicitation process at the Projects and Management Actions Workshop, held at the October 2018 ESJGWA Board meeting. This activity allowed ESJGWA Board members, GSA staff, and members of the public to participate in a real-time online polling activity through their smart-phone devices. Hard-copy paper surveys were provided for those without online access. Additionally, a template for project feedback and suggestion was created, posted online for the public, and hard copies distributed at Informational Open House events.

Project information was provided by GSAs and compiled into a draft list. This list was discussed and presented during the October and November 2018 ESJGWA Board meetings, the October and November 2018 and January 2019 Advisory Committee meetings, and the November 2018 and January 2019 Workgroup meetings. Priorities identified included:

- Project is implementable with respect to technical complexity, regulatory complexity, institutional consideration, and public acceptance
- Project benefit is located in area of greatest overdraft
- Project is affordable and cost-effective (lowest unit cost per volume water savings)
- Project provides an environmental benefit (or reduces environmental impact)
- Project addresses Disadvantaged Communities (DACs) and/or Severely Disadvantaged Communities (SDACs)
- Project is located in an area where water quality is suitable for use

Projects with the potential to contribute to the migration of a potential contaminant plume were eliminated from consideration and removed from the GSP list of projects.

6.2.2 Project Implementation

Projects will be administered by the GSA project proponents. GSAs may elect to implement projects individually or jointly with one or more GSAs or with the ESJGWA. As the ESJGWA develops GSA-level water budgets, the GSAs will have a better understanding of how projects will be implemented at the GSA-level and can better evaluate progress toward completion.

6.2.3 List of Projects

Several projects to increase water supply availability in the Subbasin were identified. The initial set of projects was reviewed with the ESJGWA Board, Advisory Committee, and Workgroup. A final list of 23 possible projects is included in the GSP, representing a variety of project types including direct and in-lieu recharge, intra-basin water transfers, demand conservation, water recycling, and stormwater reuse. Projects are classified into three categories based on project status: Planned, Potential, and Longer-term or Conceptual, as defined below.

- **Planned Projects –** Projects in this category are planned to be completed and online prior to 2040 and the projected supply is considered as offsetting the projected 2040 supply imbalance.
- **Potential Projects –** Projects in this category are currently in the planning stages and may move forward if funding becomes available. Potential Projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects.
- **Longer-term or Conceptual Projects –** Projects in this category are in the early conceptual planning stages and would require significant additional work to move forward. Longer-term/Conceptual Projects represent potential future projects that could conceptually provide a benefit to the Subbasin in the future, but that would need to be further developed.

This subsection of the GSP satisfies the requirements of CCR Title 23 § 354.44. Consistent with SGMA requirements, the project descriptions for projects contain information regarding:

- The benefitted measurable objective
- Permitting and regulatory processes
- Time-table for initiation and completion
- Expected benefits
- How the project will be accomplished
- Legal authority
- Estimated costs and plans to meet costs
- Implementation circumstances
- Public noticing

Table 6-1 provides a summary of the 23 projects. Full descriptions are included below. Figure 6-1 through Figure 6-3 shows the locations of these Planned, Potential, and Longer-term or Conceptual Projects.

Table 6-1: List of SGMA Projects

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Expected Groundwater Demand Reduction (AF/year)
						Capital	Annual O&M		
Planned Projects: Projects in this category are planned to be completed and online prior to 2040. The projected supply of projects in this category will be considered as offsetting the projected 2040 supply imbalance.									
Project 1: Lake Grupe In-lieu Recharge	In-lieu Recharge	SEWD	Groundwater levels	Can be implemented immediately	2020-2022	$2.3 M	$330,000	Installation for new intake and pipeline requires permits from DFW, CVFPB, RWQCB, and USACE	10,000
Project 2: SEWD Surface Water Implementation Expansion	In-lieu Recharge	SEWD	Groundwater levels	Design phase	2019-2020	$750,000	$100,000	Permit approvals from DFW, RWQCB, CVFPB, and USACE by private landowners	19,000
Project 3: City of Manteca Advanced Metering Infrastructure	Conservation	City of Manteca	Groundwater levels	Currently underway	2019-2021	$650,000	$300,000	None	272
Project 4: City of Lodi Surface Water Facility Expansion & Delivery Pipeline	In-lieu Recharge	City of Lodi	Groundwater levels	Planning phase	2030-2033	$4 M	$2,340,000	SWRCB permitting and CEQA required	4,750
Project 5: White Slough Water Pollution Control Facility Expansion	Recycling/ In-lieu Recharge	City of Lodi	Groundwater levels	Construction complete	2019-2020	$6 M	$4,664	None (permitting complete)	115
Project 6: CSJWCD Capital Improvement Program	In-lieu Recharge	CSJWCD	Groundwater levels	Can be implemented immediately	2020-2027, on-going with 7-year completion cycles	$50,000	$50,000	Individual applications need CSJWCD Board approval and possible streambed alteration permits	5,000

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Expected Groundwater Demand Reduction (AF/year)
						Capital	Annual O&M		
Project 7: NSJWCD South System Modernization	In-lieu Recharge	NSJWCD	Groundwater levels	Environmental review is complete, funding has been sought and a landowner improvement district formed	2018-2023	$9 M	$250,000	Permits for pump station work have been completed; minor grading and road encroachment permits may be needed	4,500
Project 8: Long-term Water Transfer to SEWD and CSJWCD	Transfers/ In-lieu Recharge	SSJ GSA	Groundwater levels	Infrastructure is in place. Environmental Review may need to be implemented	2019-2021	N/A	$9 M	Project must comply with CEQA	45,000
								Total Planned	***88,637***
Potential Projects: Projects in this category represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the "planned" projects.									
Project 9: BNSF Railway Company Intermodal Facility Recharge Pond	Direct Recharge	CSJWCD	Groundwater levels	Planning phase	2020-2023	$150,000	$50,000	Streambed alteration permit	1,000
Project 10: City of Stockton Advanced Metering Infrastructure	Conservation	City of Stockton	Groundwater levels	Initial study completed in 2011	2020/25-2025/28	$11 M	$550,000	Not determined	2,000

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Expected Groundwater Demand Reduction (AF/year)
						Capital	Annual O&M		
Project 11: South System Groundwater Banking with EBMUD	In-lieu Recharge	NSJWCD	Groundwater levels	Agreement is in place; parties need to finalize design. Environmental review and permitting needed	2020-2025	$5 M	$400,000	SWCRB change petition for Permit 10478 and San Joaquin County groundwater export permit, and regulatory permits as needed	4,000
Project 12: NSJWCD North System Modernization/ Lakso Recharge	In-Lieu Recharge/ Direct Recharge	NSJWCD	Groundwater levels	Planning phase	2021-2026	$7 M	$150,000	Regulatory permits as needed	2,600
Project 13: Manaserro Recharge Project	Direct Recharge	NSJWCD	Groundwater levels	Planning phase	2019-2022*	$300,000	$400,000	CEQA review, possible grading permit, possible water right change petition	8,000
Project 14: Tecklenburg Recharge Project	Direct Recharge	NSJWCD	Groundwater levels	Planning phase	2020-2023**	$1 M	$400,000	CEQA review and possible grading permit	8,000
Project 15: City of Escalon Wastewater Reuse	Recycling/ In-lieu Recharge/ Transfers	SSJ GSA	Groundwater levels	Planning phase	2020-2028	$18 M	$400,000	CEQA review, RWQCB permits, and road encroachment permits	672

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Expected Groundwater Demand Reduction (AF/year)
						Capital	Annual O&M		
Project 16: City of Ripon Surface Water Supply	In-lieu Recharge	SSJ GSA	Groundwater levels	Design complete; environmental permitting underway	2020-2024	$8.6 M	N/A	NEPA Categorical Exclusion, CEQA Mitigated Negative Declaration, and road encroachment permits	6,000
Project 17: City of Escalon Connection to Nick DeGroot Water Treatment Plant	In-lieu Recharge	SSJ GSA	Groundwater levels	Conceptual design phase; environmental review complete	2020-2023	$8,789,000	$250,000	Road encroachment permits	2,015
								Total Potential	***32,287***
Longer-term or Conceptual Projects: Projects in this category represent potential future projects that could conceptually provide a benefit to the Subbasin in the future, but that would need to be further developed.									
Project 18: Farmington Dam Repurpose Project	Direct Recharge	SEWD	Groundwater levels	Preplanning phase with reconnaissance study complete	2030-2050	$175 M	$2 M	Permits and approvals form SWRCB, USBR, DFW, RWQCB, CVFPB, and USACE	30,000
Project 19: Recycled Water Transfer to Agriculture	Recycling/Transfers/ In-lieu Recharge	City of Manteca	Groundwater levels	Planning phase with evaluation completed in Draft Reclaimed Water Facilities Master Plan	Not determined	$37,645,000	$679,000	NPDES Permit amendment, CEQA review, and SWRCB approval	5,193
Project 20: Mobilizing Recharge Opportunities	Direct Recharge	San Joaquin County	Groundwater levels	Early conceptual planning phase	Not determined	Not determined	Not determined	Not determined	Not determined

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Expected Groundwater Demand Reduction (AF/year)
						Capital	Annual O&M		
Project 21: NSJWCD Winery Recycled Water	Recycling/ In-Lieu Recharge/ Direct Recharge	NSJWCD	Groundwater levels	Conceptual planning and discussion	2025-2027	$1.5 M	$100,000	WDR permitting through the RWCQB and minor permits for pipeline construction	750
Project 22: Pressurization of SSJID Facilities	Conservation	SSJ GSA	Groundwater levels	Feasibility study complete	2019-2030	$328 M	$8.5 M	CEQA review and road encroachment permits	30,000
Project 23: SSJID Storm Water Reuse	Storm Water/ In-lieu Recharge/ Direct Recharge	SSJ GSA	Groundwater levels	Planning phase	2027-2030	$30 M	$30,000	CEQA review and road encroachment permits	1,100
								Total Longer-term or Conceptual	***67,043***

[1] Acronyms defined: Stockton East Water District (SEWD), Central San Joaquin Water Conservation District (CSJWCD), North San Joaquin Water Conservation District (NSJWCD), California Department of Fish and Wildlife (DFW), Central Valley Flood Protection Board (CVFPB), Regional Water Quality Control Board (RWQCB), and U.S. Army Corps of Engineers (USACE), State Water Resources Control Board (SWRCB), California Environmental Quality Act (CEQA), U.S. Bureau of Reclamation (USBR), National Pollutant Discharge Elimination System (NPDES), Waste Discharge Requirements (WDR).

* Project is anticipated to initiate on a pilot basis in 2019 and on a full-scale basis in 2020.

** Project is anticipated to initiate on a pilot basis in 2020 and on a full-scale basis in 2021.

Figure 6-1: Location of Planned Projects

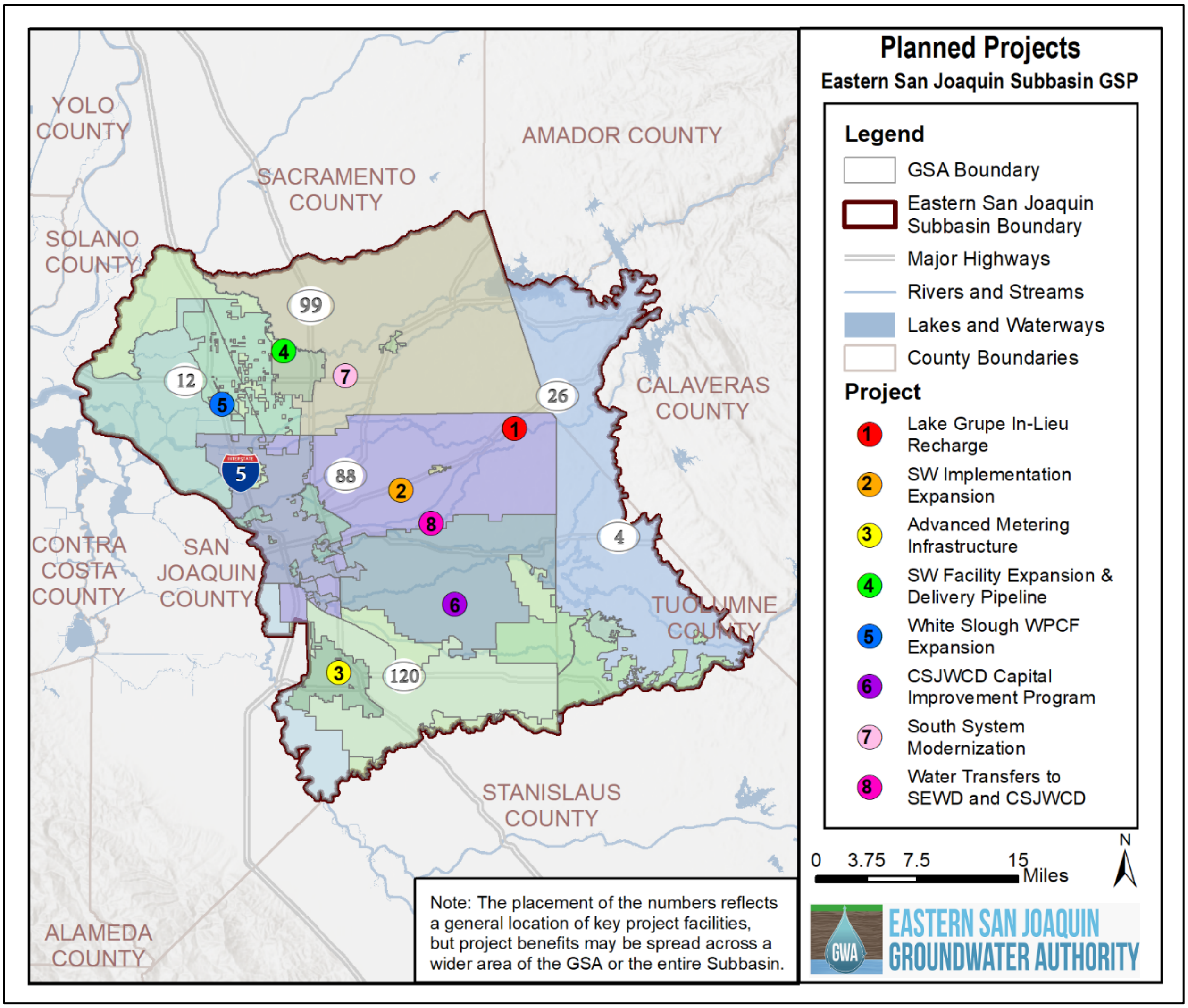


Figure 6-2: Location of Potential Projects

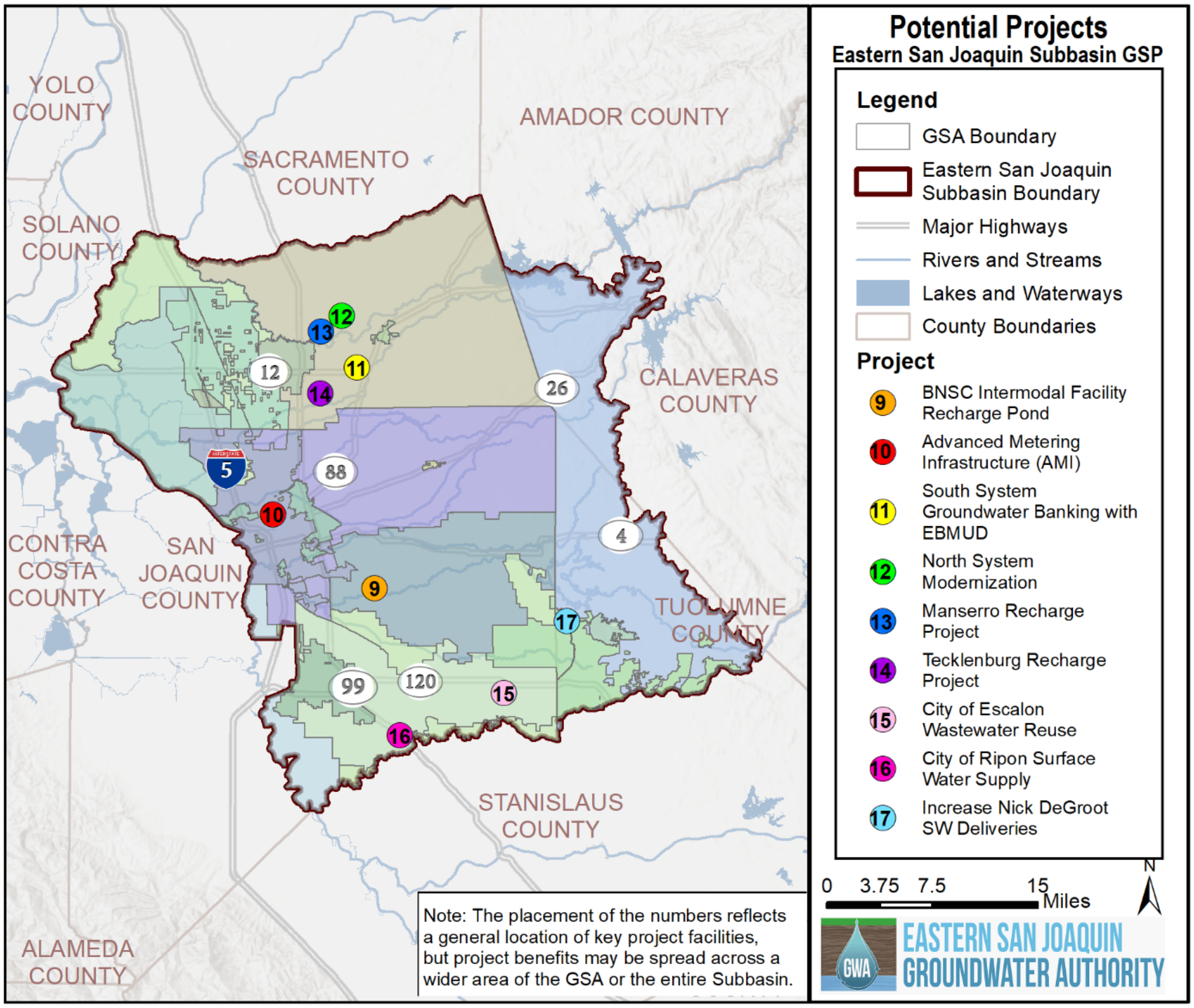
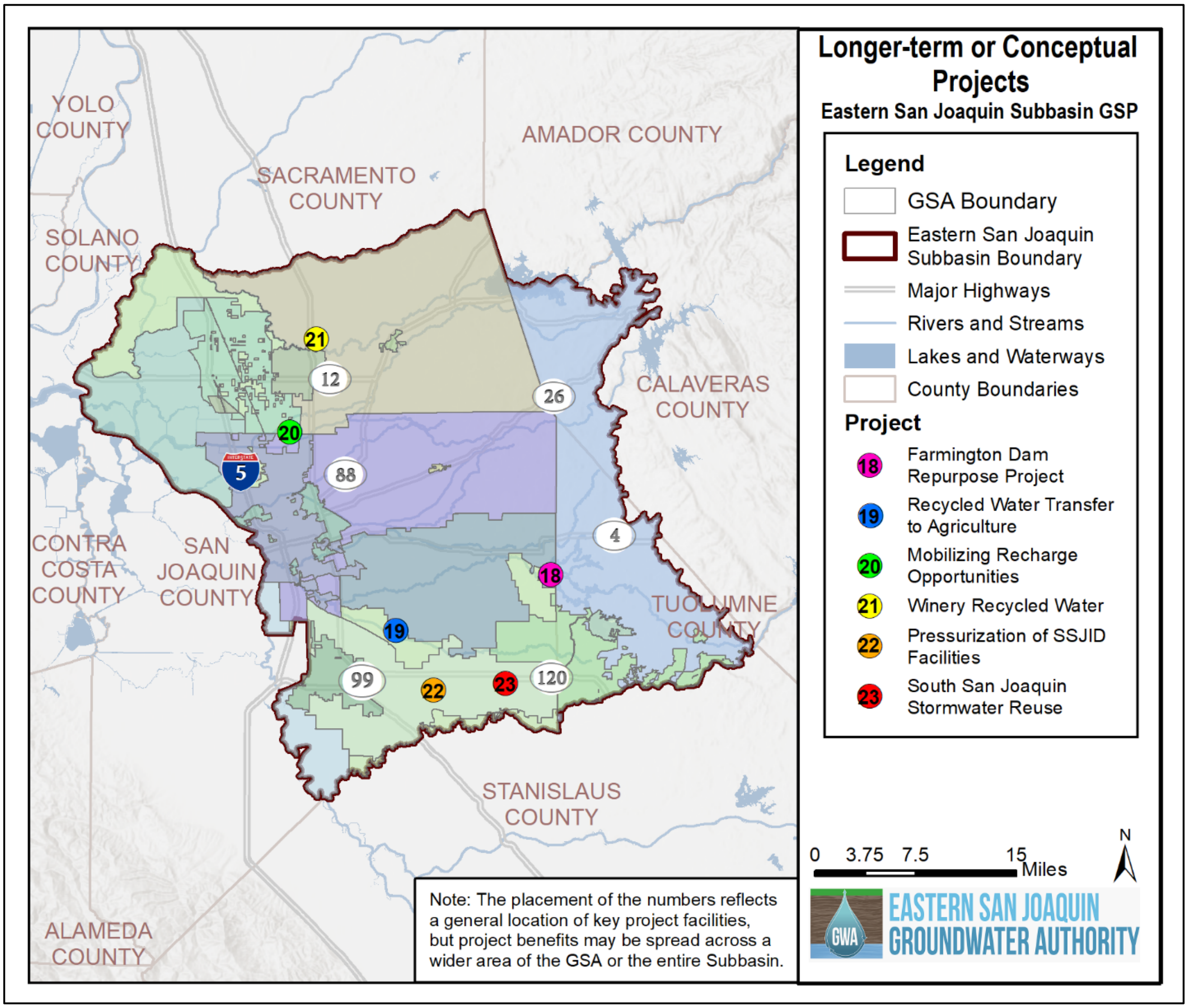


Figure 6-3: Location of Longer-Term or Conceptual Projects



6.2.4 Planned Projects

Projects categorized as Planned Projects are expected to be completed and online prior to 2040. The projected supply of projects in this category will be considered as offsetting the projected 2040 supply imbalance. Up to 88,637 AF/year groundwater demand reduction/offset/conservation is expected as a result of the eight Planned Projects included in this GSP. This value exceeds the estimated 78,000 AF/year needed for the Subbasin to reach sustainability.

6.2.4.1 Project 1: Lake Grupe In-Lieu Recharge

The Lake Grupe In-Lieu Recharge Project, proposed by SEWD, is to construct a surface water diversion turn-out on the Calaveras River, upstream of Bellota, and to supply surface water to multiple farms/growers currently using groundwater. The proposed project is to allow 2,500 acres of orchard crops to irrigate with surface water from Lake Grupe instead of using groundwater. Lake Grupe is at the end of rolling hills fed by two or more natural episodic streams. The proposed project would pump water from the Calaveras River, transport the water in a 24-inch PVC pipeline for about 5,000 feet, with an elevation gain of 170 feet through private properties, discharge the water into one of the ravines feeding Lake Grupe, and then the surrounding growers would pump the water from the Lake for irrigation. The diverted water would flow through a ravine, currently on private lands, and recharge the groundwater basin underneath. The benefit of this project is the in-lieu banking of 7,000 AF of groundwater from irrigation conversion plus additional 13,000 AF of percolation in the ravine.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	10,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: This project can be implemented immediately.

Required Permitting and Regulatory Process: This project requires the installation of a new intake in the Calaveras River and construction of a pipeline through private properties. The installation of a new intake in the Calaveras River would require permits from California Department of Fish and Wildlife (DFW), Central Valley Flood Protection Board (CVFPB), Regional Water Quality Control Board (RWQCB), and U.S. Army Corps of Engineers (USACE).

Time-table for Initiation and Completion: This project is expected to initiate in 2020 and be completed by 2022.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset 4,750 AF/year in groundwater pumping in SEWD. Benefits to groundwater levels will be evaluated through Eastern San Joaquin Water Resources Model (ESJWRM) model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The surface water source of this proposed project is from SEWD's existing contract with the U.S. Bureau of Reclamation (USBR) for the New Hogan Reservoir. Surface water is diverted from the Calaveras River. This is an existing surface water right.

Legal Authority: SEWD is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SEWD is also a GSA with authority on groundwater pumping.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $2.3 million in capital costs and $330,000 in annual operations and maintenance costs. Costs for this project will be met through SEWD District staffing and District rates to establish new accounts.

Circumstances for Implementation: This project is a Planned Project that is anticipated to move forward. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin. Implementation of this project is being considered by SEWD's Board of Directors. Upon approval, this project will begin.

Trigger for Implementation and Termination: This project is planned and SEWD is seeking grant funding and approval by the Board of Directors. This project would terminate at the requests of the landowners and approval of the Board of Directors.

Process for Determining Conditions Requiring the Project have Occurred: Not applicable; this is a Planned Project that is anticipated to move forward.

6.2.4.2 Project 2: SEWD Surface Water Implementation Expansion

As part of the SEWD Surface Water Implementation Expansion Project, SEWD would require landowners adjacent to surface water conveyance systems (rivers or pipelines) to utilize surface water as part of the SGMA implementation. This would increase surface water usage by about 18,000 to 20,000 AF/year with in-lieu groundwater recharge benefits. Currently, there are about 6,000 acres irrigated with groundwater that could be converted to surface water. There are also an additional 1,500 acres with inactive surface water accounts. SEWD would be the lead agency in environmental/CEQA review and would assist landowners/growers in establishing a turnout for agricultural irrigation and acquiring necessary permits through federal and state regulatory agencies.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	18,000 – 20,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: This project is in the design phase. The District has identified the parcels with possible connections.

Required Permitting and Regulatory Process: The required permitting for this project would include acquiring permits/approvals from California DFW, RWQCB, CVFPB, and USACE by private landowners/diverters. SEWD would be the lead agency for CEQA review and would assist landowners/diverters in obtaining the permits.

Time-table for Initiation and Completion: This project is expected to begin in 2019 and be on-going, with benefits accrued by 2020.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset 4,750 AF/year in groundwater pumping in SEWD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project relies on water from New Hogan Reservoir (Calaveras River water) and New Melones Reservoir (Stanislaus River water). This is an existing surface water right. SEWD has long-term water supply contracts with USBR for both New Hogan Reservoir and New Melones Reservoir.

Legal Authority: SEWD is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SEWD is also a GSA with authority on groundwater pumping.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $750,000 in capital costs and $100,000 in annual operations and maintenance costs. Costs for this project will be met through staffing and rates for new accounts.

Circumstances for Implementation: This project is a Planned Project that is anticipated to move forward. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin. SEWD's Board of Directors is considering implementation of this project. Upon approval, this project would begin.

Trigger for Implementation and Termination: This project is planned and SEWD is seeking grant funding and approval by their Board of Directors. This project would terminate at the requests of the landowners and approval of the Board of Directors.

Process for Determining Conditions Requiring the Project have Occurred: Not applicable, this is a Planned Project that is anticipated to move forward.

6.2.4.3 Project 3: City of Manteca Advanced Metering Infrastructure

The City of Manteca provides treated drinking water through approximately 20,696 service connections. In order to improve efficiency and reliability of water meters, the City has been replacing existing meters and upgrading the Encoder Receiver Transmitters (ERTs) on meters when required. The ERTs and new meters allow for remote reading of the flow via a radio signal to a radio receiver inside a city vehicle or at a fixed location. The City also plans to construct the infrastructure for an Advanced Metering Infrastructure (AMI) network to further increase efficiency. AMI also provides several other benefits beyond simple cost savings including improved customer service, leak detection, and real-time consumption information to the customer. Documented customer water savings and improved demand-side water conservation has occurred when real-time consumption information is available.

This project would apply advanced metering infrastructure to water meters in the City of Manteca Service Area. Improved technology would increase efficiency and decrease costs associated with manual reading. Additional benefits beyond cost savings include improved leak detection and demand-side water conservation.

Project Summary	
Submitting GSA:	City of Manteca
Project Type:	Conservation
Estimated Groundwater Demand Reduction:	272 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing demand-side water conservation opportunities.

Project Status: The City of Manteca is in the process of updating meters throughout the City and is planning to construct a network which will include a combination of fiber optic cables and series of radio tower antennas.

Required Permitting and Regulatory Process: There are no permitting or regulatory requirements for this project at this time.

Time-table for Initiation and Completion: This project is currently underway and is expected to be completed by July 2021.

Expected Benefits and Evaluation: This project is anticipated to reduce groundwater demand by 272 AF/year in the City of Manteca through leak detection and real-time consumption information to the customer. Benefits to groundwater levels will be evaluated by quantifying resulting demand reduction.

How Project Will be Accomplished/Evaluation of Water Source: This project is a demand-side conservation project. No additional water source will be utilized for this project.

Legal Authority: This project is under the authority of the City of Manteca and implemented within the City's service area.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $650,000 in capital costs and $300,000 in annual operations and maintenance costs. The AMI Project is a Capital Improvement Project with available funding.

Circumstances for Implementation: This project is a Planned Project that is anticipated to move forward. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin. The City of Manteca has started to implement the AMI infrastructure in phases by purchasing meters that have the capability to be read remotely. Installation of other components like fiber optic cable and radio tower antennas is in the planning stage.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Not applicable; this is a Planned Project that is anticipated to move forward.

6.2.4.4 Project 4: City of Lodi Surface Water Facility Expansion & Delivery Pipeline

This project would extend the filter room at the City of Lodi Surface Water Facility and add an additional 10 million gallons per day (MGD) capacity of surface water treatment. In addition to the filter addition, the City will construct a second sedimentation basin and add pumps throughout the facility to handle the additional volume of water being moved. This project also includes an extension of the 36-inch transmission pipeline leaving the water plant approximately 5,000 feet to facilitate water deliveries to locations further from the water treatment facility.

There is potential to reduce dependency on groundwater during summer months when the City of Lodi is still pumping as much as 10 MGD from the ground to support the water plant. Groundwater savings could be as high as 6,000 AF/year; however, 4,500 to 5,000 AF/year is expected. The delivery of additional raw surface water will need to be secured for this project to proceed.

Project Summary	
Submitting GSA:	City of Lodi
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	4,750 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: This project is in the planning/initial study phase. The required plumbing and infrastructure exist; however, pumps and corresponding equipment would need to be purchased. The City has not completed a study or performed engineering modelling related to feasibility. Increasing capacity would allow for more surface water diversion during summer months, but it is unlikely that during the winter months demand would exceed the current plant capacity. The City anticipates meeting peak summer demand with more surface water, which currently exceeds the 4,000 AF that is supplied by wells.

Required Permitting and Regulatory Process: This project requires SWRCB permitting and re-classification for plant upsizing. CEQA review will also need to be completed.

Time-table for Initiation and Completion: The timeline for this project has not yet been developed, but it is estimated that this project could begin in 2030 and be completed by 2033. Benefits would be realized beginning the first summer following the plant expansion and remain in perpetuity.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset 4,750 AF/year in groundwater pumping in the City of Lodi. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The City of Lodi relies on Woodbridge Irrigation District (WID) for surface water deliveries and does not currently have a contract allowing for higher volumes to be supplied. This project relies entirely on the availability of additional surface water deliveries from WID (Mokelumne River water), which will need to be negotiated at the onset of this project.

Legal Authority: The City of Lodi has legal authority to administer this project through California Water Code (CWC) § 71000-73000. Additional legal and contract negotiations will be needed with WID for additional surface water deliveries.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $4 million in capital costs, $240,000 in fixed annual operations and maintenance costs, and $2.1 million in annual variable costs (amount is variable depending on water purchase, power, and chemical needs). This project is a Capital Improvement Project Budgeted item, to be paid for from the water enterprise fund.

Circumstances for Implementation: This project is a Planned Project that is anticipated to move forward. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.

Trigger for Implementation and Termination: Expansion of the Surface Water Treatment Facility (SWTF) will be initiated when the City of Lodi is unable to meet its growing water demand with the current infrastructure. There is no expectation that this project would be terminated based on a decision made by the City of Lodi. The potential for reduced availability of surface water supply from WID would be the only potential cause for a reduction in SWFT production.

Process for Determining Conditions Requiring the Project have Occurred: In reviewing current water demands, as well as future projections of use, City of Lodi staff will determine whether an expansion of the SWTF is appropriate or not and make a recommendation to City Council. This is a Planned project that is anticipated to move forward and be online by 2040.

6.2.4.5 Project 5: White Slough Water Pollution Control Facility Expansion

This project would include the construction of a 70-acre pond expansion with a storage capacity of 388 AF. The purpose of this project is to provide tertiary-treated Title-22 effluent for use as irrigation water on approximately 890 acres of agricultural land surrounding the White Slough Water Pollution Control Facility (WPCF) to offset groundwater pumping. This project is estimated to reduce the annual volume discharged to Dredger Cut (a dead-end slough of the Sacramento-San Joaquin River Delta) by approximately 160 to 210 million gallons. Flow will be diverted from Dredger Cut at a rate up to 1,700 gallons per minute over an approximate 75- to 90-day period between October 1 and May 31 of each year. Project studies have demonstrated that the storage provided by this project will significantly offset groundwater pumping through in-lieu use.

Project Summary	
Submitting GSA:	City of Lodi
Project Type:	Recycling/In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	85-150 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing water recycling and in-lieu recharge opportunities.

Project Status: Construction of this project has been completed. Roughly 85-150 AF/year of percolation recharge is expected. Additionally, the tertiary treated wastewater will be used to irrigate the on-site agricultural fields, thereby reducing groundwater pumping for irrigation.

Required Permitting and Regulatory Process: The permitting and regulatory processes required for this project have been completed.

Time-table for Initiation and Completion: Construction of this project has been completed, with accrual of benefits expected by 2020.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset 85-150 AF/year in groundwater pumping in the City of Lodi. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project will rely on the use of recycled water, in the form of tertiary-treated Title-22 effluent form the White Slough WPCF Expansion. No additional water source will be utilized for this project.

Legal Authority: The City of Lodi has legal authority to administer this project through Water Code § 71000-73000.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $6 million in capital costs and $4,664 in annual operations and maintenance costs. This project will be financed through the DWR Proposition 84 Grant Funding Program.

Circumstances for Implementation: This project is a Planned Project that is anticipated to move forward. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin. Construction for this project has been completed.

Trigger for Implementation and Termination: There is no plan to terminate this project, as it has been completed and the operations and maintenance cost is minimal.

Process for Determining Conditions Requiring the Project have Occurred: Not applicable, this is a Planned Project that is anticipated to move forward.

6.2.4.6 Project 6: CSJWCD Capital Improvement Program

CSJWCD assists users to convert groundwater fields to surface water use. The user applies for water credits based upon new surface water acres. The user is responsible for constructing a diversion facility. As water is diverted the District reduces the water charge until credit is used or seven years since implementation have elapsed. The Capital Improvement Program has been on-going since 1996.

Project Summary	
Submitting GSA:	Central San Joaquin Water Conservation District
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	5,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: This project is planned and on-going.

Required Permitting and Regulatory Process: CSJWCD is not required to comply with permits or regulatory processes to implement and oversee the Capital Improvement Program. However, individual applicants are required to have approval of the CSJWCD Board of Directors and may be required to obtain streambed alteration permits.

Time-table for Initiation and Completion: The Capital Improvement Program has been on-going since 1996. New individual projects are anticipated to begin each year. Individual applicants are expected to complete their projects 7 years after initiation.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset 5,000 AF/year in groundwater pumping in CSJWCD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset 5,000 AF/year in groundwater pumping in CSJWCD. Benefit to the groundwater aquifer has already accrued and will continue to accrue as new projects are implemented. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project relies on this use of surface water from the New Melones Unit Central Valley Project. The surface water source is based upon a contract with the United

States for delivery of surface water from the New Melones Unit of the Central Valley Project. The contract is long-term; however, water availability is subject to drought conditions. This is an existing water right.

Legal Authority: The Water Code, Division 21 § 74000 et seq. authorizes CSJWCD to acquire, sell, and distribute water and fix rates for service throughout the District.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $50,000 in capital costs and $50,000 in annual operations and maintenance costs. This project provides for the payment of delivered surface water at a reduced rate. Any deficit in cost of water is recovered by full cost of surface water to other users, groundwater extraction fees, and acre assessments.

Circumstances for Implementation: This project is an on-going Planned Project that is anticipated to move forward. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Not applicable; this is a Planned Project that is anticipated to move forward.

6.2.4.7 Project 7: NSJWCD South System Modernization

This project will modernize the South System Pump and Distribution System to facilitate delivery of 9,000 AF/year of additional surface water to farmers in-lieu of groundwater pumping. Water would come from NSJWCD Permit 10477 supplies, which are available in about 55 percent of years.

Project Summary	
Submitting GSA:	North San Joaquin Water Conservation District
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	4,500 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: Design for this project is 60 percent complete, and environmental review is complete. Funding has been sought, with some state and federal grants awarded, and a landowner improvement district has been formed for assessments. Project design may be modified based on available funding or staging of project. This project has already started implementation with the rebuilding of the pump station in 2018 and 2019 at a cost of approximately $3 million. Approximately $2 million of this cost has been funded with grants and other outside funding, including contributions from a settlement with EBMUD. $1 million of the cost has been funded through a voluntary acreage assessment by landowners along the South System who want to use surface water. Work on the distribution system will start in 2019 and continue for several years. NSJWCD has secured a $3 million grant to cover a portion of the cost of the work needed for the pipeline. NSJWCD is continuing to work on other revenue raising efforts to raise additional funds to cover the cost of a complete rehabilitation of the distribution system.

Required Permitting and Regulatory Process: All permits for the pump station work have been obtained. Minor grading and road encroachment permits may be needed for on-going work to the distribution system.

Time-table for Initiation and Completion: This project began in 2018 and is expected to be completed by 2023.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset 4,500 AF/year in groundwater pumping in NSJWCD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project relies on surface water from NSJWCD Permit 10477 (Mokelumne River water). This is an existing surface water right.

Legal Authority: The legal authority for this project is covered under Water Code § 74000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $9 million in capital costs and $250,000 in annual operations and maintenance costs. Costs for this project will be met through grant funding, landowner assessments, and water charges.

Circumstances for Implementation: This project is a Planned Project that is anticipated to move forward. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Not applicable, this is a Planned Project that is anticipated to move forward.

6.2.4.8 Project 8: Long-Term Water Transfer to SEWD and CSJWCD

Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID) have historically participated in long-term water transfers of surplus, pre-1914, surface water rights to other entities within the Eastern San Joaquin Subbasin. These transfers have included one-year transfers to CSJWCD, as well as a nearly 10-year transfer to SEWD for both agricultural and urban purposes. The most recent transfer with SEWD occurred in 2019. These areas of the Subbasin have surface water available from the USBR's Central Valley Project; however, project water allocations become significantly reduced in below normal and dry water years. When surface water is not available, many of the agricultural customers in these areas have typically turned to groundwater in order to meet their annual and permanent crop water demands. Providing long-term water transfers from OID/SSJID to other agencies within the Subbasin would allow for increased average annual surface water deliveries to the Subbasin area, reducing groundwater reliance and overdraft within the Subbasin, especially during drought years. SEWD and CSJWCD overlie a significant portion of the Subbasin dependent on groundwater and subject to historical overdraft conditions.

No new facilities would need to be constructed to convey water from OID/SSJID to SEWD, and CSJWCD receives water through diversions from a tunnel just upstream of the OID/SSJID owned Goodwin Dam on the Stanislaus River. Historical transfers have been accomplished through the use of these existing facilities. Additional infrastructure may be necessary to increase distribution of surface water supplies to irrigated agriculture and to achieve adequate improvement toward sustainability goals.

Project funding could be provided directly from the districts participating in the water transfers. Additional infrastructure to promote additional surface water use and capital payments for surface water transfers could be provided indirectly by groundwater reliant entities, thereby providing a means of continuing to utilize groundwater while investing in a Subbasin-wide project that assures continued sustainability within the Subbasin.

Project Summary	
Submitting GSA:	South San Joaquin GSA
Project Type:	Intrabasin Transfer/In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	Up to 45,000 AF/year
Other Participating Entities:	Oakdale Irrigation District, Stockton East Water District, Central San Joaquin Water Conservation District

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: No design is needed for this project, as the infrastructure is in place. Environmental review may need to be completed.

Required Permitting and Regulatory Process: This project must comply with CEQA. Temporary transfers may have less rigorous permitting requirements.

Time-table for Initiation and Completion: Expected project time-table is 2019-2021. A new long-term transfer could begin immediately upon agreement among the parties. Transfers from OID/SSJID to SEWD/CSJWCD have historically been agreed to, with historical transfer amounts varying from 0 to 40,000 AF/year.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset up to 45,000 AF/year in groundwater pumping in SEWD and CSJWCD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations. Participating districts would report annually the amount agreed to be transferred and the amount diverted under transfer.

How Project Will Be Accomplished/Evaluation of Water Source: OID and SSJID hold pre-1914 water rights on the Stanislaus River. USBR is junior in right to OID and SSJID. This is an existing surface water right.

Legal Authority: OID and SSJID are irrigation districts formed in accordance with State law and hold pre-1914 water rights on the Stanislaus River. SEWD and CSJWCD are water conservation districts also formed in accordance with State law. Historically, water transfers occurring between OID/SSJID and SEWD/CSJWCD are approved by mutual agreement.

Estimated Costs and Plans to Meet Costs: Costs for this project are estimated at up to $9 million annually ($200 per acre-foot). Costs for this project will be met by recipients of water or groundwater pumping benefit.

Circumstances for Implementation: This project is a Planned Project that is anticipated to move forward. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin. Short-term transfers are expected to occur on an as-needed basis. A longer-term transfer must be mutually agreed to prior to implementation.

Trigger for Implementation and Termination: Transfers may take place upon mutual agreement. Termination would be subject to the terms of the agreement if applicable.

Process for Determining Conditions Requiring the Project have Occurred: Not applicable; this is a Planned Project that is anticipated to move forward.

6.2.5 Potential Projects

Projects categorized as Potential Projects are currently in the planning stages and may move forward if funding becomes available. Potential Projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. Together these projects total 32,287 AF/year in groundwater offset/recharge/conservation that could potentially be made available to the Subbasin if funding is secured.

6.2.5.1 Project 9: BNSF Railway Company Intermodal Facility Recharge Pond

Under this proposed project, CSJWCD would form an agreement with the BNSF railroad owner to access an existing drainage pond near the CSJWCD delivery channel to be used as a recharge area. This project would contribute an estimated 1,000 AF/year of groundwater offset through direct recharge to the groundwater aquifer.

Project Summary	
Submitting GSA:	Central San Joaquin Water Conservation District
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	1,000 AF/year
Other Participating Entities:	BNSF Railway

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities.

Project Status: This project is in the planning stages.

Required Permitting and Regulatory Process: A streambed alteration permit would be required to construct a diversion structure from the District delivery channel to feed the recharge pond.

Time-table for Initiation and Completion: This project would begin in 2021 and be completed by 2023.

Expected Benefits and Evaluation: This project is anticipated to directly recharge 1,000 AF/year to the groundwater basin in CSJWCD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project will rely on water from the New Melones Unit Central Valley Project. The surface water source is based upon a contract for delivery of surface water from the New Melones Unit of the Central Valley Project. The contract project is long-term; however, water availability is subject to drought conditions. This is an existing water right.

Legal Authority: The Water Code, Division 21, § 74000 et seq. authorizes CSJWCD to acquire, sell, and distribute water and fix rates for service throughout the District.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $150,000 in capital costs and $50,000 in annual operations and maintenance costs. Costs for this project would be met by groundwater extraction fee revenue, private loans, and/or possible grant funding.

Circumstances for Implementation: This project is a Potential Project, meaning it is currently in the planning stages and may move forward if funding becomes available. Potential Projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. In this case, the project parties plan to implement this project as soon as a finalized agreement with the landowner is reached and permitting and funding are established.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.5.2 Project 10: City of Stockton Advanced Metering Infrastructure

The City of Stockton Municipal Utilities Department (MUD) provides treated drinking water through approximately 48,000 water meters, of which a portion are read via a touch-read system and the remainder are read manually by staff every month. Manual meter reading is the least efficient method of meter reading and the most costly. AMI using improved technology is far more efficient and generally very cost effective when compared to manual reading. AMI also provides several other benefits beyond simple cost savings including improved customer service, leak detection, and real-time consumption information to the customer. Documented customer water savings and improved demand-side water conservation has occurred when real-time consumption information is available.

This project would apply AMI to water meters in the City of Stockton Service Area. Improved technology would increase efficiency and decrease costs associated with manual reading. Additional benefits beyond cost savings include improved leak detection and demand-side water conservation.

Project Summary	
Submitting GSA:	City of Stockton
Project Type:	Conservation
Estimated Groundwater Demand Reduction:	2,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing demand-side water conservation opportunities.

Project Status: An initial study for this project was completed in 2011.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not yet been determined.

Time-table for Initiation and Completion: This project would begin in 2020-2025 and be completed by 2025-2028.

Expected Benefits and Evaluation: This project is anticipated to reduce groundwater demand by 2,000 AF/year in the City of Stockton through leak detection and real-time consumption information to the customer. Benefits to groundwater levels will be evaluated by quantifying resulting demand reduction.

How Project Will Be Accomplished/Evaluation of Water Source: This project is a demand-side conservation project. No additional water source will be utilized for this project.

Legal Authority: This project would be under the authority of the City of Stockton and implemented within the service area.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $11 million in capital costs and $550,000 in annual operations and maintenance costs. Costs for this project would be met by ratepayers and through grants or other funding sources.

Circumstances for Implementation: This project is a Potential Project, meaning it is currently in the planning stages and may move forward if funding becomes available. Potential Projects represent a “menu of options” for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. Circumstances for implementation include inclusion in Department planning, development, and Capital Improvement Program.

Trigger for Implementation and Termination: Triggers for project implementation and termination include availability of project funding.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.5.3 Project 11: South System Groundwater Banking with EBMUD

NSJWCD, East Bay Municipal Utility District (EBMUD), and other entities in San Joaquin County entered into a Protest Dismissal Agreement in 2014 (the "PDA") to resolve various water right protests. The PDA Agreement includes a commitment to undertake a pilot-level groundwater banking project and a longer-term groundwater banking project. The pilot level banking project is called the "DREAM" project and is already underway. The DREAM project involves the delivery of 1,000 AF of EBMUD water into the NSJWCD service area along the South System to use for irrigation, effectuating 1,000 AF of in-lieu groundwater recharge. EBMUD will receive a banked water credit of 50 percent of the amount of water recharge, not to exceed 500 AF. EBMUD can withdraw the banked water in the future. NSJWCD will control the withdrawal of the banked water by pumping groundwater from a well that is centrally located in the area of recharge and then conveying the pumped groundwater to the EBMUD Mokelumne Aqueduct. The extraction and return of the banked water are subject to a San Joaquin County groundwater export permit. The permit places additional conditions and restrictions on the extraction of the banked water, including a 5 percent per year annual loss factor and pumping restrictions to prevent impacts to other groundwater users.

EBMUD and NSJWCD have started the preliminary planning for the longer-term banking project. The longer-term banking project may use the same concept as the pilot project but will involve larger quantities of water and potential additional facilities to deliver and use the water for in-lieu recharge within NSJWCD, and to extract and return banked water credits to EBMUD. The longer-term project contemplates EBMUD providing surface water supplies of 3,000 AF/year to 6,000 AF/year in dry years and 8,000 AF/year in wet years to NSJWCD. These surface water supplies would come from EBMUD's water rights on the Mokelumne River and would be in addition to surface water available under NSJWCD's water right. EBMUD would receive a banked water credit for 50 percent of the additional supplies provided, leaving a net surface/groundwater increase to the NSJWCD area of 50 percent of all additional supplies provided. The net water gain to NSJWCD may increase if EBMUD does not extract its banked supplies regularly because of the 5 percent annual loss factor in the San Joaquin County export ordinance.

The PDA also provides that the wet year water supplies could be used by SEWD for groundwater banking if they cannot be used in NSJWCD.

Project Summary	
Submitting GSA:	North San Joaquin Water Conservation District
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	4,000 AF/year
Other Participating Entities:	East Bay Municipal Utility District, Eastern Water Alliance, San Joaquin County and Stockton East Water District

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: The agreement for this project is in place. Parties need to finalize design, perform environmental review, and obtain necessary permits to operate.

Required Permitting and Regulatory Process: This project requires a SWRCB Change Petition for Permit 10478, a San Joaquin County Groundwater Export Permit, and regulatory permits as needed for facilities such as pipelines.

Time-table for Initiation and Completion: This project would begin in 2020 and be completed by 2025.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset 4,000 AF/year in groundwater pumping in NSJWCD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project would use water supplies from EBMUD Permit 10478 (Mokelumne River water). This is an existing surface water right. EBMUD has a right tied to hydrology, with amounts are set by contract.

Legal Authority: The legal authority for this project is covered under Water Code § 74000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $5 million in capital costs and $400,000 in annual operations and maintenance costs. Costs for this project will be met by grant funding, banking fees, and water charges.

Circumstances for Implementation: This project is a Potential Project, meaning it is currently in the planning stages and may move forward if funding becomes available. Potential Projects represent a “menu of options” for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. The project parties plan to implement this project as soon as design, permitting, and funding are established, by 2025.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.5.4 Project 12: NSJWCD North System Modernization/Lakso Recharge Project

This project will repair, upgrade, and modernize the North System Pump and Distribution System to facilitate delivery of 4,000 to 6,000 AF/year of surface water to farmers in-lieu of groundwater pumping. Water would come from NSJWCD Permit 10477 supplies, which are available in about 55 percent of years. Average deliveries would be 5,000 AF/year in about half of the years. In addition, there is a small, sandy recharge pond location on the Lakso property located along the upper portion of the North System pipeline along Tretheway Road. The pond is about 2 acres in size and can recharge about 2 AF/day. NSJWCD could convey water through the NSJWCD North System, to the Lakso recharge pond, to directly recharge surface water during times that water is available but there is not irrigation demand, such as during the December through May time period or during the interim period of years before the remainder of the North System pipeline is repaired or replaced.

Project Summary	
Submitting GSA:	North San Joaquin Water Conservation District
Project Type:	In-lieu Recharge/Direct Recharge
Estimated Groundwater Offset and/or Recharge:	2,600 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu and direct recharge opportunities.

Project Status: This project is in the planning/initial study phase. NSJWCD is soliciting landowner input on design and financing options.

Required Permitting and Regulatory Process: This project would require regulatory permitting as needed for minor construction related to rehabilitation of existing water delivery infrastructure.

Time-table for Initiation and Completion: This project would begin in 2021 and be completed by 2026.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and critical to establishing long-term Subbasin sustainability. This project is anticipated to offset 2,600 AF/year in groundwater pumping in NSJWCD. In addition, there is opportunity to directly recharge surface water to the groundwater basin at specified times. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project would use water supplies available through NSJWCD Permit 10477 (Mokelumne River water). This is an existing surface water right.

Legal Authority: The legal authority for this project is covered under Water Code § 74000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $7 million in capital costs and $150,000 in annual operations and maintenance costs. Costs for this project will be met by grant funding, landowner assessments (pending approval), and water charges.

Circumstances for Implementation: This project is a Potential Project, meaning it is currently in the planning stages and may move forward if funding becomes available. Potential Projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. NSJWCD plans to implement this project as soon as funding is secured.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.5.5 Project 13: Manaserro Recharge Project

NSJWCD is investigating constructing and operating a 10-acre recharge pond on the North side of the Mokelumne River on property owned by the Manaserro family through a long-term lease. NSJWCD would use Permit 10477 water available during December 1 through June 30 that is not needed for irrigation, for recharge. This project could recharge 10,000 AF/year or more in years when water is available. Because this project can use water available during the direct diversion flood season, water is expected to be available more frequently under the NSJWCD water right for this project, or 80 percent of years. Capital costs assume that NSJWCD would lease the 10-acre property for this project.

Project Summary	
Submitting GSA:	North San Joaquin Water Conservation District
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	8,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities.

Project Status: This project is in the planning phase.

Required Permitting and Regulatory Process: This project would require CEQA review, a possible grading permit, and a possible water right change petition.

Time-table for Initiation and Completion: This project would begin in 2019 on a pilot basis and in 2020 on a full-scale basis. This project would be completed by 2022.

Expected Benefits and Evaluation: This project is anticipated to directly recharge 8,000 AF/year to the groundwater basin in NSJWCD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project would use water supplies available through NSJWCD Permit 10477 (Mokelumne River water). This is an existing surface water right. Once Permit 10477 supplies are fully committed to in-lieu recharge projects, NSJWCD could apply to appropriate Mokelumne River flood flows for this direct recharge project.

Legal Authority: The legal authority for this project is covered under Water Code § 74000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $300,000 in capital costs and $400,000 in annual operations and maintenance costs. Costs for this project will be met by grant funding and landowner assessments (pending approval).

Circumstances for Implementation: This project is a Potential Project, meaning it is currently in the planning stages and may move forward if funding becomes available. Potential Projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. Circumstances for implementation include securing funding. Project may be implemented on a smaller scale depending on use of water by other projects in the District.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.5.6 Project 14: Tecklenburg Recharge Project

NSJWCD is investigating constructing and operating a 10-acre recharge pond on the South side of the Mokelumne River on property owned by the Tecklenburg family through a purchase. NSJWCD would use Permit 10477 water available during December 1 through June 30, and not needed for irrigation, for recharge. This project could recharge 10,000 AF/year or more in years when water is available. Because this project can use water available during the direct diversion flood season, water is expected to be available more frequently under the NSJWCD water right for this project, or 80 percent of years. Capital costs assume that NSJWCD would purchase the 10-acre property for this project.

Project Summary	
Submitting GSA:	North San Joaquin Water Conservation District
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	8,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities.

Project Status: This project is in the planning phase.

Required Permitting and Regulatory Process: This project would require CEQA review and a possible grading permit.

Time-table for Initiation and Completion: This project would begin in 2020 on a pilot basis and in 2021 on a full-scale basis. This project would be completed by 2023.

Expected Benefits and Evaluation: This project is anticipated to directly recharge 8,000 AF/year to the groundwater basin in NSJWCD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project would use water supplies available through NSJWCD Permit 10477 (Mokelumne River water). Once Permit 10477 supplies are fully committed to in-lieu recharge projects, NSJWCD could apply to appropriate Mokelumne River flood flows for this direct recharge project. This is an existing surface water right.

Legal Authority: The legal authority for this project is covered under Water Code § 74000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $1 million in capital costs and $400,000 in annual operations and maintenance costs. Costs for this project will be met by grant funding and landowner assessments (pending approval).

Circumstances for Implementation: This project is a Potential Project, meaning it is currently in the planning stages and may move forward if funding becomes available. Potential Projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. Circumstances for implementation include securing funding. This project may be implemented on a smaller scale depending on use of water by other projects in the District.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.5.7 Project 15: City of Escalon Wastewater Reuse

This project entails the reuse of wastewater that would include tertiary treatment of the City of Escalon's effluent and blending in SSJID's irrigation distribution system. This additional source of supply could then be used for groundwater recharge or transfer within the Subbasin to offset groundwater demands using SSJID facilities and/or water right entitlements to facilitate the transfer. The treated water will meet Title-22 Water Standards.

The City of Escalon's Wastewater Treatment Plant treats approximately 600,000 gallons per day (1.84 AF per day) with peak flows up to 1 MGD. The plant is located near SSJID's Main Distribution Canal, and the effluent would need to be pumped and a pipeline of approximately 4,000 linear feet would need installed in addition to improvements at the plant to meet Title-22 Water Standards.

Project Summary	
Submitting GSA:	South San Joaquin GSA
Project Type:	Recycling/Direct Recharge/ Intrabasin Transfer
Estimated Groundwater Offset and/or Recharge:	672 AF/year
Other Participating Entities:	City of Escalon

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing water recycling and direct recharge opportunities.

Project Status: This project is in the planning/initial study phase.

Required Permitting and Regulatory Process: This project would require CEQA review, Regional Water Quality Control Board permitting, and road encroachment permits.

Time-table for Initiation and Completion: This project would begin in 2020 and would be completed by 2028.

Expected Benefits and Evaluation: This project is anticipated to offset 672 AF/year in groundwater pumping for use in direct recharge in the City of Escalon or in interbasin transfers to other areas of the Subbasin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations

How Project Will Be Accomplished/Evaluation of Water Source: This project will rely on the use of recycled water, in the form of tertiary-treated Title-22 effluent form the City of Escalon's Wastewater Treatment Plant. No additional water source will be utilized for this project.

Legal Authority: The City of Escalon is an incorporated city and provides municipal services including wastewater treatment. SSJID is an irrigation district formed in accordance with State law.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $18 million in capital costs and $400,000 in annual operations and maintenance costs. Costs for this project will be met by developer impact fees, connection fees, and sewer rate fees.

Circumstances for Implementation: This project is a Potential Project, meaning it is currently in the planning stages and may move forward if funding becomes available. Potential Projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. Provided this project is feasible as determined in the initial planning phase, the Escalon City Council would need to approve this project as well as the SSJID Board of Directors.

Trigger for Implementation and Termination: This project would need to be determined to be feasible with adequate funding likely from multiple sources such as development impact fees, connection fees, and sewer rate fees.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin. The Escalon City Council would need to make the requisite findings and approve a financing package for this project.

6.2.5.8 Project 16: City of Ripon Surface Water Supply

The City of Ripon serves water to 15,000 residents along with businesses and industries located within its limits. This project would supplement the City of Ripon's municipal water supply with treated surface water from SSJID. A5-mile pipeline from the existing treated water transmission pipeline to Ripon's water distribution system and a booster pump station would need to be constructed.

The City of Ripon is currently under contract with SSJID for a maximum of 6,000 AF/year of Stanislaus River water, which is the expected water supply for this project.

Project Summary	
Submitting GSA:	South San Joaquin GSA
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	6,000 AF/year
Other Participating Entities:	City of Ripon

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: The design for this project is complete. The City is pursuing a National Environmental Policy Act (NEPA) Categorical Exclusion and CEQA Mitigated Negative Declaration. Construction of this project will begin once this project is fully funded. Construction is expected to take one year.

Required Permitting and Regulatory Process: This project will require a NEPA Categorical Exclusion and CEQA Mitigated Negative Declaration. Road encroachment permits will also be required.

Time-table for Initiation and Completion: This project would begin in 2020 and would be completed by 2024.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset 6,00 AF/year in groundwater pumping in the City of Ripon. Benefits are expected to accrue for 50 years, through 2074. Benefits to groundwater levels will be evaluated through ESJWRM model simulations. This proposed conjunctive use project would provide the community of Ripon, along with the region that relies on the groundwater Subbasin, with numerous benefits, including:

- Conservation of groundwater through in-lieu recharge
- Use of renewable energy and energy conservation
- Safer and cleaner drinking water

How Project Will Be Accomplished/Evaluation of Water Source: SSJID holds pre-1914 water rights on the Stanislaus River. This is an existing surface water right. The City of Ripon has an agreement in place to divert a maximum of 6,000 AF/year from SSJID facilitates under SSJID's existing pre-1914 water right, which is the expected water supply for this project.

Legal Authority: The City of Ripon is an incorporated city and provides municipal water service. SSJID is an irrigation district formed in accordance with State law. SSJID holds pre-1914 water rights on the Stanislaus River.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $8.6 million in capital costs. Costs for this project will be met by grants, water rates, and development impact fees.

Circumstances for Implementation: This project is a Potential Project, meaning it is currently in the planning stages and may move forward if funding becomes available. Potential Projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. The City of Ripon is in the process of completing the environmental process and securing the necessary finances to move forward.

Trigger for Implementation and Termination: Project implementation will initiate once this project is approved by the City of Ripon and the financing is in place. Termination would be subject to the terms of the agreement if applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin. The Ripon City Council would need to make the requisite findings under NEPA, CEQA, and approve a financing package for this project.

6.2.5.9 Project 17: City of Escalon Connection to Nick DeGroot Water Treatment Plant

The City of Escalon partnered in the construction of the Nick DeGroot Water Treatment Plant and continues to provide financial partnership in its operation. However, Escalon has not constructed the turnout and distribution system improvements necessary to receive their surface water allotments. Finance and construction of these improvements would make it possible for Escalon to receive their contract entitlements under Phase 1 (2,015 AF) further reducing Escalon's groundwater demand. Escalon, as a partner city in the plant, could readily begin receiving water once turnout improvements and distribution pipelines are constructed. SSJID operates the Nick DeGroot Water Treatment Plant and serves treated Stanislaus River water under its pre-1914 water right to the cities of Manteca, Lathrop, and Tracy.

Project Summary	
Submitting GSA:	South San Joaquin GSA
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	2,015 AF/year
Other Participating Entities:	City of Escalon and SSJID

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: This project is in the conceptual design phase. Environmental review has been completed.

Required Permitting and Regulatory Process: This project will require road encroachment permits.

Time-table for Initiation and Completion: This project would begin in 2020 (pending funding) and be completed by 2023.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and critical to establishing long-term Subbasin sustainability. This project anticipated to offset 2,015 AF/year in groundwater pumping in the City of Escalon. Benefits are expected to accrue for 50 years, through 2073. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: SSJID holds pre-1914 water rights on the Stanislaus River. This is an existing surface water right.

Legal Authority: The City of Escalon is an incorporated city and provides municipal water service. SSJID is an irrigation district formed in accordance with State law. SSJID holds pre-1914 water rights on the Stanislaus River. The City of Escalon is project partner in the Nick DeGroot Water Treatment Plant and has an existing agreement with SSJID which entitles Escalon to receive 2,015 AF/year of treated surface water.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $8,789,000 in capital costs and $250,000 in annual operations and maintenance costs. Costs for this project will be met by grants, water rates, and development impact fees.

Circumstances for Implementation: This project is a Potential Project, meaning it is currently in the planning stages and may move forward if funding becomes available. Potential Projects represent a “menu of options” for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Planned Projects. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. The City of Escalon is in the process of securing the necessary finances to move forward.

Trigger for Implementation and Termination: Project implementation will initiate once this project is approved by the City of Escalon and the financing is in place. Termination would be subject to the terms of the agreement if applicable

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin. The Escalon City Council would need to make the requisite findings and approve a financing package for this project.

6.2.6 Longer-term or Conceptual Projects

Projects categorized as Longer-term or Conceptual Projects are in the early conceptual planning stages and would require significant additional work to move forward. Longer-term/Conceptual Projects represent potential future projects that could conceptually provide a benefit to the Subbasin in the future, but that would need to be further developed. Together these projects total an approximated 67,043 AF/year in groundwater offset/recharge/conservation that could potentially be made available to the Subbasin if funding is secured.

6.2.6.1 Project 18: Farmington Dam Repurpose Project

This proposed project would convert the Farmington Dam, currently a flood control structure, into a water supply reservoir. This existing Farmington Dam has a flood control capacity of 52,000 AF. The proposed project would increase the total reservoir capacity to 112,000 AF which includes 60,000 AF for water supply and 52,000 AF for flood control. The water supply could be stored and used even in drought conditions. The increased water supply would also encourage growers to switch to surface water irrigation instead of reliance on groundwater.

USACE completed a reconnaissance report in 1997 with an estimated cost of $91.4 million based on an effective pricing date of October 1996. Including environmental and cultural resources mitigation costs, which were not included in 1997, the cost today would be approximately $175 million.

Other entities that would benefit from this project includes CSJWCD and potentially OID.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	30,000 AF/year
Other Participating Entities:	USACE

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities.

Project Status: This project is in the pre-planning stage. A reconnaissance study has been completed.

Required Permitting and Regulatory Process: The required permitting for this project would include acquiring permits/approvals from SWRCB, USBR, California DFW, RWQCB, CVFPB, and USACE.

Time-table for Initiation and Completion: This project would begin in 2030 and be completed by 2050.

Expected Benefits and Evaluation: This project is anticipated to directly recharge 30,000 AF/year to the groundwater basin in SEWD. Benefits to groundwater levels will be evaluated through model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: SEWD and CSJWCD have a water supply contract with USBR to use water from the New Melones Reservoir (Stanislaus River water). This is an existing surface water right.

Legal Authority: SEWD is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SEWD is also a GSA with authority on groundwater pumping. Farmington Dam is owned and operated by USACE and upon agreement, and USACE would be the agency with authority to modify the dam structure.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $175 million in capital costs and $2 million in annual operations and maintenance costs. Costs for this project will be met through the pursual of grant funding.

Circumstances for Implementation: This project is a Longer-term/Conceptual Project, meaning it is in the early conceptual planning stages and would require significant additional work to move forward. Longer-term/Conceptual Projects represent potential future projects that could conceptually provide a benefit to the Subbasin in the future. As scenarios change, Longer-term/Conceptual Projects can come online to bring additional resources for adaptive management. This project could be implemented when agreements are reached with all federal and state regulatory agencies and when funding is available.

Trigger for Implementation and Termination: The trigger for implementation and termination would be the water supply from New Melones Reservoir and groundwater levels in the Subbasin.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Longer-term/Conceptual Projects will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.6.2 Project 19: Recycled Water Transfer to Agriculture

Under the Recycled Water Transfer to Agriculture project, the City of Manteca would sell recycled water to agricultural users northeast of the City, located within the CSJWCD service area, or provide the water to the local GSAs for use in groundwater basin recharge to overcome existing overdraft conditions and help sustain the Subbasin. The City would target customers located northeast of the City so that recycled water use for irrigation would offset groundwater pumping in an area with a significant cone of depression. No specific customers have been identified this alternative; rather, this alternative was developed primarily to support a cost estimate for designing and constructing a recycled water pipeline to this area of the county. Under this alternative, it is assumed that agricultural users would receive water during the 6-month irrigation season, resulting in a demand of 1,990 AF/year under current conditions and 5,190 AF/year at buildout.

Project Summary	
Submitting GSA:	City of Manteca
Project Type:	Recycling/Transfer/In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	5,193 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing recycling, transfer, and in-lieu recharge opportunities.

Project Status: This project is in the planning/initial study phase. This project has been evaluated by the City in their Draft Reclaimed Water Facilities Master Plan planning efforts.

Required Permitting and Regulatory Process: This project would require an NPDES Permit amendment, CEQA review, and approval from the State Water Resources Control Board to deliver water from the current discharge location to the potential project.

Time-table for Initiation and Completion: The initiation and completion dates for this project are unknown at this time.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset 5,193 AF/year in groundwater pumping in agricultural areas northeast of the City of Manteca. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project will rely on the use of recycled water, in the form of tertiary-treated Title-22 effluent form the City of Manteca's Wastewater Quality Control Facility. No additional water source will be utilized for this project.

Legal Authority: This project would be under the authority of the City of Manteca for portions located within its service area. Legal authority outside of city limits would be identified if this project moves forward to implementation.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $37,645,000 in capital costs and $679,000 in annual operations and maintenance costs. Funding sources would be identified if a project moves forward to implementation.

Circumstances for Implementation: This project is a Longer-term/Conceptual Project, meaning it is in the early conceptual planning stages and would require significant additional work to move forward. Longer-term/Conceptual Projects represent potential future projects that could conceptually provide a benefit to the Subbasin in the future. As scenarios change, Longer-term/Conceptual Projects can come online to bring additional resources for adaptive management. Implementation of this recycled water project is dependent on the identification of recycled water users and the installation of facilities to transmit recycled water to the location where it is needed. Agreement(s) between recycled water users and the City would also be required.

Trigger for Implementation and Termination: The trigger for project implementation would be the identification of recycled water users and agreements between recycled water users and the City.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Longer-term/Conceptual Projects will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.6.3 Project 20: Mobilizing Recharge Opportunities

This project would put in place a framework to quickly mobilize and take advantage of recharge opportunities (e.g., existing storm ponds, lake features, temporary flood easements, agricultural field ponding, etc.) This project would provide access to funding to expedite recharge projects as opportunities arise. Additional governance and budgetary controls would need to be developed. Flood-Managed Aquifer Recharge (Flood-MAR) opportunities will be considered through ongoing coordination with existing agencies.[1]

Project Summary	
Submitting GSA:	San Joaquin County
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	To be determined

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities.

Project Status: This project is still in the early conceptual planning stages.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: The initiation and completion dates for this project are unknown at this time.

Expected Benefits and Evaluation: This project is anticipated to directly recharge the groundwater basin in areas that are geographically dispersed throughout the Subbasin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The identification of water source will occur as project develops.

Legal Authority: [Information pending]

Estimated Costs and Plans to Meet Costs: The estimated costs for this project and approach for meeting costs are unknown at this time.

Circumstances for Implementation: The circumstances for implementation of this project are unknown at this time.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Longer-term/Conceptual Projects will be based on long-term management or changing needs of the GSA or Subbasin.

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[1] Flood-MAR is an integrated and voluntary resource management strategy that uses flood water resulting from, or in anticipation of, rainfall or snow melt for managed aquifer recharge (MAR) on agricultural lands and working landscapes, including but not limited to refuges, floodplains, and flood bypasses. Flood-MAR can be implemented at multiple scales, from individual landowners diverting flood water with existing infrastructure, to using extensive detention/recharge areas and modernizing flood management infrastructure/operations (CA DWR, 2019).

6.2.6.4 Project 21: Winery Recycled Water

This project will blend NSJWCD Permit 10477 water with wastewater from winery(ies) and deliver blended water for irrigation to accomplish in-lieu recharge or put in recharge ponds and accomplish direct groundwater recharge.

Project Summary	
Submitting GSA:	North San Joaquin Water Conservation District
Project Type:	Recycling/In-lieu Recharge/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	750 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing recycling, in-lieu recharge, and direct recharge opportunities.

Project Status: This project is in the early stages of discussing concepts with a local winery.

Required Permitting and Regulatory Process: This project would require WDR permitting through the Central Valley Regional Water Quality Control Board (CVRWQCB). Minor permits would be required for pipeline construction.

Time-table for Initiation and Completion: This project would begin in 2025 and be completed by 2027.

Expected Benefits and Evaluation: This project is anticipated to offset 750 AF/year in groundwater pumping in NSJWCD for use in in-lieu or direct recharge.

How Project Will Be Accomplished/Evaluation of Water Source: This project will blend NSJWCD Permit 10477 (Mokelumne River water) with wastewater from wineries.

Legal Authority: The legal authority for this project is covered under Water Code § 74000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $1.5 million in capital costs and $100,000 in annual operations and maintenance costs. Costs for this project will be met by grant funding, landowner assessments (pending approval), and charges paid by the winery (pending contract).

Circumstances for Implementation: This project is a Longer-term/Conceptual Project, meaning it is in the early conceptual planning stages and would require significant additional work to move forward. Longer-term/Conceptual Projects represent potential future projects that could conceptually provide a benefit to the Subbasin in the future. As scenarios change, Longer-term/Conceptual Projects can come online to bring additional resources for adaptive management. Circumstances for implementation of this project include securing funding and winery cooperation contract.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Longer-term/Conceptual Projects will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.6.5 Project 22: Pressurization of SSJID Facilities

SSJID currently operates a 3,800-acre pilot pressurized irrigation project within its service area. This project provides irrigation water at pressure to a grower's turnout with nearly on-demand service. The service has promoted and influenced the adoption of high-efficiency irrigation systems and also promoted the use of SSJID surface water over private groundwater facilities in the area. SSJID is currently considering expansion of this type of irrigation service to the rest of its service territory. Further analysis needs to be done to understand the project benefits and impacts related to groundwater.

The remaining service area considered is 56,300 acres. In 2014, the District completed a feasibility study on delivering a full pressurization system. The study included projections on on-farm savings and benefits (pumping/electrical costs, water quality) and included converting current groundwater farmers. The study observed four alternatives and concluded that a decentralized system comprising of six pump stations and reservoirs at strategic locations throughout the District would be the most feasible alternative. The study found that pressurization is estimated to reduce groundwater pumping from 40,000 AF annually to 10,000 AF annually within the District's jurisdiction.

Project Summary	
Submitting GSA:	South San Joaquin GSA
Project Type:	Conservation
Estimated Groundwater Demand Reduction:	30,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing demand-side water conservation opportunities.

Project Status: A feasibility study for this project has been completed. Inclusion in a Strategic Water Master Plan is in progress.

Required Permitting and Regulatory Process: This project would require CEQA review and road encroachment permits.

Time-table for Initiation and Completion: This project has been implemented on a pilot scale (3,800 acres, Division 9), and can be phased based on customer needs and system compatibility. This project is expected to be completed by 2030.

Expected Benefits and Evaluation: This project is anticipated to reduce groundwater demand by 30,000 AF/year in the SSJID service area. Benefits are expected to accrue for 30 years. Benefits to groundwater levels will be evaluated by quantifying resulting demand reduction.

How Project Will Be Accomplished/Evaluation of Water Source: This project is a demand-side conservation project. No additional water source will be utilized for this project.

Legal Authority: SSJID is an irrigation district formed in accordance with State law.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $328 million in capital costs and $8.5 million in annual operations and maintenance costs. Costs for this project will be met by existing sources (i.e., hydropower generation, user fees, and water transfers) and enhanced revenue sources (i.e., grants, additional user fees, additional water transfers).

Circumstances for Implementation: This project is a Longer-term/Conceptual Project, meaning it is in the early conceptual planning stages and would require significant additional work to move forward. Longer-term/Conceptual Projects represent potential future projects that could conceptually provide a benefit to the Subbasin in the future. As scenarios change, Longer-term/Conceptual Projects can come online to bring additional resources for adaptive management. The SSJID Strategic Water Master Plan is currently underway and is intended to prioritize system capital improvements based on customer and system needs. This project can be phased based on customer demand and available funding.

Trigger for Implementation and Termination: The trigger for implementation for this project is sufficient customer demand and a financial plan for necessary enhanced revenues. The trigger for termination is subject to irrigation service agreement terms if applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Longer-term/Conceptual Projects will be based on long-term management or changing needs of the GSA or Subbasin. The SSJID Board of Directors would need to make the requisite findings and approve a financing package for this project.

6.2.6.6 Project 23: SSJID Storm Water Reuse

SSJID and the Cities of Ripon and Escalon have previously proposed storm water capture for storage and irrigation reuse, or for groundwater recharge to benefit the groundwater Subbasin. Currently, the City of Escalon, and to a limited extent the City of Ripon, discharge storm water into SSJID facilities during the winter months. This storm water is conveyed through SSJID's main canal or lateral irrigation distribution system and eventually is conveyed into the Stanislaus River or the San Joaquin River via French Camp Slough. Capturing and storing excess storm water would allow for quantities of water that could be used to offset or enhance groundwater in multiple ways. SSJID is in the process of quantifying the amount of storm water it discharges during the winter months that could be made available to be repurposed for sustainable groundwater management practices. Additional infrastructure may be needed to provide adequate storage for groundwater recharge.

The City of Escalon currently has a drainage area of approximately 1,200 acres with 10 drainage systems which accumulate to a maximum discharge capacity of approximately 50 cubic feet per second (cfs) that drains into two District Laterals. It is estimated on average that 700 AF/year of run-off comes from the City of Escalon.

The City of Ripon currently has a drainage area of approximately 2,200 acres with four drainage systems. The majority of the storm run-off discharges to the Stanislaus River. A portion of storm water discharges into the District's laterals and canals. It is estimated approximately 400 AF/year of run-off discharges to District facilities.

Additional monitoring will need to be implemented to obtain more accurate discharge flows from both cities.

Preliminary cost estimate includes two 20-acre storm drain retention basins in each city strategically located near District facilities.

Project Summary	
Submitting GSA:	South San Joaquin GSA
Project Type:	Storm Water/In-lieu Recharge/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	1,100 AF/year
Other Participating Entities:	City of Escalon, City of Ripon, SSJID

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing storm water capture, in-lieu recharge, and direct recharge opportunities.

Project Status: This project is in the planning/initial study phase.

Required Permitting and Regulatory Process: This project will require CEQA review and road encroachment permits.

Time-table for Initiation and Completion: This project would begin in 2027 and be completed by 2030.

Expected Benefits and Evaluation: This project is anticipated to offset 1,100 AF/year in groundwater pumping in SSJ GSA for use in in-lieu or direct recharge. Benefits are expected to accrue for 50 years, through 2080. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project would rely on the use of captured storm water. No additional water source will be utilized for this project.

Legal Authority: The Cities of Escalon and Ripon are incorporated cities and provide municipal stormwater/drainage services. SSJID is an irrigation district formed in accordance with State law and also provides limited drainage service.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $30 million in capital costs and $30,000 in annual operations and maintenance costs. Costs for this project will be met by developer impact fees, connection fees, and sewer rate fees.

Circumstances for Implementation: This project is a Longer-term/Conceptual Project, meaning it is in the early conceptual planning stages and would require significant additional work to move forward. Longer-term/Conceptual Projects represent potential future projects that could conceptually provide a benefit to the Subbasin in the future. As scenarios change, Longer-term/Conceptual Projects can come online to bring additional resources for adaptive management. The project proponents are in the process of determining the feasibility of this project including the possibility of securing the necessary finances to move forward.

Trigger for Implementation and Termination: Project implementation would begin once this project is approved by the cities of Escalon and Ripon, and the SSJID Board of Directors, and a financing plan is in place. Termination would be subject to the terms of the agreement if applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Longer-term/Conceptual Projects will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.7 Mokelumne River Loss Study

The Mokelumne River Loss Study, proposed by NSJWCD, will study reaches of the Mokelumne River downstream of Camanche Reservoir to better understand and account for losses due to percolation, evaporation, riparian evapotranspiration, and more to inform management actions and SGMA basin accounting. Results of the study will be used to support model refinement and validation (described in Section 7.4.1) in this region and will help to fill the interconnected surface water data gap discussed in Section 4.7.3. The project is expected to cost about $100,000 and will take two years to complete.

6.2.8 Notification Process

Notification and public outreach around projects will be conducted at the GSA level. GSAs will post project updates to their websites to notify the public that the implementation of projects is being considered or has been implemented. This will include a description of the actions to be taken. These updates will also be provided to the other GSAs and will be published on the ESJGWA website and other appropriate locations. Additional noticing for the public will be conducted consistent with permitting requirements in the case of the enactment of fees or assessments. Outreach may include public notices, meetings, website or social media presence, and email announcements.

6.3 MANAGEMENT ACTIONS

Management actions are generally administrative, locally implemented actions that the GSAs could take that affect groundwater sustainability. Management actions typically do not require outside approvals, nor do they involve capital projects. No management actions currently related to pumping activities or groundwater allocations have been proposed for the Subbasin; however, GSAs maintain the flexibility to implement such demand-side management actions in the future if need is determined.

If consideration of a demand reduction program were to take place in the future, public outreach and education on the potential structure of the program, as well and feasible monitoring and enforcement mechanisms, would be necessary to enable a successful program. Outreach could include public notices, meetings, website or social media presence, and email announcements.

There are a number of conservation and demand management actions currently in place in the Subbasin, including those outlined in Urban Water Management Plans (UWMPs) and Agricultural Water Management Plans (AWMPs), as identified below.

- **CCWD Urban Water Management Plan** (Demand management measures include water waste prevention ordinance, metering, conservation pricing, public education and outreach, programs to assess and manage distribution system real loss, water conservation program coordination and staffing support, rebates and giveaways) (CCWD, 2016).
- **City of Lodi Urban Water Management Plan** (Demand management measures include water waste prevention ordinance, metering, conservation pricing, public education and outreach, programs to assess and manage distribution system loss, water conservation program coordination and staffing support, rebate program) (City of Lodi, 2016)
- **Cal Water Urban Water Management Plan** (Demand management measures include water waste prevention ordinance, metering, conservation pricing, public education and outreach, programs to assess and manage distribution system real loss, water conservation program coordination and staffing support, and other demand management measures) (Cal Water, 2015).
- **City of Ripon Urban Water Management Plan** (Demand management measures include water waste prevention ordinance, metering, conservation pricing, public education and outreach, programs to assess and manage distribution system real loss, water conservation program coordination and staffing support, and other demand management measures) (City of Ripon, 2017).
- **SEWD Urban Water Management Plan** (Demand management measures include metering, public education and outreach, water conservation program coordination and staffing support, asset management, and wholesale supplier assistance programs) (SEWD, 2015).
- **SSJID Urban Water Management Plan** (Demand management measures include water waste prevention ordinance, metering, conservation pricing, public education and outreach, programs to assess and manage distribution system real loss, water conservation program coordination and staffing support, asset management, wholesale supplier assistance programs, and other demand management measures) (SSJID, 2015).
- **City of Stockton Urban Water Management Plan** (Demand management measures include water waste prevention ordinance, metering, conservation pricing, public education and outreach, programs to assess and manage distribution system real loss, water conservation program coordination and staffing support, water survey programs for residential customers, residential plumbing retrofit, conservation programs for commercial, industrial, and institutional accounts; and landscape conservation programs and incentives) (City of Stockton, 2015).
- **OID Agricultural Water Management Plan** (Efficient water management practices include delivery measurement accuracy, volumetric pricing, alternative land use, recycled water use, capital improvements for on-farm irrigation systems, incentive pricing structures, increasing water ordering and delivery flexibility, supplier spill and tailwater recovery systems, increase planned conjunctive use, automate canal control, facilitate customer pump testing, designate water conservation coordinator, provide for availability of water management services, evaluate supplier policies to allow more flexible deliveries and storage, and evaluate and improve efficiencies of supplier's pumps) (OID, 2016).
- **SEWD Agricultural Water Management Plan** (Efficient water management practices include water measurements, volume-based pricing, alternate land use, recycled water use, on-farm irrigation capital improvements, incentive pricing structure, infrastructure improvement, order/delivery flexibility, supplier spill and tailwater systems, conjunctive use, automated canal controls, customer pump test/evaluation, water conservation coordinator, water management services to customers, identify institutional changes, and supplier pump improved efficiency) (SEWD, 2015).

- **SSJID Agricultural Water Management Plan** (Efficient water management practices include delivery measurement accuracy, volumetric pricing, alternative land use, recycled water use, capital improvements for on-farm irrigation systems, incentive pricing structures, lining or piping of distribution system and construction of regulating reservoirs, increasing water ordering and delivery flexibility, supplier spill and tailwater recovery systems, increase planned conjunctive use, automate canal control, facilitate pump testing, designate water conservation coordinator, provide for availability of water management services, evaluate supplier policies to allow more flexible deliveries and storage, and evaluate and improve efficiencies of supplier's pumps) (SSJID, 2015).

Additional management activities are discussed in Chapter 7: Plan Implementation, including:

- Monitoring and recording of groundwater levels and groundwater quality data
- Maintaining and updating the Subbasin Data Management System (DMS) with newly collected data
- Annual monitoring of progress toward sustainability
- Annual reporting of Subbasin conditions to DWR as required by SGMA

6.4 ADAPTIVE MANAGEMENT STRATEGIES

Although the ESJGWA does not provide direct authority to require GSAs to implement projects, the GWA will be working on GSA-level water budgets and will be requesting annual or biannual reports to evaluate progress. If the projects do not progress, or if monitoring efforts demonstrate that the projects are not effective in achieving stated recharge and/or offset targets, the GWA will convene a working group to evaluate supply-side and demand-side management actions such as the implementation of groundwater pumping curtailments, land fallowing, etc.

Based on comments from DWR in their November 18, 2021 Consultation Initiation Letter (Letter) requesting additional detail on management actions that could be implemented, the ESJGWA has developed descriptions of adaptive management measures to be considered for implementation if projects are demonstrated to not be effective in achieving Subbasin sustainability targets. After implementation of the Category A projects (as described in Chapter 2 of this revised GSP and below), the adaptive management actions identified below could be implemented if additional measures are required to sustainably manage groundwater in the Subbasin. These adaptive management actions are programs that are not currently ready for implementation, are in the early planning stages, and do not have firm schedules for development but rather would be implemented as needed sometime after 2026 following reevaluation of Subbasin sustainability during the 5-Year GSP Update in 2025. The following describes these potential programs as they are currently contemplated; none of these programs are planned for implementation in the Subbasin at this time.

- **Groundwater Extraction Fee with Land Use** Modifications – A groundwater extraction fee or groundwater production charge could be collected from entities that own or operate an agricultural well. Revenue from these fees could then be used to pay for a variety of activities such as the construction of water infrastructure, groundwater conservation initiatives, proper construction and destruction of wells to prevent contamination, groundwater recharge and recovery projects, purchase of imported water or other supplies to replenish the groundwater basin through direct or in-lieu recharge, and/or purchasing and permanent fallowing of marginally-productive agricultural lands dependent on groundwater. Several agencies in California have already implemented such a program and have seen success in utilizing revenue to benefit the local groundwater basin. A similar methodology could be applied within the Eastern San Joaquin Subbasin.

- **Rotational Fallowing or Permanent Fallowing of Crop Lands** – Agricultural water use can be temporarily reduced by fallowing crop lands. While this can have economic impacts to a region, the benefits may also include improved water supply reliability, improved groundwater quality, increased groundwater levels, reduced subsidence, and operational flexibility. Rotational fallowing of crop lands reduces the economic impacts to any one area by rotating the areas of fallowing. This management action could be combined with a recharge project through the application of surplus water supplies to the fallowed lands resulting in in-lieu groundwater recharge or the repurposing of the permanently fallowed lands to create wildlife habitat or some other land use benefit that is not reliant on groundwater as a supply. This management action could be implemented, if needed, to help the Subbasin work towards its sustainability goals. However, the rules by which this management action would be implemented would have to be developed by the GSAs within the Subbasin.

- **Conservation Programming for Demand Reduction –** A demand reduction measure serves to reduce water demand, surface water losses, and/or nonessential water uses. Demand reduction measures may include a conservation rate structure or a uniform rate structure with a conservation program that achieves demand reduction. Conservation and demand management programs have been a priority for utility providers across the state for decades. Water conservation programs can by implemented by utilities to help offset the increasing demands being placed on water resources. Actions that may be considered a demand reduction measure include, but are not limited to, the following activities:
    - Conservation rates
    - Water efficient landscaping
    - Smart meters
    - Water efficient fixtures and appliances
    - Water conservation education effort

  Many of the GSAs in the Subbasin are currently implementing conservation programming for demand reduction. Under this management action, additional resources would be directed toward conservation programming for demand reduction such that these programs can be enhanced or expanded.

- **Mandatory Demand Reduction –** To reduce groundwater demand to allow and encourage the recovery of the groundwater aquifer, mandatory demand reduction may be considered by the ESJGWA as needed to meet the sustainability needs of the Subbasin if projects and management actions fall short of reduction and offset targets. Mandatory measures could include establishment of a per-acre groundwater allocation, metering, extraction reporting, land retirement, and other measures to ensure land is not in production. The proposed projects and management actions (PMAs) demonstrate that these mandatory demand reduction programs are not likely to be needed in the Eastern San Joaquin Subbasin and are a low priority. Several GSAs in critically overdrafted subbasins are implementing mandatory demand reductions as part of their sustainability efforts under SGMA.

Additionally, the GWA will conduct regular ‘calls for projects’ to identify additional potential projects and management actions that may be implemented to support Subbasin sustainability, and will, as part of this process, update information regarding projects already identified herein.

6.5 SIMULATION OF PROJECTS AND MANAGEMENT ACTIONS IN PROJECTED WATER BUDGET

The November 18, 2021 Letter from DWR identified two potential deficiencies with the Subbasin GSP which may preclude DWR’s approval, as well as potential corrective actions to address each potential deficiency. Potential Deficiency 1 related to the GSP’s requirement of two consecutive non-dry (i.e., below normal, above normal, or wet) water year types and the exclusion of dry and critically dry water-year types in the identification of undesirable results. (Please see Chapter 3, Sustainable Management Criteria, for revisions that address this deficiency). Potential Deficiency 1 also requests additional detail on how projects and management actions, in conjunction with the proposed chronic lowering of groundwater levels sustainable management criteria, will offset drought related groundwater reductions and avoid significant and unreasonable impacts. Specifically, Potential Correction Action 1(b) stated that the GSP "fails to identify specific extraction and groundwater recharge management actions the GSAs would implement or otherwise describe how the Subbasin would be managed to offset...dry year reductions of groundwater storage”. As a Potential Corrective Action, the following is suggested: “The GSP should be revised to include specific projects and management actions the GSAs would implement to offset drought year groundwater level declines.”

As part of the process to respond to DWR, the ESJGWA worked with each GSA individually to update GSP project descriptions with new information that has become available in the past two years since the GSP was first adopted in 2020. These revised projects were divided into two categories: Category A projects (projects that are likely to advance in the next five years and have existing water rights or agreements) and Category B projects (projects that are not anticipated to advance in the next five years, but could be leveraged in the future, particularly if Category A projects do not fully achieve stated recharge and/or offset targets). Category A projects and Category B projects are shown in Table 6-2 and Table 6-3, respectively, along with project assumptions; please see Chapter 2, Basin Setting, for information as to how the Category A projects were simulated in the projected water budget and for a description of their effectiveness on addressing overdraft in the Subbasin. Category B projects may be elevated to a Category A project should feasibility studies demonstrate a viable project, if water rights or contracts are firmly identified, if partnerships are formed, and if economic evaluation demonstrate that the projects are cost effective.

Table 6-2: Category A Projects

Project	Submitting GSA	Project Type	Water Source	Baseline Water Year Type	Annual Volume (AFY)	Notes
1. Lake Grupe In-Lieu Recharge	Stockton East Water District	In-Lieu Recharge	The surface water source of this project is from SEWD's existing contract with the U.S. Bureau of Reclamation (USBR) for the New Hogan Reservoir. Surface water is diverted from the Calaveras River. This is an existing surface water right.	Drought	2,000	Range of 0-2,000 AFY in multiple dry years
				Dry	4,900	
				Normal	4,900	
				Wet	4,900	
2. SEWD Surface Water Implementation Expansion	Stockton East Water District	In Lieu Recharge	This project relies on water from New Hogan Reservoir (Calaveras River water) and New Melones Reservoir (Stanislaus River water). This is an existing surface water right. SEWD has long-term water supply contracts with USBR for both New Hogan Reservoir and New Melones Reservoir.	Drought	4,000	Range of 0-4,000 AFY in multiple drought years
				Dry	8,000	
				Normal	19,000	
				Wet	19,000	
3. West Groundwater Recharge Basin	Stockton East Water District	Direct Recharge	This project relies on water from New Hogan Reservoir (Calaveras River water) and New Melones Reservoir (Stanislaus River water). This is an existing surface water right. SEWD has long-term water supply contracts with USBR for both New Hogan Reservoir and New Melones Reservoir. In addition to Calaveras River and Stanislaus River water, stormwater runoff will also contribute to the volume of water available for recharge.	Drought	1,500	
				Dry	4,000	
				Normal	16,000	
				Wet	16,000	
4. CSJWCD Capital Improvement Program	Central San Joaquin Water Conservation District	In-Lieu Recharge	This project relies on water from New Melones Reservoir. This is an existing surface water right. CSJWCD has long-term water supply contracts with USBR for the New Melones Unit Central Valley Project.	Drought	0	
				Dry	12,000	
				Normal	24,000	
				Wet	24,000	

Project	Submitting GSA	Project Type	Water Source	Baseline Water Year Type	Annual Volume (AFY)	Notes
5. Long-Term Water Transfer to SEWD and CSJWCD	South San Joaquin GSA	Transfers/In-Lieu Recharge	This project relies on water from New Melones Reservoir (Stanislaus River water). This is an existing surface water right (pre-1914) held by Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID).	Drought	20,000	This project currently only covers the transfer of water from OID and SSJID to SEWD urban customers.
				Dry	5,000	
				Normal	0	
				Wet	0	
6. White Slough Pollution Control Facility Expansion	City of Lodi	Recycled Water/In-Lieu Recharge	Treated wastewater effluent from White Slough Water Pollution Control Facility.	Drought	3,729	
				Dry	3,729	
				Normal	3,729	
				Wet	3,729	
7. NSJWCD South System Modernization	North San Joaquin Water Conservation District	In-Lieu Recharge/Direct Recharge	This project relies on water from the Mokelumne River. This is an existing water right held by NSJWCD (Permit 10477).	Drought	0	
				Dry	0	
				Normal	4,800	
				Wet	6,000	
8. NSJWCD Tecklenburg Recharge Project	North San Joaquin Water Conservation District	Direct Recharge	This project relies on water from the Mokelumne River. This is an existing surface water right held by NSJWCD (Permit 10477).	Drought	0	
				Dry	1,000	
				Normal	4,800	
				Wet	6,000	
9. NSJWCD South System Groundwater Banking with EBMUD	North San Joaquin Water Conservation District	In-Lieu Recharge	This project relies on water from the Mokelumne River. This is an existing water right held by East Bay Municipal Utility District (EBMUD) (Permit 10478) as per Protest Dismissal Agreement from 11/25/2014.	Drought	0	
				Dry	1,500	
				Normal	6,400	80% of wet year supply
				Wet	8,000	
10. NSJWCD North System Modernization/Lakso Recharge	North San Joaquin Water Conservation District	In-Lieu Recharge/Direct Recharge	This project relies on water from the Mokelumne River. This is an existing surface water right held by NSJWCD (Permit 10477).	Drought	0	
				Dry	1,000	
				Normal	3,200	
				Wet	4,000	
11. Delta Water Treatment Plant Groundwater Recharge	City of Stockton	Direct Recharge	This project relies on raw water from the Delta Water Treatment Plant.	Drought	5,040	
				Dry	5,040	

Project	Submitting GSA	Project Type	Water Source	Baseline Water Year Type	Annual Volume (AFY)	Notes
Improvements Project Geotechnical Investigation				Normal	5,040	
				Wet	5,040	

Table 6-3: Category B Projects

Project Name	Project Type	Submitting GSA	Current Status	Time-table (initiation and completion)	Annual Volume (AFY)
Perfecting Mokelumne River Water Right	In-lieu Recharge	San Joaquin County	Planning phase	2022-2025	20,000 to 50,000
City of Manteca Advanced Metering Infrastructure	Conservation	City of Manteca	Currently underway	2019-2021	272
City of Lodi Surface Water Facility Expansion & Delivery Pipeline	In-lieu Recharge	City of Lodi	Planning phase	2030-2033	4,750
BNSF Railway Company Intermodal Facility Recharge Pond	Direct Recharge	CSJWCD	Planning phase	2020-2023	1,000
City of Stockton Advanced Metering Infrastructure	Conservation	City of Stockton	Initial study completed in 2011	2020/25-2025/28	2,000
Manaserro Recharge Project	Direct Recharge	NSJWCD	Planning phase	2019-2022*	8,000
City of Escalon Wastewater Reuse	Recycling/ In-lieu Recharge/ Transfers	SSJ GSA	Planning phase	2020-2028	672
City of Ripon Surface Water Supply	In-lieu Recharge	SSJ GSA	Design complete; environmental permitting underway	2020-2024	6,000
City of Escalon Connection to Nick DeGroot Water Treatment Plant	In-lieu Recharge	SSJ GSA	Conceptual design phase; environmental review complete	2020-2023	2,015
Farmington Dam Repurpose Project	Direct Recharge	SEWD	Preplanning phase with reconnaissance study complete	2030-2050	30,000
Recycled Water Transfer to Agriculture	Recycling/Transfers/ In-lieu Recharge	City of Manteca	Planning phase with evaluation completed in Draft Reclaimed Water Facilities Master Plan	Not determined	5,193

Project Name	Project Type	Submitting GSA	Current Status	Time-table (initiation and completion)	Annual Volume (AFY)
Mobilizing Recharge Opportunities	Direct Recharge	San Joaquin County	Early conceptual planning phase	Not determined	Not determined
NSJWCD Winery Recycled Water	Recycling/ In-Lieu Recharge/ Direct Recharge	NSJWCD	Conceptual planning and discussion	2025-2027	750
Pressurization of SSJID Facilities	Conservation	SSJ GSA	Feasibility study complete	2019-2030	30,000
SSJID Storm Water Reuse	Storm Water/ In-lieu Recharge/ Direct Recharge	SSJ GSA	Planning phase	2027-2030	1,100

6.6 POTENTIAL AVAILABLE FUNDING MECHANISMS

The SWRCB has identified potential funding mechanisms that can be used toward the planning, construction, and implementation of GSP projects. Several funding types may be applicable to the current list of Planned Projects and potential future projects for the Eastern San Joaquin GSP including: projects included in an Integrated Water Resource Management Plan (IRWMP), projects addressing drinking water, stormwater recharge, water recycling projects, wastewater and system improvement projects, and projects that focus on DAC or SDAC areas.

The range of applicable projects, per SWRCB Funding Opportunities fact sheet and per Water Code § 10727.4(h), include recharge projects, groundwater contamination remediation, water recycling projects, in-lieu use, diversions to storage, conservation, conveyance, and extraction projects. Additional projects or management actions outside of this list may also be applicable if a GSA determines it will help achieve the sustainability goal for the Subbasin (see GSP Regulations § 354.44). Many of the available funding mechanisms accept applications on a continuing basis. Table 6-4 provides an overview of the project types and available funding and programs as well as important dates to consider for implementation. Funding options are explained in greater detail in the Chapter 7: Plan Implementation.

Table 6-4: Overview of Project Types and Available Funding Mechanisms

Project Type and Purpose	Funding Type	Program	Important Dates
Water recycling projects	Planning and construction grants and financing	Water Recycling Funding Program (Prop 1 and 13)	Planning applications accepted on continuous basis. Construction applications received by December 31st of each year will be used to develop a priority score. Projects which receive a priority score equal to or greater than the yearly fundable list cutoff score will be placed on the fundable list for the upcoming fiscal year.
Wastewater treatment for DAC & SDAC projects	Planning and construction grants and financing	Small Community Grant Fund (Prop 1 and CWSRF)	Applications accepted on continuous basis.
Drinking Water	Planning and implementation grants	Groundwater Grant Program (Prop 1)	Round 2 awards late 2019. Round 3 solicitation to be released 2020.
Public water system improvements	Planning and construction grants and financing	Drinking Water Grants (Prop 1 and 68, and DWSRF)	Applications accepted on continuous basis.
Stormwater recharge projects	Implementation grants	Storm Water Grant Program (Prop 1)	Round 2 solicitation estimated in spring 2020.
IRWM projects (included and implemented in an adopted IRWMP)	Implementation Grant	IRWM Implementation Grant Program (Prop 1)	Solicitation released spring 2019. Round 1 applications due Fall 2019. Round 2 solicitation estimated in 2020.

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7. PLAN IMPLEMENTATION

The Eastern San Joaquin Groundwater Sustainability Agency (GSAs) will work together in mutual cooperation to implement the Eastern San Joaquin Subbasin Groundwater Sustainability Plan (GSP) in compliance with the Sustainable Groundwater Management Act (SGMA). Implementing the GSP includes implementation of the projects and management actions included in Chapter 6: Projects and Management Actions, as well as the following items:

- Eastern San Joaquin GSP implementation program management
- Eastern San Joaquin GSAs administration and management
- Implementation of the monitoring program and reporting
- Data collection and analysis
- Public outreach
- Development of 5-year update and reports
- Grant writing

This chapter provides a description of the above items, including contents of the annual and 5-year reports that will be provided to the Department of Water Resources (DWR) as required under SGMA regulations.

7.1 IMPLEMENTATION SCHEDULE

Development and adoption of a GSP by the January 31, 2020 deadline was a large task. During GSP development, the Eastern San Joaquin Groundwater Authority Board of Directors (ESJGWA Board) identified key areas that would need to be further developed as part of 5-year updates.

The ESJGWA Board has formed an Ad-Hoc Committee and tasked it with making recommendations on a range on implementations and funding topics, including applying for grant funding under DWR's Proposition 68 Sustainable Groundwater Management (SGM) Planning Grant – Round 3. The Ad-Hoc Committee has convened on a weekly to bi-weekly basis beginning in early July 2019.

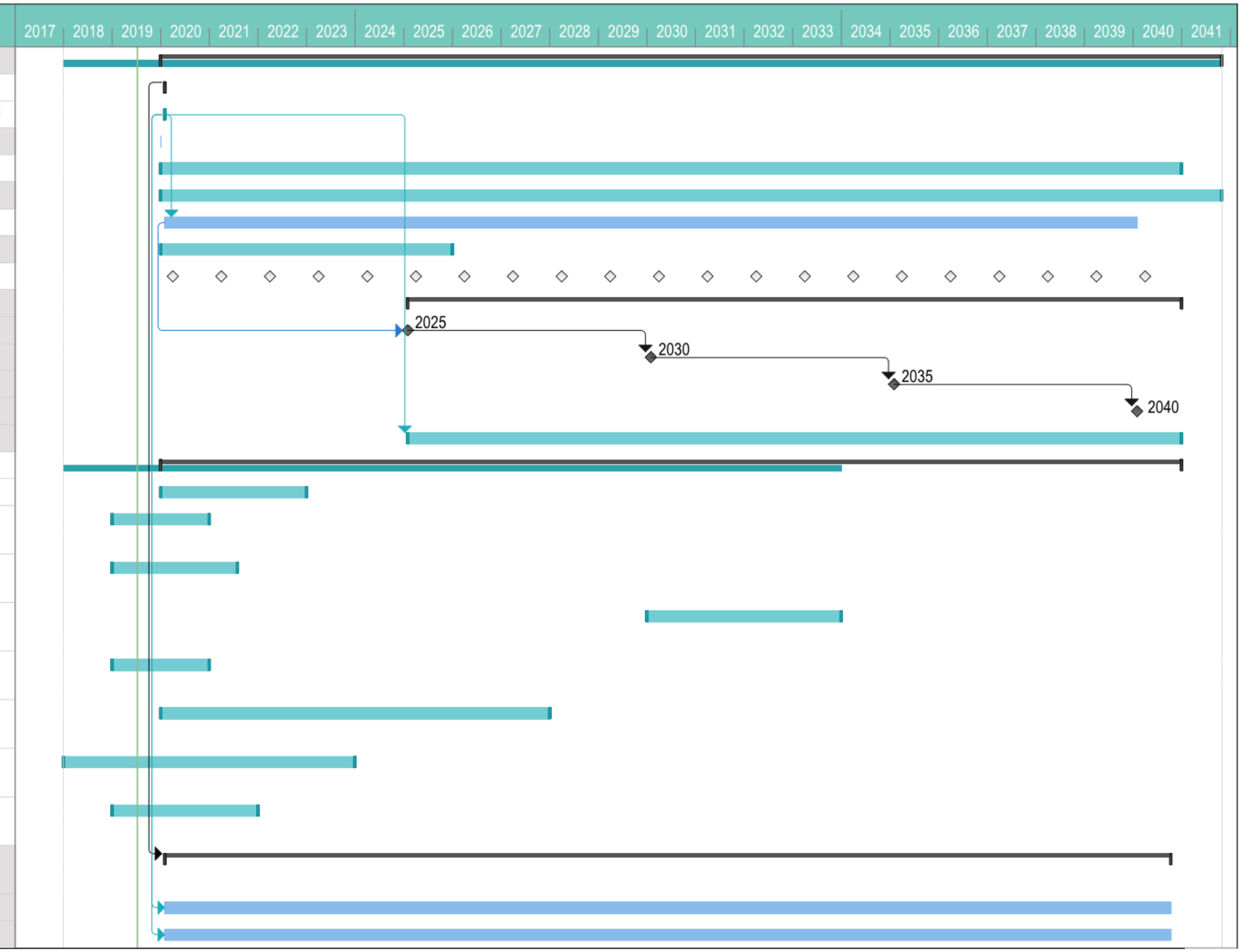
Table 7-1 illustrates the Eastern San Joaquin GSP's schedule for implementation from 2020 to 2040, highlighting the high-level activities anticipated for each 5-year period. A more detailed schedule is provided in Figure 7-1. These activities are necessary for ongoing GSP monitoring and updates, as well as tentative schedules for projects and management actions. Additional details on the activities included in the timeline are provided in these activities' respective sections of this GSP.

Table 7-1: GSP Schedule for Implementation 2020 to 2040

2020	2025	2030	2035 – 2040
Monitoring and Reporting	**Project Implementation**	**Prepare for Sustainability**	**Implement Sustainable Operations**
• Establish monitoring networks • Install new wells • Model refinement and verification studies • Initial project implementation • Ongoing outreach regarding GSP and projects	• GSAs conduct 5-year evaluation/update • Project implementation continues • Potential Project Evaluation and initiation • Monitoring and reporting continue • Outreach regarding GSP and projects continues	• GSAs conduct 5-year evaluation/update • Longer-term/ Conceptual Project evaluation • Monitoring and reporting continue • Outreach continues	• GSAs conduct 5-year evaluation/update • Project implementation completed

Figure 7-1: GSP Implementation Schedule

Task Name	Start	Finish
GSP Implementation	2019	2041
Plan Implementation	2020	2020
Plan submittal to the State		1/31/20
GSP Implementation Program Management	2019	2019
GSA Administration	2019	2040
Public Outreach	2019	2041
Monitoring	2020	2040
Model Refinements & Data Collection	2020	2025
Annual Reports	2020	2040
Five-Year Evaluation Reports	2025	2040
Five Year Report/Evaluation 1		
Five Year Report/Evaluation 2		
Five Year Report/Evaluation 3		
Five Year Report/Evaluation 3		
Plan Updates (as needed)	2025	2040
Project Implementation	2019	2040
Project 1: Lake Grupe In-lieu Recharge	2020	2022
Project 2: SEWD Surface Water Implementation Expansion	2019	2020
Project 3: City of Manteca Advanced Metering Infrastructure Project	2019	2021
Project 4: City of Lodi Surface Water Facility Expansion & Delivery Pipeline	2030	2033
Project 5: White Slough Water Pollution Control Facility Expansion	2019	2020
Project 6: CSJWCD Capital Improvement Program	2020	2027
Project 7: NSJWCD South System Modernization	2018	2023
Project 8: Long-term Water Transfer to SEWD and CSJWCD	2019	2021
Adaptive Management Action Implementation (as-needed)	2020	2040
Evaluate Unimplemented Projects	2020	2040
Revisit Projects not included in GSP	2020	2040



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7.2 IMPLEMENTATION COSTS

In implementing the GSP, the GSAs will incur costs which will require funding. Table 7-2 summarizes these activities and their estimated costs. The areas associated with ESJGWA-wide management and GSP implementation will be borne by the ESJGWA through contributions from the member GSAs, under a cost-sharing arrangement to be developed following GSP adoption. Projects will be administered by the GSA project proponents. GSAs may elect to implement projects individually or jointly with one or more GSAs or with the ESJGWA.

Table 7-2: Costs to GSAs and GSP Implementation Costs

Activity	Estimated Cost[1]
GSP Implementation and Management for GSAs	
Monitoring and Reporting	
Monitoring	Approximately $175,000 annually
Annual Reporting	$50,000 - $75,000 annually
Data Management System Updates	$30,000 - $50,000 (first year only) $20,000 (following years, annually)
Data Collection and Analysis	
Model Refinements	$275,000 (one time)
Additional Wells if needed	$200,000 per well (multi-level)
Review of water quality data in broad network	$20,000 - $40,000 (annually)
Administrative Actions	$140,000 - $230,000 (annually)
Developing 5-Year Evaluation Reports	$800,000 - $2,000,000 every 5 years
Public Outreach and Website Maintenance	$35,000 - $60,000 (annually)
Grant Writing	By application type: $45,000 - $60,000 (State) $50,000+ (Federal)
Implementing GSP: Projects and Management Actions (Planned Projects Only)	
Project 1: Lake Grupe In-Lieu Recharge	$2.3 million (one time) $330,000 (annually)
Project 2: SEWD Surface Water Implementation Expansion	$750,000 (one time) $100,000 (annually)
Project 3: City of Manteca Advanced Metering Infrastructure	$650,000 (one time) $300,000 (annually)
Project 4: City of Lodi Surface Water Facility Expansion and Delivery Pipeline	$4 million (one time) $2,340,000 (annually)
Project 5: White Slough Water Pollution Control Facility Expansion	$6 million (one time) – complete $4664 (annually)
Project 6: CSJWCD Capital Improvement Program	$50,000 (annually)
Project 7: NSJWCD South System Modernization	$9 million (one time) $250,000 (annually)
Project 8: Long-term Water Transfer to SEWD and CSJWCD	Up to $9 million (annually), $200 per AF

[1] Estimates are rounded and based on full implementation years (FY2021 through FY2040). Different costs may be incurred in FY 2020 as GSP implementation begins.

7.3 MONITORING AND REPORTING

7.3.1 Monitoring

The GSAs will follow direction for the monitoring programs described in Chapter 4: Monitoring Networks to track conditions for the applicable sustainability indicators discussed in Chapter 3: Sustainable Management Criteria. Monitoring network data will be collected and used to determine whether undesirable results are occurring and whether minimum thresholds are being reached or exceeded, and to determine if adaptive management is necessary. This data will be managed using the Eastern San Joaquin Subbasin Data Management System (DMS) (see Chapter 5: Data Management System). The GSP monitoring networks make use of existing monitoring programs and develop further monitoring to continue characterization of the system and support development of water budgets. Key components involved in the implementation of the monitoring network activities for the GSP include:

- Semi-annual groundwater level monitoring at 139 wells
- Coordinating between new GSP monitoring program and existing California Statewide Groundwater Elevation Monitoring (CASGEM) program
- Semi-annual groundwater quality monitoring at 43 wells
- Documentation of groundwater quality monitoring protocols

Components of the annual monitoring program costs include:

- Field crew ($50,000 - $60,000)
- Equipment rental with truck, level meter, and pumps ($7,000 - $10,000)
- Laboratory costs ($24,000 - $30,000)
- Existing monitoring and reporting costs for CASGEM ($50,000 - $75,000)

7.3.2 Developing Annual Reports

Annual reports must be submitted by April 1 of each year following GSP adoption. Annual reports must include 3 key sections: 1) General Information, 2) Basin Conditions, and 3) Plan Implementation Progress. An outline of what information will be provided in each of these sections in the annual report is included below. Annual reporting will be completed in a manner and format consistent with California Code of Regulations (CCR) Tile 23 § 356.2. As annual reporting continues, it is possible that this outline will change to reflect basin conditions, the priorities of GSAs, and applicable requirements from DWR. Annual reporting is estimated to cost approximately $50,000 to $75,000 annually.

7.3.2.1 General Information

General information will include an executive summary that highlights the key contents of the annual report. As part of the executive summary, this section will include a description of the sustainability goals, provide a description of GSP projects and their progress, and annually updated implementation schedule and map of the Subbasin. Key components as required by SGMA regulations include:

- Executive Summary
- Map of the Subbasin

7.3.2.2 Basin Conditions

Basin conditions will describe the current groundwater conditions and monitoring results. This section will include an evaluation of how conditions have changed in the Subbasin over the previous year and compare groundwater data for the year to historical groundwater data. Pumping data, effects of project implementation (e.g., recharge data, conservation, if applicable), surface water flows, total water use, and groundwater storage will be included. Key components as required by SGMA regulations include:

- Groundwater elevation data from the monitoring network
- Hydrographs and contour maps of elevation data
- Groundwater extraction data
- Surface water supply data
- Total water use data
- Change in groundwater storage, including maps

7.3.2.3 Plan Implementation Progress

Progress towards successful plan implementation would be included in the annual report. This section of the annual report would describe the progress made toward achieving interim milestones as well as implementation of projects and management actions. Key components as required by SGMA regulations include:

- Plan implementation progress
- Sustainability progress

7.3.3 DMS Updates

Updates and maintenance to the DMS will be made annually, including import of monitoring data and export of summarized data for annual reporting.

The first year will include refinements and is expected to cost $30,000 to $50,000, with following years expected to cost $20,000 annually.

7.4 DATA COLLECTION AND ANALYSIS

7.4.1 Model Refinements

The ESJWRM will be updated based on newly available information or additional information provided by GSAs. This will include extending the historical model time series through at least 2020 and refining the model grid to align with the most recently updated GSA boundaries. Areas of higher uncertainty, such as the Sacramento-San Joaquin River Delta (Delta), Sierra Nevada foothills, and stream-aquifer interaction, will be refined using additional information made available through GSP monitoring and projects to achieve better calibration. Once the model has been updated and calibrated, new SGMA scenarios will be developed, including the current, projected, and sustainable scenarios as well as associated water budgets and the evaluation of sustainability indicators based on project implementation. The historical model is expected to be updated and calibrated by 2023 so that updated scenarios can be developed before the first GSP update in 2025. Total model refinement costs are expected to be $275,000.

7.4.2 Installation of Additional Wells

Additional groundwater level monitoring wells may be installed throughout the Subbasin if needed to fill remaining data gaps or for other management purposes after separate currently planned monitoring well installations have been completed. Well installation costs can vary widely based on well depth and soil conditions. An estimate average cost for installing a groundwater level monitoring well is $200,000 per well.

7.4.3 Review of Water Quality Data in Broad Network

The GSAs will be reviewing water quality data in an exploratory fashion on an annual basis. This will include an evaluation of TDS, anions/cations, and arsenic on a Subbasin-wide scale to better inform basin conditions and management. This level of effort is expected to cost between $20,000 - $40,000 annually. Efforts include:

- Coordination with existing monitoring programs:
    - Review of data submitted to the Department of Pesticide Regulation (DPR), Division of Drinking Water (DDW), Department of Toxic Substances Control (EnviroStor), and GeoTracker as part of the Groundwater Ambient Monitoring and Assessment (GAMA) database.
    - Regular check-ins with existing monitoring programs, such as Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) and the Irrigated Lands Regulatory Program (ILRP).
    - Annual review of annual monitoring reports prepared by other programs, such as CV-SALTS and ILRP.
    - GSAs will invite representative(s) from the Regional Water Quality Control Board, San Joaquin County Division of Environmental Health, and ILRP to attend an annual meeting of the GSAs to discuss constituent trends and concerns in the Subbasin in relation to groundwater pumping.

7.4.4 Data Gaps and Uncertainties

The ESJGWA acknowledges that there are many factors that could affect the availability of surface water, including the SWRCB plans to reduce flows available for use by 40-60 percent as part of the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan). Such regulations will need to be evaluated by GSAs in the implementation of projects. The process of providing annual reports to DWR and of GSAs self-reporting to the ESJGWA will allow the ESJGWA to update the Plan and adjust the implementation course as needed based on changing conditions. The GSP allows project implementation to be updated as needed, and it is currently too speculative to say what the impact will be from the proposed Bay-Delta Plan Update regulation, as the SWRCB has not yet determined how the regulation will be been implemented.

7.5 ADMINISTRATIVE ACTIONS

Each of the 16 GSAs are administered independently and involve meetings and oversight of individual GSA projects and programs. GSAs can be made up of one or multiple agencies, cities, and counties, as described in Chapter 1: Agency Information, Plan Area, and Communication. GSA administration will include: coordination meetings; coordination meetings of the GSP Implementation Ad-hoc Committee, regular email communications to update GSA members on on-going basin activities; coordination activities with the other GSAs, such as on projects or studies; administration of projects implemented by the GSA; and general oversight and coordination. Coordination meetings between the 16 GSAs are assumed to occur bi-monthly, with other oversight and administration activities occurring as needed and on an on-going basis. GSA administration is also expected to require additional effort during GSP updates, and around the time of annual report and 5-year evaluation report development. Other administrative actions may involve tracking and evaluating GSP implementation and sustainability conditions as well as assessing the benefit to the Subbasin. Annual costs for GSA administrative actions are estimated to range from $140,000 to $230,000. This estimate assumes $50,000 per year for annual audit and insurance expenses.

7.6 DEVELOPING 5-YEAR EVALUATION REPORTS

SGMA requires that GSPs be evaluated regarding their progress towards meeting the approved sustainability goals at least every 5 years and to provide a written assessment to DWR. An evaluation must also be made whenever the GSP is amended. A description of the information that will be included in the 5-year report is provided below and would be prepared in a manner consistent with CCR Title 23 § 356.4. Annual costs for 5-year GSP updates are estimated to range from $800,000 to $2,000,000.

7.6.1 Sustainability Evaluation

This section will contain a description of current groundwater conditions for each sustainability indicator and will include a discussion of overall Subbasin sustainability. Progress towards achieving interim milestones and measurable objectives will be included, along with an evaluation of groundwater quality and groundwater elevations (being used as direct or proxy measures for several sustainability indicators) in relation to minimum thresholds.

A chloride isocontour map will be developed to evaluate the seawater intrusion sustainability indicator. As data are collected from wells within the water quality monitoring network (see Section 4.3), an isocontour line can be drawn with the most current data. If the drawn isocontour line crosses the minimum threshold isocontour line at chloride concentrations 2,000 mg/L or higher, the ESJGWA would consider that an undesirable result had occurred. It is unlikely that the Subbasin will experience an undesirable result due to seawater intrusion during the SGMA planning horizon.

7.6.2 Plan Implementation Progress

This section will describe the current status of project and management action implementation since the previous 5-year report. An updated project implementation schedule will be included, along with any new projects that were developed to support the goals of the GSP and a description of any projects that are no longer included in the GSP. The benefits of projects that have been implemented will be included, and updates on projects and management actions that are underway at the time of the 5-year report will be reported.

7.6.3 Reconsideration of GSP Elements

Part of the 5-year report will include a reconsideration of GSP Elements. As additional monitoring data are collected during GSP implementation, land uses and community characteristics change over time, and GSP projects and management actions are implemented, it may become necessary to revise the GSP. This section of the 5-year report will reconsider the basin setting, management areas (if applicable), undesirable results, minimum thresholds, and measurable objectives. If appropriate, the 5-year report will recommend revisions to the GSP. Revisions would be informed by the outcomes of the monitoring networks, and changes in the Subbasin, including but not limited to, changes to groundwater uses or supplies and outcomes of project implementation.

The water year types from the San Joaquin Valley Water Year Hydrologic Classification used in this Plan are based on stream inflows from a variety of streams in the San Joaquin Valley. In the future, a more locally-relevant index may be developed that would be more representative of conditions specific to the Subbasin.

7.6.4 Monitoring Network Description

A description of the monitoring network will be provided in the 5-year report. Data gaps, or areas of the Subbasin that are not monitored in a manner consistent with the requirements of the regulations, will be identified or re-assessed if previously identified. An assessment of the monitoring networks' function will be provided, along with an analysis of data collected to-date. If data gaps are identified, the GSP will be revised to include a program for addressing these data gaps, along with an implemented schedule for addressing data gaps and how the GSAs will incorporate updated data into the GSP.

7.6.5 New Information

New information that has become available since the last 5-year evaluation or GSP amendment would be described and the GSP evaluated in light of this new information. If the new information would warrant a change to the GSP, this would also be included.

7.6.6 Regulations or Ordinances

The 5-year report will include a summary of the regulations or ordinances related to the GSP that have been implemented by DWR since the previous report and address how these may require updates to the GSP.

7.6.7 Legal or Enforcement Actions

Enforcement or legal actions taken by the GSAs or their member agencies in relation to the GSP will be summarized in this section along with how such actions support sustainability in the Subbasin.

7.6.8 Plan Amendments

A description of amendments to the GSP will be provided in the 5-year report, including adopted amendments, recommended amendments for future updates, and amendments that are underway during development of the 5-year report.

7.6.9 Coordination

The Eastern San Joaquin GSP will be implemented by the GSAs identified in Chapter 1: Agency Information, Plan Area, and Communication. These GSAs will work in collaboration with neighboring subbasins, namely: the Modesto, Cosumnes, South American, Solano, East Contra Costa, and Tracy Subbasins.

This section of the 5-year report will describe coordination activities between these entities, such as meetings, joint projects, or data collection efforts. If additional neighboring GSAs have been formed since the previous report, or changes in neighboring subbasins have occurred, resulting in a need for new or additional coordination within or outside the Subbasin, such coordination activities would be included as well.

7.7 PUBLIC OUTREACH

During GSP development, GSAs and the ESJGWA used multiple forms of outreach to communicate SGMA-related information and solicit input. The GSAs intend to continue public outreach and provide opportunities for engagement during GSP implementation. This will include providing opportunities for public participation, at public meetings, providing access to GSP information online, and continued coordination with entities conducting outreach to diverse communities in the Subbasin. Announcements will continue to be distributed via email prior to public meetings. Emails will also be distributed as specific deliverables are finalized, when opportunities are available for stakeholder input and when this input is requested, or when items of interest to the stakeholder group arise, such as relevant funding opportunities. The Eastern San Joaquin SGMA website, managed as part of GSP administration, will be updated a minimum of monthly, and will house meeting agendas and materials, reports, and other program information. The website may be updated to add new pages as the program continues and additional activities are implemented. Additional public workshops will be held semi-annually to provide an opportunity for stakeholders and members of the public to learn about, discuss, and provide input on GSP activities, progress toward meeting the sustainability goal of this GSP, and the SGMA program. Costs to support outreach are estimated to range from $35,000 to $60,000 annually.

7.8 IMPLEMENTING GSP-RELATED PROJECTS AND MANAGEMENT ACTIONS

Costs for the projects and management actions are described in Chapter 6: Projects and Management Actions of this GSP. Financing of the projects and management actions would vary depending on the activity. Potential financing for projects and management actions are provided in Table 7-3, although other financing may be pursued as opportunities arise or as appropriate. The GSAs may adopt adaptive management actions as needed to evaluate potential for unimplemented projects and revisiting projects not included within the 23 projects listed in this GSP. This includes Longer-term/Conceptual Projects provided in Chapter 6: Projects and Management Actions.

Table 7-3: Funding Mechanisms for Proposed Projects and Management Actions

Project/Management Action Title and Type		Responsible Agency[1]	Potential Funding Mechanisms
Planned Projects			
Project 1: Lake Grupe In-Lieu Recharge	In-lieu Recharge	SEWD	District staffing and District rates to establish new accounts
Project 2: SEWD Surface Water Implementation Expansion	In-lieu Recharge	SEWD	District staffing and District rates to establish new accounts
Project 3: City of Manteca Advanced Metering Infrastructure	Conservation	City of Manteca	Capital Improvement Project budgeted item with available funding
Project 4: City of Lodi Surface Water Facility Expansion & Delivery Pipeline	In-lieu Recharge	City of Lodi	Capital Improvement Project budgeted item with available funding
Project 5: White Slough Water Pollution Control Facility Expansion	Recycling/In-lieu Recharge	City of Lodi	DWR Proposition 84 Grant Funding Program
Project 6: CSJWCD Capital Improvement Program	In-lieu Recharge	CSJWCD	Surface water sales, groundwater extraction fees, and acre assessments
Project 7: NSJWCD South System Modernization	In-lieu Recharge	NSJWCD	Grant funding, landowner assessments, and water charges
Project 8: Long-term Water Transfer to SWED and CSJWCD	Intra-basin Transfer/ In-lieu Recharge	SSJ GSA	Costs met by recipients of water or groundwater pumping benefit
Potential Projects			
Project 9: BNSF Railway Company Intermodal Facility Recharge Pond	Direct Recharge	CSJWCD	Groundwater extraction fee revenue, private loans, and/or possible grant funding
Project 10: City of Stockton Advanced Metering Infrastructure	Conservation	City of Stockton	Met by ratepayers and through grants or other funding sources
Project 11: South System Groundwater Banking with EBMUD	In-lieu Recharge	NSJWCD	Grant funding, banking fees, and water charges
Project 12: NSJWCD North System Modernization/ Lakso Recharge	In-lieu Recharge	NSJWCD	Grant funding, landowner assessments, and water charges
Project 13: Manaserro Recharge Project		NSJWCD	Grant funding and landowner assessments
Project 14: Tecklenberg Recharge Project		NSJWCD	Grant funding and landowner assessments
Project 15: City of Escalon Wastewater Reuse	Recycling/In-lieu Recharge	SSJ GSA	Developer impact fees, connection fees, and sewer rate fees

Project/Management Action Title and Type		Responsible Agency[1]	Potential Funding Mechanisms
Project 16: City of Ripon Surface Water Supply	In-lieu Recharge	SSJ GSA	Grants, water rates, and development impact fees
Project 17: City of Escalon Connection to Nick DeGroot Water Treatment Plant	In-lieu Recharge	SSJ GSA	Grants, water rates, and development impact fees
Longer-term or Conceptual Projects			
Project 18: Farmington Dam Repurpose Project	Direct Recharge	SEWD	Grant funding
Project 19: Recycled Water Transfer to Agriculture	Recycling/Transfer/ In-lieu Recharge	City of Manteca	To be identified
Project 20: Mobilizing Recharge Opportunities	Direct Recharge	San Joaquin County	To be identified
Project 21: NSJWCD Winery Recycled Water	Recycling/In-Lieu Recharge/Direct Recharge	NSJWCD	Grant funding, landowner assessments, and charges paid by the winery
Project 22: Pressurization of SSJID Facilities	Conservation	SSJ GSA	Existing sources (hydropower generation, user fees, water transfers) and enhanced sources (grants, additional user fees, additional water transfers)
Project 23: SSJID Storm Water Reuse	Storm Water/ Direct Recharge	SSJ GSA	Developer impact fees, connection fees, and property related fees
Other			
Mokelumne River Loss Study	Model Refinement and Verification	NSJWCD	Not determined

[1] Acronyms defined: Stockton East Water District (SEWD), Central San Joaquin Water Conservation District (CSJWCD, North San Joaquin Water Conservation District (NSJWCD), and South San Joaquin Groundwater Sustainability Agency (SSJ GSA).

7.9 GSP IMPLEMENTATION FUNDING

Implementation of the GSP is projected to cost between $600,000 and $1 million per year excluding projects and management actions costs. Additional one-time costs are estimated to be on the order of $315,000. Development of this GSP was funded through a Proposition 1 Sustainable Groundwater Planning Grant. To the degree they become available, outside grants will be sought to assist in reducing cost of implementation to participating agencies, residents, and landowners of the Subbasin. However, there will be a need to establish funding mechanisms to support the implementation of the GSP and future SGMA compliance. At the April 10, 2019 ESJGWA Board Meeting, the Board approved an action to conduct monitoring, measuring, and modeling at the basin-scale subject to a financing plan that will be developed after the GSP is approved. Costs for GSP project implementation will be met by project proponents. Also at the April 10, 2019 ESJGWA Board Meeting, the Board took an action to approve development and implementation of projects in the GSP Implementation Plan at the GSA level, with the option for GSAs with projects in the GSP to work with additional parties in the development of their projects.

Costs of overall GSP administration are expected to be shared by the GSAs. Financing options under consideration could include pumping fees, assessments, loans, and grants. Individual GSAs will create their own financing plans to address their portion of the cost share according to the ESJGWA. Table 7-4 lists examples of potential financing options.

Prior to implementing any fee or assessment program, the GSAs would complete a rate assessment study or other analysis if required by the regulatory requirements.

Table 7-4: Potential Funding Sources for GSP Implementation

Funding Source	Certainty
Ratepayers (within Project Proponent service area or area of project benefit)	**High** – User rates pay for operation and maintenance (O&M) of a utility's system. Depends upon rate structure adopted by the project proponent and, if applicable, the Proposition 218 rate approval process. Can be used for project implementation as well as project O&M.
General Funds or Capital Improvement Funds (of Project Proponents)	**High** – General or capital improvement funds are set aside by agencies to fund general operations and construction of facility improvements. Depends upon agency approval.
Special taxes, assessments, and user fees (within Project Proponent service area or area of project benefit)	**High -** Monthly user fees, special taxes, and assessments can be assessed by some agencies should new facilities directly benefit existing customers. Depends upon the rate structure adopted by the project proponent and, if applicable, the Proposition 218 rate approval process.
Clean Water State Revolving Fund (CWSRF) Loan Program administered by the California State Water Resources Control Board (SWRCB)	**Medium** – Historically, the SWRCB has had $200 to $300 million available annually for low-interest loans (typically ½ of the General Obligation Bond Rate) for water recycling, wastewater treatment, and sewer collection projects. During recent years, available funding has become limited due to high demand. Success in securing a low-interest loan depends on demand of the CWSRF Program and available funding. Applications are accepted on a continuous basis. SWRCB prepares a fundable list for each fiscal year. In order to receive funding, a project must be on the fundable list. Full applications must be submitted by the end of the calendar year to be considered for inclusion on the following year's fundable list.

Funding Source	Certainty
Water Recycling Funding Program (WRFP) – Planning and Construction Grants from SWRCB	**High** (planning) / **Low** (construction) – WRFP grants are funded by Proposition 1, as well as the general CWSRF Program. Planning grants (for facilities planning) are available and can fund 50% of eligible costs, up to $75,000. Construction grants have been exhausted. Low-interest loans through the CWSRF program are available and while limited, recycled water projects receive priority over wastewater projects (which are also eligible under CWSRF, the umbrella program for the WRFP).
Drinking Water State Revolving Fund Loan Program administered by the SWRCB Division of Drinking Water	**High** – Approximately $100 to $200 million is available on an annual basis for drinking water projects. Low-interest loans are available for project proponents should they decide to seek financing. Funding has become more limited; however, applicants are encouraged to apply.
Infrastructure State Revolving Fund Loan Program administered by the California Infrastructure and Economic Development Bank (I-Bank)	**High** – Low-interest loans are available from I-Bank for infrastructure projects (such as water distribution). Maximum loan amount is $25 million per applicant. Applications are accepted on a continuous basis.
Title XVI Water Recycling and Reclamation / Water Infrastructure Improvements for the Nation (WIIN) Program – Construction Grants administered by the United States Bureau of Reclamation (USBR)	**Medium** – Grants up to 25% of project costs or $20 million, whichever is less, are available from USBR for water recycling projects. A Title XVI Feasibility Study must be submitted to and approved by USBR to be eligible. USBR solicits grants annually.
WaterSMART Title XVI Water Recycling and Reclamation Program – Feasibility Study Grants administered by USBR	**Low** – Grants up to $150,000 have been available in the past for preparation of Title XVI Feasibility Studies. It is possible future rounds may be administered.
Bonds	**Medium** – Revenue bonds can be issued to pay for capital costs of projects allowing for repayment of debt service over 20- to 30- year timeframe. Depends on the bond market and the existing debt of project proponents.
Integrated Regional Water Management (IRWM) implementation grants administered by the California Department of Water Resources (DWR)	**Medium** – The Westside-San Joaquin IRWM Region, the primary IRWM region overlapping the Delta-Mendota Subbasin, will pursue grant funding through the Proposition 1, Round 1 IRWM Implementation Grants. The Westside-San Joaquin IRWM Region bridges two funding areas: The San Joaquin River Funding Area and the Tulare-Kern Funding Area. Application due dates vary by Funding Area; the application for the San Joaquin River Funding Area is due in November 2019 and the application for the Tulare-Kern Funding Area was due in September 2019. Approximately $28 million will be available in the San Joaquin River Funding Area and approximately $30 million will be available in the Tulare-Kern Funding Area over two rounds (where Round 2 solicitation will begin in 2020).

Funding Source	Certainty
Proposition 68 grant programs administered by various state agencies	**Medium** – Grant programs funded through Proposition 68, which was passed by California voters in June 2018, administered by various state agencies are expected to be applicable to fund GSP implementation activities. These grant programs are expected to be competitive, where $74 million has been set aside for Groundwater Sustainability statewide. The ESJGWA will pursue funding under DRW's Sustainable Groundwater Management Planning Grant – Round 3 in November 2019.
Disadvantaged Community (DAC) Involvement Program	**Medium** – The Westside-San Joaquin IRWM Region will receive funding through DWR's DAC Involvement Program through the San Joaquin River Funding Area (which was awarded a total of $3.1 million for the Funding Area as a whole) and the Tulare/Kern Funding Area (which was awarded a total of $3.4 million for the Funding Area). This funding has been secured by the respective Funding Areas. Funding may be used to help develop a project within the Westside-San Joaquin IRWM Region in order to advance it toward implementation. This program is not guaranteed to be funded in the future.

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