Eastern San Joaquin Groundwater Subbasin

2024 Groundwater Sustainability Plan Amendment: Agency Information, Plan Area, and Communication

Prepared by:

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

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EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

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Acronyms

µg/L	micrograms per liter
1,2,3-TCP	1,2,3-Trichloropropane
AB	Assembly Bill
ACS	American Community Survey
AEM	Airborne Electromagnetic
AEM	airborne electromagnetic survey
AF	acre-feet
AF/day	acre-feet per day
AF/year	acre-feet per year
AMI	Advanced Metering Infrastructure
AMI	automated metering infrastructure
ASR	aquifer storage and recovery
AWMP	Agricultural Water Management Plan
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
C&E Plan	Communication and Engagement Plan
C2VSim-FG	California Central Valley Simulation Model – Fine Grid
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
CalTrans	California Department of Transportation
CASGEM	California Statewide Groundwater Elevation Monitoring
CC	climate change
CCR	California Code of Regulations
CCR	Consumer Confidence Report
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	continuous 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
CWC	California Water Code
CWSRF	Clean Water State Revolving Fund
DAC	Disadvantaged Community
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
DPC	Delta Protection Commission
DPR	Department of Pesticide Regulation
DPW	San Joaquin County Department of Public Works
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
EO	Executive Order
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
ft/mi	feet per mile
GAMA	Groundwater Ambient Monitoring and Assessment
GBA	Groundwater Basin Authority
GCM	global climate model
GDE	groundwater dependent ecosystem
GICIMA	Groundwater Information Center Interactive Mapping Application
GIS	Geographic Information System
GMP	Groundwater Management Plan
gpd	gallons per day
gpm	gallons per minute
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWL	groundwater level

HCM	Hydrogeologic Conceptual Model
ICU Program	Integrated Conjunctive Use Program
IDW	inverse distance weighted
ILRP	Irrigated Lands Regulatory Program
InSAR	interferometric synthetic aperture radar
IRWM	Integrated Regional Water Management
IRWMP	Integrated Regional Water Management Plan
ISW	interconnected surface water
IWFM	Integrated Water Flow Model
JPA	Joint Powers Agreement
JPL	Jet Propulsion Laboratory
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
MICUP	Mokelumne River Integrated Conjunctive Use Program
µmhos/cm	micromhos per centimeter
MO	measurable objective
MOA	memorandum of agreement
MokeWISE	Mokelumne Watershed Interregional Sustainability Evaluation
MSL	mean sea level
MT	minimum threshold
MtBE	methyl tertiary-butyl ether
MUD	Municipal Utilities Department
MWH	Montgomery Watson Harza
NAD 83	North American Datum of 1983
NASA	National Aeronautics and Space Administration
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
NGS	National Geodetic Survey
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
O&M	operations and maintenance

OES	San Joaquin County Office of Emergency Services
OID	Oakdale Irrigation District
OSWCR	Online System for Well Completion Reports
PCBL	Projected Conditions Baseline
PCE	perchloroethylene
PDA	Protest Dismissal Agreement
pdf	portable document format
PFOA	perfluorooctantoic acid
PFOS	perfluorooctanesulfonic acid
PG&E	Pacific Gas and Electric Company
PMA	Projects and Management Actions
PMC	Project Management Committee
PRISM	Precipitation-Elevation Regressions on Independent Slopes Model
PS	persistent scatter
RCA	recommended corrective action
RCD	Resource Conservation District
RCP	representative climate pathways
RD	Reclamation District
RFP	request for proposal
RL	Reporting Limit
RMN	representative monitoring network
RMW	representative monitoring well
RWQCB	Regional Water Quality Control Board
SAGBI	Soil Agricultural Groundwater Banking Index
SAW	Stakeholder Advisory Workgroup
SB	Senate Bill
SCADA	supervisory control and data acquisition
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	Sustainable Groundwater Management Act
SJC	San Joaquin County
SJC POC	San Joaquin Valley Point of Contacts
SJCFCWCD	San Joaquin County Flood Control and Water Conservation District
SJV	San Joaquin Valley
SMC	sustainable management criteria
SMCL	secondary maximum contaminant levels
SNMP	Salt and Nutrient Management Plan
SOPAC	Scripps Orbit and Permanent Array Center
SRA	State Recreation Area
SS	specific storage
SSJ	South San Joaquin
SSJ GSA	South San Joaquin GSA

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
TAC	Technical Advisory Committee
TAFY	thousand acre-feet per year
TCE	trichloroethene
TDS	total dissolved solids
TNC	The Nature Conservancy
TSS	Technical Support Services
UNAVCO	University Navstar Consortium
UNGL	University of Nevada Geodetic Laboratory
USACE	United States 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
VFD	variable frequency drive
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
WIIN	Water Infrastructure Improvements for the Nation
Workgroup	Groundwater Sustainability Workgroup
WPCF	Water Pollution Control Facility
WRFP	Water Recycling Funding Program
WRIMS	Water Resource Integrated Modeling System
WY	water year

EXECUTIVE SUMMARY

ES-1. Introduction

Critical Dates for the Eastern San Joaquin Subbasin

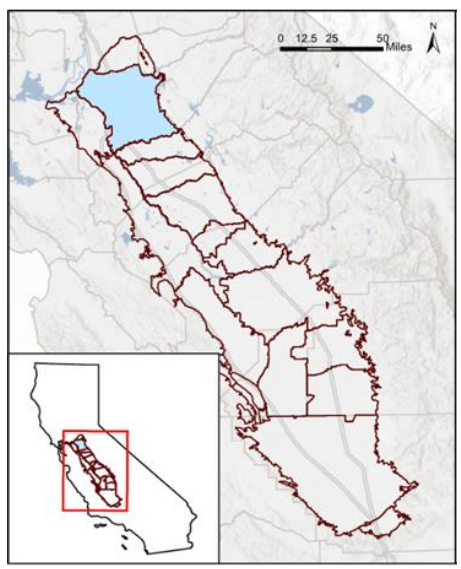
- ☒ 2020 By January 31: Submit GSP to DWR
- ☒ 2025 Evaluate GSP and update if warranted
- ☐ 2030 Evaluate GSP and update if warranted
- ☐ 2035 Evaluate GSP and update if warranted
- ☐ 2040 Achieve sustainability for the Subbasin

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], Calaveras County, 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 a Steering 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 43 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 95,000 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



To address the requirements prescribed in SGMA and outlined in the GSP Emergency Regulations (2016), the Subbasin GSAs prepard and submitted a Final GSP by the initial January 31, 2020 deadline. On January 28. 2022, the ESJGWA received a Determiniation Letter from DWR. The Letter identified two deficiencies in the Subbasin GSPs which precluded 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. On July 27, 2022, the GSAs submitted the 2022 Revised GSP to DWR. In a July 6, 2023 Determination Letter, DWR concluded that the GSAs has taken sufficient actions to correct the deficienes identified by DWR and approved the 2022 Revised Plan. This 2023 Determiniation Letter also outlined eight recommended corrective actions that the GSAs could consider addressing during preparation of the first Periodic Evaluation. The ESJGWA determined that a Plan Amendment was required to adequately address the recommended corrective actions.

A Public Draft of the 2024 GSP Amendment was prepared and made available for public review and comment on October 1, 2024 for a period of 31 days ending on October 31, 2024. The ESJGWA received numerous comments from the public, reviewed and prepared responses to comments, and revised the Draft 2024 GSP Amendment. This Final 2024 GSP Amendment includes those edits and revisions, as well as edits to address the eight recommended corrective actions in DWR's 2023 Determination Letter.

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 bi-monthly Project Management Committee (PMC) meetings, Steering Committee meetings, ESJGWA Board meetings, public meetings, an informational open house event, and information distribution to property owners and residents in the Subbasin.

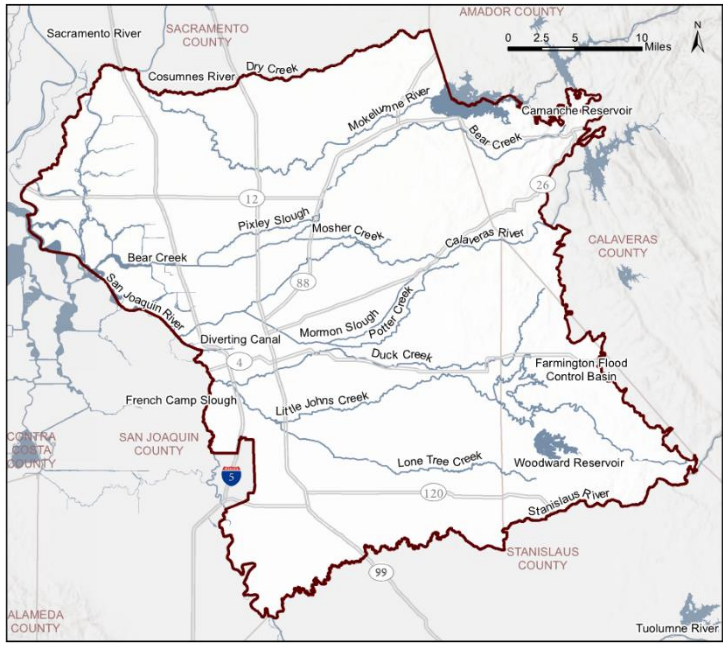
Public Meeting Type	Number of Meetings
ESJGWA Board Meetings	5
Steering Committee Meetings	5
Project Management Committee Meetings	20
Public Events (Meetings & Informational Open House Events)	3

To support the 5-year Periodic Evaluation of the GSP and development the 2024 GSP Amendment, the Steering Committee recommended that the chair of the ESJGWA form an Ad Hoc Project Management Committee (PMC). Approved by the Steering Committee in December 2023, the PMC was comprised of six GSA volunteers representing the varied interests in the Subbasin and covering both urban and agricultural areas. The PMC met bi-monthly during the GSP Periodic Evaluation and GSP Amendment process, and was tasked with driving the review and update process and coordinating other SGMA implementation efforts, including development of a Domestic Well Mitigation Program, coordination of stakeholder outreach and engagement, and annual and long-term budgeting. PMC members reviewed draft work products and other meeting materials to provide input and direction as needed at the bi-monthly meetings. The PMC was also responsible for recognizing and flagging items requiring discussion and direction from stakeholders, the Steering Committee, and the ESJGWA.

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 westward 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- 2: Basin Setting

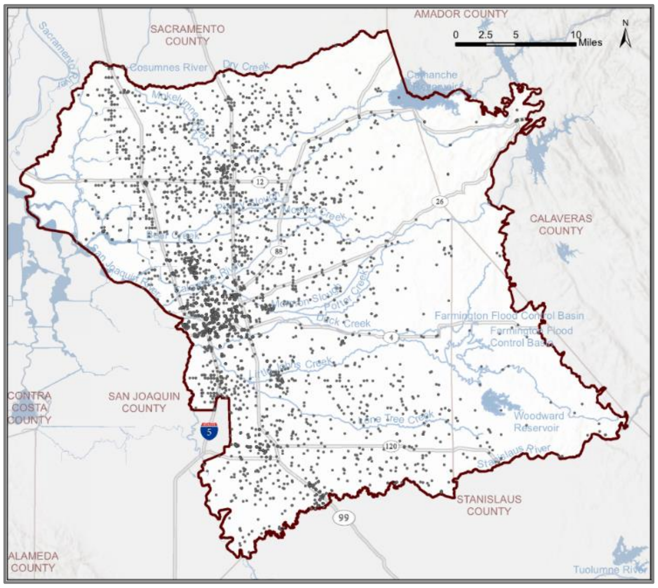


ES-5. Existing Groundwater Conditions

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. In the most recent years, groundwater levels show a general trend of increasing as a result of two signficantly wet water years following two critically dry water years. It has also been established through isotope analysis that the implementation of the Tecklenberg project has added to groundwater levels in the project area.

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, and chloride are 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. Maximum chloride concentrations have been reported at concentrations greater than 2,000 mg/L, with higher concentrations measured in the central and western regions of the Subbasin. 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). The SMCL for chloride is 250 mg/L. Chloride concentrations are typically low across the Subbasin with the majority of measurements falling within the 0-250 mg/L range. Elevated concentrations of other constituents, such as nitrate, arsenic, and point-source contaminants, are generally localized and not widespread and are

Figure ES- 3: GAMA Water Quality Sampling Locations



generally related to natural sources or land use activities. The GSP establishes ongoing monitoring of salinity (as TDS and chloride) and uses publicly available groundwater quality data to assess groundwater quality relative to 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 0.01 percent per year (or -0.34 MAF per year) between 1995 and 2023. 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 considered an applicable sustainability indicator for the Eastern San Joaquin Subbasin as the adjoining Sacramento-San Joaquin River Delta (Delta) is managed as a freshwater body, there is minimal pumping near the Delta, and there are relatively low chloride concentrations in the Subbasin.

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 substantially 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. The Eastern San Joaquin Water Resources Model (ESJWRM) Version 3.0 was used to identify interconnected reaches of rivers and streams contained within or bounding the Subbasin by comparing monthly groundwater elevations from the historical calibration of the ESJWRM to streambed elevations along the streams represented. The Mokelumne, Stanislaus, and lower San Joaquin Rivers were found to be connected at least 80 percent of the time over the model simulation period, and the Calaveras River less than 20 percent of the time. ESJWRM Version 3.0 was also used to evaluate current conditions to those simulated for Water Year 2015 (representing dry conditions with low groundwater levels after a multi-year drought). The resultant trends were very similar to historical gains and losses, with the exception of the Stanislaus River, which has a high number of stream nodes in the center portion of the river that are losing under current conditions. ESJWRM Version 3.0, while the best available tool at the time of analysis, contains uncertainty preventing the GSAs from having sufficient data to determine if or when streams or reaches are connected to the groundwater table with this level of granularity. The GSAs will be collecting more data with the new ISW monitoring wells to help inform this analysis going forward.

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.

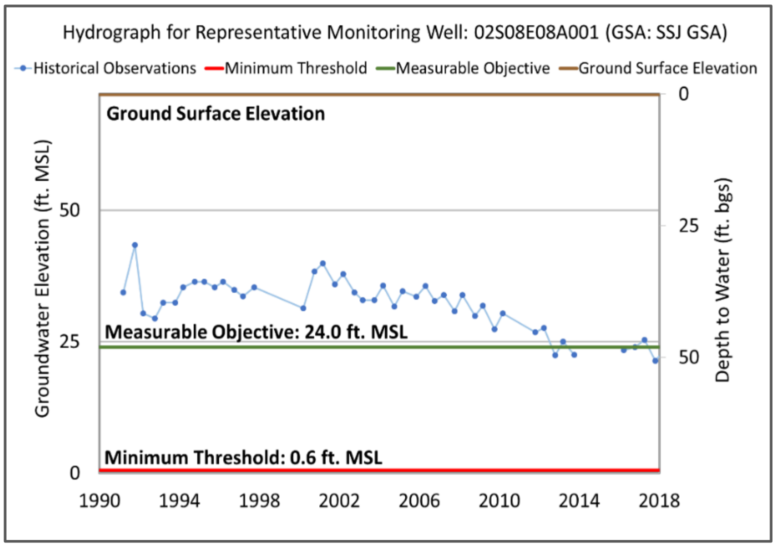
Measurable Objectives – Measurable objectives are a specific set of quantifiable goals for the maintenance or improvement of groundwater conditions.

The method prescribed by SGMA to measure undesirable results involves setting minimum thresholds and measurable objectives for a series of representative monitoring wells or sites for each sustainability indicator. Representative monitoring wells are identified to provide a basis for measuring groundwater conditions (levels and quality) 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 level and/or quality data and potential to effectively represent the groundwater conditions. For the sustainability indicator relating to inelastic land subsidence, representative montioring locations measure ground surface elevations. Similar to the monitoring networks for groundwater levels and quality, monitoring sites were selected based on the history of recorded data and the potential to effectively represent conditions across the Subbasin. As determined following further evaluation, the sustainability indicator relating to significant and unreasonable seawater intrusion was deemed not applicable to the Eastern San Joaquin Subbasin as the Subbasin is not on the coast, and saltwater intrusion through the Delta is managed by upstream reservoir releases to maintain salinity concentrations around 2 parts per thousand.

A total of 23 representative wells were identified for measurement of groundwater levels in the Subbasin, 21 representative wells were identified for groundwater quality monitoring, and 12 representive wells were identified for monitoring related to interconnected surface water. For measurements related to inelastic land subsidence, four CGPS stations and six survey benchmarks were selected to form the monitoring network for this sustainability indicator. The GSP uses groundwater level data as the basis for evaluating conditions for groundwater storage.

Minimum thresholds and measurable objectives were developed for each of the representative monitoring sites. 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. Similar analyses can be made for groundwater quality and land subsidence.

Figure ES- 4: Sample Relationship Between Minimum Threshold and Measurable Objective



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 historical (2015) 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 and wells that community water systems may rely on. 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 for groundwater levels were established based on the historical (2015) drought low and provide a buffer above the minimum threshold. A table summarizing minimum thresholds and measurable objectives is included in Chapter 3 of this Amended GSP. Graphs showing the minimum threshold and measurable objective for each of the representative wells are contained in an appendix to the GSP.

The minimum thresholds and measurable objectives for groundwater levels are used for the groundwater storage sustainability indicator, as this sustainability indicator is strongly linked to groundwater levels. The groundwater levels minimum thresholds are found to be protective of groundwater storage

Minimum thresholds for groundwater 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 total dissolved solids (TDS), 250 mg/L chloride, or the groundwater concentration of those constituents as measured in 2015 at the representative monitoring location, whichever is greater. These values reflect the Secondary Maximum Contaminant Limit (SMCL) for the two constituents of concern (TDS and chloride), plus ackowledges groundwater quality degradation that was already occurring in 2015. Furthermore, these values reflect the agricultural nature of the Subbasin.

Measurable objectives for groundwater quality were set at 600 mg/L for TDS, and the maximum maximum recent historical measurement (as measured between 2015 and 2023) for chloride. The TDS measurable objective of 600 mg/L was developed based on the TDS recommended SMCL for drinking water of 500 mg/L with an added 100 mg/L buffer. A measurable objective of 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. The chloride measurable objective was set equal to the maximum measured chloride concentration as measured during recent historical conditions (between 2015 and 2023), accounting for fluctuations in constituent concentrations with hydrologic conditions.

The minimum threshold for inelastic land subsidence in the Subbasin was set at no more than 0.2 foot/year [2.4 inches/year] in any five-year period between 2020 and 2040, resulting in no more than a total additional 2 feet (24 inches) of land subsidence by 2040. This is set within the same magnitude of estimated error of the InSAR data (+/- 0.1 foot [0.03 m]), which is currently the most comprehensive tool available for measuring subbasin-wide land subsidence consistently each year, based on historical subsidence rates. Additionally, the minimum threshold of 24 inches of additional subsidence by 2040 reflects the historical subsidence level with an added buffer, and is in line (both by method and magnitude) with the minimum thresholds established by other nearby basins overlying the Corcoran Clay.

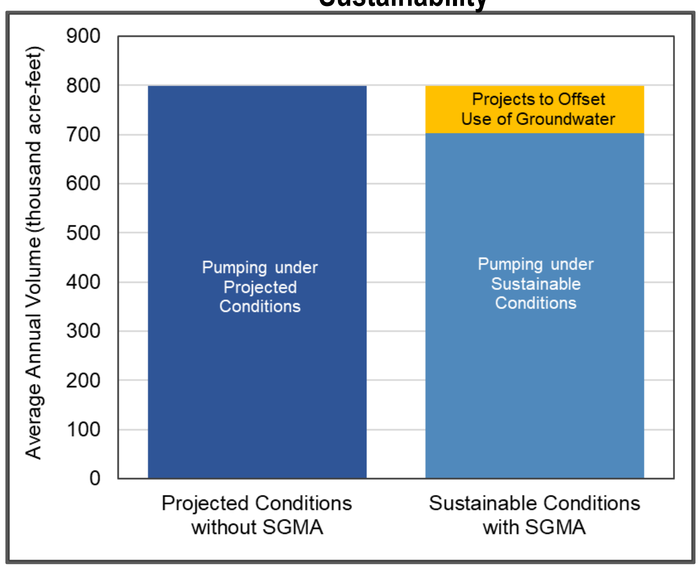
The measurable objective for inelastic subsidence is based on the long-term avoidance of land subsidence: 0 ft/year, on a long-term average. This measurable objective is set recognizing the interconnectedness of the Subbasin with surrounding subbasins, and the ability to meet this objective is dependent on the successful management of all nearby subbasins

Finally, the minimum thresholds and measurable objectives established for interconnected surface water representative monitoring wells both use groundwater levels as a metric. Groundwater level data are used to calculate water table gradients and, therefore, the volume of water gained and lost. The interconnected surface water minimum thresholds and measurable objectives for wells with historical groundwater level observations are the same as for the chronic lowering of groundwater levels minimum thresholds. Analyses were conducted to demonstrate that the groundwater level minimum thresholds are protective of stream depletions and stream-aquifer interactions (stream connectivity, stream gains and losses, and stream gains and losses as a percentage of streamflow), and therefore the use of these minimum thresholds is justified. For new representative montiroing wells without historic data sets, minimum thresholds and measurable objectives will be established after at least four years of data have been collected, including data for at least one wet year and one dry or critical year during that time period, utilizing the methodologies outlined in Chapter 3 of this GSP.

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- 5: Subbasin-Wide Total Groundwater Pumping and Offsets Required to Achieve Sustainability



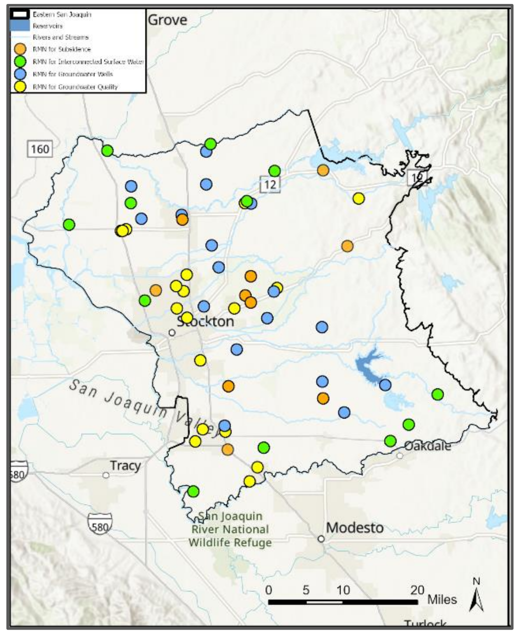
The groundwater evaluations conducted as a part of the developmnet of this GSP Amendment provide revised estimates of the historical, current, and projected groundwater budget conditions. The current analysis was prepared using the best available information and through updates to the Subbasin's groundwater modeling tool, the Eastern San Joaquin Water Resources Model (ESJWRM), Version 3.0. It is anticipated that as additional information becomes available, the model will continue to be updated to continuously refine estimates of annual pumping and overdraft .

As part of the 5-year Periodic Evaluation and preparation of this Amended GSP, the ESJWRM was updated to Version 3.0 to incorporate new data relating to layering, streams, land use, urban water demand, surface water supply and water deliveries and to extend the simulation period through Water Year 2023. The model was then recalibrated for the extended period, and water budgets were updated for historical conditions, current conditions, projected conditions baseline, and projected conditions with the impacts of climate change. Projected conditions scenarios were also updated to incorporate an updated list of projects and management actions as well as updates to the sustainable yield estimate.

Based on these analyses, at projected groundwater pumping levels, the long-term groundwater pumping offset and/or recharge required for the Subbasin to achieve a 0 AF/year change in storage is approximately 95,000 AF/year. Groundwater levels are expected to continue to decline based on projections of current land and water uses. Projects and management actions 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 three additional 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 a 0 AF/year change in storage is approximately 166,000 AF/year.

Figure ES- 6: Monitoring Sites



ES-8. Monitoring Networks

This GSP Amendment outlines the representative monitoring networks for five of the six sustainability indicators. (Seawater intrusion is no longer considered an applicable sustainability indicator for the Eastern San Joaquin Subbasin.) The objective of these monitoring networks is to monitor conditions across the Subbasin and to detect trends toward undesirable results. Specifically, the monitoring networks were developed to do the following:

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

There are four representative monitoring networks in the Eastern San Joaquin Subbasin: two representative networks for water levels (one for the chronic lowering of groundwater levels sustainability indicator and one for the interconnected surface waters sustinability indicator), a representative network for groundwater quality, and a representative network for inelastic land subsidence. Representative networks are used to determine compliance with the minimum thresholds.

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), the United States Army Corps of Engineers (USACE), the California Department of Transportation (CalTrans), the San Joaquin County Department of Public Works, and participating GSAs. The groundwater level and interconnected surface water monitoring networks consist largely of wells that are already being used for monitoring in the Subbasin. New wells were added to the monitoring networks, including one well located in the Delta, two deep, multi-completion monitoring wells constructed under DWR's Technical Support Services (TSS) program, and five new shallow monitoring wells for interconnected surface water assessment. Figure ES-7 shows the location of existing monitoring sites for all representative monitoring networks.

Wells in the monitoring networks for water levels (for both the groundwater level and interconnected surface water sustainability indicators) and groundwater quality will be measured on a semi-annual schedule. Monitoring for subsidence will also occur semi-annually. 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 monitoring sites in the representative monitoring networks is shown in the table below.

Summary of Representative Monitoring Network Wells/Stations	
Data Collected	**Well/Station Count**
Groundwater Level	23
Interconnected Surface Water	12
Groundwater Quality	21
Subsidence (CGPS stations and survey benchmarks)	10

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.

Recently, a mobile and tablet interface was developed for the DMS to facilitate the real-time upload of data collected in the field. The mobile interface is implemented using the Esri ArcGIS Field Maps mobile app (or the Collector app if already installed) and is integrated with the DMS via web services to ArcGIS Online*. The mobile interface is intended to provide all ESJGWA staff and their consultants with an easy-to-use interfaces to collect well and groundwater related data in the field. Data collected using the mobile interfaces are pulled into the DMS on a nightly basis where it is quality controlled prior to insertion into the database.

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

Figure ES- 8: Opti DMS Screenshot

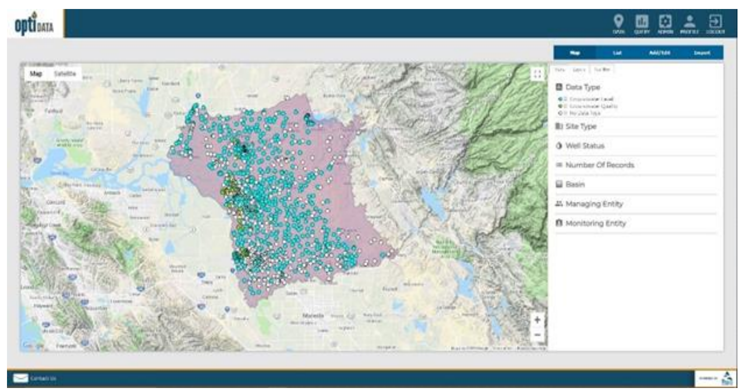
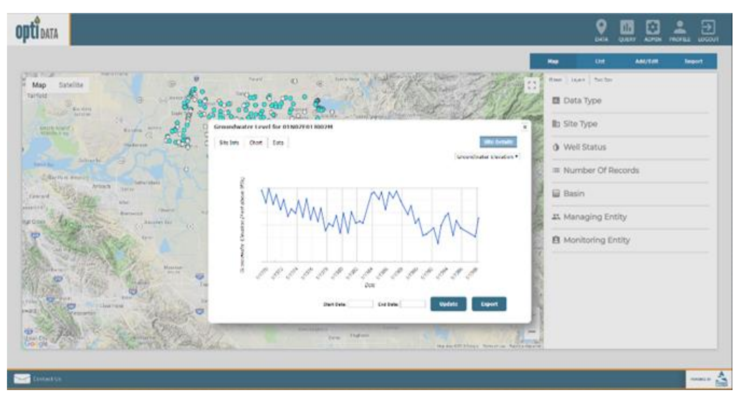


Figure ES- 8: Typical DMS Data Display



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 95,000 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 and reduction activities, including water use efficiency upgrades. While the implementation of projects to address sustainabilty has been and will continue to be the cornerstone of the ESJ GSP, the Subbasin is committed to developing a Demand Management Program that would include pumping restrictons if projects are not implemented as expected.

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 Subbasin's Demand Management Program, a new management action in this GSP, will be implemented.

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, Steering Committee, and Workgroup. A final list of 41 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. Four new additional projects were approved by the ESJGWA Board at their September 11, 2024 meeting, and are not included in below. More information on these projects is included in Appendix 6-A. With the addition of these four projects, the GSP now includes 45 total projects. Projects are classified into two categories based on project status: Category A and Category B. Category A projects are those that are completed or are anticipated to advance in the next five years and have existing water rights or agreements. Category B projects are those that are not anticipated to advance in the next five years, but may be implemented in the future. 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. These projects are summarized below.

[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 Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Capital Costl	Estimated Annual O&M Costs	Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
Category A Projects - projects that were completed or are anticipated to advance in the next five years and have existing water rights or agreements									
Lake Grupe In-lieu Recharge	In-lieu Recharge	SEWD	Groundwater levels	Completed	2020-2023	$2.3 M	$330,000	Installation for new intake and pipeline requires permits from DFW, CVFPB, RWQCB, and USACE	4,900
SEWD Surface Water Implementation Expansion	In-lieu Recharge	SEWD	Groundwater levels	Implementation	2019-2029	$750,000	$100,000	Permit approvals from DFW, RWQCB, CVFPB, and USACE by private landowners	19,000
White Slough Water Pollution Control Facility Expansion	Recycling/ In-lieu Recharge/Direct Recharge	City of Lodi	Groundwater levels	Construction complete	2019-2020	$6 M	$4,664	None (permitting complete)	1,000
CSJWCD Capital Improvement Program	In-lieu Recharge	CSJWCD	Groundwater levels	Can be implemented immediately	2020-2027, on-going with 7-year completion cycles	N/A	$50,000	Individual applications need CSJWCD Board approval and possible streambed alteration permits	24,000

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Capital Costl	Estimated Annual O&M Costs	Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
NSJWCD South System Modernization	In-lieu Recharge	NSJWCD	Groundwater levels	Environmental review complete, funding secured for Phases 1, 2 and 3. Landowner improvement district formed. Phases 1-2 complete.	2018-2025 for Phases 1, 2, 3; 2025-2028 for Phase 4; 2028-2035 for future phases	Phase 1&2: $7 M Phase 3: $4 M Phase 4: $8 M Future Phases: $10-20 M	Phase 1&2: $200,000 Phase 3: $200,000 Phase 4: $200,000 Future Phases: $200,000	Permits for pump station work have been completed; minor grading and road encroachment permits may be needed	10,000
Long-term Water Transfer to SEWD and CSJWCD	Transfers	SSJ GSA	Groundwater levels	Infrastructure is in place. CEQA completed and agreements in place	2019-2021	N/A	$9 M	Project must comply with CEQA	20,000
South System Groundwater Banking with East Bay Municipal Utilities District (EBMUD)	In-lieu Recharge	NSJWCD	Groundwater levels	Pilot Dream Project will be complete by February 2024. Working on expanded banking project	2020-2024	$5 M	$400,000	SWCRB change petition for Permit 10478 and San Joaquin County groundwater export permit, and regulatory permits as needed	4,000
NSJWCD North System Modernization/ Lakso Recharge	In-Lieu Recharge	NSJWCD	Groundwater levels	Constructed Phase 1A, in progress on Phase 1B. Planning Phase 2	2021-2026	$7 M	$150,000	Regulatory permits as needed	4,000
Tecklenburg Recharge Project	Direct Recharge	NSJWCD	Groundwater levels	Substantially complete	2022-2024	$1 M	$400,000	CEQA review and possible grading permit	2,000
City of Stockton Phase 1: Groundwater Recharge Project	Direct Recharge	City of Stockton	Groundwater levels	Basin design in progress. Construction to begin spring 2025.	2022-2026	$11.5 M	To be Determined	Project must comply with CEQA	20,000
West Groundwater Recharge Basin	Direct Recharge	SEWD	Groundwater levels	Ongoing	2032	To be Determined	To be Determined	To be Determined	16,000

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Capital Costl	Estimated Annual O&M Costs	Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
NSJWCD Private Pump Partnerships	In-Lieu Recharge/Direct Recharge	NSJWCD	Groundwater levels	Ongoing	2024	To be Determined	To be Determined	To be Determined	3,000
Oakdale Irrigation District In-lieu and Direct Recharge Project	Direct Recharge/In-Lieu Recharge	OID	Groundwater levels	Ongoing	2023-2032	To be Determined	To be Determined	To be Determined	25,000
City of Stockton Advanced Metering Infrastructure	Conservation	City of Stockton	Groundwater levels	In progress. Contract awarded in March 2024.	2023-2028	$17 M	To be determined	Not determined	2,000
								Total Category A	***154,900***
Category B Projects - projects that are not anticipated to advance in the next five years, but may be implemented 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									
City of Manteca Advanced Metering Infrastructure	Conservation	City of Manteca	Groundwater levels	Experiencing Delays	Not determined	$650,000	$300,000	None	272
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
BNSF Railway Company Intermodal Facility Recharge Pond	Direct Recharge	CSJWCD	Groundwater levels	Planning phase	2020-2025	N/A	$50,000	Streambed alteration permit	1,000

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Capital Costl	Estimated Annual O&M Costs	Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
Manaserro Recharge Project	Direct Recharge	NSJWCD	Groundwater levels	Planning phase	2023-2025	$500,000	$50,000	CEQA review, possible grading permit, possible water right change petition	8,000
City of Escalon Wastewater Reuse	Recycling/ In-lieu Recharge/ Transfers	SSJ GSA	Groundwater levels	Planning phase	2020-2028	To be determined$18 M	To be determined$40 0,000	CEQA review, RWQCB permits, and road encroachment permits	672
City of Ripon Surface Water Supply	In-lieu Recharge	SSJ GSA	Groundwater levels	Design complete; environmental permitting underway; negotiations for the right to connect are underway.	2028-2030	To be determined	To be determined	NEPA Categorical Exclusion, CEQA Mitigated Negative Declaration, and road encroachment permits	6,000
City of Escalon Connection to Nick DeGroot Water Treatment Plant	In-lieu Recharge	SSJ GSA	Groundwater levels	Conceptual design; environmental review complete; Council approval are pending further design work and rate study	2028-2030	To be determined	To be determined	Road encroachment permits	2,015

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Capital Costl	Estimated Annual O&M Costs	Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
Farmington Dam Repurpose Project	Direct Recharge	SEWD	Groundwater levels	Planning/Initial Study	2030-2050	To be determined	To be determined	Permits and approvals form SWRCB, USBR, DFW, RWQCB, CVFPB, and USACE	60,000
Mobilizing Recharge Opportunities	Direct Recharge	San Joaquin County	Groundwater levels	Project Development	2024-2040	Not determined	Not determined	Not determined	158,000
NSJWCD Winery Recycled Water	Recycling/ In-Lieu Recharge/ Direct Recharge	NSJWCD	Groundwater levels	Conceptual planning and discussion	2025-2027	To be determined	To be determined	WDR permitting through the RWCQB and minor permits for pipeline construction	750
SSJID Storm Water Reuse	Storm Water/ In-lieu Recharge/ Direct Recharge	SSJ GSA	Groundwater levels	Planning phase	2027-2030	To be determined$30 M	To be determined$30,000	CEQA review and road encroachment permits	1,100
Wallace-Burson Conjunctive Use Program	Conjunctive Use/Direct Recharge	Eastside GSA	Groundwater levels	Conceptual planning and discussion	2030-2040	To be determined	To be determined	Not determined	3,000
Calaveras River Wholesale Water Service Expansion	In-Lieu Recharge	Eastside GSA	Groundwater levels	Conceptual planning	2020-2040	To be determined	To be determined	Not determined	600

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Capital Costl	Estimated Annual O&M Costs	Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
Recycled Water to Manteca Golf Course	Recycling	City of Manteca	Groundwater levels	12-in pipeline installed. Waiting for DWR to determine grant recipients	To Be Determined	To be determined	To be determined	Not determined	406
Threfall Ranch Reservoir, In-Lieu and Direct Recharge Project	In-Lieu Recharge/Direct Recharge	Eastside GSA	Groundwater levels	Design	2025	To be determined	To be determined	Not determined	2,000
Perfecting Mokelumne River Water Right	In-Lieu Recharge	San Joaquin County	Groundwater levels	Planning	2024-2025	$125,000 (spent to date) Total TBD	To be determined	Not determined	158,000
North System Groundwater Recharge Project - Phase 2	Direct Recharge	NSJWCD	Groundwater levels	Design phase with planned construction in 2025-2026	2026-2029	$10 M	$100,000	Not determined	3,000
Stormwater Collection, Treatment, and Infiltration	Direct Recharge/ Stormwater	City of Manteca	Groundwater levels	Planning/Initial Study	To Be Determined	To be determined	To be determined	Not determined	To Be Determined
Off-Stream Regulating Reservoir	Direct Recharge	SEWD	Groundwater levels	Conceptual Phase	2026-2050	To be determined	To be determined	Not determined	To Be Determined
On-Farm Recharge Project	Direct Recharge	SEWD	Groundwater levels	Planning/Initial Study	2024-2030	N/A	$100,000	Not determined	To Be Determined
Bellota Weir Modifications Project	Direct Recharge/ Stormwater	SEWD	Groundwater levels	SRF loan application submitted. $12.3M grant received. Minor construction started	2023-2030	$ 85 M	$1.5M	USACE, FWS,CVFPB,CEQA,NEPA	5,200

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Capital Costl	Estimated Annual O&M Costs	Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
Water Supply Enhancement Project - Distribution Pipelines	In-Lieu Recharge/Direct Recharge	SEWD	Groundwater levels	Design	2024-2040	$7M	To be determined	RWQCB,CEQA, USACE,CVFPB, DFW	17,000
Water Treatment Plant Aquifer Storage Recovery Well - 7401	Direct Recharge	SEWD	Groundwater levels	Implementation	2024-2026	$1.5 M	To be determined	RWQCB,CEQA, NEPA	2,420
Beckman Well	Direct Recharge	SEWD	Groundwater levels	Refurbish	2024-2028	$200,000	N/A	RWQCB,CEQA	800
West Linden Project	In-Lieu Recharge/Direct Recharge	SEWD	Groundwater levels	Planning/Design	2024-2035	$60M	To be determined	CEQA,RWQCB, road encroachment permits	60,000
Water Supply Enhancement Project - Direct Recharge	Direct Recharge	SEWD	Groundwater levels	Design	2024-2030	To be determined	To be determined	Not determined	To Be Determined
SSJID Water Master Plan - System Improvements	In-Lieu Recharge	SSJ GSA	Groundwater levels	Feasibility study complete	2023-2040	$ 30 – 40 M	To be determined	Not determined	15,000
								Total Category B	***509,985***

[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).

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ES-11 GSP Implementation

The overdraft condition in the Subbasin requires either projects to offset groundwater pumping and/or increase recharge, or pumping reduction. The exact amount of required offset/recharge will be reevaluated after additional data are collected and analyzed. As previously noted, the overarching philosophy of the ESJ GSP is to implement projects to address the overdraft condition. Should the projects be delayed or not provide the benefits identified, the Subbasin will implement the Demand Management Program, a new management action in this GSP.

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
- Maintaining and updating the Subbasin Data Management System (DMS) with newly collected data
- Addressing identified data gaps
- 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 amending the plan 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.

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. These costs include:

- ESJGWA administration
- Groundwater level monitoring and reporting
- Groundwater quality monitoring and reporting
- Inelastic land subsidence monitoring and reporting

- Water use estimation
- Data management
- Stakeholder engagement
- Oversight of management actions
- 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 $350,000.

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 $85 million, depending on the project. Annual project costs range from $3,000 to $9 million per year to provide funds for operations and maintenance.

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) was 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) was originally 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 2020 GSP was subsequently revised in 2022 to address comments from DWR in their determination letter dated January 28, 2022. This 2024 GSP Amendment addresses comments in DWR’s July 6, 2023 determination letter approving the 2022 Revised GSP, and continues to provide a path to achieve and document sustainable groundwater management within 20 years following initial 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 of the GSP's initial adoption in 2020. 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

Fritz Buchman, C.E., T.E., CFM
Director
San Joaquin County Department of Public Works
1810 E. Hazelton Ave.,
Stockton, CA 95205
(209) 468-3101

fbuchman@sjgov.org

1.1.4 Agency Information

The Eastern San Joaquin GSP was developed jointly by the members of 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], Calaveras County, 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.

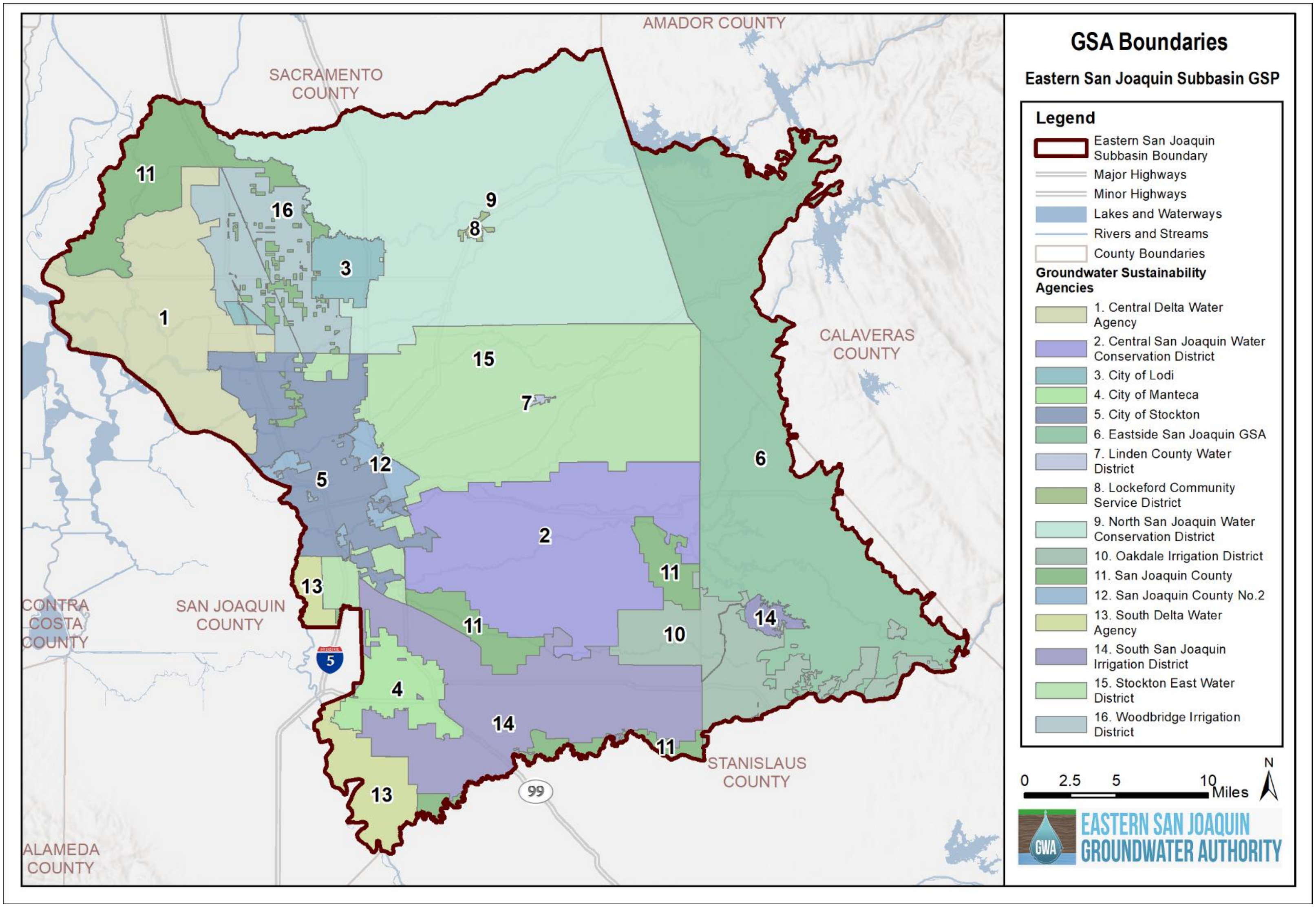
The GSAs represent a diverse range of water management organizations. The agencies include water agencies, irrigation districts, water conservation districts, and local governments at the city and county level. The GSAs work through the ESJGWA to coordinate implementation of the GSP by each GSA to cover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

California Water Service Company Stockton District (Cal Water) 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 and implementation 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 2020 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.

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.

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 10:30 a.m. to coordinate efforts to implement 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 GSA's respective governing boards
- Approving and implementing a GSP

The ESJGWA Board is guided by a Steering Committee that is made up of one representative from each GSA and convenes every second Wednesday of the month at 8:30 a.m. The Steering Committee is responsible for developing recommendations on technical and substantive Subbasin-wide matters. The Steering 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 implementation of the GSP, including groundwater conditions, thresholds, and projects and management actions
- Recommending the action and/or approval of a GSP

To support the 5-year Periodic Evaluation of the GSP and development the 2024 GSP Amendment, the Steering Committee recommended that the chair of the ESJGWA form an Ad Hoc Project Management Committee (PMC).

Approved by the Steering Committee in December 2023, the PMC was comprised of six GSA volunteers representing the varied interests in the Subbasin and covering both urban and agricultural areas. At the time of the development of the 2024 GSP Amendment, the six members of the PMC represented the following GSAs: City of Stockton, North San Joaquin Water Conservation District, Oakdale Irrigation District, San Joaquin County, South San Joaquin Irrigation District, and Stockton East Water District. The PMC met bi-monthly during the GSP Periodic Evaluation and GSP amendment process, and was tasked with driving the review and update process and coordinating other SGMA implementation efforts, including development of a Well Mitigation Program, coordination of stakeholder outreach and engagement, and annual and long-term budgeting. PMC members reviewed draft work products and other meeting materials to provide input and direction as needed at the bi-monthly meetings. The PMC was also responsible for recognizing and flagging items requiring discussion and direction from stakeholders, the Steering Committee, and the ESJGWA. While the PMC informed administrative concepts and reviewed draft work products at the staff level, they did not have decision-making authority.

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 City of Manteca's approximately 13,000 acres 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 700 AF/year of reclaimed wastewater is applied to fodder crops on City-owned and leased lands (City of Manteca, 2020).

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, Calaveras County, 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.

- Calaveras County Water District – The Calaveras County Water District (CCWD) provides water service to approximately 13,360 municipal and residential customers in six service areas 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. CCWD has several customers with riparian rights along the Calaveras River, has one service area that relies solely on groundwater, and has several areas that utilize recycled water.

- Calaveras County – Calaveras County has a total area of 1,037 square miles and extends beyond the boundaries of the Eastern San Joaquin Subbasin. Calaveras County Water District is the only public water supplier to residents located in the portion of the County overlying the Subbasin. The only incorporated city, Angels Camp, is located outside of the Subbasin. Calaveras County had one of the fastest growing annual percent increases in population in California between 2000 and 2010 (CCWD, 2020). For the portion of Calaveras County that falls within the Eastern San Joaquin Subbasin, there are numerous domestic, municipal, and monitoring wells.

- Stanislaus County – 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 CCWD, Calaveras County, and Rock Creek Water District as the Eastside GSA. The land is mostly unirrigated, and water needs are met by private pumping.

- Rock Creek Water District – 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. LCWD is 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 commercial 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.

- North Delta Water Agency – 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 16,000 people and is expected to grow to about 30,800 people by 2040 (U.S. Census Bureau, 2020). 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 2020 (U.S. Census Bureau, 2020). 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 discontiguous, 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 the 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, 2003, and 2020. 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

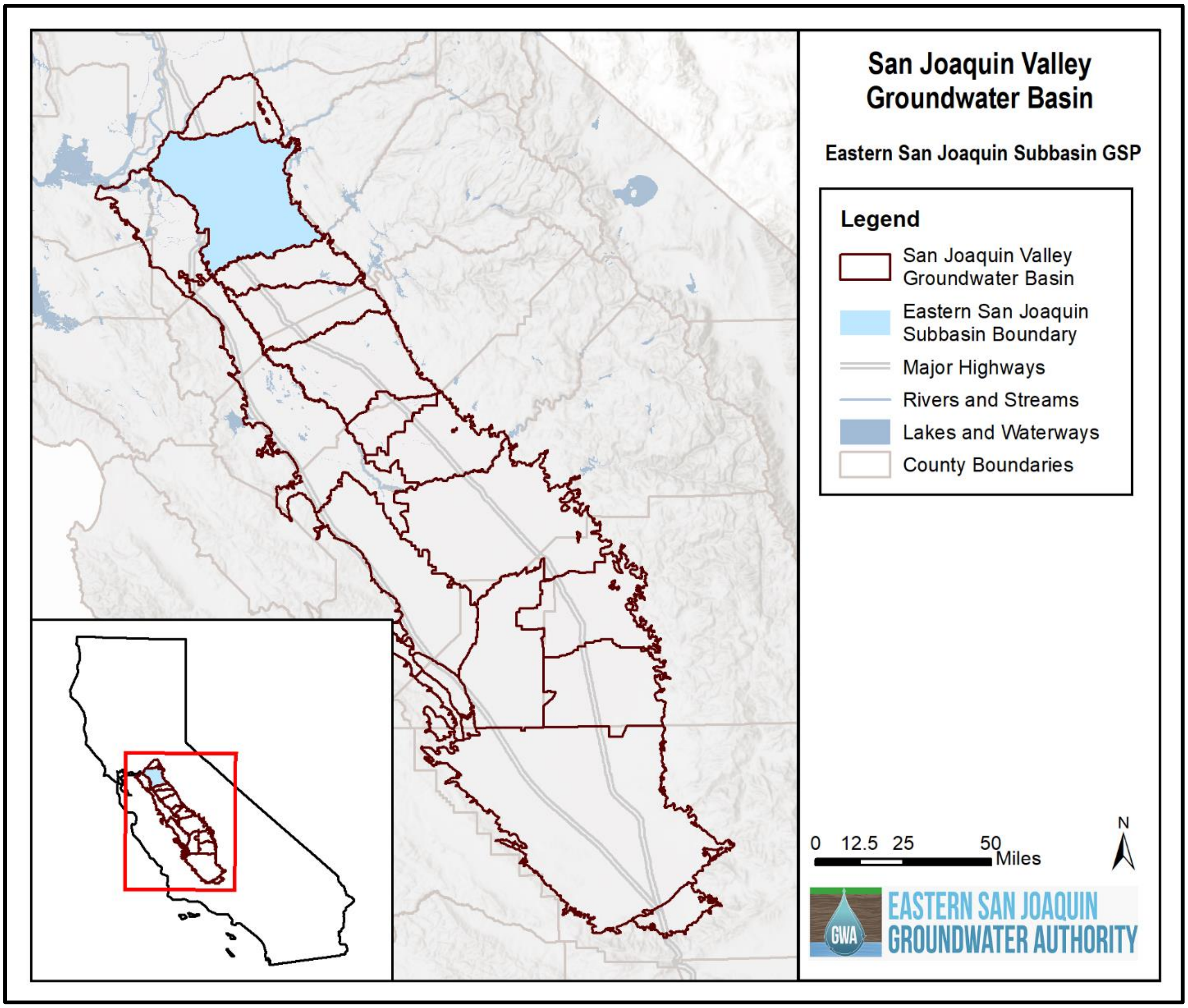
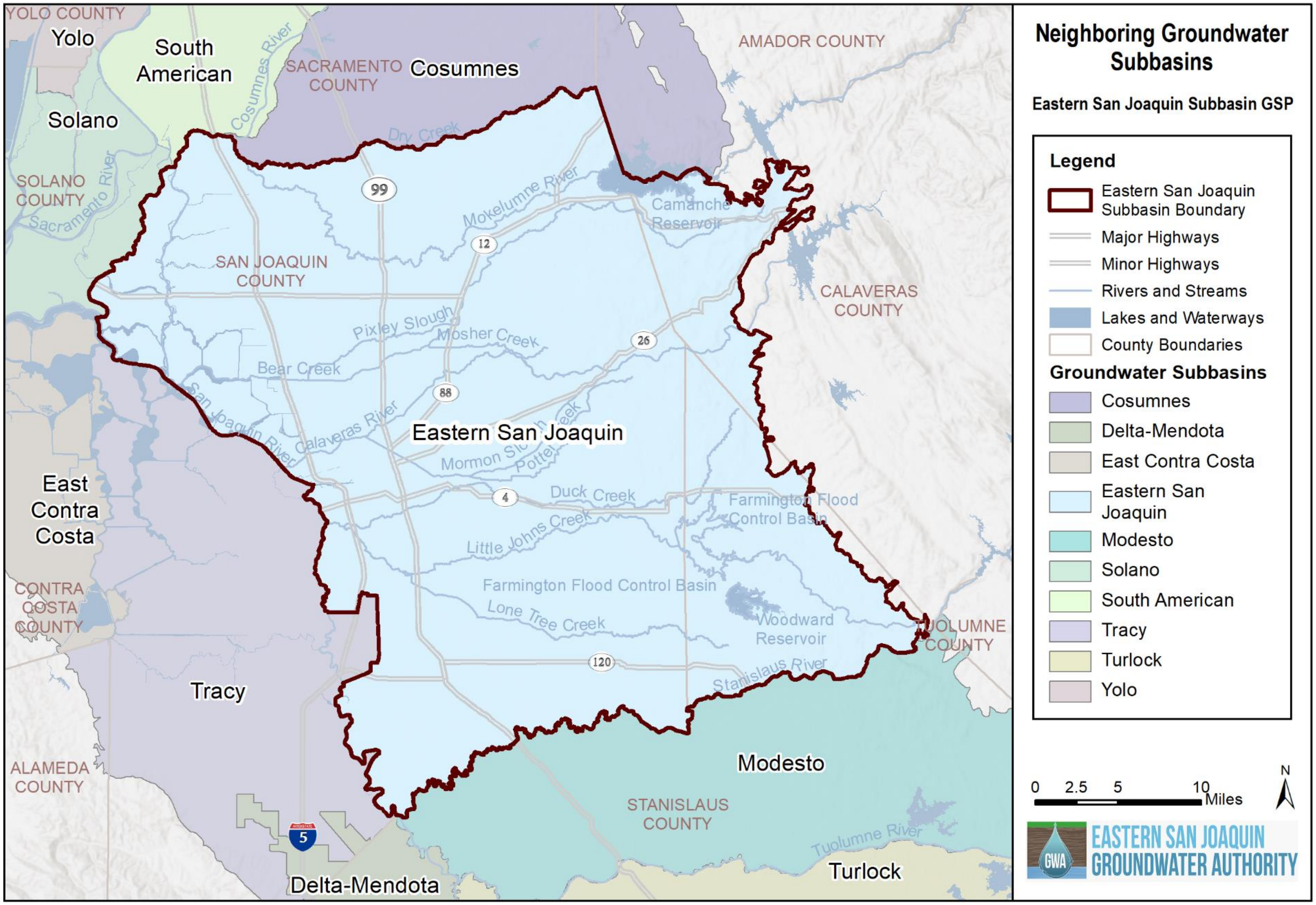


Figure 1-5: Neighboring Groundwater Subbasins



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

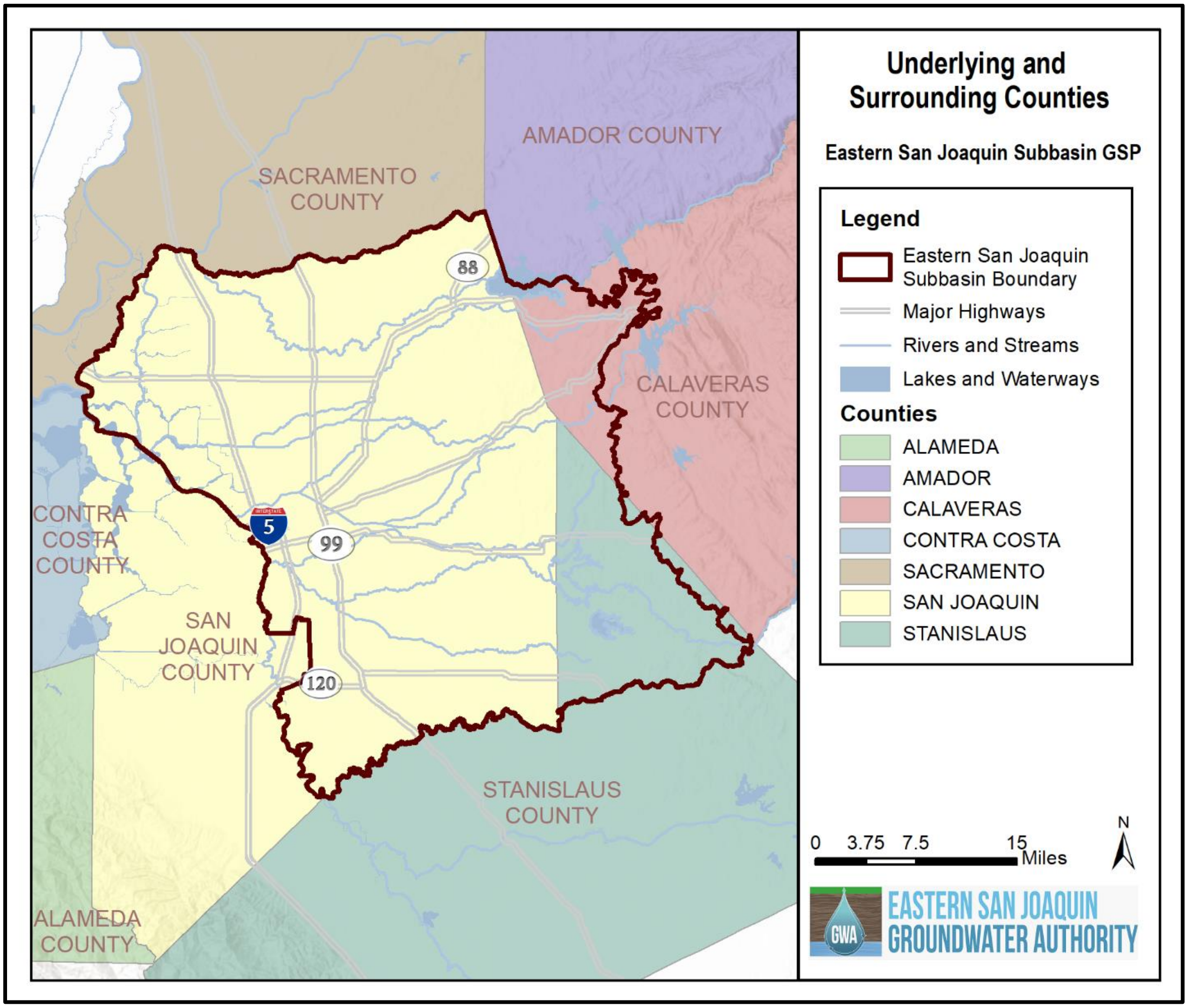


Figure 1-7 shows the Eastern San Joaquin Subbasin and the Subbasin's key geographic features. The Subbasin encompasses an area of about 1,195 square miles. There are eight entities within the region with land use jurisdiction: the County of San Joaquin, the County of Calaveras, the County of Stanislaus, 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

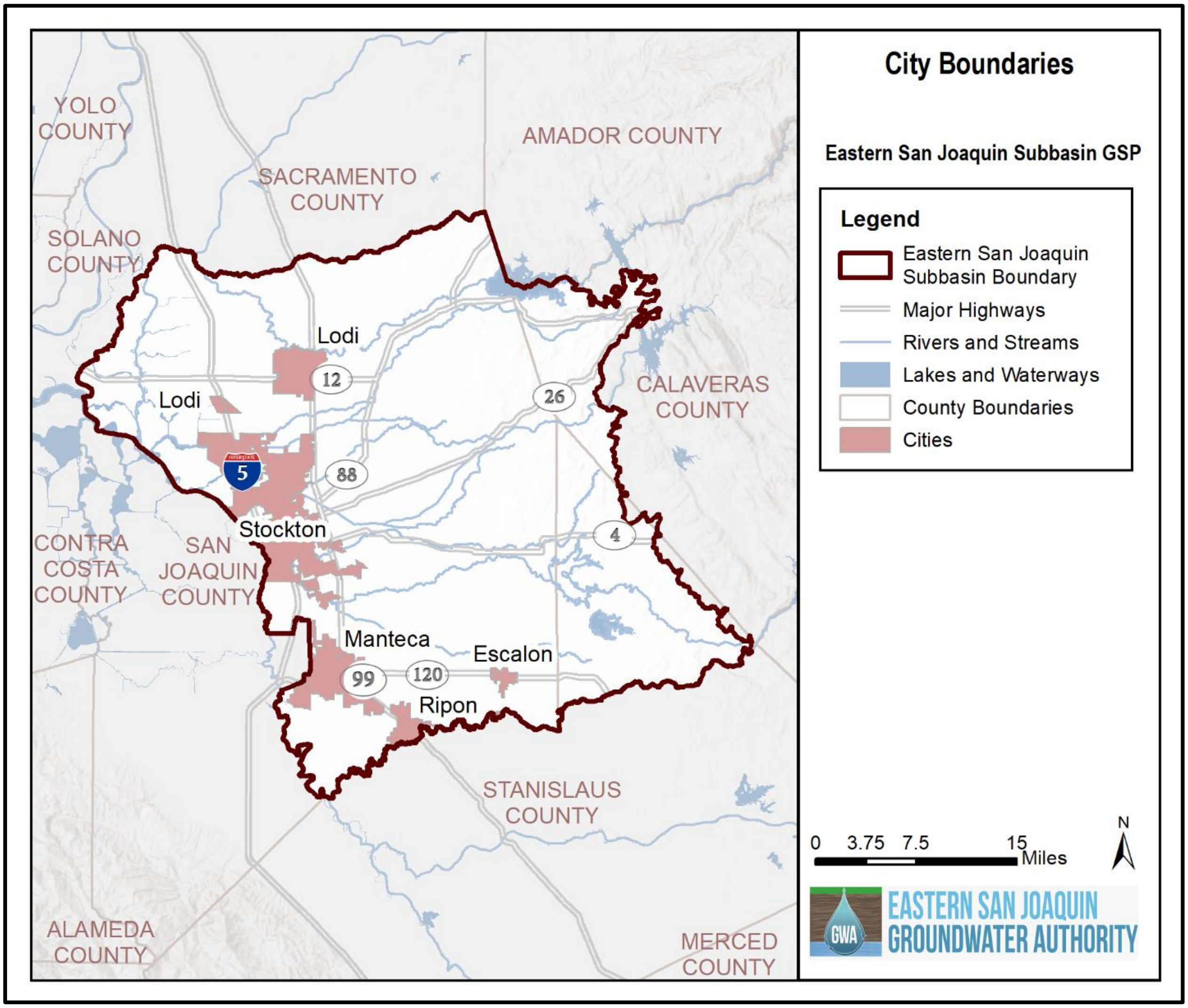


Figure 1-8 shows the spatial extent of Disadvantaged Communities (DACs) and Severely Disadvantaged Communities (SDACs) in the Eastern San Joaquin Subbasin. DWR defines DACs as census geographies (census tracts, census block groups, and census-designated places) with an annual median household income (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 2016-2020 ACS dataset was used, establishing statewide MHI as $78,672 (CA DWR, Mapping Tools).

Figure 1-8: Disadvantaged Communities (DACs)

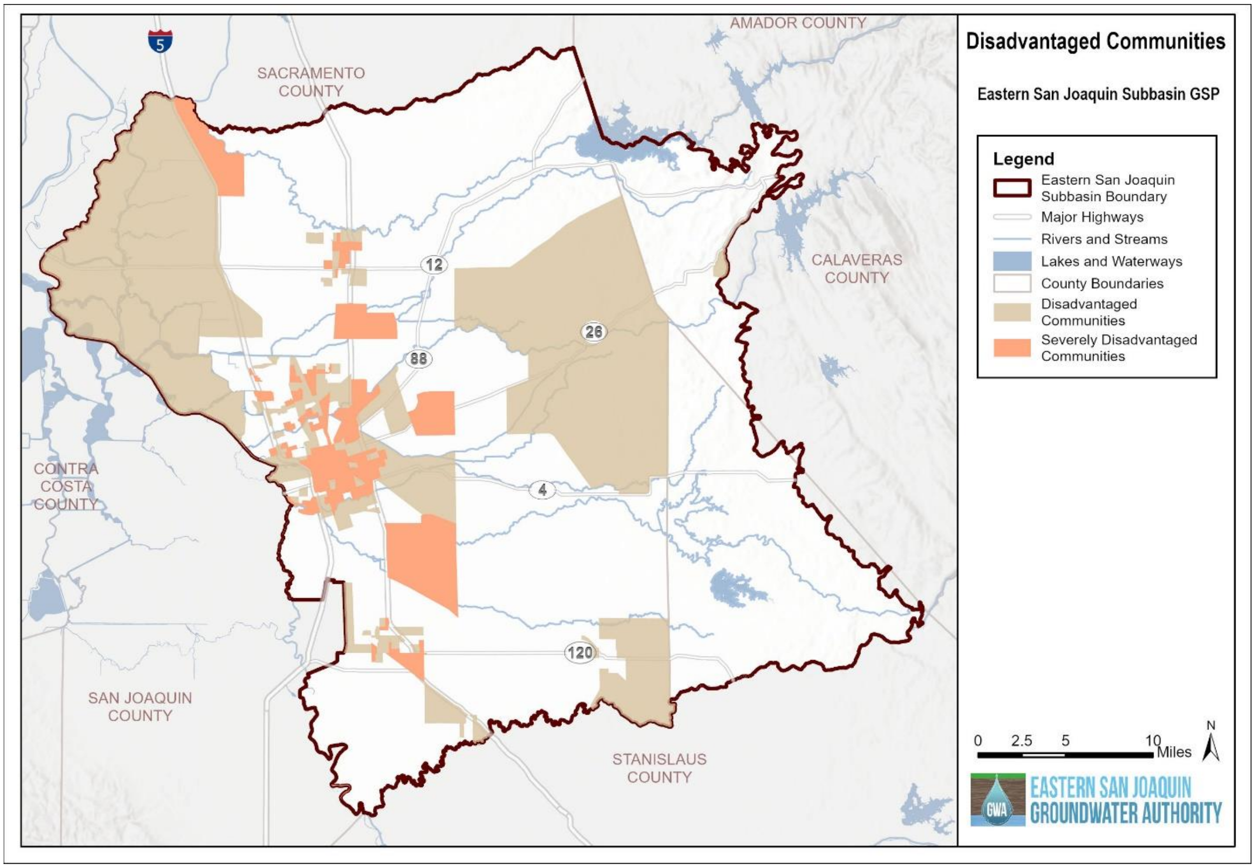
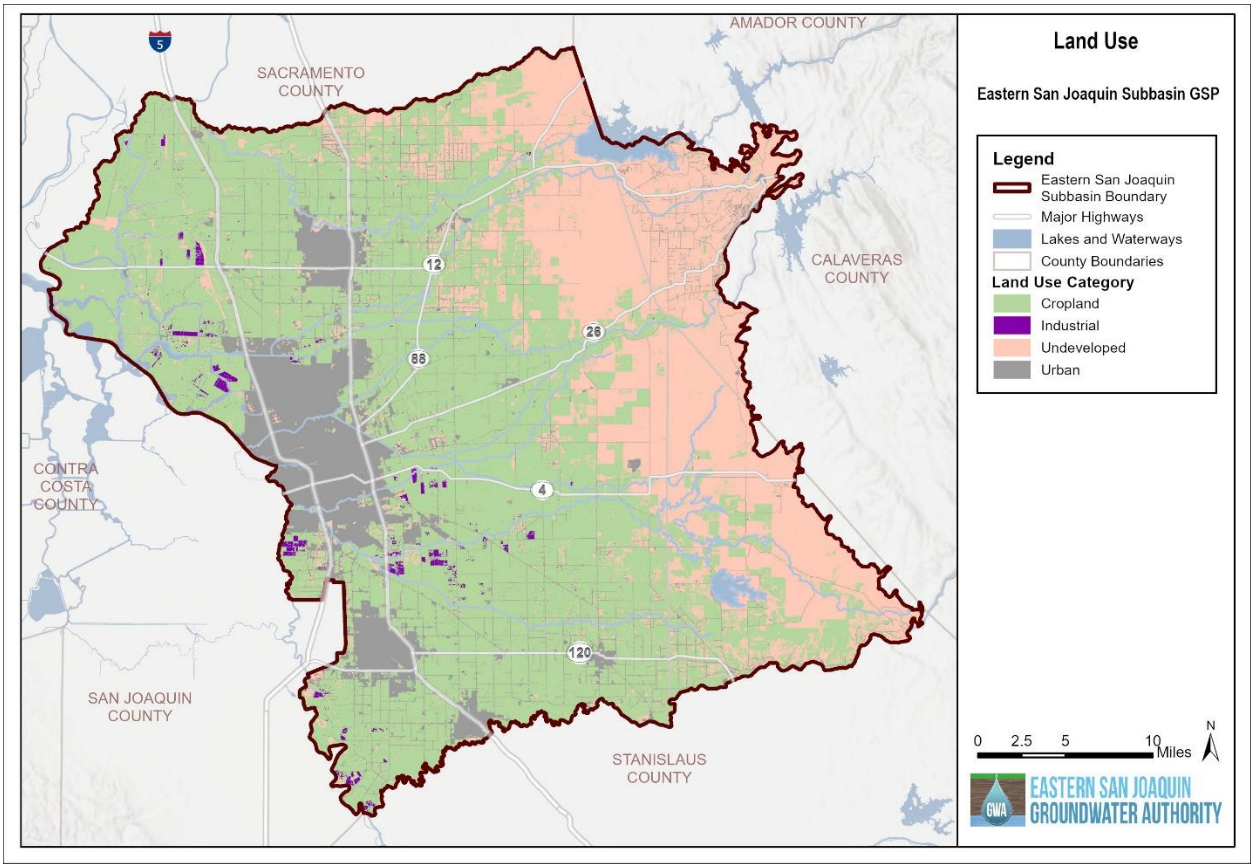


Figure 1-9 shows a map of land use in the Eastern San Joaquin Subbasin across four general categories: cropland, industrial, undeveloped, and urban. These categories were mapped based on categories identified from the United States Department of Agriculture's (USDA) CropScape 2022 dataset.

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, 2022).

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 2022 CropScape dataset (USDA, 2022).

Figure 1-10: Land Use by Crop Type

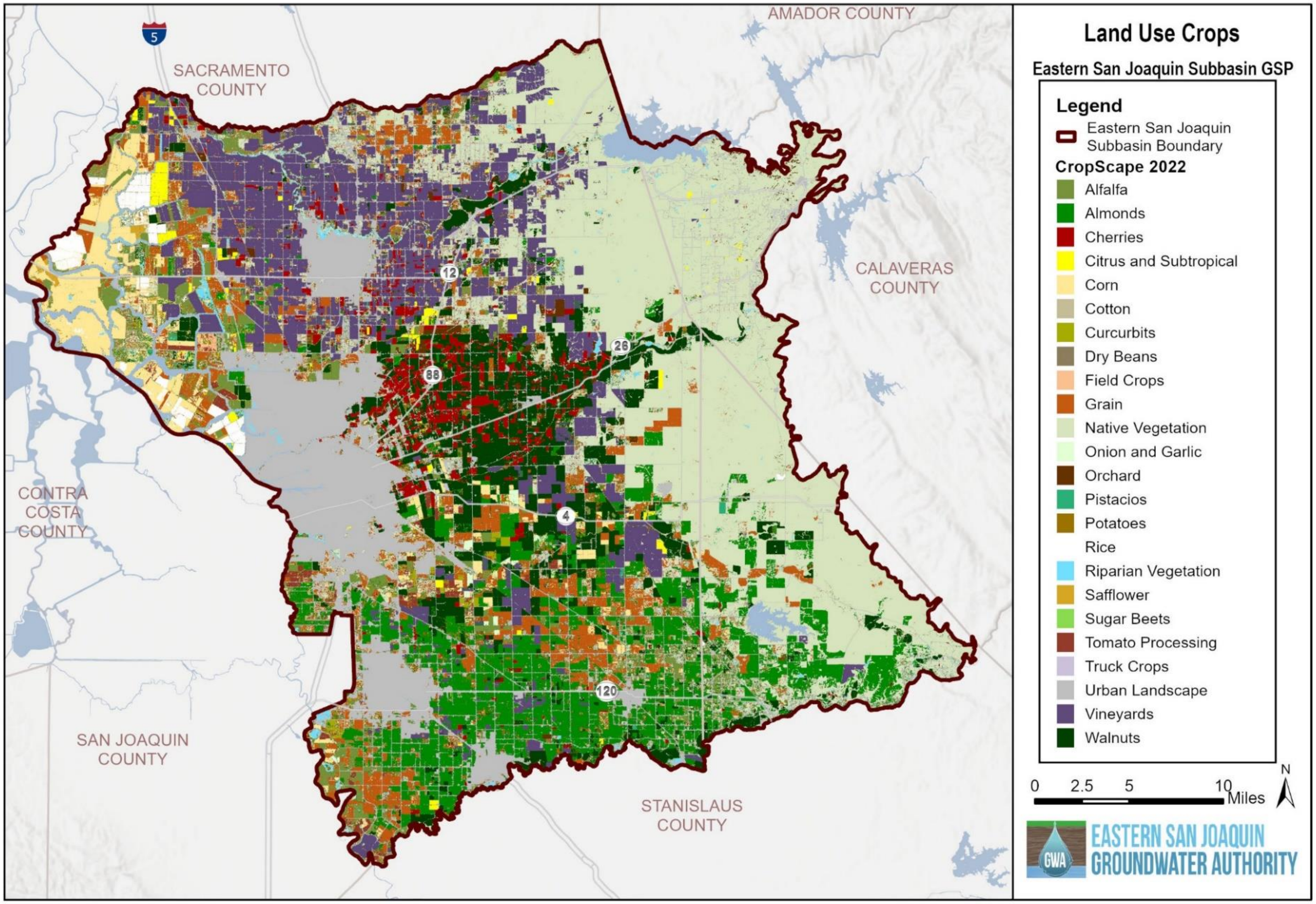


Figure 1-11 shows a map with boundaries of federal and state public lands within the region that includes the Eastern San Joaquin Subbasin. The United States Fish and Wildlife Service (USFWS) manages the San Joaquin River National Wildlife Refuge situated in Stanislaus County where the Tuolumne, Stanislaus, 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 maintains the Caswell Memorial State Park located along the Stanislaus River near Ripon (California State Parks, 2019). 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

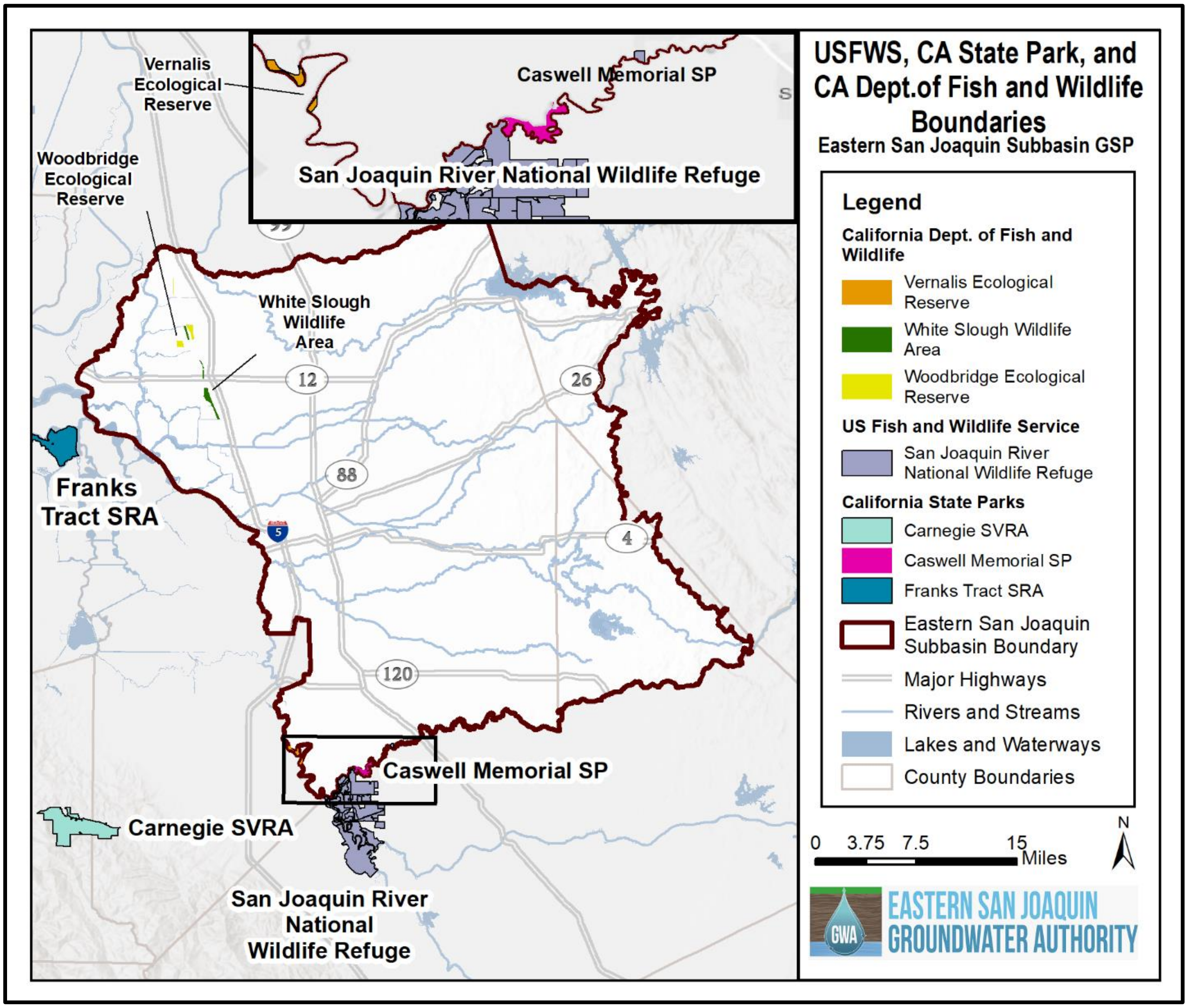


Figure 1-12 to Figure 1-14 shows the density, as of 2019, of domestic, public, and production wells per square mile in the Eastern San Joaquin Subbasin, as classified by the DWR Online System for Well Completion Reports (OSWCR), which is discussed in Section 1.2.2.1. This includes approximately 1,000 unique wells collected primarily from DWR's Water Data Library (WDL), but also other state, regional, and local monitoring entities (CA DWR, n.d.). 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-E. Appendix 1-E contains additional detail on where community water systems are found in the Subbasin.

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

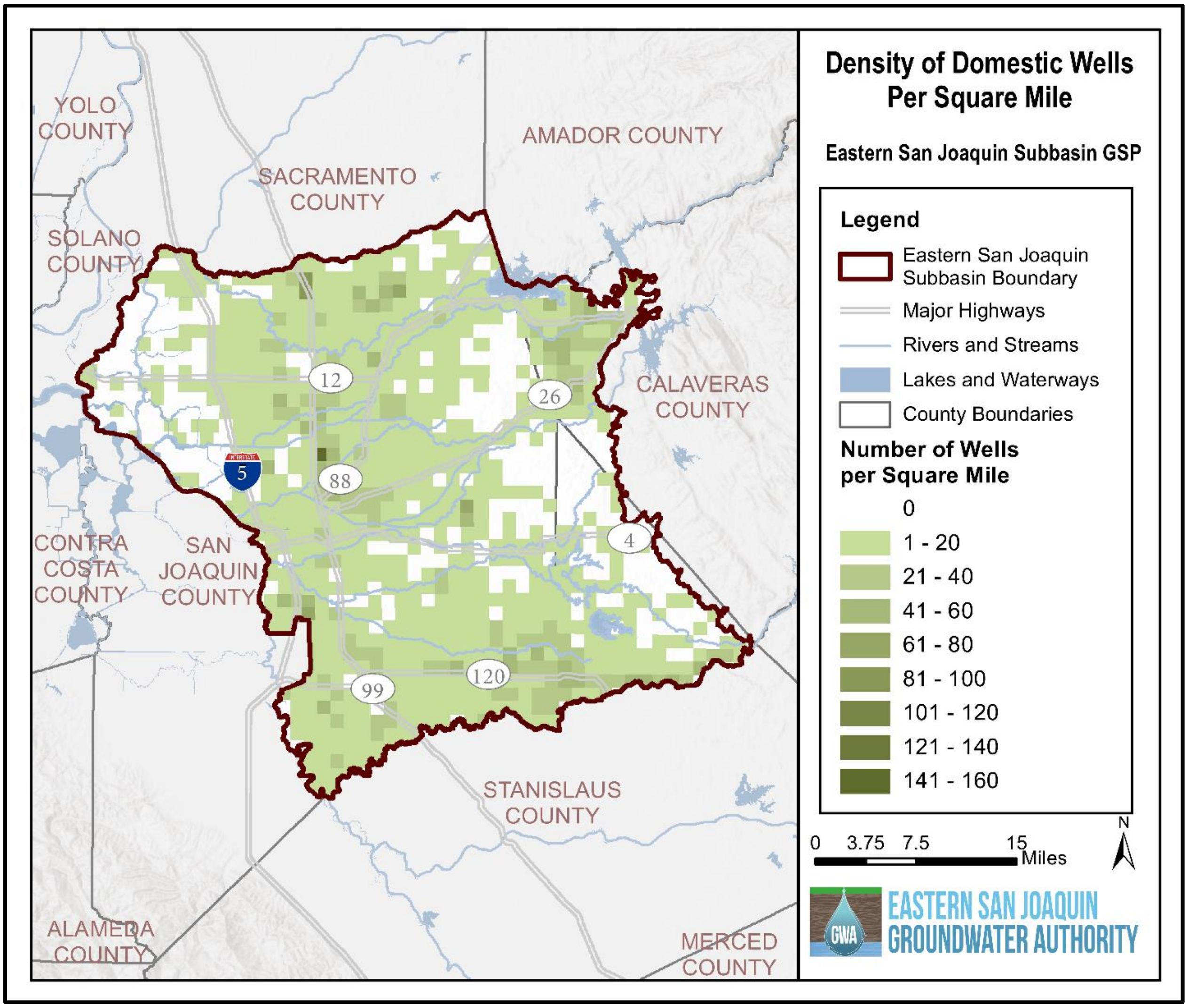


Figure 1-13: Density of Public Wells per Square Mile

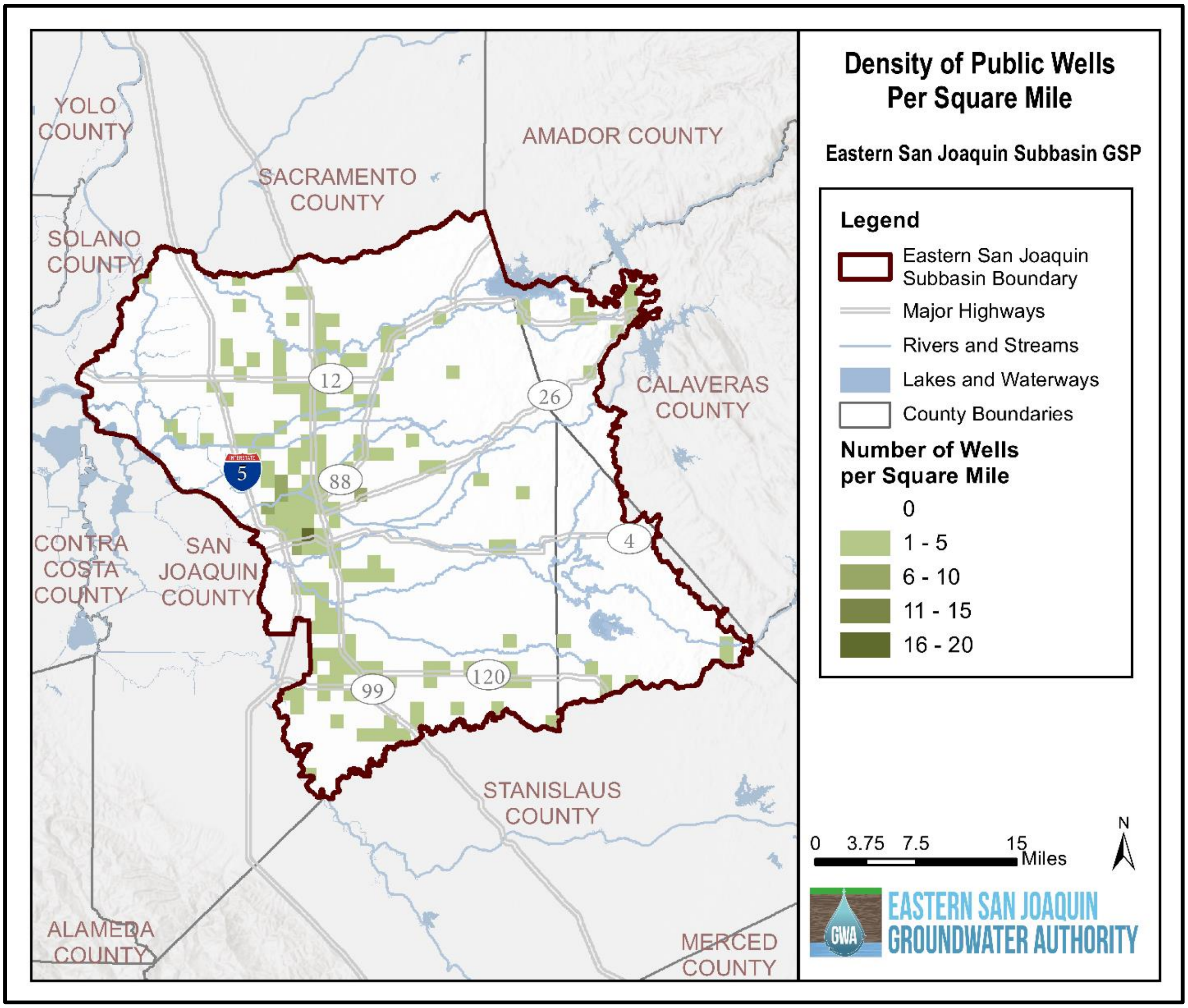
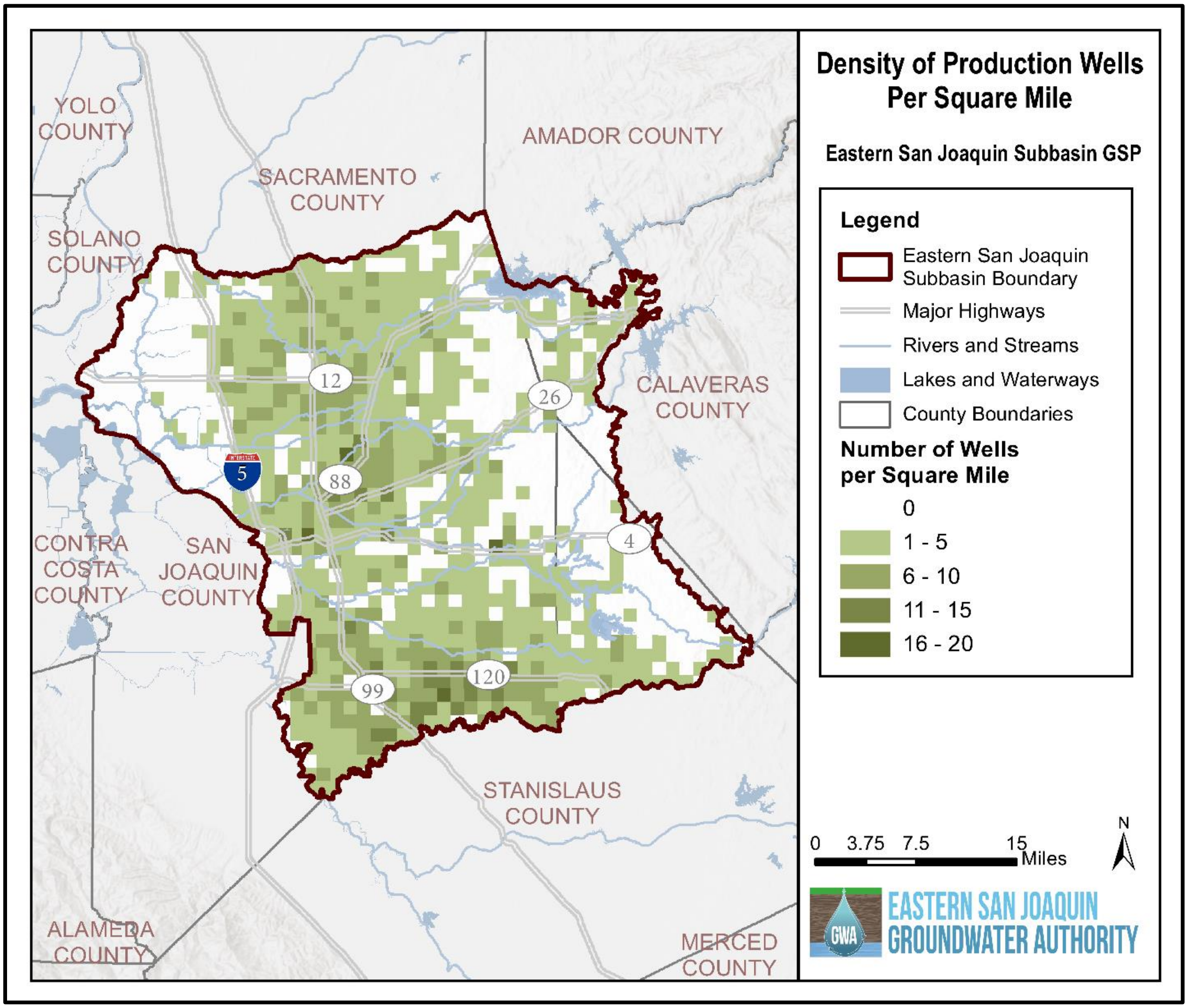


Figure 1-14: Density of Production Wells per Square Mile



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):
  - Airborne Electromagnetic (AEM) Surveys
  - 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). As part of SGMA implementation, wells that are in the Subbasin's representative monitoring network have been migrated out of CASGEM and into SGMA; all other pre-existing CASGEM wells remain in that program under voluntary monitoring status.

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 at varying frequencies and detail. These data were provided as part of the Eastern San Joaquin Water Resources Model (ESJWRM) data collection efforts and were compared with and included in groundwater level and water quality datasets analyzed for updates to the ESJWRM model and the preparation of this GSP.

The development and update 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, and through the Subbasin Steering Committee. Through this effort, many of the staff and consultants representing the GSAs forming the ESJGWA participated 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 and revision 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, extensometers, and Interferometric Synthetic Aperture Radar (InSAR) surveys. CGPS data are primarily available from two programs.

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.

University of Nevada Geodetic Laboratory (UNGL) - Several additional CGPS stations from the University of Nevada Geodetic Laboratory (UNGL) were also located in the Subbasin. These stations provide additional subsidence data for the Subbasin; however, these stations have drawbacks, such as data gaps, and discontinuous monitoring, and are used on an academic/research basis that may result in increased monitoring gaps. Station CA15 is located north of the city of Stockton and has a continuous period of record between September 2013 and October 2021. Station CMNC is located along the southern edge of the Camanche Reservoir and has observations in 2020 and between February 2022 through January 2024. These locations also provided additional spatial coverage to the UNAVCO and SOPAC CGPS stations

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.

California Department of Water Resources -– DWR has made two InSAR datasets available for SGMA application: TRE Altamira InSAR point and raster data and the National Aeronautics and Space Administration's Jet Propulsion

Laboratory's (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.

There are no DWR or USGS extensometers in the Eastern San Joaquin Subbasin.

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 Other Water Management Programs and Plans

The subsections below contain descriptions of historical and current 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

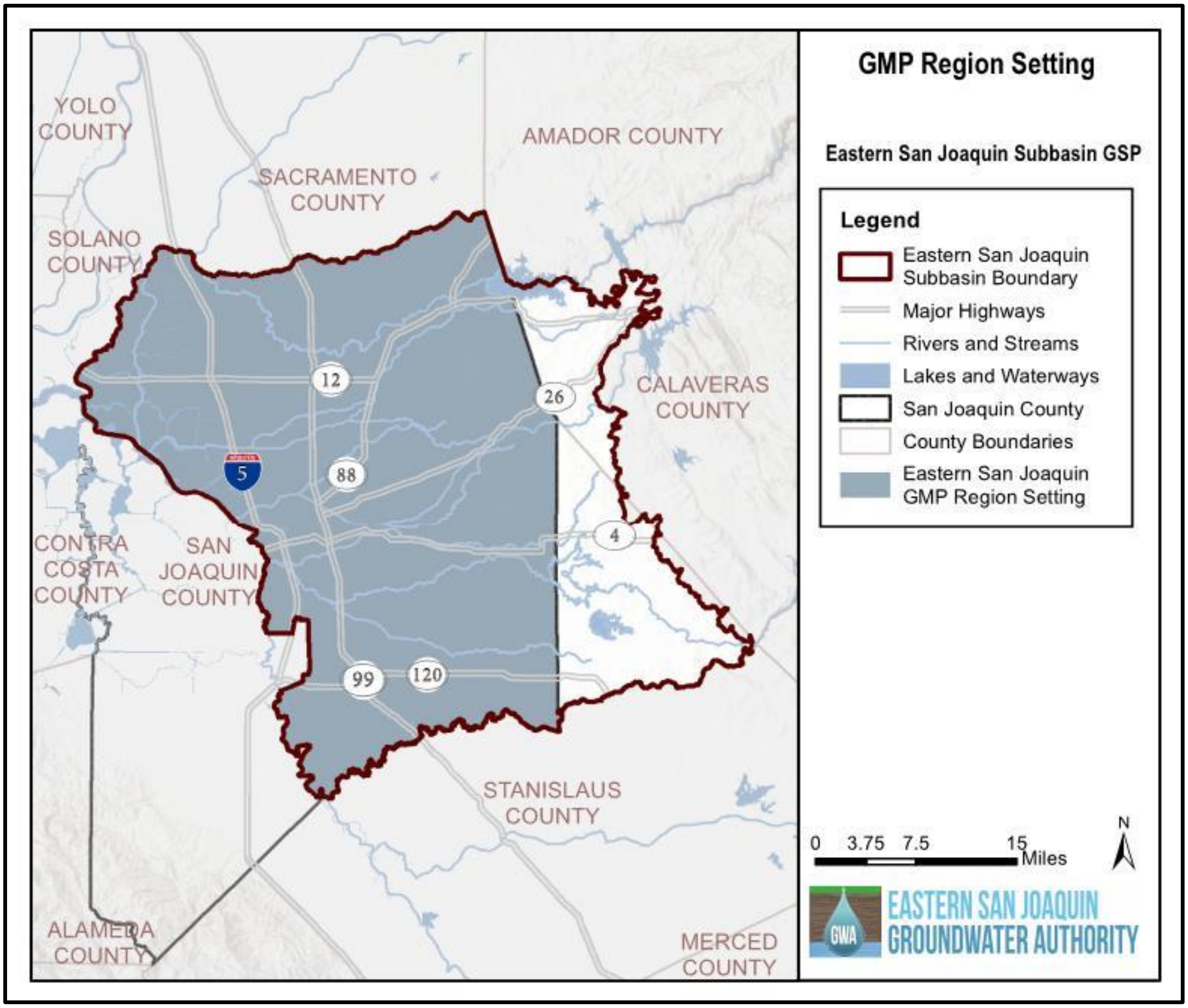
The Eastern San Joaquin Groundwater Basin Groundwater Management Plan (GMP), developed by the Northeastern San Joaquin County Groundwater Banking Authority in September 2004, was a collaborative effort between local water interests with historically diverse viewpoints to reinforce local control and provide direction for the sustainable development of groundwater resources. The GMP covered a geographic region that included the entire Eastern San Joaquin Subbasin that falls within San Joaquin County but excluded portions within Calaveras and Stanislaus counties to the east. The GMP boundaries were 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.

Now a legacy document superseded by the Eastern San Joaquin GSP, the 2004 GMP provided valuable resources related to potential concepts, projects, and monitoring strategies that were leveraged in the early versions of this GSP (Northeastern San Joaquin County Groundwater Banking Authority, 2004). The following management objectives influenced the development and 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, with an Addendum released in February 2021. 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 (San Joaquin County, 2021).

The following 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

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 updated 2020 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 are developed by Cal Water, CCWD, City of Lodi, City of Manteca, City of Ripon, City of Stockton, SSJID, and SEWD every five years 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.

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.

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. CSJWCD also uses the Upper Farmington Canal for distribution, as well as natural watercourses within its boundaries.

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.

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.

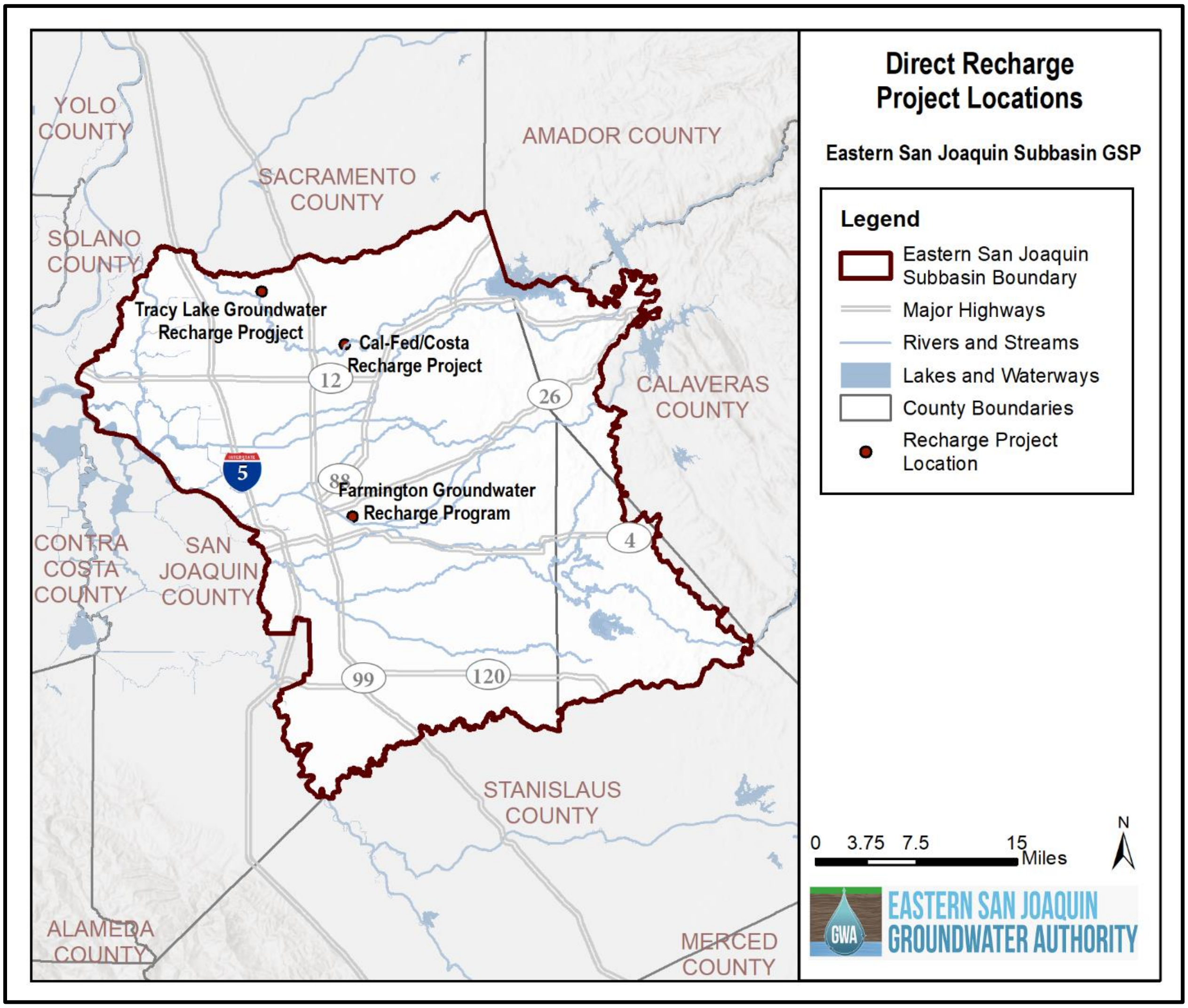
1.2.2.9 Conjunctive Use Programs Prior to SGMA Implementation

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 that were in place in the Eastern San Joaquin Subbasin prior to the beginning of SGMA implementation in 2020, 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 that conducted in-lieu recharge prior to SGMA implementation include CCWD, City of Lodi, City of Manteca, City of Stockton, CSJWCD, OID, SEWD, SSJID, and WID. Riparian users of surface water also benefit from in-lieu recharge.

Direct recharge projects existed 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 expanding these programs to 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 added in 2020. 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 Groundwater Recharge Projects Prior to SGMA Implementation



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-F.

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, initially developed in 1996, underwent an extensive update process in collaboration with local stakeholders and policymakers to understand the challenges facing the community and to enact a common vision for the future. This update, with its various elements, was finalized in 2019. (The Housing Element was finalized in 2023.)

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, 2019).

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 February 2024 to reflect the current conditions of the city. This recent version updated the 2003 General Plan and was the result of 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, 2024).

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 2022. 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, last updated in March 2019, identifies historical declining groundwater levels as a result of increased urban demands. While steps have been taken to address groundwater levels, the General Plan calls for continued protection and conservation of groundwater sources while pursuing additional water supplies to meet continued growth (City of Modesto, 2019).

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

On 28 March 2022, Governor Newsom signed Executive Order (EO) N-7-22 to amend prior proclamations of states of emergency due to California's ongoing drought conditions. EO N-7-22 required that additional steps be taken by well permitting agencies to approve a permit for the construction of a new well or alternation of an existing well located in a medium- or high- priority basin subject to SGMA. For applicable wells, permitting agencies must obtain written verification from the GSA managing the area of the basin where the proposed well is to be located that the well would not conflict with the GSP or decrease the likelihood of the basin reaching its Sustainability Goal. EO N-7-22 was subsequently rescinded once the drought-related state of emergency was lifted.

On 13 February 2023, Governor Newsom signed EO N-3-23 to keep in place some of the provisions originally contained EO N-7-22 One of the provisions retained by EO N-3-23 is the requirement that well permitting agencies not approve a permit for a new well or alteration of an existing well without first obtaining written verification of GSA approval that groundwater extraction by the proposed well would not be inconsistent with the GSP and the programs it contains. The EO exempts *de minimis* new wells and new wells that replace existing, actively permitted wells with wells that will produce an equivalent quantity of water when the existing well is being replaced because it has been acquired by eminent domain or while under threat of condemnation.

The Basin GSAs are working with the permitting agencies (i.e., counties) to review and provide written verifications for permit applications within their jurisdictions as required under the EO. As described above, several counties have already amended their well permitting processes to incorporate GSA verification.

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 (SJC EHD, 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

In response to EO N-3-23, San Joaquin County updated its well permitting process to require applicants to fill out either a Well Exemption Statement (for exempt wells) or a New Well Information Form (for non-exempt wells). For non-exempt wells, the New Well Information Form is forwarded with the rest of the application to the applicable GSA for review and consideration for a written verification.

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

In response to EO N-3-23, Calaveras County updated its well permitting process to require applicants to fill out either a Well Exemption Statement (for exempt wells) or a New Well Information Form (for non-exempt wells). For non-exempt wells, the New Well Information Form is forwarded with the rest of the application to the applicable GSA for review and consideration for a written verification.

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. On April 5, 2022, the county adopted the “Stanislaus County Groundwater Well Siting and Construction Guidelines,” which prescribed well annular seal depths to be more protective than current standards, with special requirements to address local hydrogeologic conditions and know water quality issues. The default minimum seal depth was increased from 20-50 feet to 50-80 feet and deeper seals are specified that exceed the state well standards, (CA DWR, 1991), to provide additional protection under locally variable conditions. Standards for seal depths were identified for the safe construction of all wells to prevent the intermixing of water between the upper zone and underlying aquifers.

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 supplemental application for non-exempt wells must be submitted and demonstrate that the groundwater pumped from the well will be sustainably extracted and will not cause any of the “Undesirable Results” listed in Section 9.37.030 (9) of the ordinance. Additional permit application fees may be required, and the application review is conducted at the expense of the applicant (Stanislaus County, 2019c).

In response to EO N-3-23, Stanislaus County updated its well permitting process to refer applicable well permits to the GSAs for approval. If a GSA finds that a well permit application is not consistent with requirements in its GSP to prevent Undesirable Results, the applicant must provide substantial evidence that the proposed extraction is will not cause or contribute to their occurrence in accordance with Stanislaus County’s Discretionary Well Permitting Implementation Guidelines.

The minimum annular seal depths for wells in Stanislaus 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

Special Management Area	Feet
Corcoran clay area upper zone	50 – 80
Corcoran clay area lower zone	at least 10 feet into Corcoran clay below the upper zone
Alluvial fan upper zone	50 – 80
Alluvial fan lower zone	50 – 80 or at least 10 feet into a competent clay layer below the upper zone
Fractured bedrock	50 or into the first solid rock stratum below the water table or to prevent the vertical migration of pollution
Wells completed in setback zones	Qualified Professional required
Wells completed in areas with potential lower zone contamination	Qualified Professional required

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. Actions to identify and monitor for saline water intrusion is described in Section 3.3.3.

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 3.3.3.

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 California Environmental Quality Act (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 3.3.6, 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 (CVRWQCB, 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-E Of these 433 community water systems, 182 are located in DAC or SDAC areas, shown also in Appendix 1-E.
- 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 27 percent of the Subbasin area is considered disadvantaged and 5.4 percent is considered severely disadvantaged. 33 percent of the Subbasin population is considered either DAC or SDAC; within that, 16.5 percent of the population is SDAC. DACs include the following census designated

places (CDPs)[1]: Stockton City CDP, Terminous CDP, Taft Mosswood CDP, and French Camp CDP. Severely disadvantaged communities include: Kennedy CDP, August CDP, Garden Acres 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 2024 GSP was Discussed

During the 2024 update of the ESJ GSP, meetings of the ESJGWA Board and Steering Committee were open to the public with meeting information noticed, as appropriate, and posted to the ESJGWA website (discussed below in Section 1.3.4.2.2). In addition, public meetings and an informational open house event were held throughout the GSP update process (see Section1.3.4.2.4).

Below is a list of the public meetings where elements of this 2024 GSP Amendment were discussed.

Meeting Type	Date
Steering Committee Meeting	November 8, 2023
Steering Committee Meeting	December 13, 2023
ESJGWA Board Meeting	January 10, 2024
Steering Committee Meeting	March 13, 2024
ESJGWA Board Meeting	March 13, 2024
Steering Committee Meeting	April 10, 2024
ESJGWA Board Meeting	June 12, 2024
Stakeholder Advisory Workgroup Meeting #1	June 27, 2024
Stakeholder Advisory Workgroup Meeting #2	July 17, 2024
Steering Committee Meeting	August 14, 2024
ESJGWA Board Meeting	August 14, 2024

[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.

Meeting Type	Date
Steering Committee Meeting	September 11, 2024
GSA Open House	September 25, 2024
ESJGWA Board Meeting	December 11, 2024

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 the Steering Committee, the PMC, 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 adopt the final GSP Amendment. Projects will be administered by the GSA project proponents. Although the ESJGWA does not provide direct authority to require GSAs to implement projects, the ESJGWA will be working on GSA-level water budgets and evaluating the best ways to evaluate progress. Work toward implementing projects and management actions is further described in Sections 6.2 and 6.3, respectively. If the implementation of projects is not sufficient to achieve sustainability goals, a demand management policy, included as a management action in the 2024 GSP Amendment, provides a framework for how the GSAs of the Subbasin plan to achieve sustainability through other means. 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 the initial development of the GSP and this particular update, the ESJGWA engaged both stakeholders and the public. This effort has been greatly aided by the facilitation support provided through DWR's Facilitation Support Services Program. In some cases, outreach and engagement opportunities were specific to the initial development of the 2020 GSP; these are detailed in Section 1.3.4.1. In other cases, outreach and engagement opportunities began during the 2020 GSP development process and have been adapted or modified for this 2024 GSP Amendment; these are discussed in Section 1.3.4.2.

1.3.4.1 Opportunities Specific to the 2020 GSP Development Process

1.3.4.1.1 Groundwater Sustainability Workgroup

When developing the initial 2020 GSP, the ESJGWA convened a Workgroup in order to promote stakeholder input and relied upon the Workgroup when developing the 2020 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 2020 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. While this Workgroup was not active during the 2024 GSP amendment process, the information collected during their involvement remains relevant and a guiding factor in this update and GSP implementation activities.

Table 1-4: Groundwater Sustainability Workgroup Interests (Collected During Development of 2020 GSP)

Eastern San Joaquin Groundwater Authority Groundwater Sustainability Workgroup – Interests Represented										
AG Agricultural Community **CM** 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**
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 Community **CM** 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**
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.

Eastern San Joaquin Groundwater Authority Groundwater Sustainability Workgroup – Interests Represented										
AG Agricultural Community **CM** 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**
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.
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.

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

Eastern San Joaquin Groundwater Authority Groundwater Sustainability Workgroup – Interests Represented

AG	Agricultural Community	**BUS**	Business
CM	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
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.
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.

1.3.4.1.2 Situation Assessment

During development of the initial 2020 GSP, 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

Based on Situation Assessment findings, changes were made to the 2020 GSP development process, including meeting presentations and discussions, the draft GSP, and its review schedule.

1.3.4.2 Continuing Opportunities for Public Engagement

The sections below detail the opportunities for public engagement that were specific to this 2024 GSP Amendment. Many began with the development of the initial 2020 GSP and have been continued and modified as appropriate to fit the needs of this particular GSP Amendment process.

1.3.4.2.1 Communication and Engagement Plan

With the support of the Workgroup, the ESJGWA developed an initial Stakeholder Outreach and Engagement Plan in June 2018 during the development of the 2020 GSP. This plan was updated as part of the 2024 GSP amendment process and renamed the Eastern San Joaquin Communication and Engagement Plan (C&E Plan). The ESJGWA supported the update of this Plan (see Appendix 1-H) for the San Joaquin Subbasin, which details communications and engagement recommendations for GSAs to consider as the GSP continues to be implemented and the needs of interested parties in the region evolves. The original goals of the Outreach and Engagement Plan are still relevant in the recent iterations of this plan:

- 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 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

The ESJGWA used various methods to engage with and solicit input from interested parties during the 2020 GSP development process. In order to evolve the updated C&E Plan with the needs of the community, the development process started with a review of previously established commitments made by Subbasin GSAs and the ESJGWA in various SGMA-related documents and by the needs and ideas presented by interested parties. Seven individual or small group interviews were conducted between March and July of 2023 with key interested parties in the Subbasin to gather feedback on communication and engagement strategies taken during GSP implementation. Interviewees represented diverse interests, including disadvantaged communities, municipal and industrial, agricultural, domestic well, and those representing environmental water users.

Gaps or inefficiencies throughout GSP implementation were identified, showing a consistent lack of adequate support in key areas:

- Concerns over Demand Management Program: Respondents expressed concerns about potential demand reduction strategies that could be overly restrictive and disruptive to their lives and livelihoods.
- Lack of Clarity on Sustainability Approaches: There was a perceived lack of clear answers and progress regarding long-term sustainability approaches.
- Cost Concerns: High water management costs and increased water rates were a concern, indicating a lack of public understanding around GSAs approach to funding.
- Bureaucratic Processes: Respondents noted overly bureaucratic processes that might limit the effectiveness of the GSAs and the ESJGWA if things escalate beyond the local level.
- Lack of Consistency and Transparency: There was a significant lack of consistency and transparency, particularly in how, where, and when GSAs share information and engage with each other and the public.

In order to address these key areas, the C&E Plan details the following strategies that could be implemented or expanded:

- Communications and Engagement Tracker: A strategy that involves the GSAs establishing a record-keeping system to catalogue the type and timing of outreach activities, enhancing their level of organization and compliance with requirements, with the support of the ESJGWA where necessary and feasible.

- Outreach Toolkit: A comprehensive approach by the GSAs to create a suite of standardized outreach materials and a library of relevant guides, aiming to ensure consistent messaging and best practices in communications and engagement, with the support and coordination of the ESJGWA.
- Interested Parties Database: GSAs create a shared and comprehensive database, supported by the ESJGWA, to distribute information tailored to different jurisdictions and audiences, with the database managed by a third-party platform for easy maintenance, access, and tracking of public engagement.
- Targeted Outreach: GSAs, in compliance with applicable regulations, implement specific efforts to identify, contact, educate, and engage with underrepresented groundwater users and non-English speakers on groundwater resource management, with coordination and collaboration support from the ESJGWA.
- Workgroups and Committees: GSAs, in compliance with applicable regulations, consider establishing a committee or workgroup focused on small and underrepresented communities to engage on well protection and other related projects affecting these groundwater users, with support from the ESJGWA,
- Native American Heritage Commission: GSAs submit and receive a Tribal and Sacred Land tribal contact list to the Native American Heritage Commission, ensuring they stay informed and in contact with recognized Indigenous communities in the region, a core component of inclusive engagement, especially for project implementation, with support from the ESJGWA
- Website Management: GSAs, in compliance with applicable regulations, establish and maintain web pages on their own or the ESJGWA websites, containing clear and accessible information, updates, and resources related to groundwater management, with the choice of management depending on the GSAs' comfort and discretion.
- Enterprise Management System Management and Transparency: GSAs and/or the ESJGWA, in compliance with applicable regulations, maintain a catalog of data management systems and publish their methodology for maintaining and using the collected data, ensuring full transparency.
- Comment Portal: GSAs and/or the ESJGWA, in compliance with applicable regulations, establish, maintain, and respond to public comments through an email contact portal, which collects data on the commenter and allows for categorization of comments, with links to the portal clearly available on their websites.
- Funding and Financing: ESJGWA, in compliance with applicable regulations, coordinate with its member agencies to evaluate funding, grant, or in-kind support resources for facilitation, media relations, or outreach coordination services, supporting the addition of new staff or a dedicated outreach coordinator for the Subbasin to enhance communications and engagement efforts related to GSP implementation.
- Outreach Coordinator: Recommendation to contract with an outreach coordinator to assist the ESJGWA and its member agencies with the tactics listed in the C&E Framework and any other ongoing communications and engagement efforts in the Subbasin, in compliance with all applicable codes and regulations.

1.3.4.2.2 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 ESJGWA mailing list to receive updates on GSP development and outreach events. Improvements to the website itself and the approach for its use will be continuously updated to meet the public engagement goals of the Subbasin.

1.3.4.2.3 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 has been 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 continues to serve as the foundation for targeted outreach and communication 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**
Government Agency (i.e. County, State)	64
Business (i.e. Consultant, Local Business, Legal Representation)	41
Nonprofit (i.e. Environmental Organization, Thinktank)	5
Higher Education	3
Community Based Organization (i.e. Farm Bureau)	2
Water Purveyors (i.e. Public Utilities, Irrigation Districts)	77
No Affiliation Provided	93
Total	**285**

Outreach materials promoting informational open house events were distributed via email to the stakeholder database, and hard copies were distributed to this list throughout implementation process since the 2020 GSP.

The following section describes the stakeholder education and outreach activities completed during the development of the 2024 GSP Amendment.

1.3.4.2.4 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 two public Stakeholder Advisory Workgroup (SAW) meetings and one informational open house event devoted to SGMA outreach and providing information to the public on the 2024 GSP Amendment 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.
    - **June 26, 2024 –** Robert J. Cabral Agricultural Center, Stockton (23 attendees)
    - **July 17, 2024 –** Robert J. Cabral Agricultural Center, Stockton (18 attendees)
    - **September 25, 2024 –** Robert J. Cabral Agricultural Center, Stockton (40 attendees)
- 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.

- Individually, member GSAs provided targeted outreach materials to their constituencies through the distribution of outreach and informational materials
- Community events, including guided tours of facilities for the community, grower outreach meetings, and a tour for community leaders, were held to promote recharge projects and plans, and discuss challenges.
- Member GSAs provided SGMA and project related updates to their Boards and other leadership bodies, including the Water Advisory Committee and the Linden-Peters Chamber of Commerce.
- Factsheets, email announcements, and newsletters were used to raise awareness about topics and events relevant to the GSP and SGMA.
- Social media channels, such Facebook, were used to distribute targeted information relevant to SGMA, the GSP, and specific projects.
- Comment cards, provided in postcard format at the public informational open house, allowed the public and stakeholders to contribute written comments, solicit additional information, make suggestions, and submit other feedback as appropriate.

1.3.4.2.5 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 Steering Committee and ESJGWA Board meeting. Information provided for GSP development was refined based on input from public meetings. Stakeholder involvement was additionally supported through the two public meetings and the open house held in September 2024 to solicit input on the draft Amended GSP from a wide range of beneficial users of groundwater in the Subbasin. Questions raised by participants at these meetings were addressed and, as needed, follow-up content presented and discussed at subsequent 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. Interviews in the initial stages of the C&E Plan development and survey responses received during the later stages, both provided valuable insight into how engagement can be improved. The second in-person SAW meeting also yielded some feedback, centering on two areas.

- How to fund efforts toward sustainability, both at the GSA level and the ESJGWA level.
- How to increase involvement of more diverse interests beyond water managers.

1.3.4.2.6 Draft 2024 GSP Amendment Public Comment Review Period

The Public Draft 2024 GSP Amendment was posted on the ESJGWA website for a 31-day public comment period from October 1, 2024 through October 31, 2024. Notices and press releases were provided in English and Spanish publicizing the public comment period and inviting members of the public to attend the September 2024 informational open house event for more information. This event was scheduled to align with the release of the Public Draft 2024 GSP Amendment to provide a forum for the public to receive information, ask questions, and provide input. Hard copies were made available upon request.

The ESJGWA received 52 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.

- Barton Ranch, Inc.

- Calaveras County Water District
- California Department of Fish and Wildlife
- City of Stockton
- Sierra Club, Delta-Sierra Group
- NV5
- Restore the Delta

The PMC was responsible for reviewing and summarizing public comments, and drafting proposed response to comment recommendations for approval by the ESJGWA Board. 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, ESJGWA has participated in the San Joaquin Valley Point of Contacts (SJC POC) meetings hosted quarterly, as well as initial introductory meetings with its neighboring subbasins. Given that the ESJ Subbasin was the first of its neighbors to submit a plan, the majority of neighboring basins were not in a position to begin meaningful coordination until recently. There have been discussions about the establishment of annual meetings between representatives of the ESJGWA and the neighboring subbasins to begin a more formal coordination process. The purpose of these coordination meetings will be to share and discuss elements relevant to the subbasins, including water budget estimates, boundary flow assumptions, shared interconnected surface waters, and minimum thresholds.

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
- Tracy Subbasin – September 25, 2024

To establish these annual coordination meetings, the ESJGWA plans to reach out to neighboring subbasins as part of GSP implementation to set more formal coordination between neighboring subbasins.

1.3.6 Notice of Intent to Adopt the GSP

A Notice of Intent (NOI) to adopt a GSP was signed by the Plan Manager on behalf of the GSAs and distributed on July 24, 2024. 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 Manteca
- City of Ripon
- City of Stockton

The signed NOI is provided in Appendix 1-K.

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 (Historical Groundwater Conditions) and Section 2.3 (Current Groundwater Conditions) describe and present groundwater trends, levels, hydrographs and level contour maps, estimated changes in groundwater in storage, identify groundwater quality issues, address land subsidence, and address surface water interconnection.
- **Water Budgets –** Section 2.4 (Water Budgets) describes the data used to develop the water budget. This section also discusses how the water budgets were 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 hydrogeologic conceptual model (HCM) for the Eastern San Joaquin Subbasin (Subbasin), as was included in the 2020 Groundwater Sustainability Plan (GSP) and reconsidered during the 2024 Periodic Evaluation. 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 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. Most information was compiled during the development of the 2020 GSP. Where new data available between 2020 and 2024 provide additional information to the HCM, it has been incorporated into this chapter. New data support the original understanding of the Subbasin HCM and therefore, the original HCM remains in the 2024 GSP with additional detail incorporated where additional insights can be made.

To accomplish the data compilation task, software programs such as Microsoft Excel, ArcGIS, QGIS, CrossView, and Python[1] platforms for entering, storing, displaying, and evaluating the volume of data available were used. The following subsections describe the online programmatic databases from which much of the data were sourced and provide 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 provided the basis for determining groundwater levels across the Eastern San Joaquin Subbasin in the 2020 GSP. CASGEM maintains a website that allows users to download site locations and groundwater level information. San Joaquin County's monitoring well data came from the San Joaquin County Flood Control and Water Conservation District (SJCFCWCD).

[1] Python version 3.11 was used as well as the Pandas, NumPy, Matplotlib, GeoPandas, Rasterio, Shapely, and cmocean packages

Since the 2020 GSP, all groundwater level data have been centralized in the California Department of Water Resource's (DWR) Water Data Library (WDL) database. Well information can be found in WDL, and all available historical data can be downloaded for each well.

There are 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).Substantial efforts have been made to fill these data gaps since the 2020 GSP. Section 7.1 describes what has been done as part of GSP implementation between 2020 and 2024 to address these gaps.

Figure 2-1: Depth of All Wells in Water Data Library

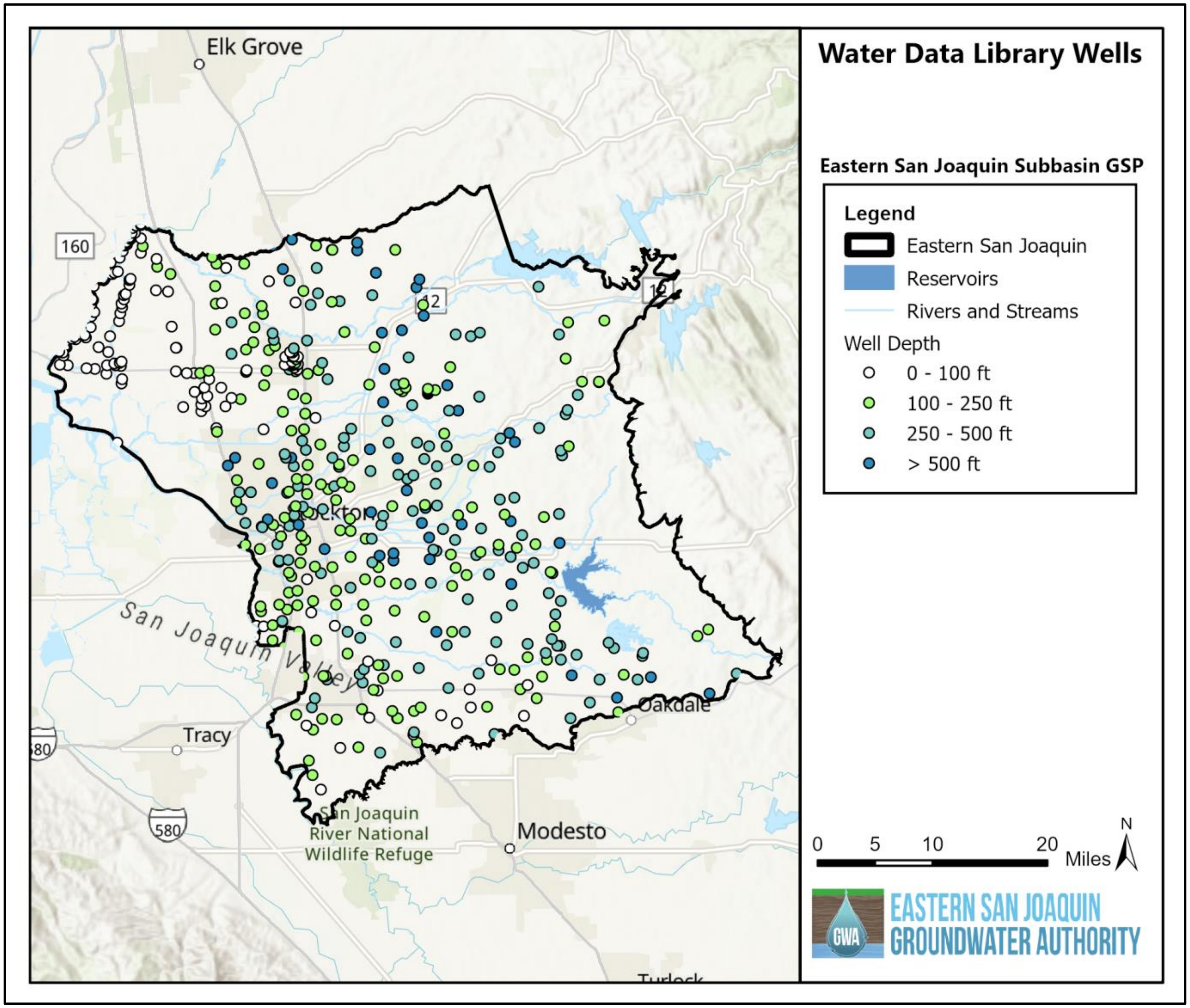
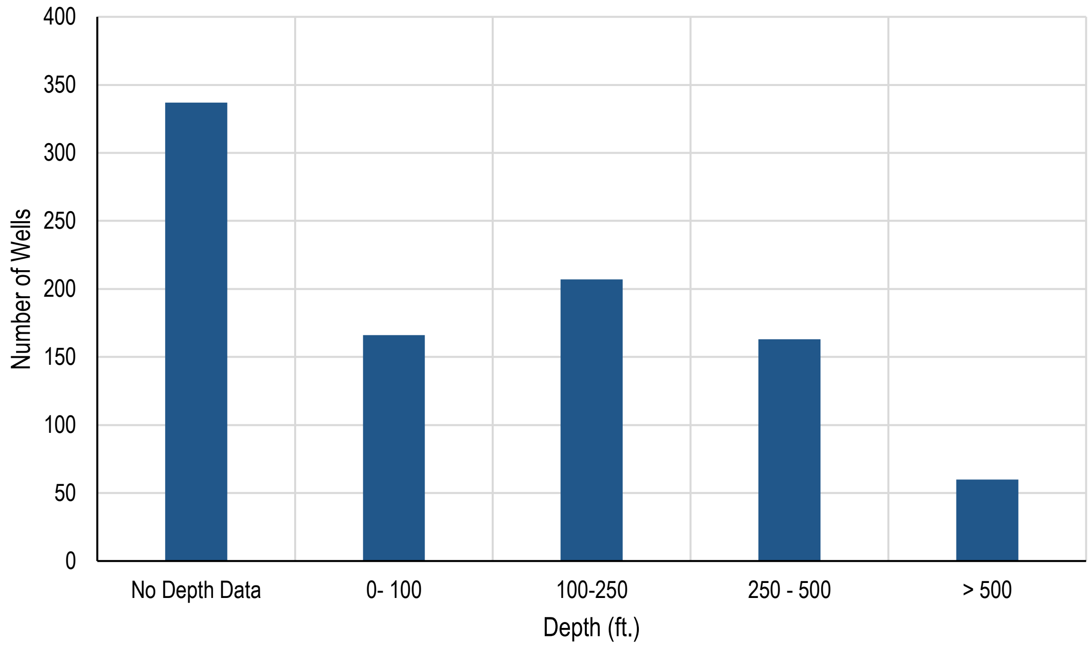


Figure 2-2 shows the distribution of well depths of WDL wells within the Subbasin, a large number of which do not have construction depth or screen interval information. This makes determining groundwater levels for depth-discrete aquifer intervals impossible. Groundwater elevation contour maps were prepared for the Subbasin's single principal aquifer, consistent with CCR Title 23 § 354.16 Groundwater Conditions requirements. Despite uncertainties due to limited construction information, this GSP presents maps that provide a useful description of groundwater conditions.

Figure 2-2: Depth Distribution of Wells in Water Data Library



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 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 many 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.

No new groundwater quality sources have been identified since the development of the 2020 GSP that are as comprehensive as GAMA.

Figure 2-3: GAMA Monitoring Well Network

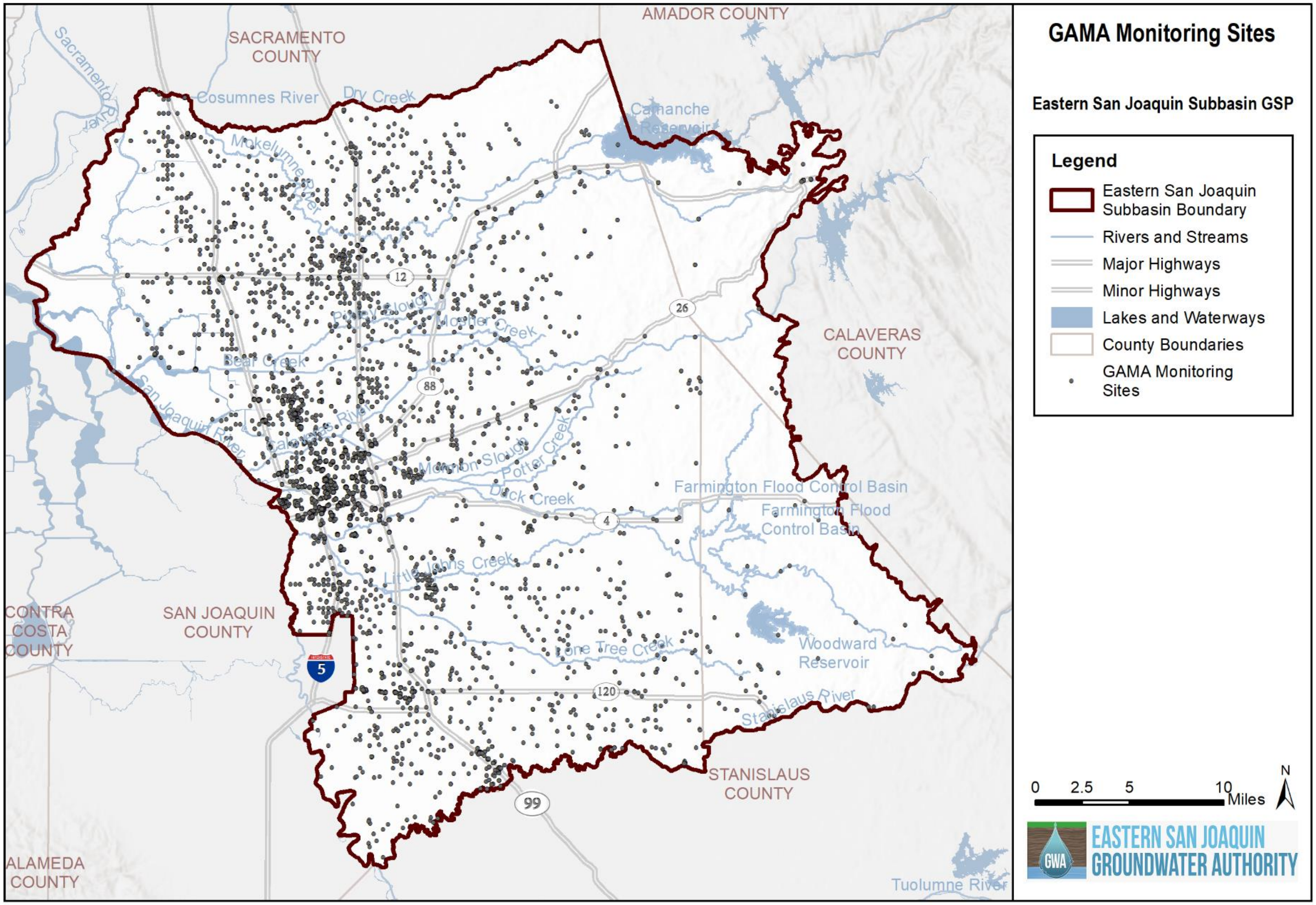
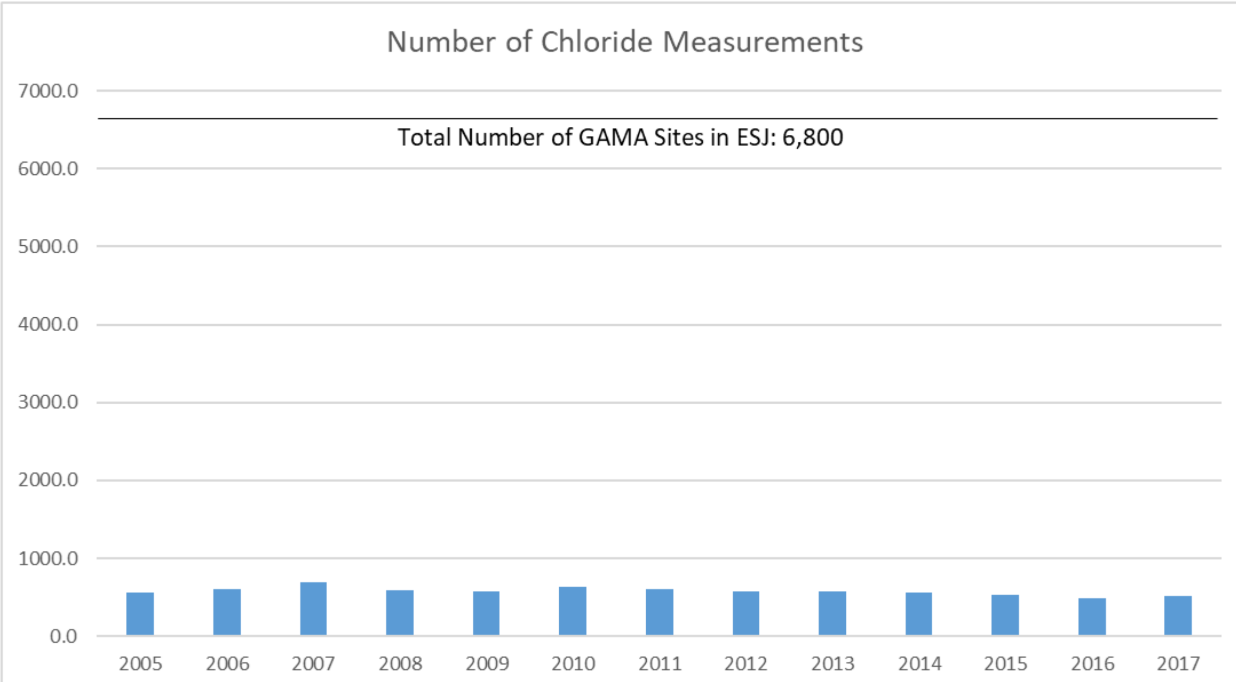


Figure 2-4: Number of Chloride Measurements Taken at GAMA Monitoring Sites (2005-2017)



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 Chapter 4 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 Microsoft 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 geometric center 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 Airborne Electromagnetic (AEM) Surveys

Airborne Electromagnetic (AEM) surveys were completed across the state since the 2020 GSP. The data collected provides additional data to inform the HCM of the surveyed basins. Data are collected from a helicopter carrying geophysical equipment on a large hexagonal frame about 30 meters above the ground. This equipment sends a weak electromagnetic signal into the ground and measures the response received back. An electrical resistivity profile of the subsurface down to depths of as much as 300 meters can be developed using the received data. The Eastern San Joaquin Subbasin was included in Survey Area 6, which also included the Cosumnes, Tracy, and East Contra Costa Subbasins and Livermore Valley Groundwater Basin.

Figure 2-5 shows where the survey's flight lines were completed across the Subbasin (CA DWR, 2023 and CA DWR, 20024).

Aquifers are typically composed of sands and gravels that have high resistivities, while aquitards are composed of silt and clays that have low resistivities. The resistivity profiles help in mapping the overall dimensions and extent of the aquifer systems. The AEM survey data is analyzed in detail, correlated with data from nearby wells, and modeled to produce subsurface maps of the resistivity, lithology (the physical characteristics of rocks), and an initial hydrostratigraphic model (a description of the water-bearing and water-confining properties of rocks). Well lithology and oil and gas well geophysical logs located along the AEM flight lines were compiled to provide additional data to support the surveys. Groundwater levels and water quality data were also compiled.

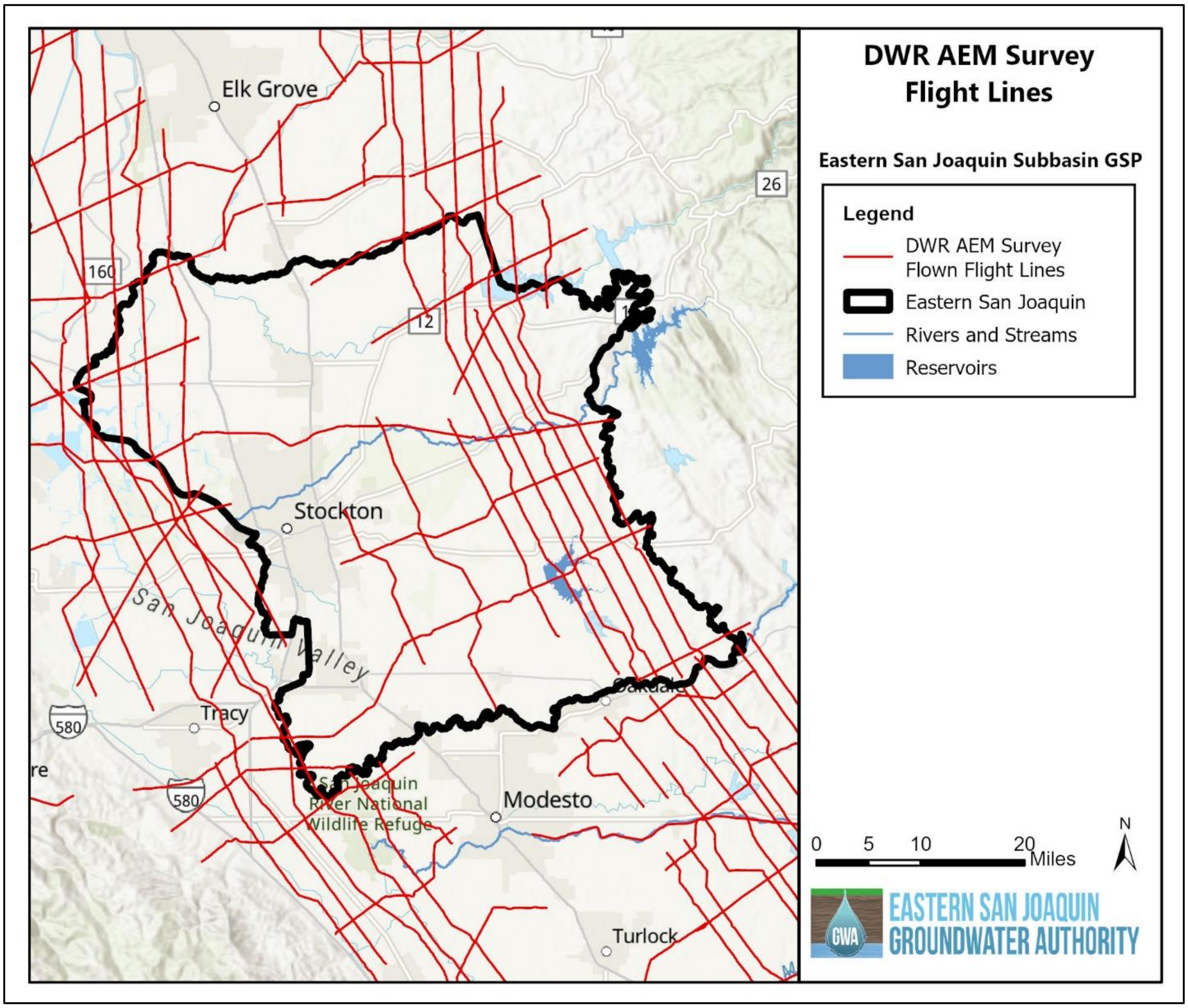
DWR processed the collected AEM data to filter out potential noise in the data and, if necessary, remove the data where interference is too great to effectively interpret. Resistivity models were produced that provide profiles indicative of areas with relatively coarser-grained (sands and gravels) and finer-grained (silts and clays) material, represented by areas of higher and lower resistivities, respectively. The resistivity data were then processed, combining the detailed high-quality well lithologic data with information on the spatial heterogeneity from the resistivity to provide an interpretation of lithology. The resistivity and coarse fraction data were combined to produce an initial hydrostratigraphic model for each subbasin, designating areas or layers of the subsurface having similar hydrogeologic properties (Department of Water Resources (CA DWR), 2023).

The resistivity data, and the texture interpretation DWR developed, are useful as an additional source of information to contribute to local understanding of the Subbasin's hydrogeology and structural features. These data were incorporated into the following pieces of the GSP:

- New cross-sections in the HCM
- Additional shallow subsurface texture map included in the HCM
- Refinements to the model stratigraphy in ESJWRM, described in detail in the ESJWRM Version 3.0 Model Documentation TM included in Appendix 2-C.

Python was used to process the data provided by DWR.

Figure 2-5: AEM Flight Lines across ESJ Subbasin



2.1.1.5 GIS Data

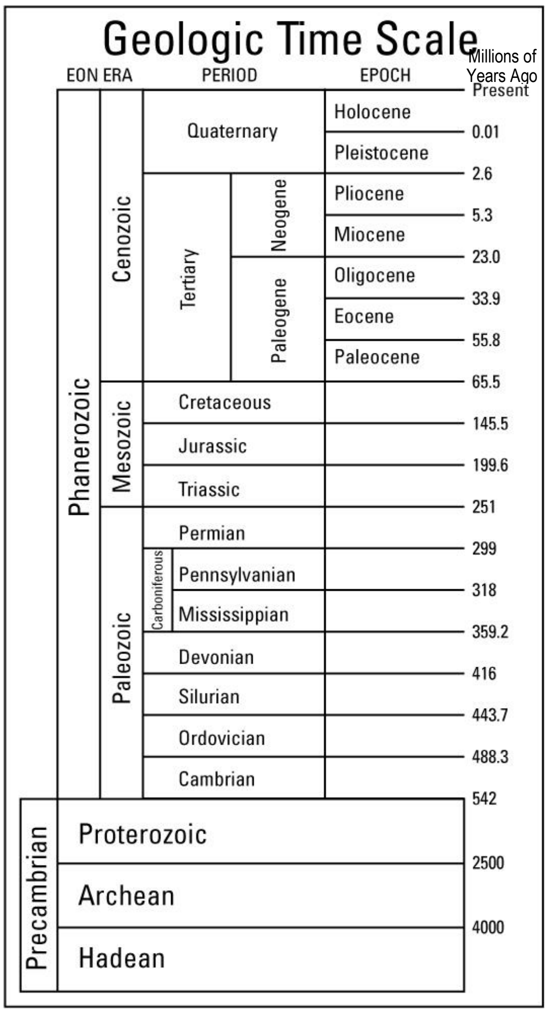
In accordance with CCR Title 23 §354.14, maps of various basin attributes are required as part of the HCM. To produce these maps, GIS software was used to store, manage, and analyze spatial and tabular data. GIS software was also used to extrapolate data through complex processes in cases where information 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 2-6 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 2-6: 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 2-7.

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 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 Hydrologic Features

The major hydrologic features within the Eastern San Joaquin Subbasin are shown in

Figure 2-8. 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 2-8. 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 2-7: Topography

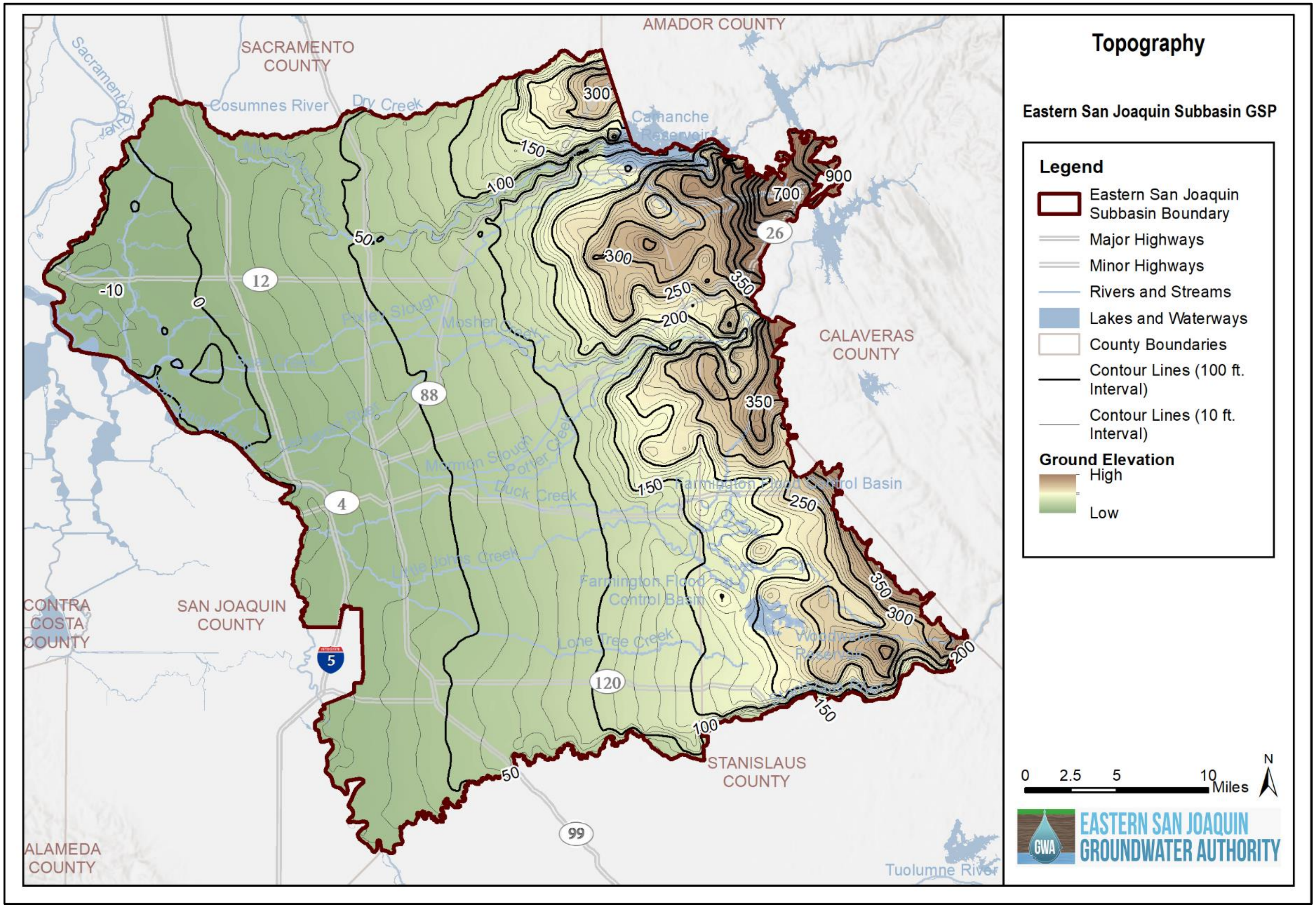
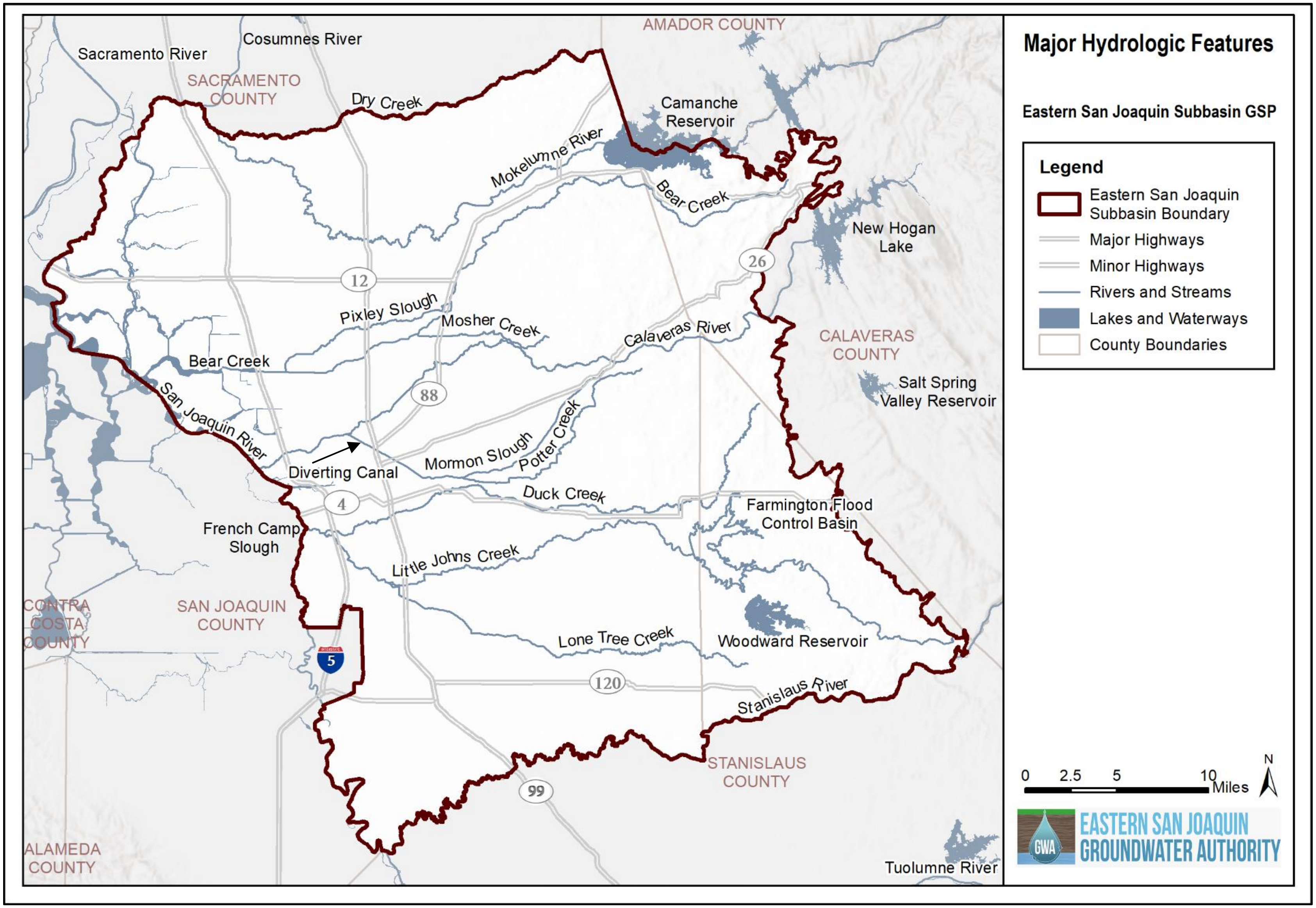


Figure 2-8: Major Hydrologic Features



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). Three 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 the communities of 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 2-9). 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 the communities of 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 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).

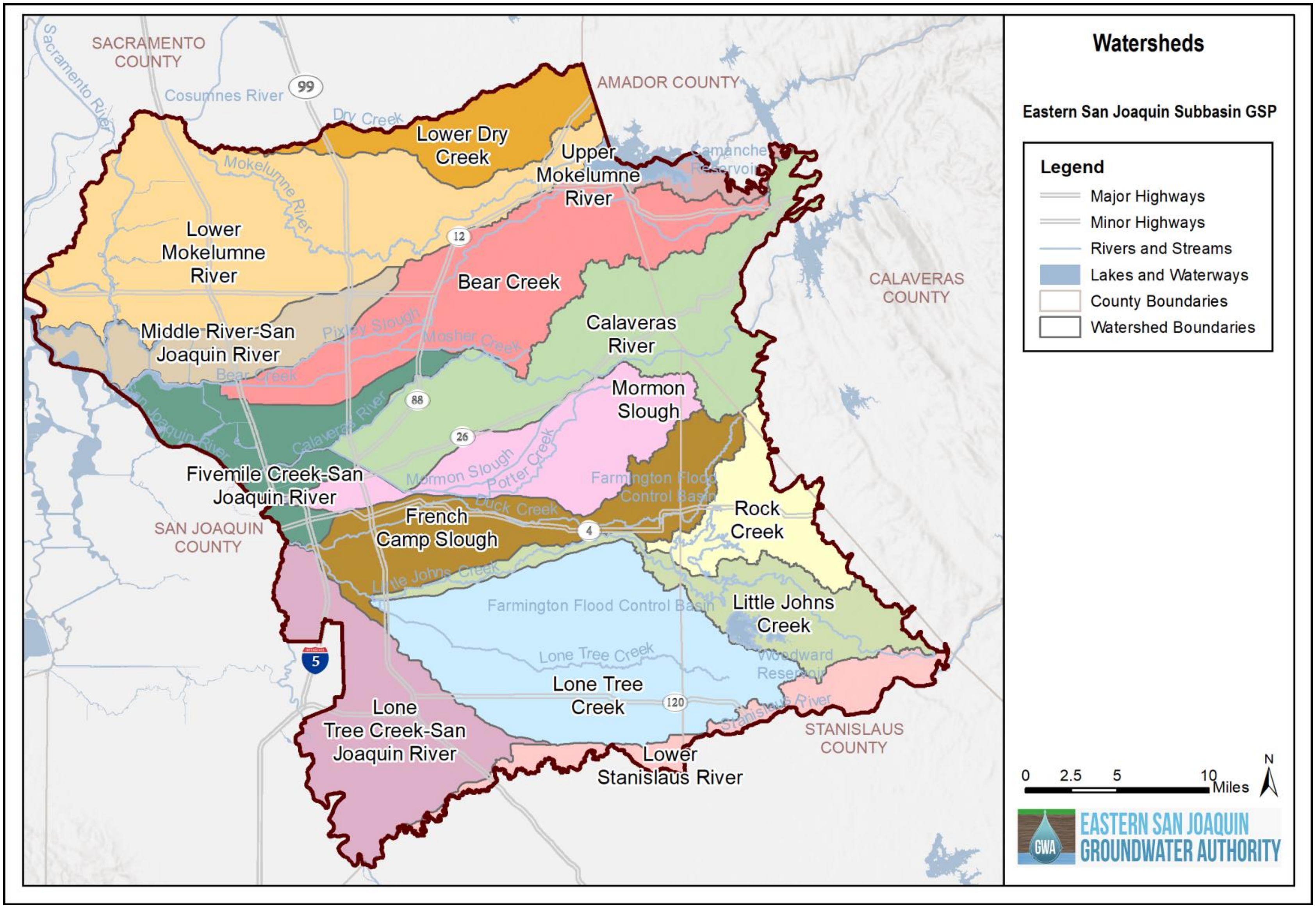
The Calaveras River, also with headwaters in the Sierra Nevada, drains a watershed of about 1,370 km^2 (530 mi^2) and flows into and across the Subbasin to its confluence with the San Joaquin River on the northwest side of Stockton. Flow in the Calaveras River below the New Hogan Reservoir varies seasonally 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 2-9 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 2-9: Eastern San Joaquin Subbasin Watersheds



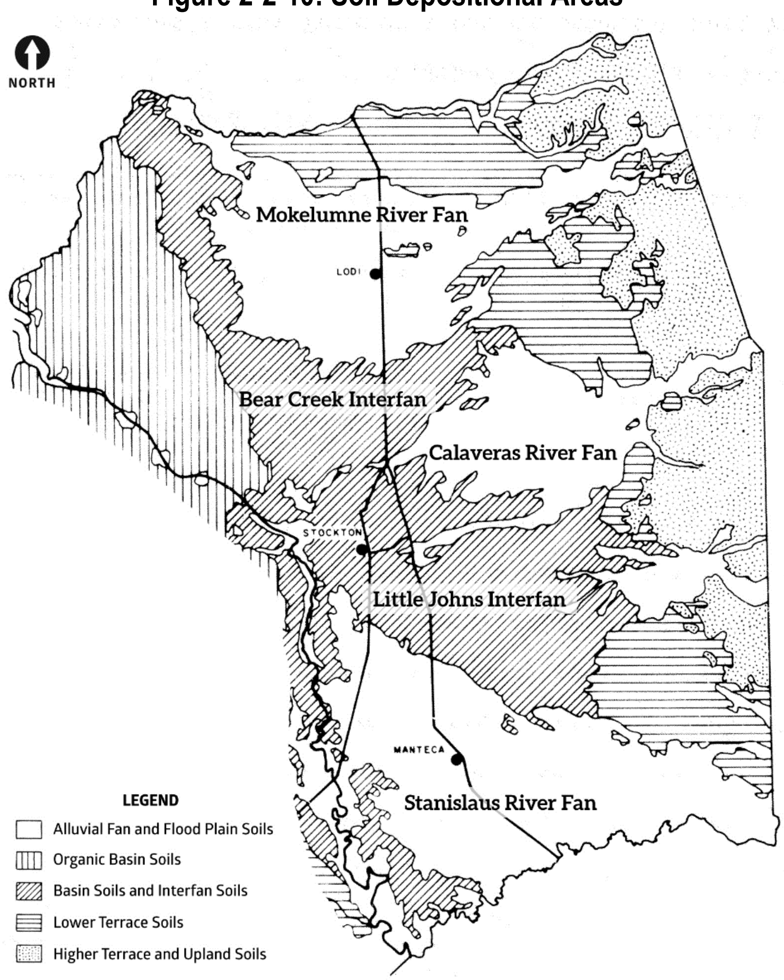
2.1.4.3 Surface Soils

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 two 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 2-2-10 shows the areal distribution of the five soil types in San Joaquin County (CA DWR, 1967).

Figure 2-2-10: 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 2-2-10 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, whereas 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 five 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 2-11 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 2-11).

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 five 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) and 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 2-12 in dark blue cross hatching.

Figure 2-11: Hydrologic Soil Groups

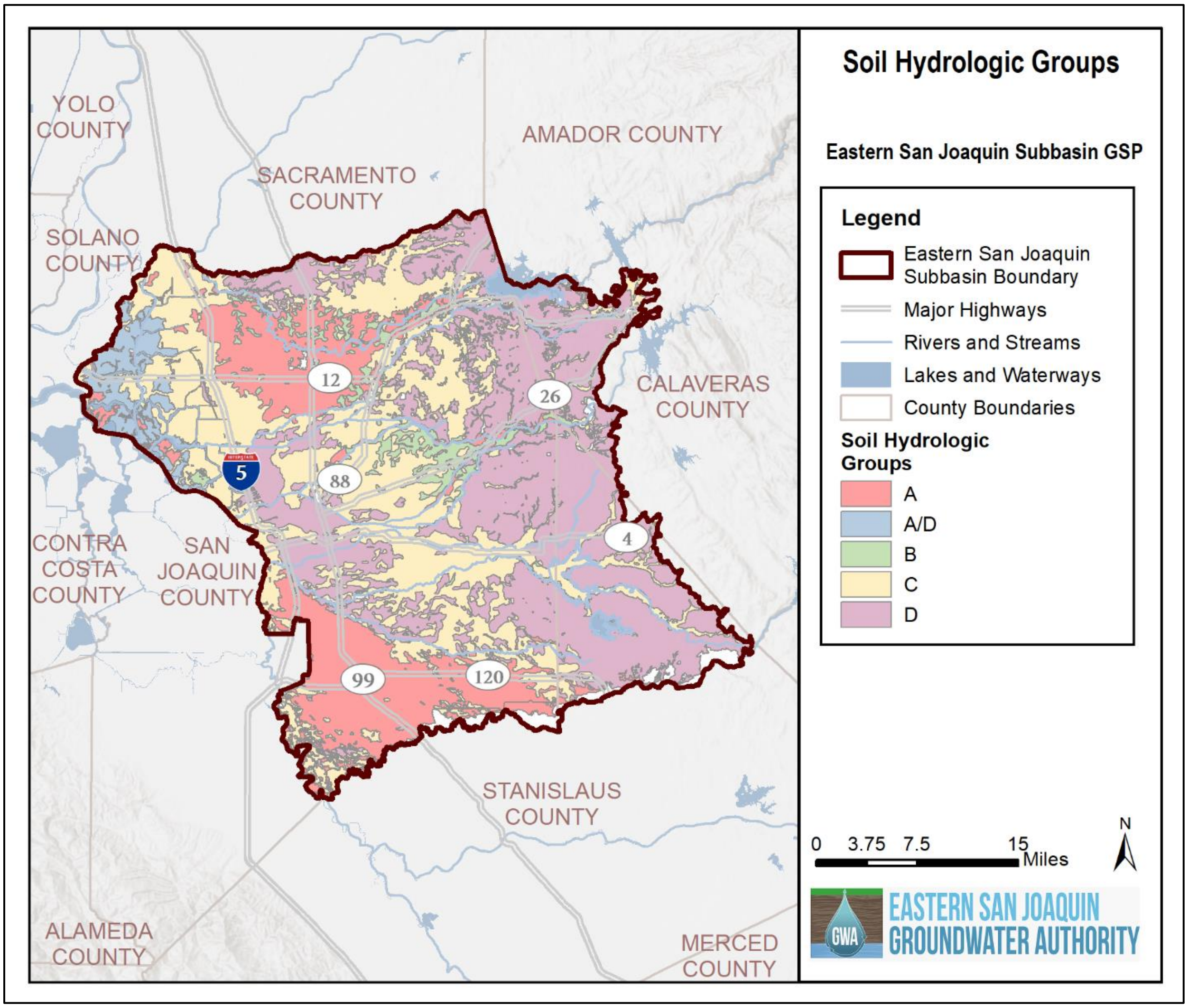
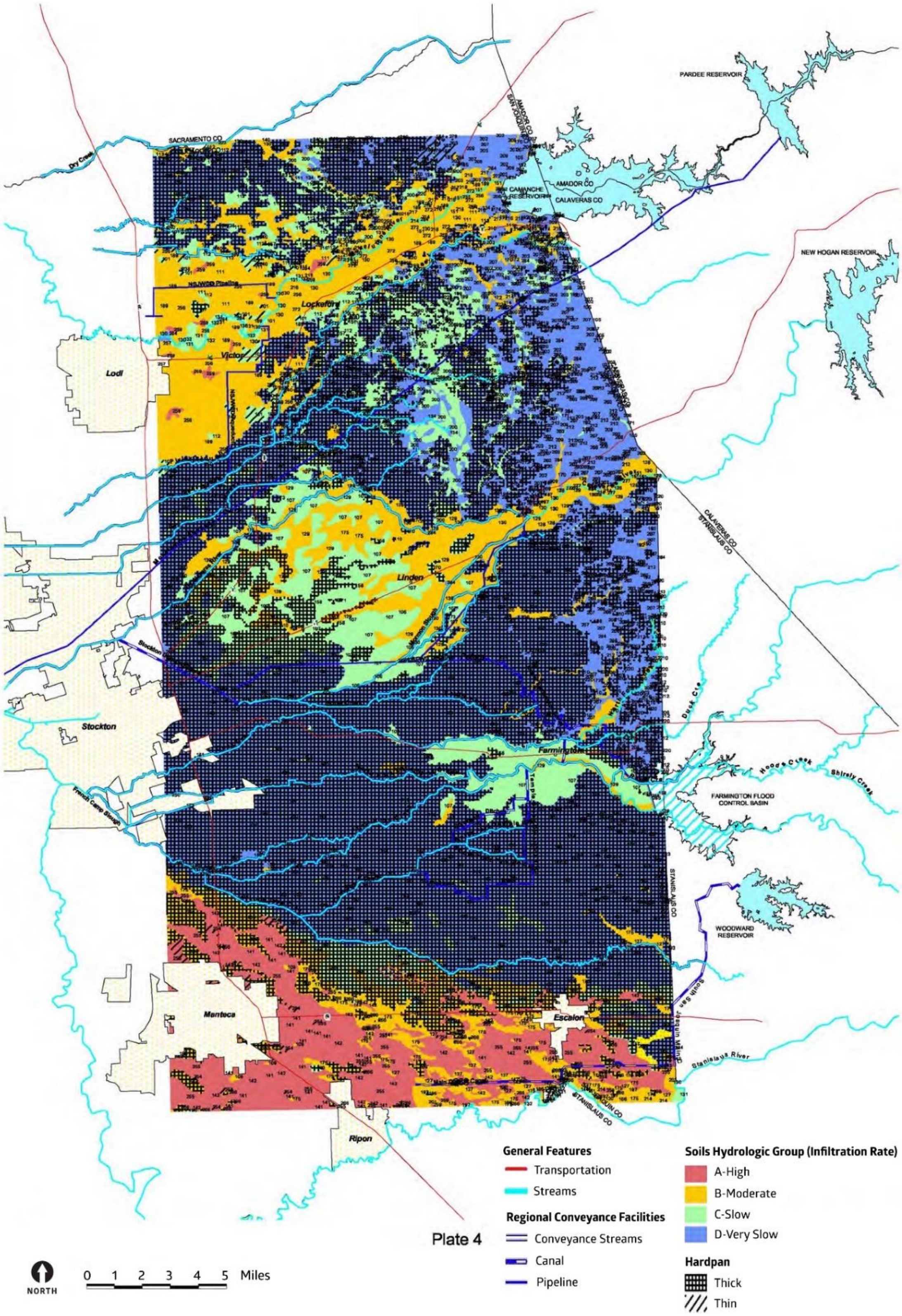


Figure 2-12: Occurrence of Hardpan within the Eastern San Joaquin Subbasin



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 2.4.

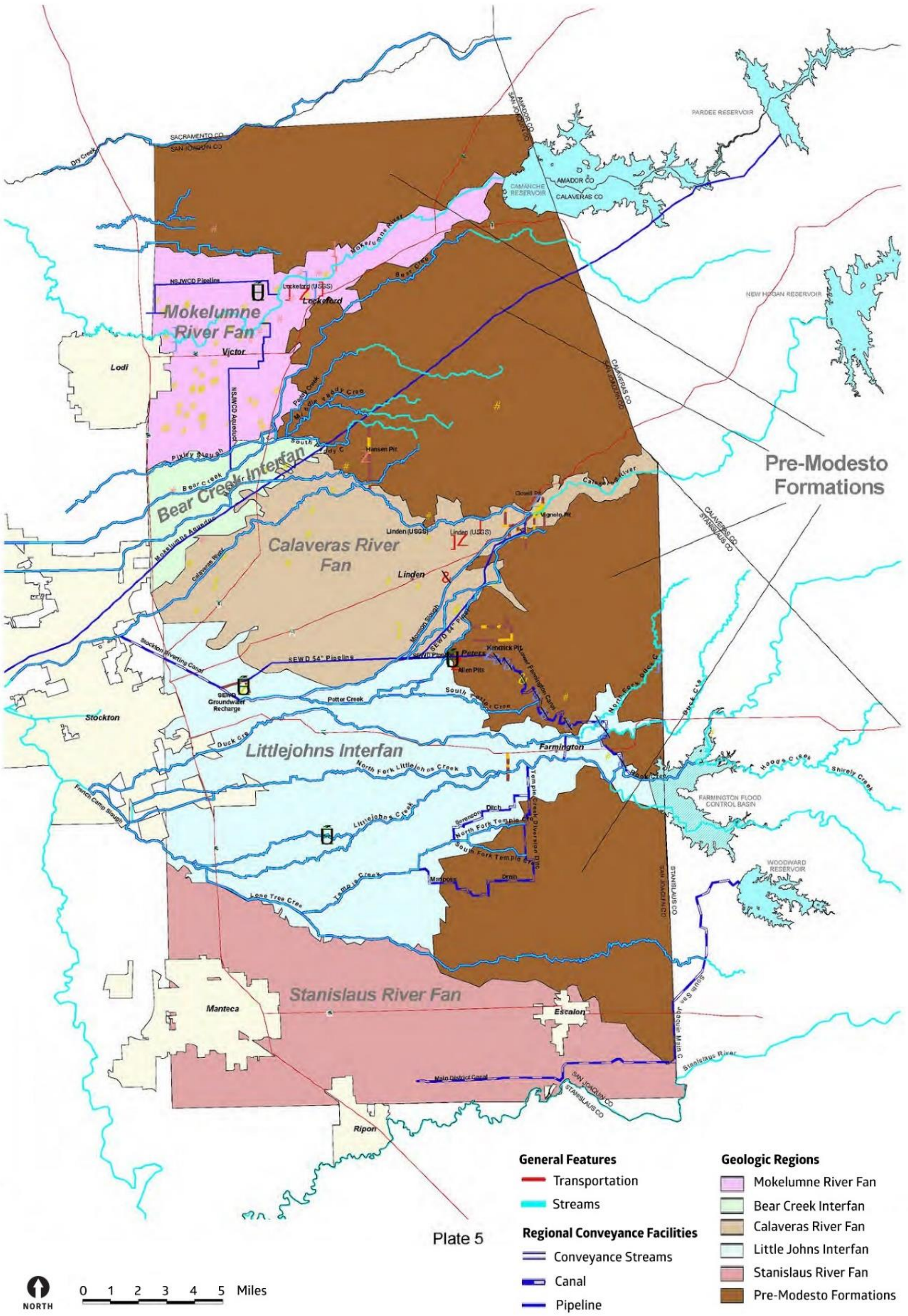
2.1.4.5.1 Description of Recharge Areas

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 2-13 depicts the aerial extents of the alluvial fans, interfan areas, and pre-Modesto formations.

Figure 2-13: Areal Extents of Alluvial Fans, Interfans, and Pre-Modesto Formations

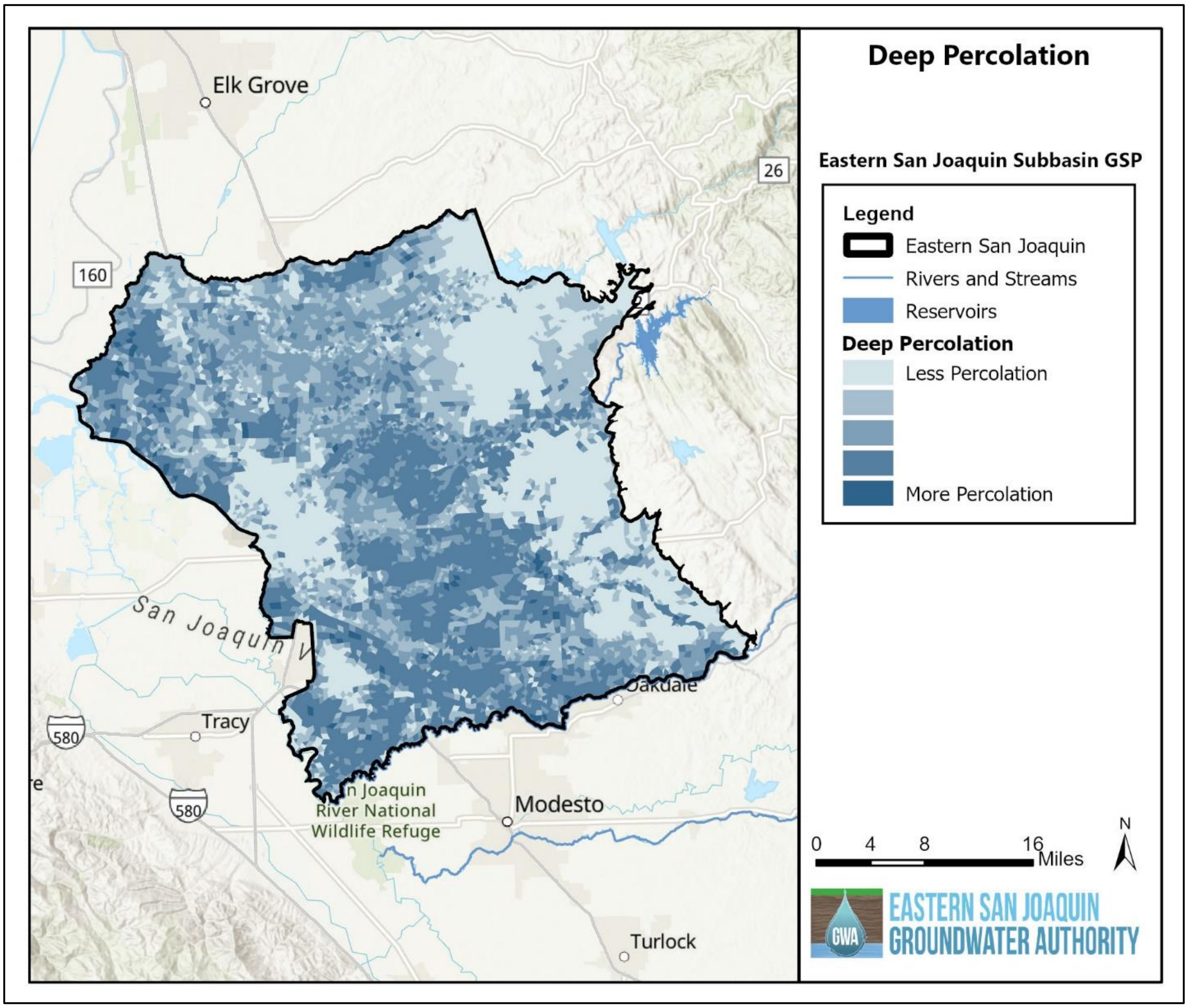


Within this overall framework, the alluvial fans of each drainage contain coarse-grained channel and levee deposits of relatively high permeability within finer-grained overbank and floodbasin deposits of low permeability. Stream channels migrate and abruptly jump to new locations over time in this depositional 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 2-14 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 conjunctive use programs that were in place prior to the implementation of SGMA, and Figure 1-16, shown previously in Chapter 1: Agency Information, Plan Area, and Communication, maps direct recharge areas in the Subbasin.

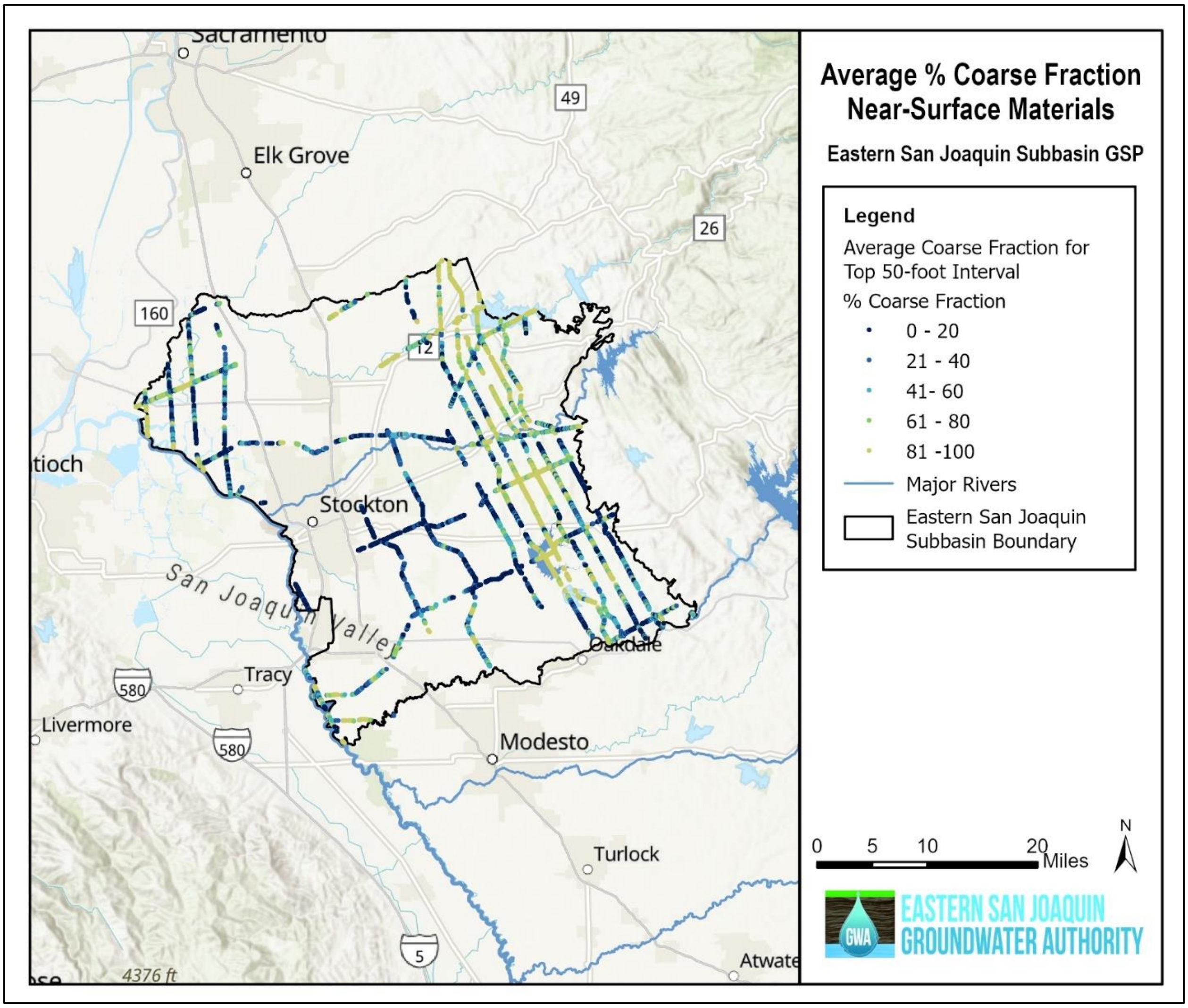
DWR's texture interpretation of the AEM data provided an additional data source for evaluating near-surface conditions in terms of percent coarseness of the material. Figure 2-15 shows the average percent coarseness (coarse fraction) in the top 50 ft of the subsurface along the survey flight lines. Darker blues represent finer material, while greens and yellows represent coarser material. On the eastern side of the Subbasin, where the alluvial fans identified in Figure 2-13 lie, the resistivity data indicate that the near-surface material is relatively coarser than in other areas of the Subbasin. This is consistent with general understanding of alluvial fan structure, where coarser materials are found further east where the gradient is higher. Increasingly to the west, the material becomes increasingly finer. Resistivity-based coarse fraction data complements ESJWRM model output, Hydrologic Soil Group mapping, Soil Agricultural Groundwater Banking Index (SAGBI) mapping, and geologic maps to identify areas in which natural groundwater recharge is occurring.

Figure 2-14: Existing Areas of Groundwater Recharge (ESJWRM Version 3.0)



Note: Figure shows the distribution of deep percolation of precipitation and applied water based on ESJWRM Version 3.0 model outputs. It does not include recharge from rivers and streams, boundary flows, or recharge projects.

Figure 2-15: Average Percent Coarse Fraction in Near-Surface Materials



2.1.4.5.2 Description of Discharge Areas

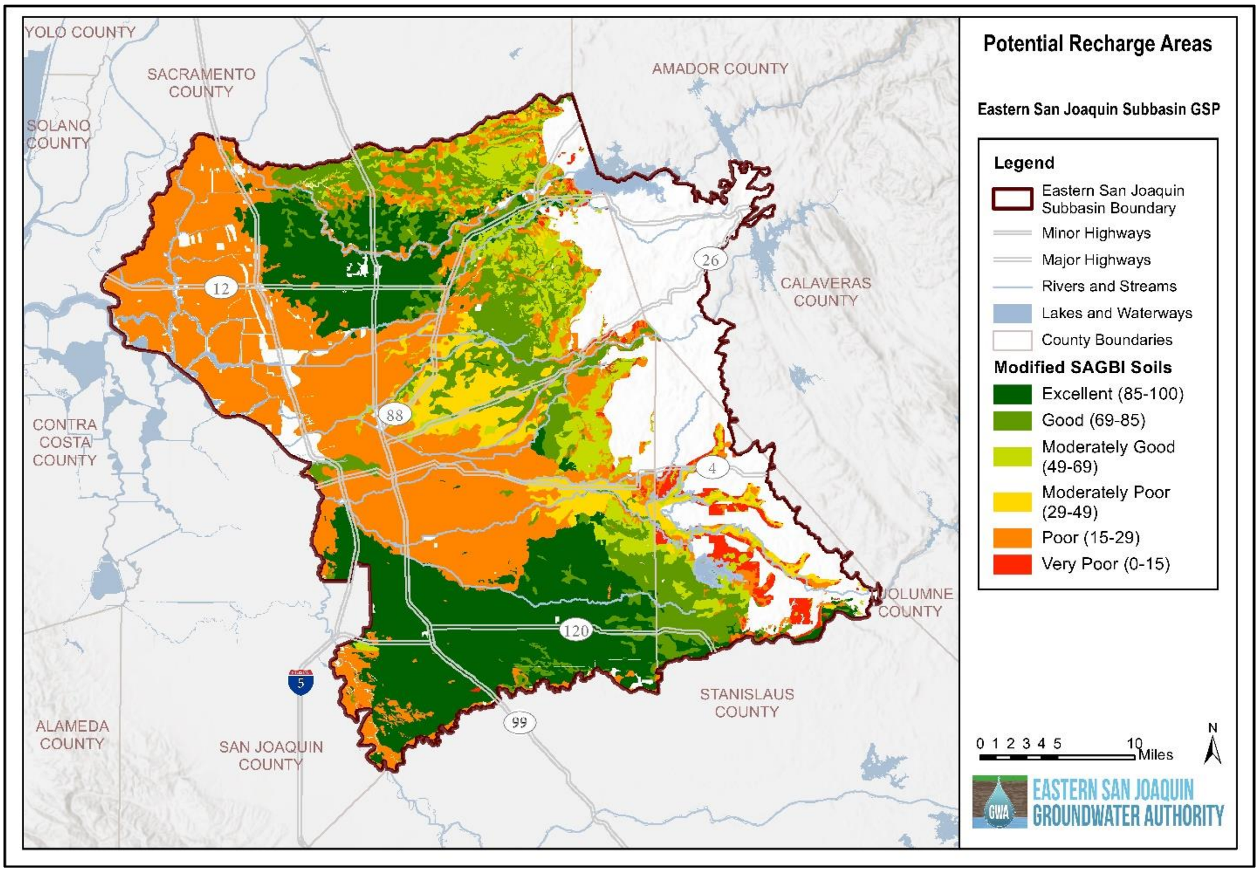
Groundwater discharge primarily occurs through groundwater production wells. Groundwater production in Eastern San Joaquin Subbasin is discussed further in Section 2.2. Groundwater also discharges to rivers and streams where groundwater elevations are higher than river stage. Other sources of groundwater 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 analyses based on modeling results from the ESJWRM for approximately 1,700 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 2-16 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 2-16: Potential Recharge Areas



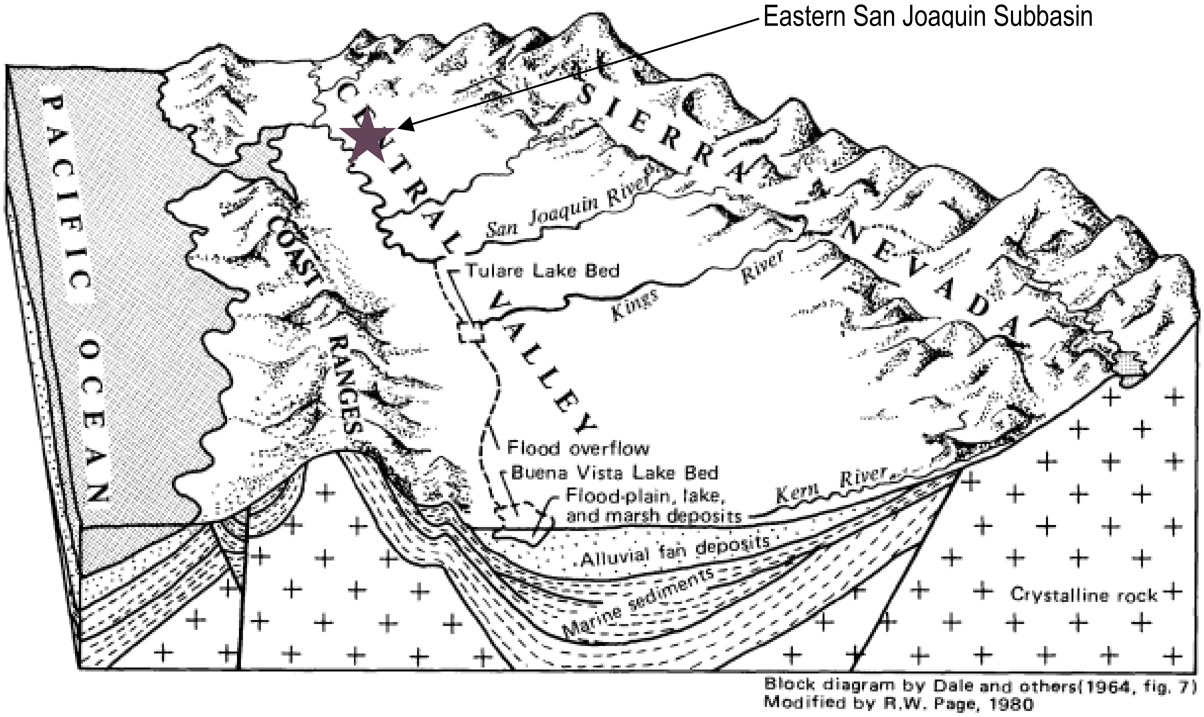
2.1.5 Geologic Formations and Stratigraphy

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 2-17) 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 2-17, and the granitic Sierra Nevada geomorphic province, labeled "Sierra Nevada" in Figure 2-17.

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 2-17: 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 Formations are characterized by 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 2-18 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 2-18: Geologic Map

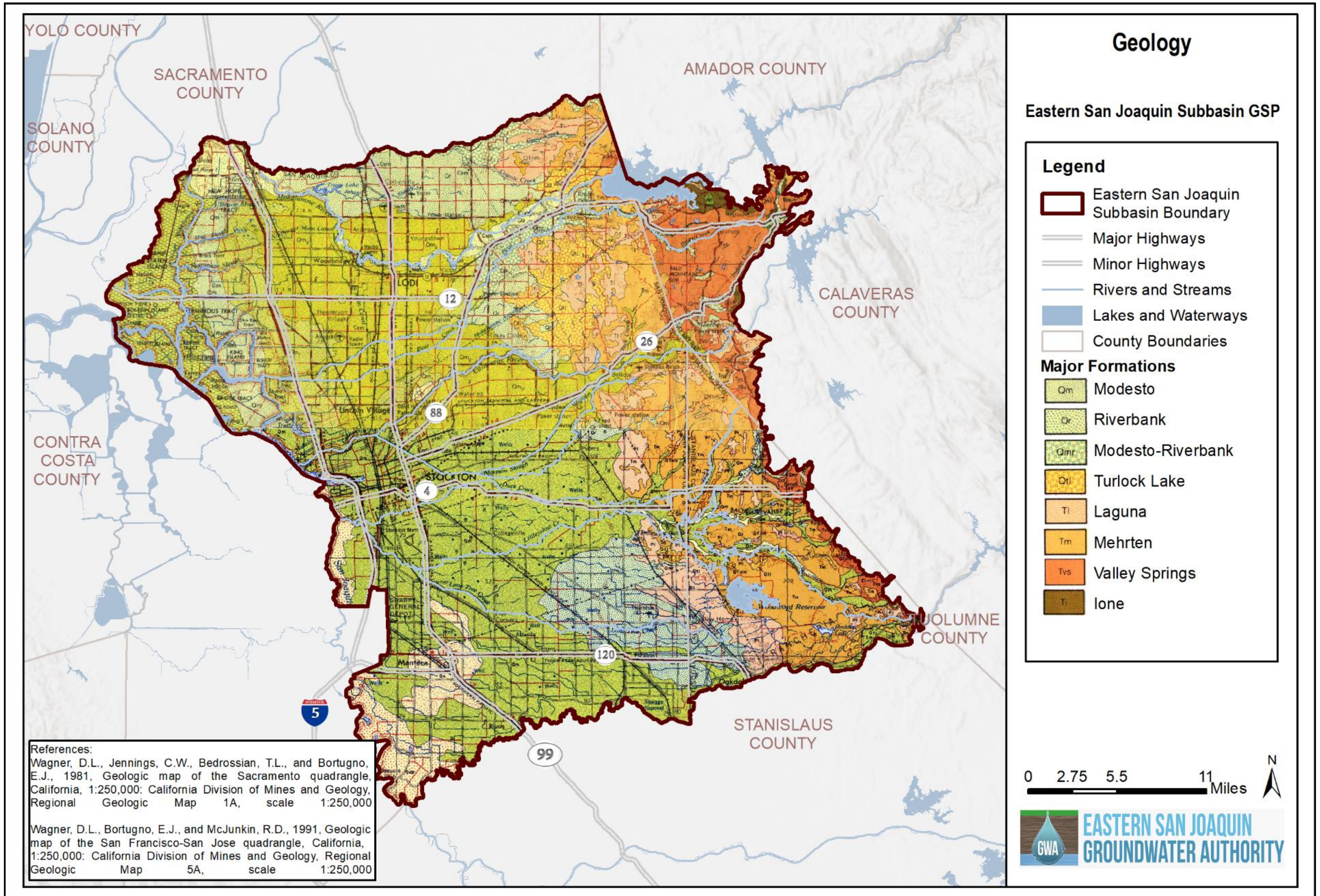


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Table 2-2: Generalized Stratigraphic Column, Formation Descriptions, and Water-Bearing Properties

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.
CENOZOIC	*Quaternary*	Late Pliocene	Modesto (Qm)	65-130±	Continental fan and interfan material, locally some basin types, lenticular gravel, sand, silt, clay.	Moderate permeabilities. Unconfined aquifer.
CENOZOIC	*Quaternary*	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.
CENOZOIC	*Quaternary*	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.
CENOZOIC	*Tertiary*	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.
CENOZOIC	*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.
CENOZOIC	*Tertiary*	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.
CENOZOIC	*Tertiary*	Eocene	Ione (Tl)	0-500±	Light colored clay and sand. Marine shale, siltstone and sandstone	Contains saline waters except where flushed in outcrop areas.
MESO ZOIC	*Creta-ceous*	Cretaceous Jurassic	Undifferentiated Bedrock		Igneous, metamorphics and ultramafics.	Contains saline waters. Not relevant to fresh water basin except as possible contaminant source.
MESO ZOIC	*Pre-Cretace-ous*					

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 Mehrten 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 that 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 produce water 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 Formation and is not found in the central and northern portions of the Subbasin. The Corcoran Clay 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).

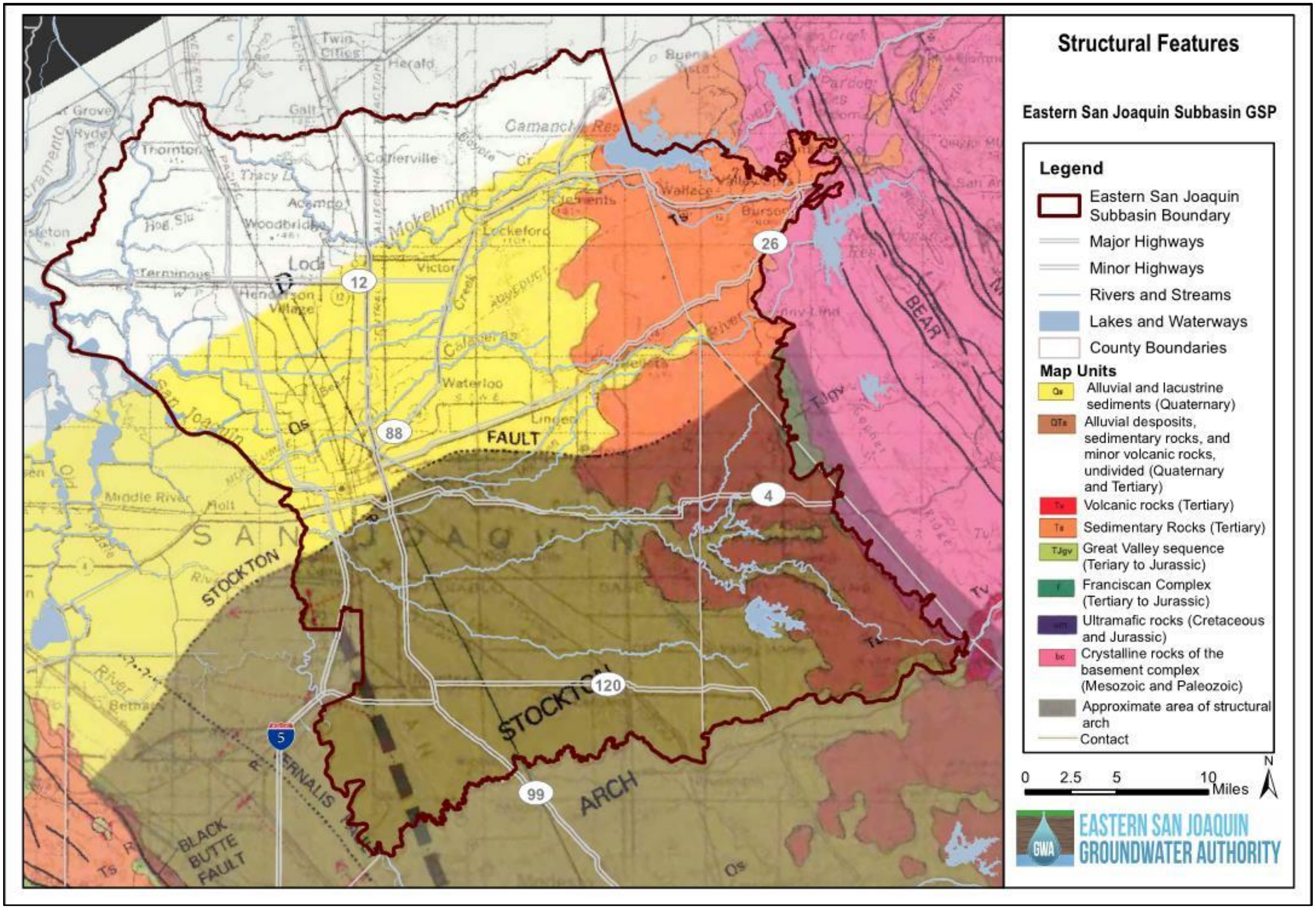
2.1.6 Faults and Structural Features

The Stockton Fault – The Stockton Fault is the largest fault in the Eastern San Joaquin Subbasin, shown in Figure 2-19. 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 2-20. 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.

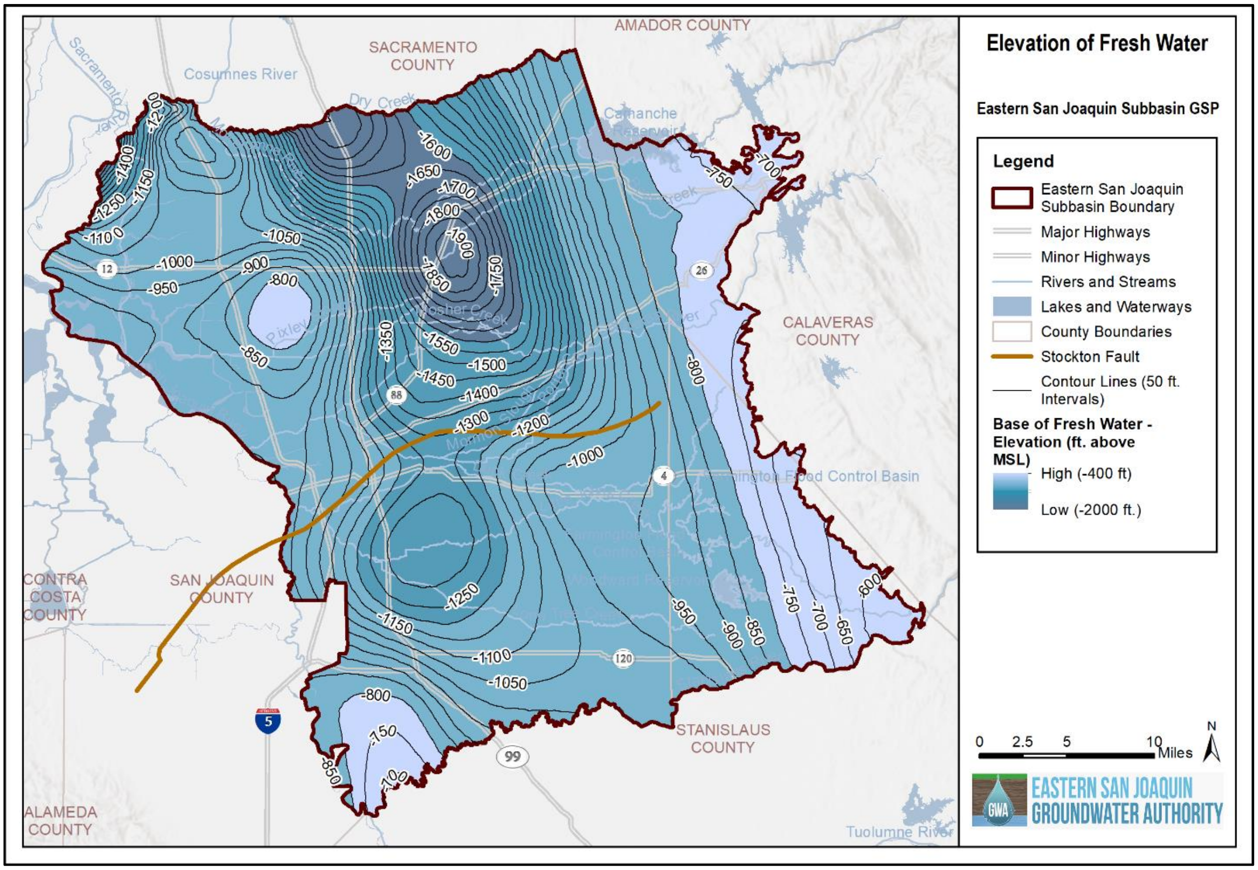
Stockton Arch – The Stockton Arch is a broad transverse structure that underlies the southern half of the Eastern San Joaquin Subbasin. The arch is bounded on the north by the Stockton Fault, and the southern limit is the line of truncation of Paleogene strata south of Modesto (Bartow, 1985). Indications 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 2-19: 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 2-20. The base of fresh water is discussed further in Sections 2.1.7 and 2.1.8.2.

Figure 2-20: 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 feet/mile) and the Valley Springs Formation (94 - 120 feet/mile), between the Mehrten Formation (99 - 131 feet/mile) and the Laguna Formation (52 - 79 feet/mile), and between the Laguna Formation and the Quaternary deposits (less than 18 feet/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 2-21. 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 2-22, Figure 2-23, and Figure 2-24.

Four additional cross-sections (F-F', G-G', H-H', and I-I') were added as part of the 2024 Amended GSP, following the release of DWR's AEM data. To supplement the existing cross-sections by geologic formation, these additional cross-sections show an estimate of percent coarseness of the subsurface material. Percent coarseness estimations were developed by DWR, derived from AEM resistivity data through a comprehensive translation process in which texture characteristics of the subsurface are related to the collected resistivity measurements. Cross-sections by coarse fraction represent multiple flown survey lines stitched together to show a continuous line. Darker brown areas represent relatively finer materials (lower coarse fraction) and lighter yellow areas represent coarser materials (higher coarse fraction). Lithology logs used by DWR to generate the texture interpretation of the resistivity data are included on each cross-section. Figure 2-25 shows the locations of these four additional cross-sections. Cross-sections F-F', G-G', H-H', and I-I' are included in Figure 2-26, Figure 2-27, Figure 2-28, Figure 2-29, respectively.

Figure 2-21: Cross-Section, by Formation, Location Map

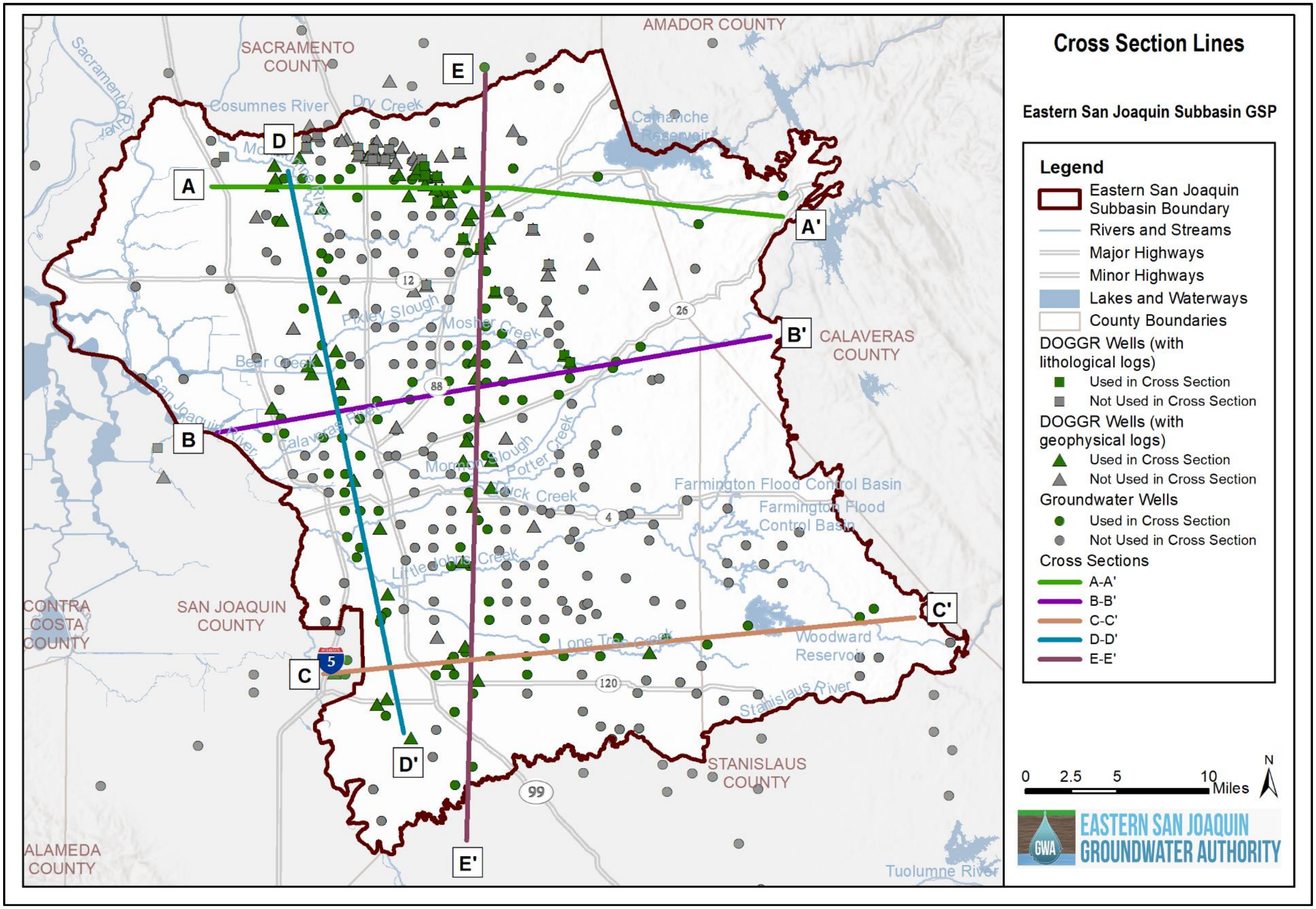


Figure 2-22: Hydrogeologic Cross-sections A-A' and B-B'

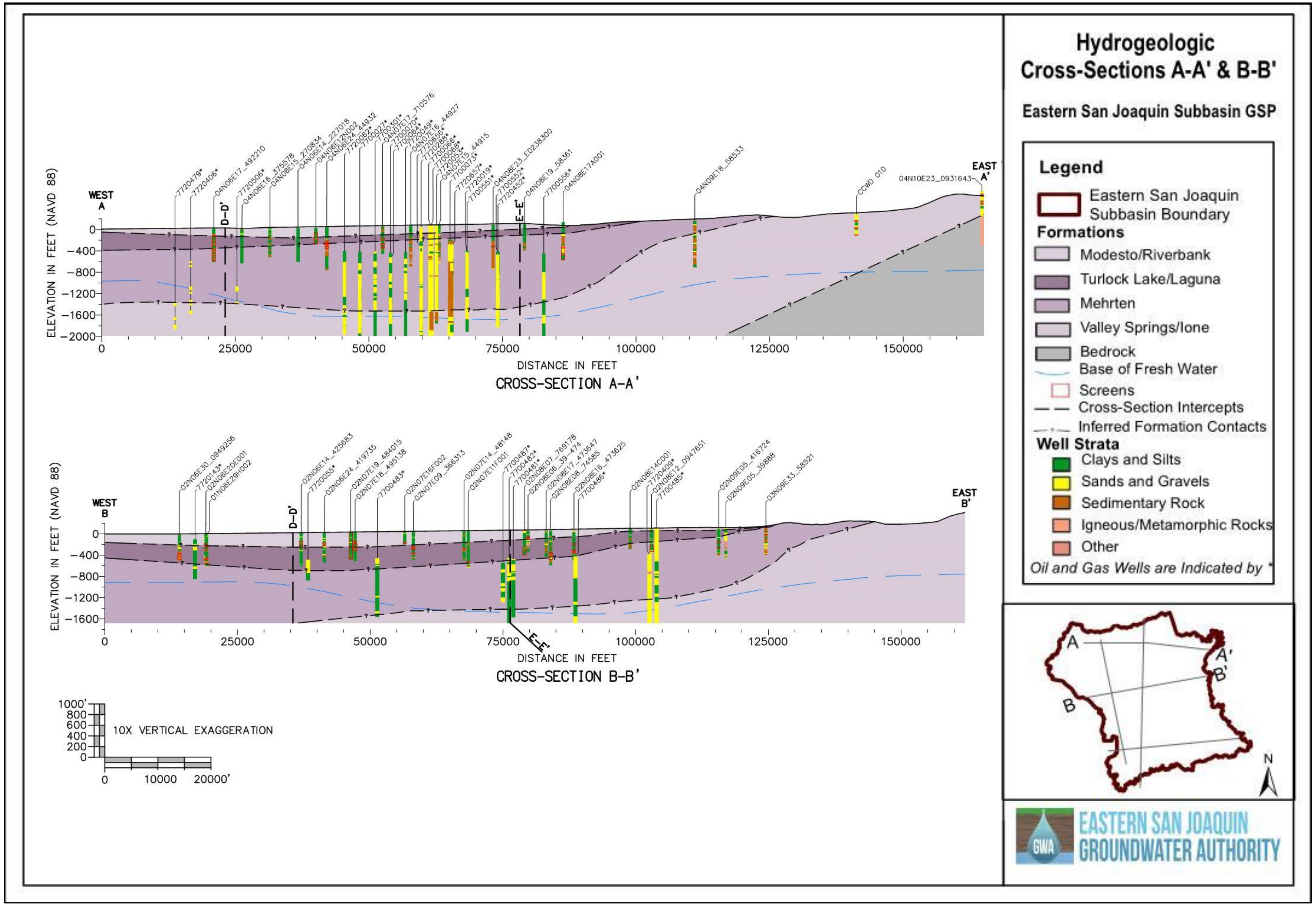


Figure 2-23: Hydrogeologic Cross-sections C-C' and D-D'

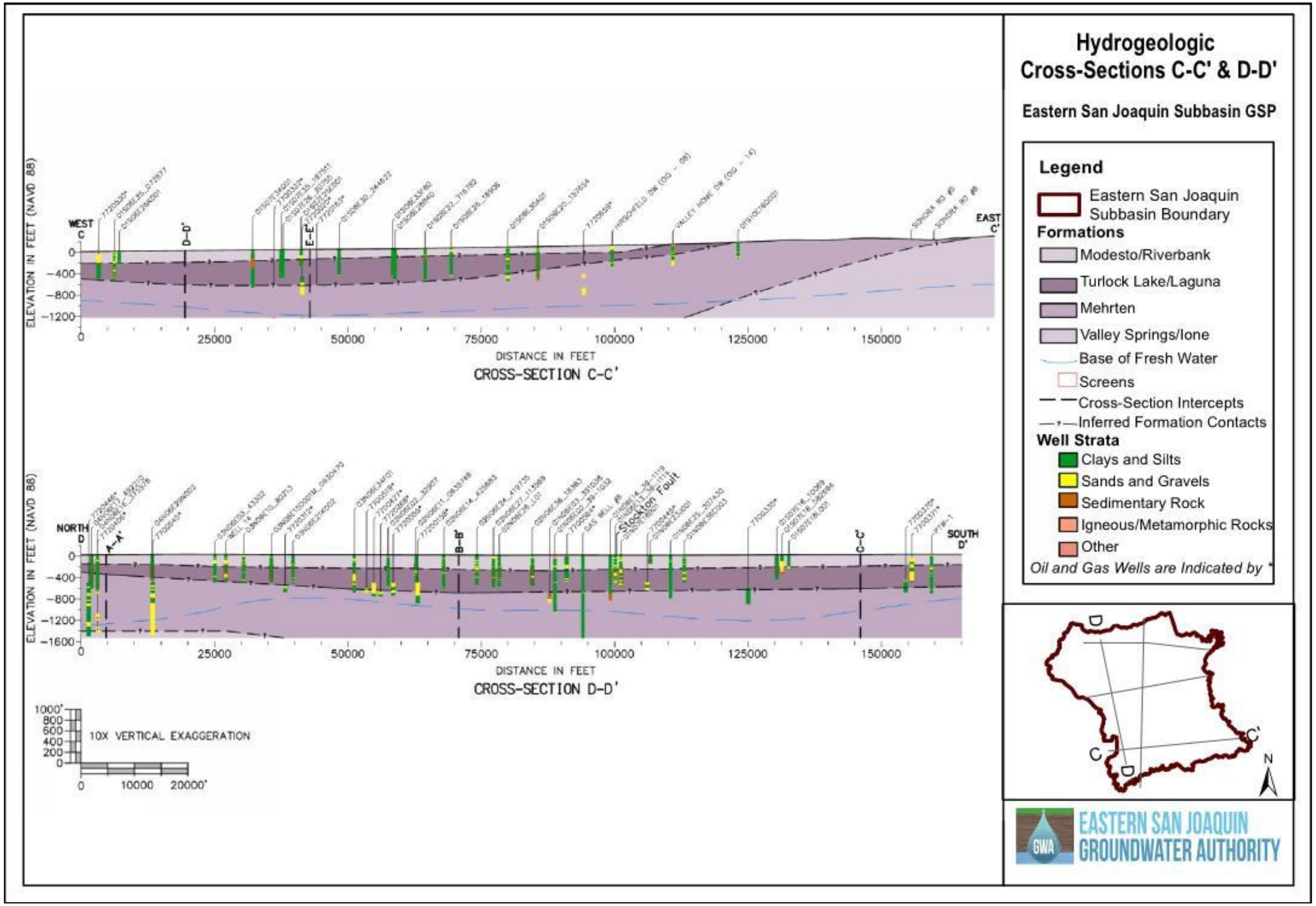


Figure 2-24: Hydrogeologic Cross- section E-E’

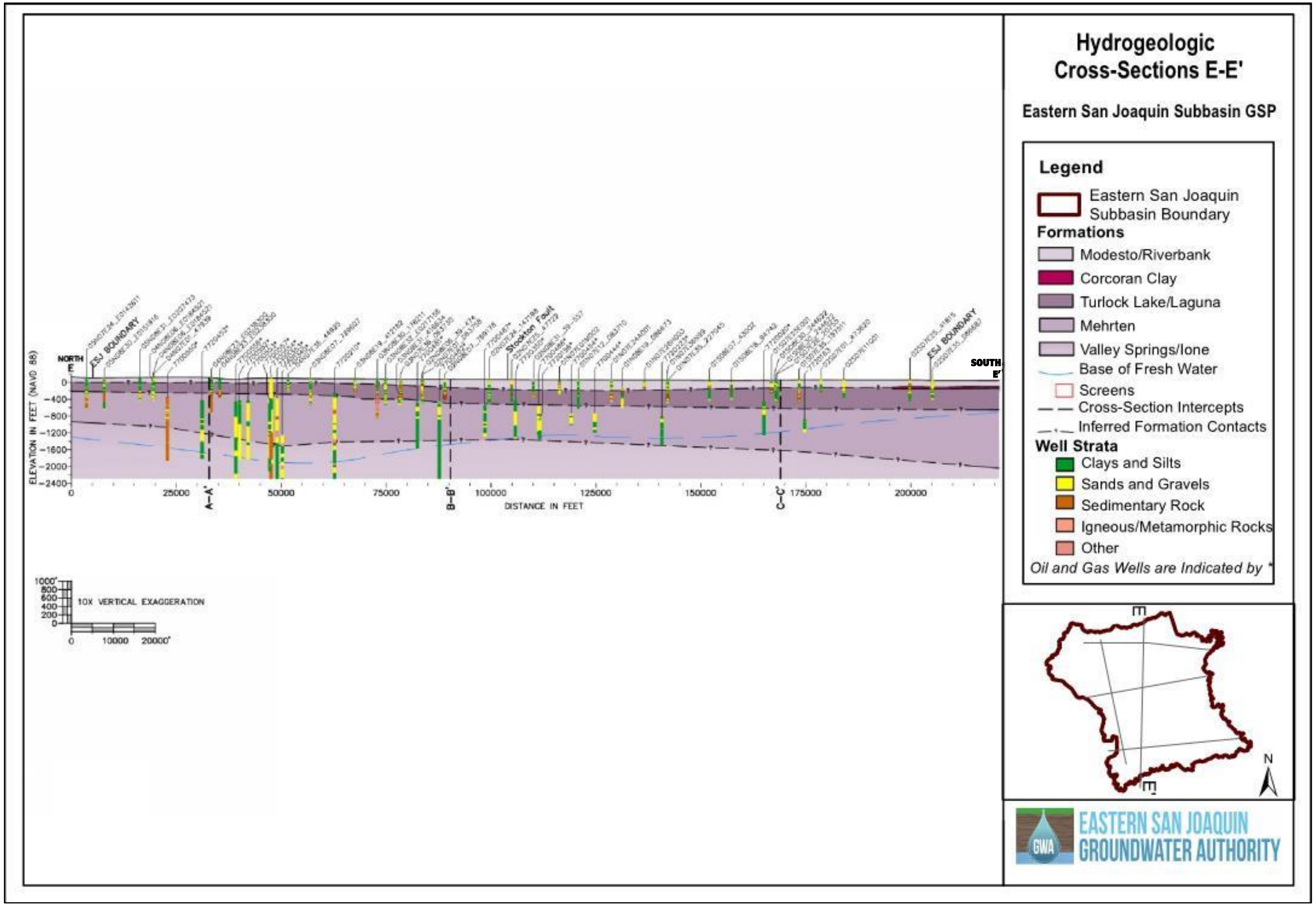


Figure 2-25: Cross-Section, by Percent Coarseness, Location Map

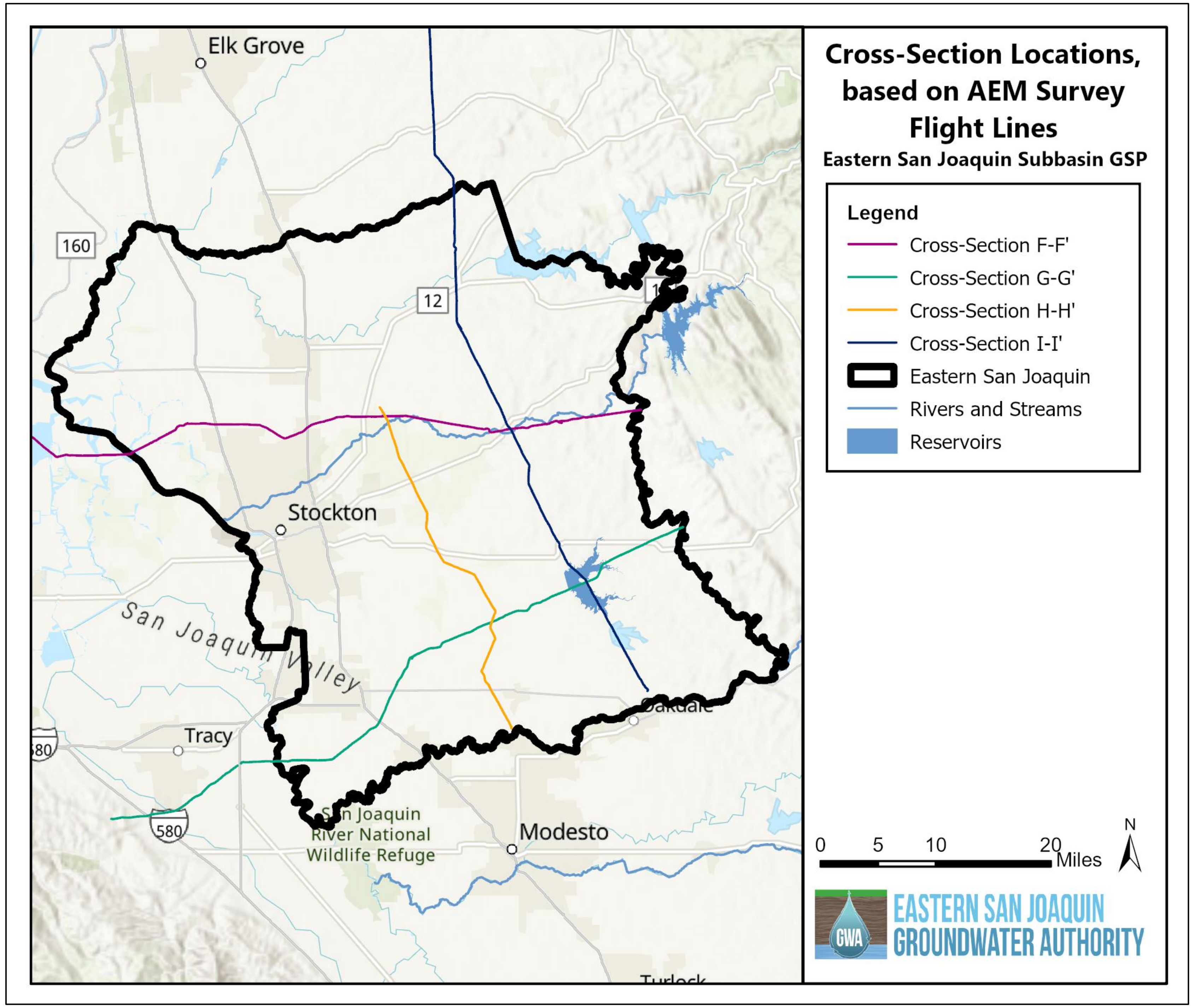


Figure 2-26: Percent Coarse Cross-Section F-F'

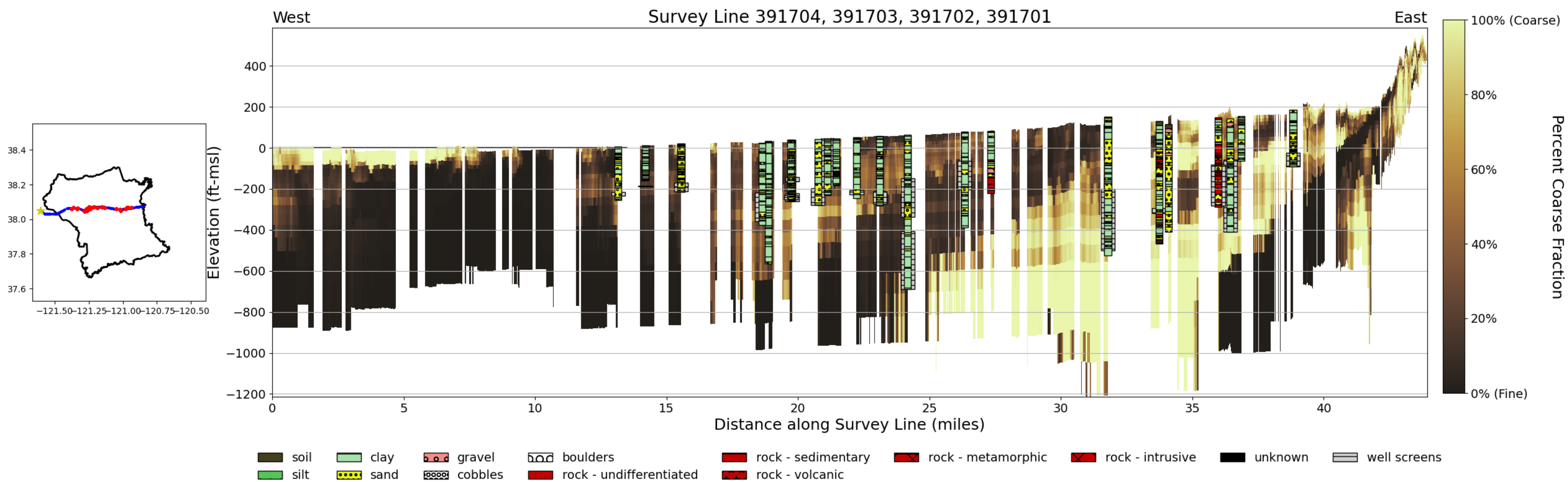


Figure 2-27: Percent Coarse Cross-Section G-G'

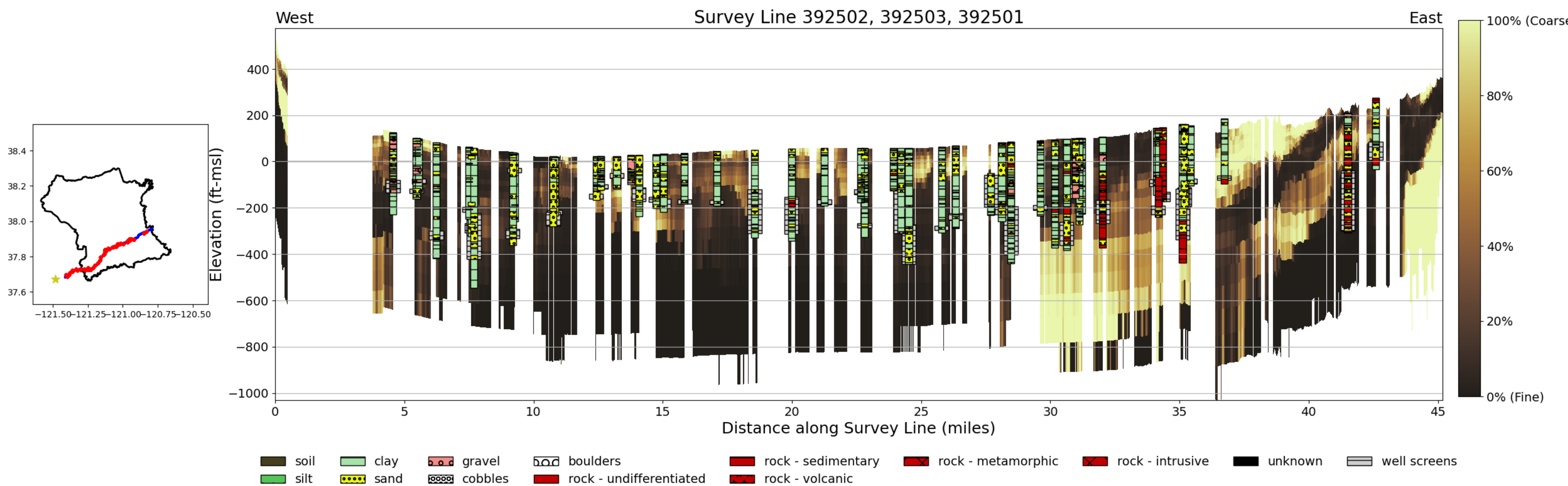


Figure 2-28: Percent Coarse Cross-Section H-H'

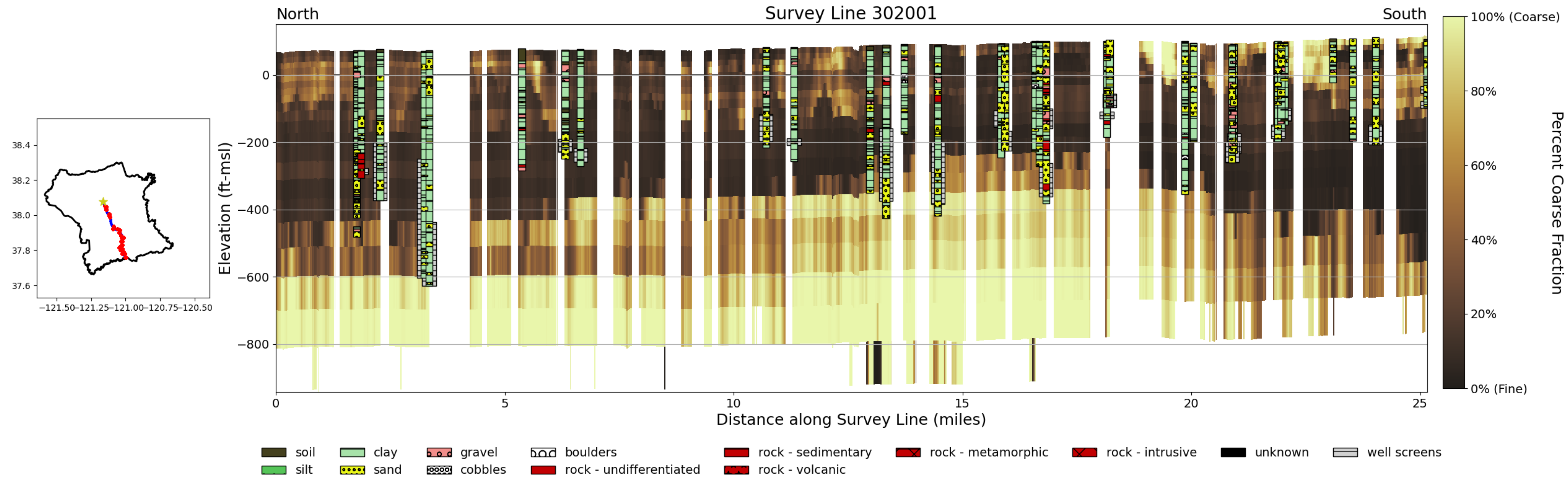
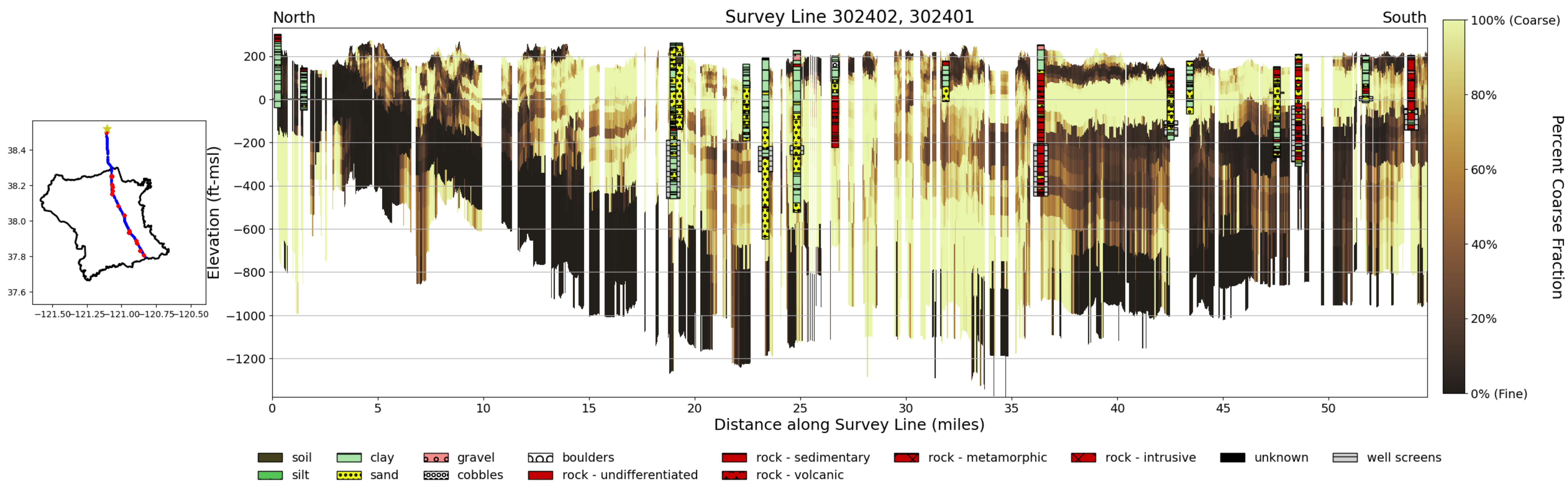


Figure 2-29: Percent Coarse Cross-section I-I'



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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 2-20. 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 Formation, and the Laguna Formation 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 1-5 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 2-20, 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 2-22 through Figure 2-24). Cross-sections were based on over 330 well logs in the Subbasin. From these 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 preparing 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

Analyses 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

These results were cross-checked with the AEM data to validate the texture of shallow deposits, such as alluvial fans and sediments that interact with streams, and were used in updates to the hydrogeological conceptual model and the ESJWRM model stratigraphy. See Appendix 2-C for more detail on how AEM texture data were incorporated into the representation of Subbasin hydrostratigraphy.

Figure 2-30 and Figure 2-31 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 2-30: Bottom Elevation of Water-Bearing Zones (Shallow)

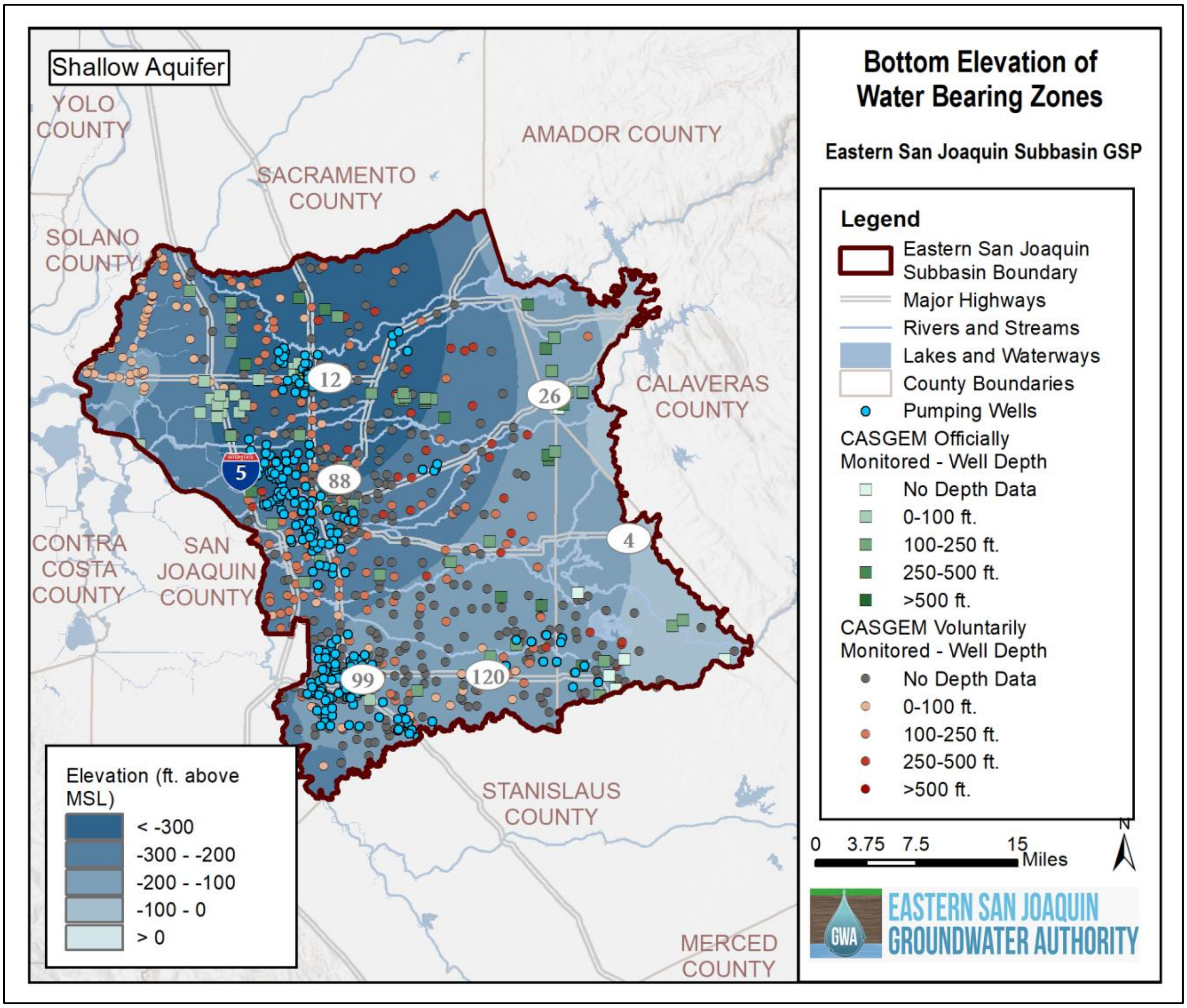
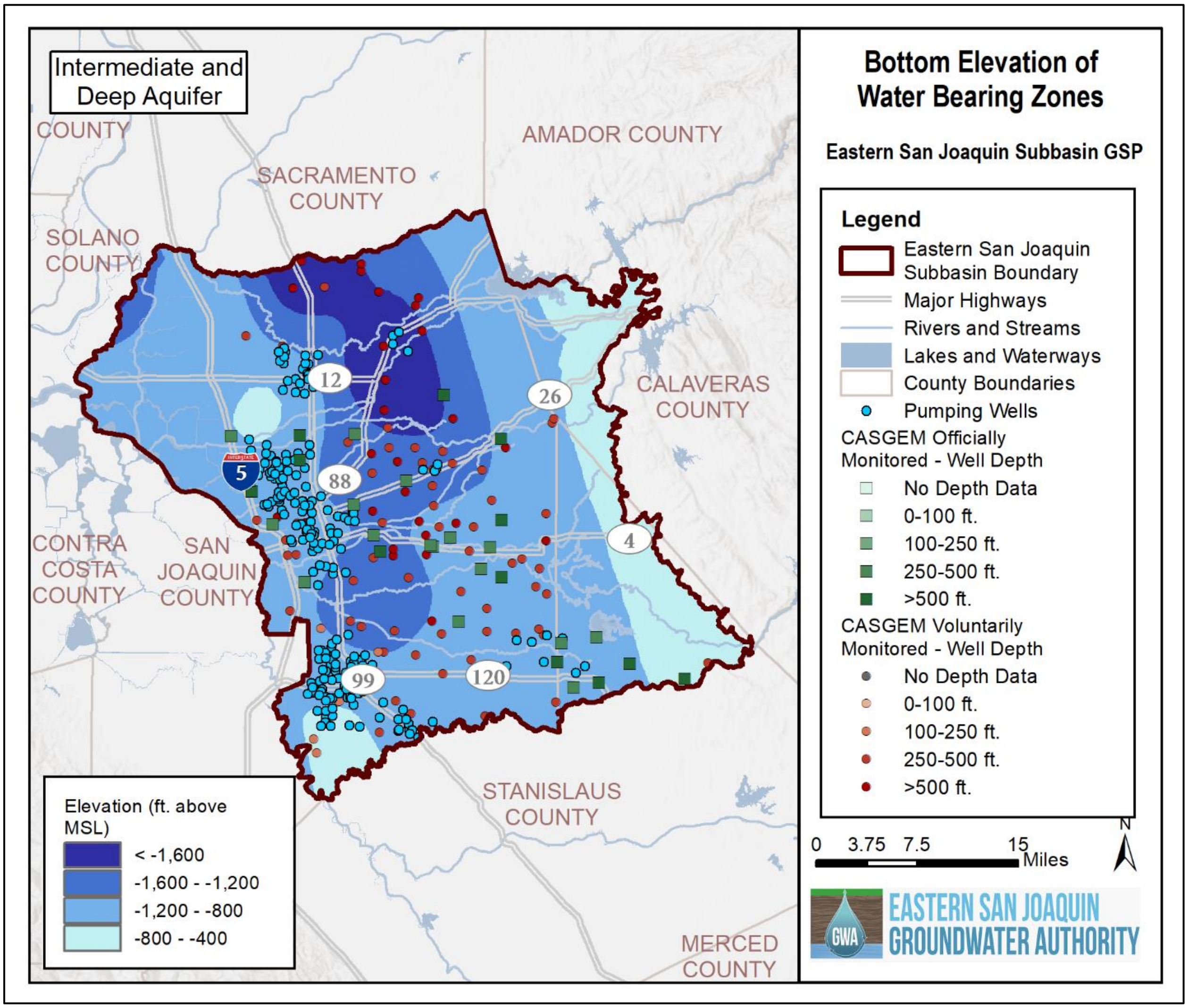


Figure 2-31: Bottom Elevation of Water-Bearing Zones (Deep and Intermediate)



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 2-22, Figure 2-23, and Figure 2-24). 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 and AEM texture data. This zone has high yielding wells. Aquifer characteristic values range as follows (CA DWR, 1967; Burow et al., 2004):

- Transmissivities up to 90,000 gpd/feet

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

2.1.9.1.2 Intermediate Zone

As depicted on the hydrogeologic cross-sections A-A’ through E-E’ (see Figure 2-22, Figure 2-23, and Figure 2-24), 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 under semi-confined conditions 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 gallons per day (gpd)/feet
- Storage coefficients typically 0.00001 (unitless)
- Vertical permeability estimates up to of 0.07 feet/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 2-22, Figure 2-23, and Figure 2-24). 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 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 2-22, Figure 2-23, and Figure 2-24), 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/feet
- Storage coefficients that are typically 0.0001
- Vertical permeability estimates up to of 0.05 feet/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. 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 2-22, Figure 2-23, and Figure 2-24) 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).

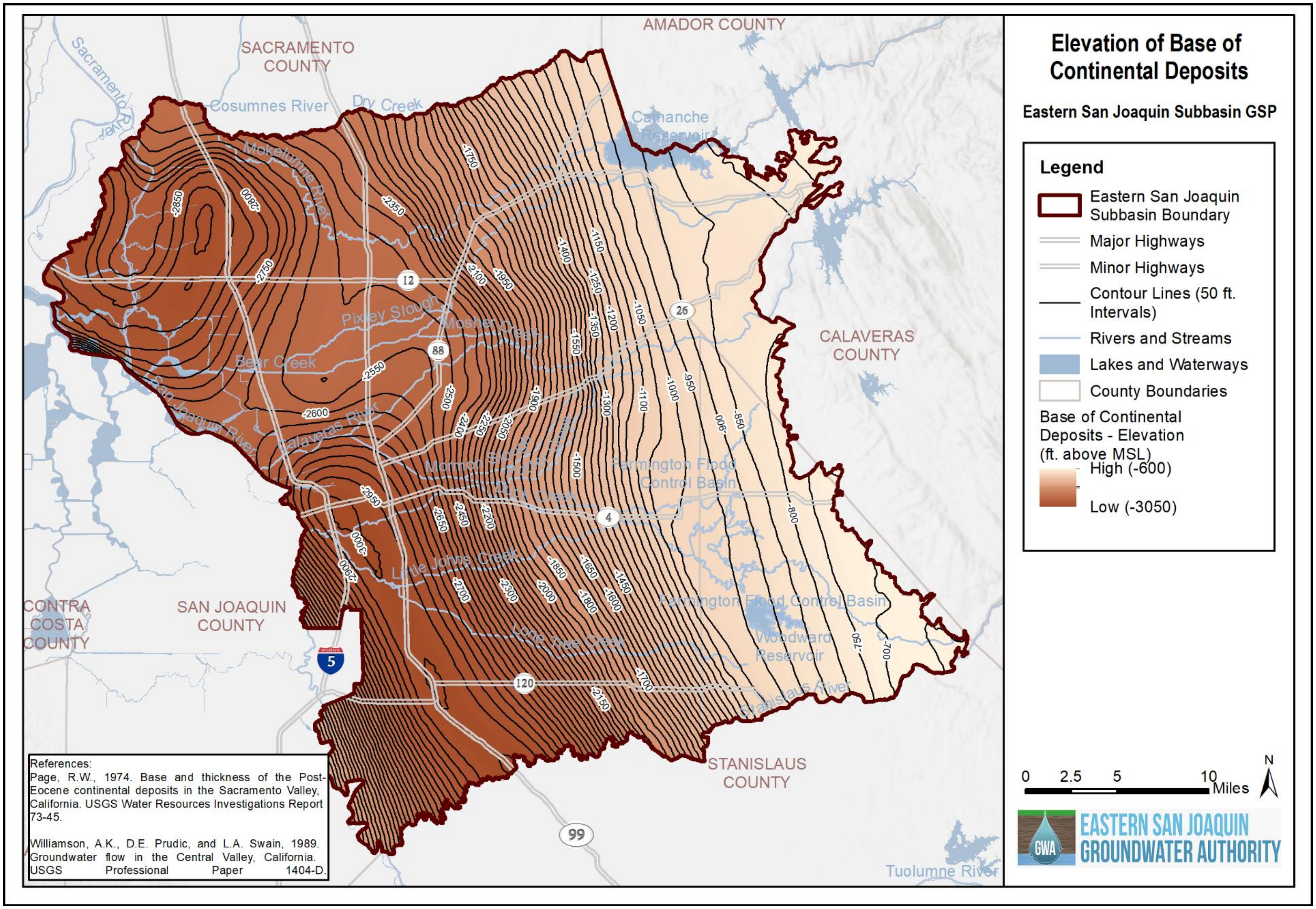
Discontinuous clay horizons have been eroded significantly by the movement of the ancestral rivers. As depicted on the cross-sections, thickest sequences of uppermost permeable units and overbank fines below these layers have been observed. The general thickness and depth are supported by a southeast 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 2-20 or Figure 2-31) to the base of continental deposits (shown in Figure 2-32), 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 2-32: 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 2-33. 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 riverbeds. 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 2-33: Sand and Gravel Isopach Map

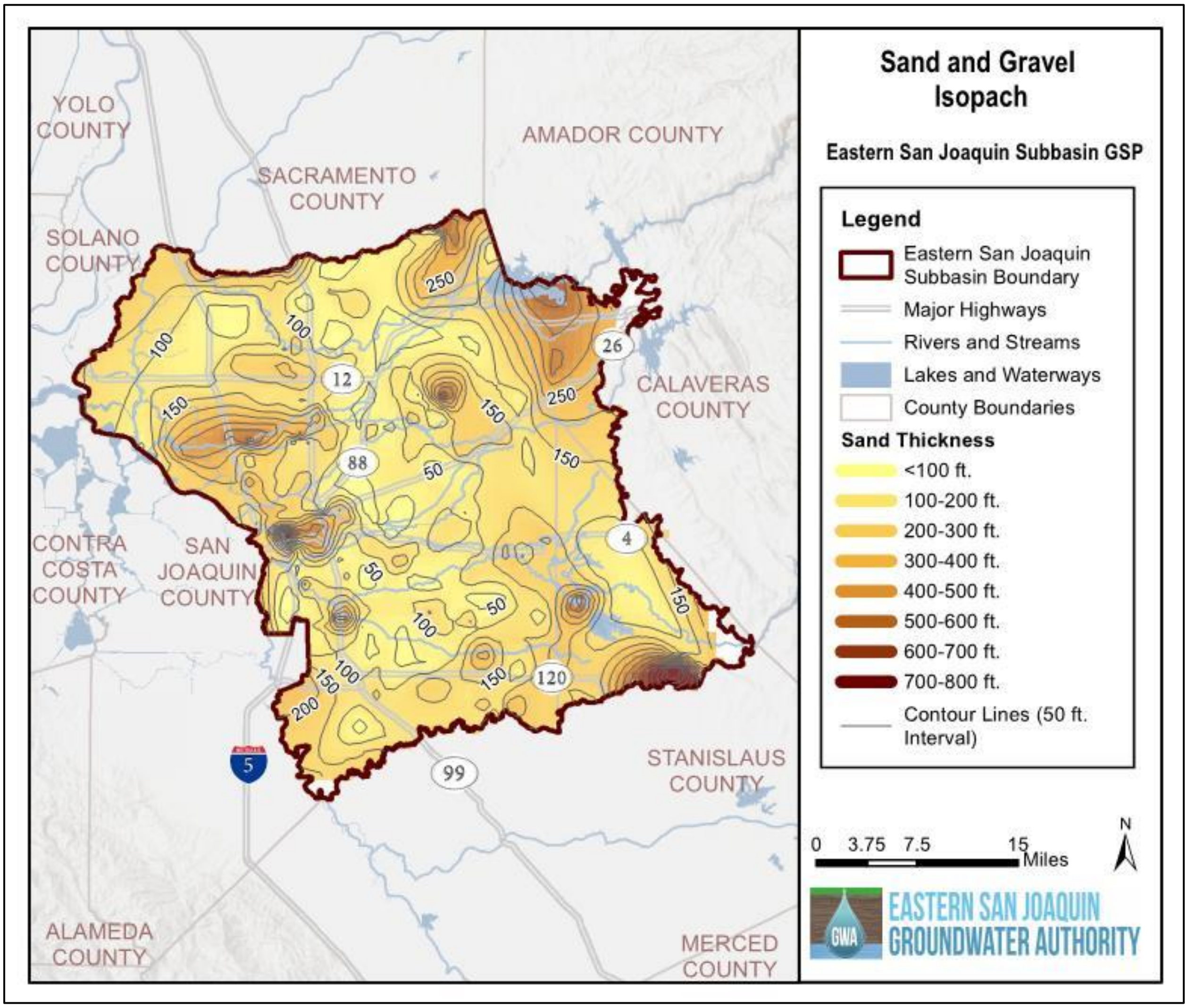


Table 2-3: Production Zone Capacities

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/feet^2 and a thickness of 120 feet, the aquifer transmissivity averages approximately 60,000 gpd/feet, which is similar to the documented values reported above (Freeze and Cherry, 1979). For additional comparison, data for the five layers of the ESJWRM were provided in the ESJWRM Model Report and Version 3.0 Model Documentation Updates TM (see Appendix 2-A and Appendix 2-C, respectively)

The distribution of production wells and monitoring wells is provided on Figure 2-30 and Figure 2-31. 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):

- Horizontal Hydraulic Conductivity – The horizontal hydraulic conductivity varies across the non-saline model layers ranging from 1.1 ft/day to 72.7 feet/day or 0.148 to 10 gal/day/feet^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

All Wells			
Water-Bearing Zone	Number of Wells	Average Construction Depth (feet bgs)	Average Construction Bottom Elevation (feet MSL)
Shallow	452	165	-82
Intermediate and Deep	201	539	-411
Pumping Wells			
Water-Bearing Zone	Number of Wells	Average Bottom of Screen Depth (feet bgs)	Average Bottom of Screen Elevation (feet MSL)
Shallow	148	270	-238
Intermediate and Deep	113	369	-300
Groundwater Wells Used in Cross-Sections, by Formation			
Water-Bearing Zone	Number of Wells	Average Bottom of Borehole Depth (feet bgs)	Average Bottom of Borehole Elevation (feet MSL)
Shallow	39	234	-144
Intermediate and Deep	273	672	-566

2.1.9.2.2 Regional Historical 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 west 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 a 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-seven 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 in 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 portion of 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 2-18, Figure 2-22, Figure 2-23, and Figure 2-24). 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).

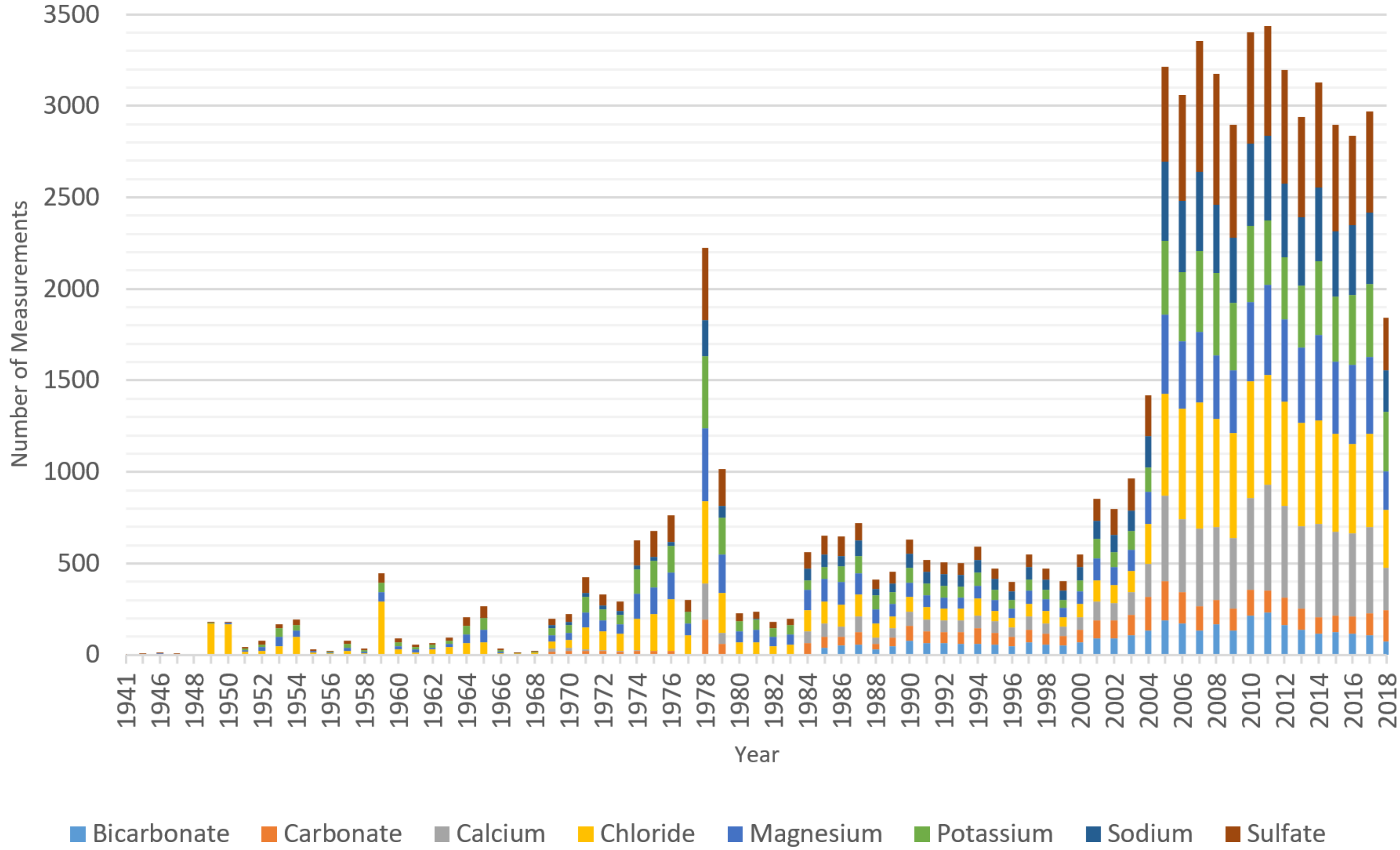
General water quality of principal aquifers is summarized in the following sections, as required by CCR Title 23 §354.14. General water quality can be determined by assessing commonly measured inorganic parameters as indicators of change. Evaluating these inorganic parameters involves looking at historical 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 2-34. This analysis was not updated as part of this GSP amendment as basic groundwater chemistry reflects the geology of origin, which has not varied considerably since the preparation of the 2020 GSP.

Figure 2-34: Total Number of Cation/Anion Measurements in the Eastern San Joaquin Subbasin

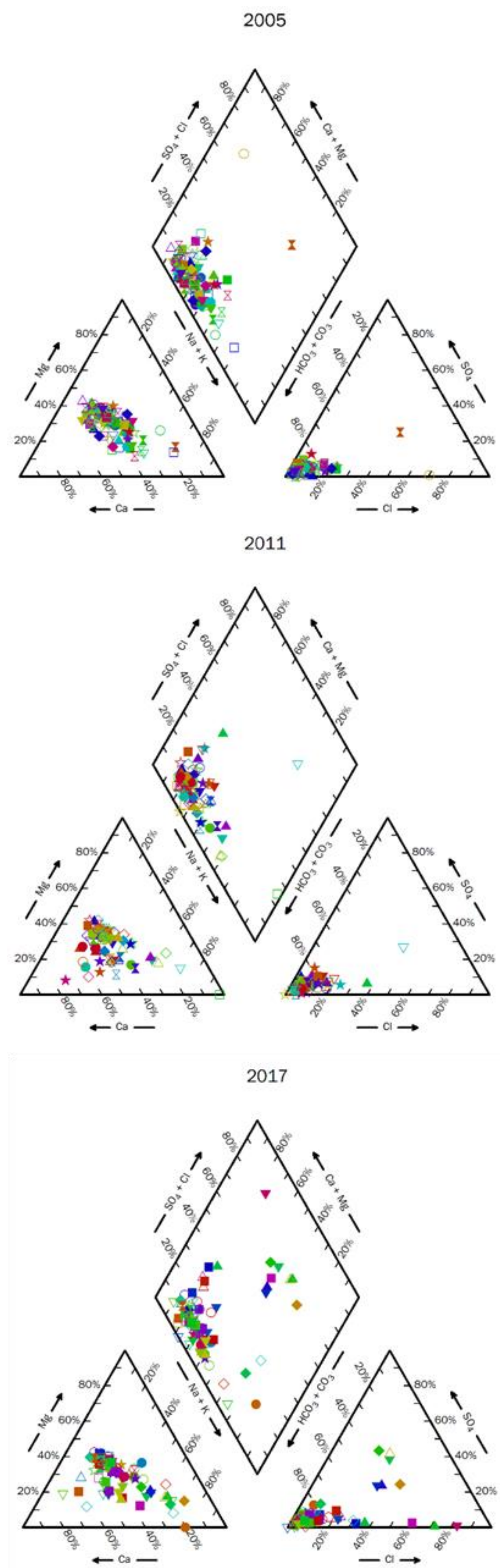


General water quality of the Subbasin can be determined by assessing water type over specific years, in this case, within the time frame of 2005 to 2017. Evaluating the years 2005, 2011, and 2017 provides an even spread over the selected time frame and gives an idea of possible water type trends. Trilinear diagrams for each of these years show relative concentrations of the major cations and anions (see Figure 2-35). 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.

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 (Historical Groundwater Conditions).

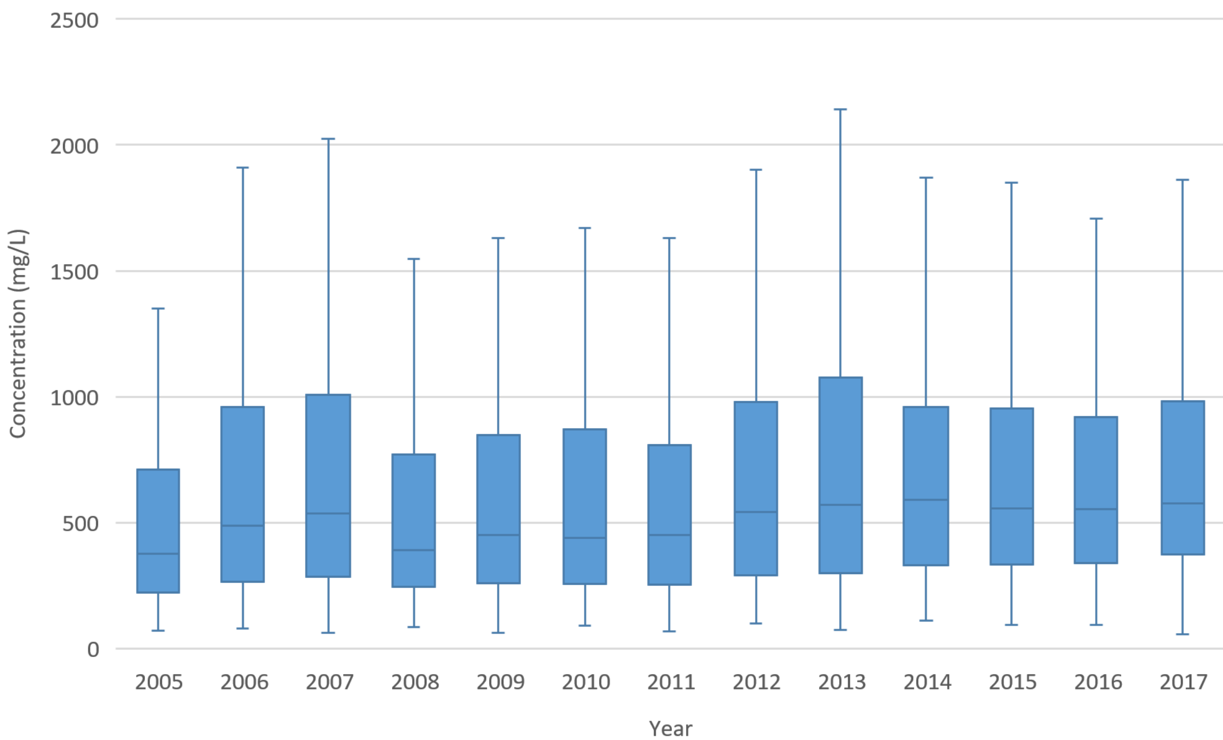
Figure 2-35: Trilinear Diagrams



2.1.9.2.3.3 Total Dissolved Solids

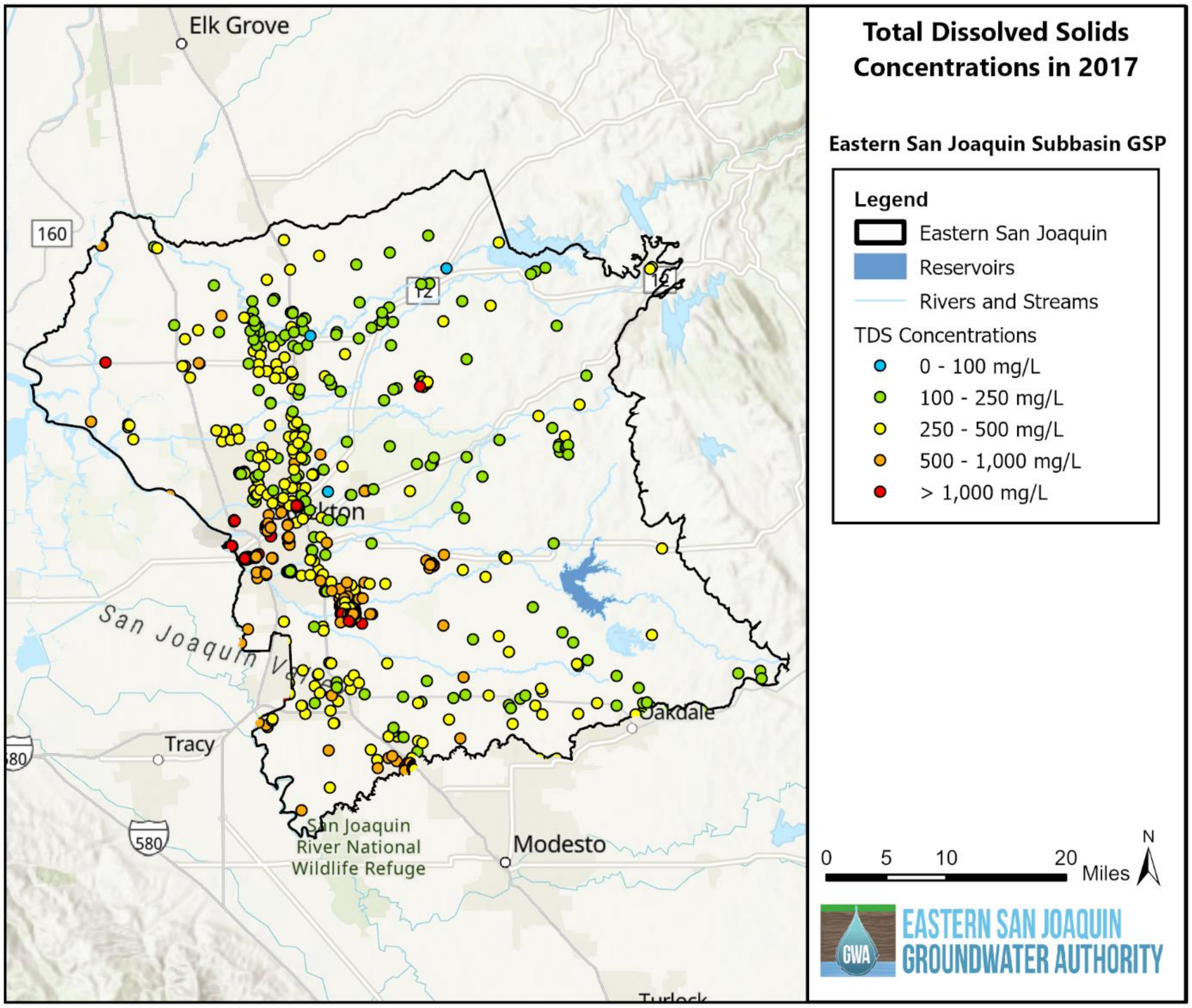
A wide range of total dissolved solids (TDS) values exist in the Eastern San Joaquin Subbasin. Based on data in the GAMA database from 2005 to 2017, TDS values generally varied from 100 to 2,000 mg/L (Figure 2-36), with a median value of 520 mg/L. Over the 13-year period shown in Figure 2-36, the median concentration of TDS has steadily increased from approximately 400 mg/L in 2005 to approximately 600 mg/L in 2017. Figure 2-37 shows the variation of TDS concentrations across the basin 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 are provided in Section 2.2 (Historical Groundwater Conditions).

Figure 2-36: TDS 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 2-37: TDS Concentrations in 2017

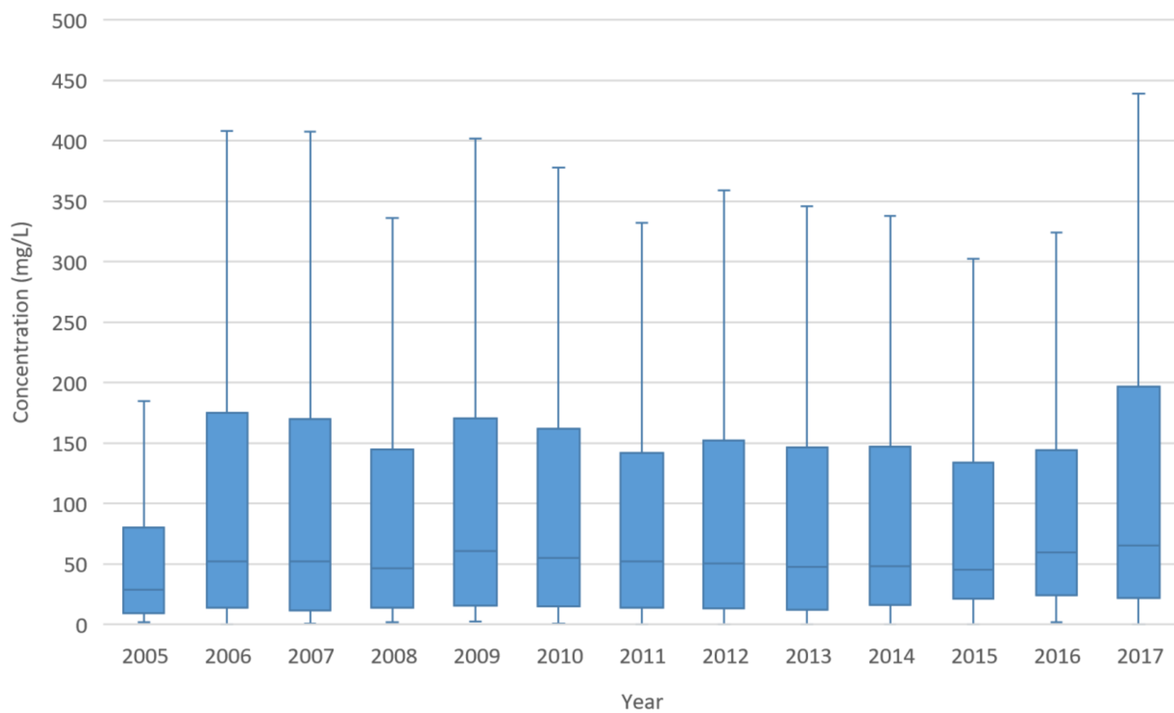


2.1.9.2.3.4 Chloride

Chloride concentrations also vary considerably across the Eastern San Joaquin Subbasin. Based on data in the GAMA database from 2005 to 2017, chloride values generally varied from non-detect to 300 mg/L (Figure 2-38), with a median value of 50 mg/L. Over the 13-year period shown in Figure 2-38, the median concentration of chloride has remained fairly stable. Higher chloride concentrations during 2017 are apparent near the cities of Manteca and Stockton (

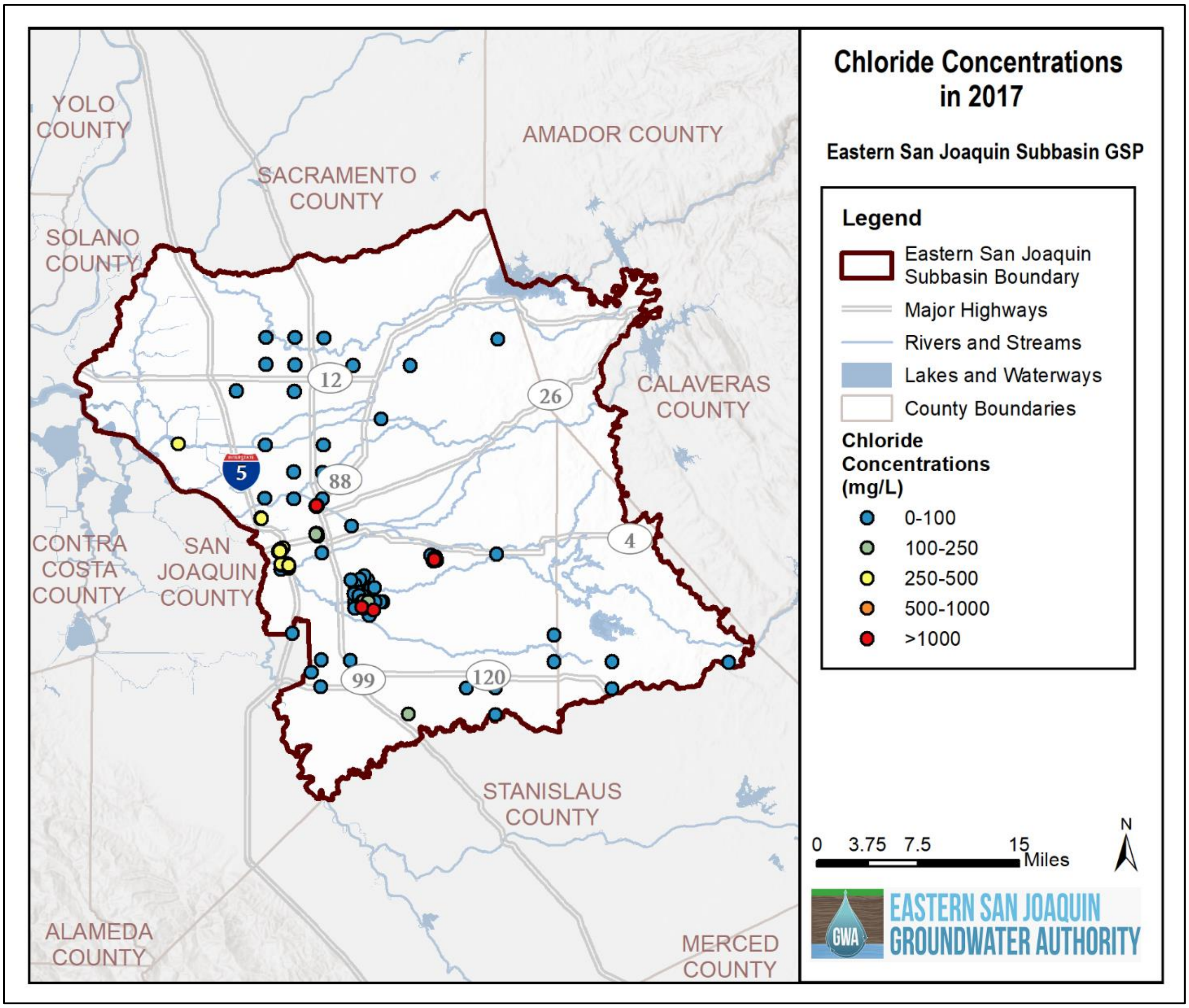
Figure 2-39). Sources of chloride in the Subbasin are similar to those for TDS and include Delta sediments, deep deposits, and irrigation return water. Additional details on chloride concentrations are provided in Section 2.2 (Historical Groundwater Conditions).

Figure 2-38: Chloride 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.

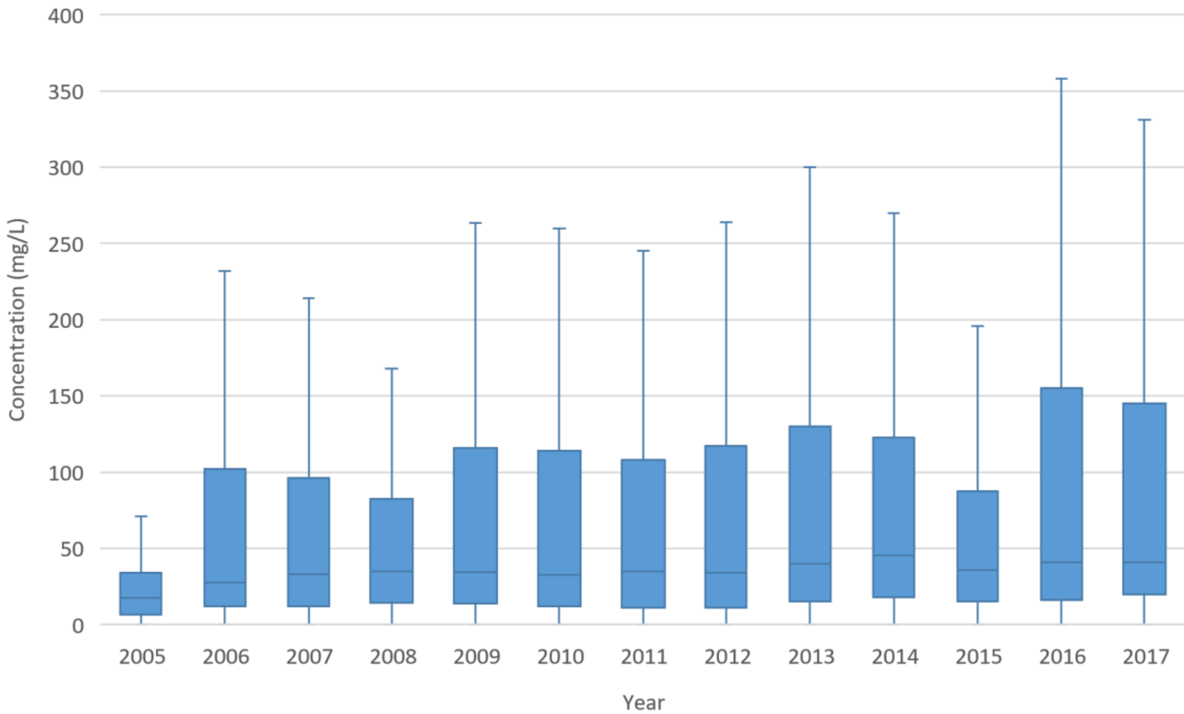
Figure 2-39: Chloride Concentrations in 2017



2.1.9.2.3.5 Sulfate

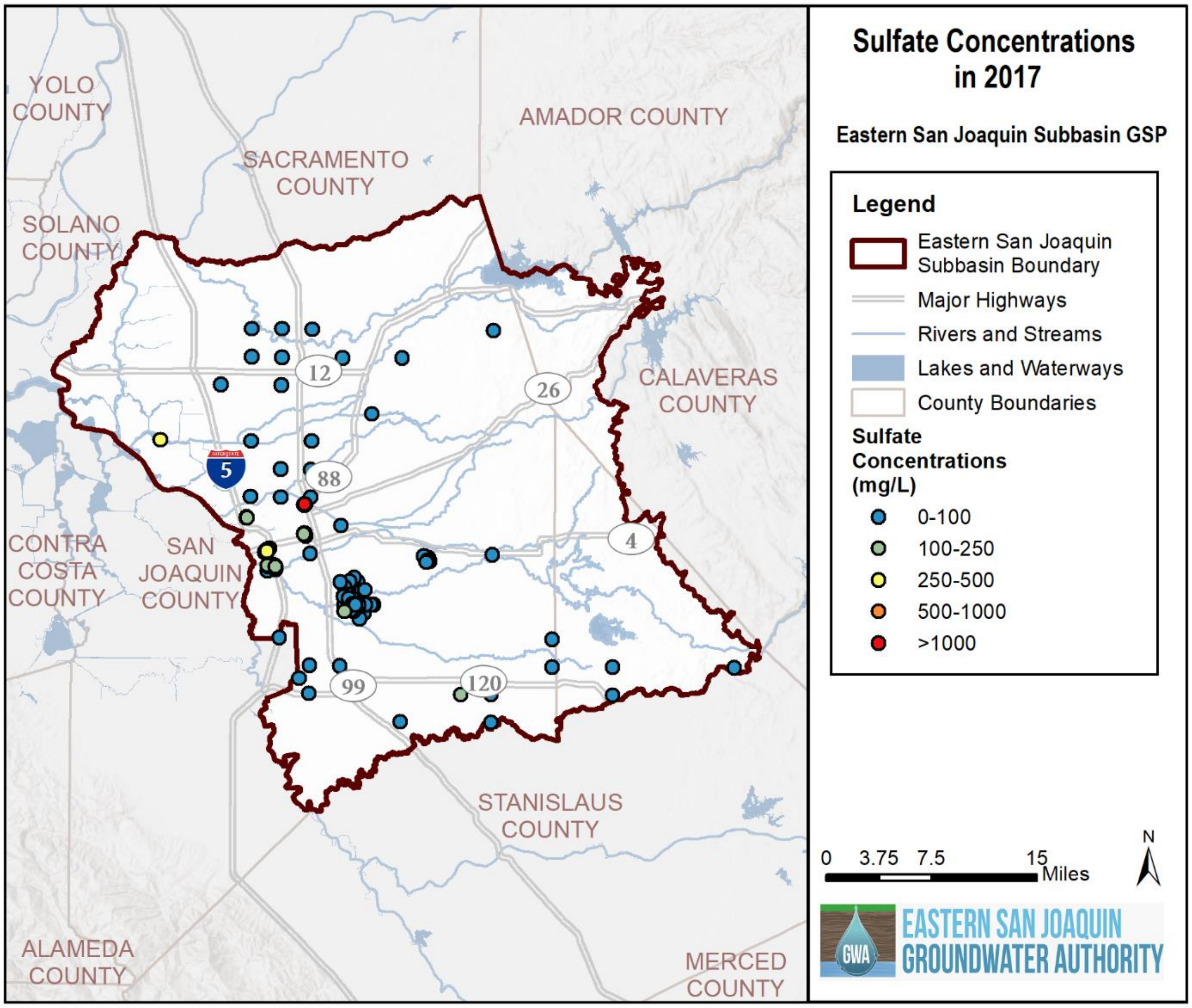
Sulfate concentrations vary considerably across the Eastern San Joaquin Subbasin ranging from non-detect to around 250 mg/L with a median value of around 25 mg/L Figure 2-40, based on data in the GAMA database from 2005 to 2017. Over the 13-year period shown in Figure 2-40, the median concentration of sulfate, like chloride, has remained fairly stable and does not show any obvious trends. Higher sulfate concentrations during 2017 are apparent near the cities of Manteca and Stockton Figure 2-41

Figure 2-40: 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 2-41: Sulfate Concentrations in 2017



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. While recent efforts have been made to address these data gaps, as noted below, the following data gap elements still 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. While this data gap has been filled to some extent with the airborne electromagnetic (AEM) data collected by DWR and the boring logs from the new monitoring wells constructed in the Subbasin, improving the understanding of the Subbasin aquifer system and leading to the addition of a shallow alluvium layer and other refinements to ESJWRM numerical flow model refinements, much still remains unknown. 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. This data gap has been partially addressed by the recent construction of the two Technical Support System (TSS) and Delta multi-completion well.
- Additional shallow groundwater data near surface waters and natural communities commonly associated with groundwater (NCCAGs). This data gap has been partially addressed by the recent construction of five new shallow monitoring wells near interconnected surface waters.
- Additional groundwater level data in the east and northwest areas of the Subbasin. This data gap has been partially addressed by recent improvements to the groundwater level representative monitoring network. See Chapter 4 for additional information.
- 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. This data gap has been partially addressed by the recent construction of five new shallow monitoring wells near interconnected surface waters and formation of a representative monitoring network specific for monitoring impacts to interconnected surface waters.

Groundwater Quality Data

- Water quality of the three zones within the principal aquifer. This data gap has been partially addressed through recent refinements to the representative monitoring network for groundwater quality. See Chapter 4 for additional information.
    - 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.

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 HISTORICAL GROUNDWATER CONDITIONS

This section describes historical groundwater conditions in the Eastern San Joaquin Subbasin as of the development of the 2020 GSP. As such, this section includes both historical conditions in the Subbasin prior to 2019, and the current conditions as of the development of the 2020 GSP in 2019. These sections are maintained in the GSP to provide a context of the conditions occurring at the time the 2020 GSP was developed.

As required by the GSP regulations, the groundwater conditions section includes:

- Definition of current groundwater conditions in the Subbasin (as of 2020 GSP development)
- 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 0)
- Seawater Intrusion (Section 0)
- Groundwater Quality (Section 2.2.4)
- Land Subsidence (Section 0)
- Interconnected Surface Water (Section 2.2.6)

Details of GDEs are provided in Section 2.2.7 and Section 2.3.7 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 2-42). 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 2.3 (Water Budgets), the Historical Water Budget from the 2020 GSP 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 2-42, 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 2-42: Hydrographs of Selected Wells

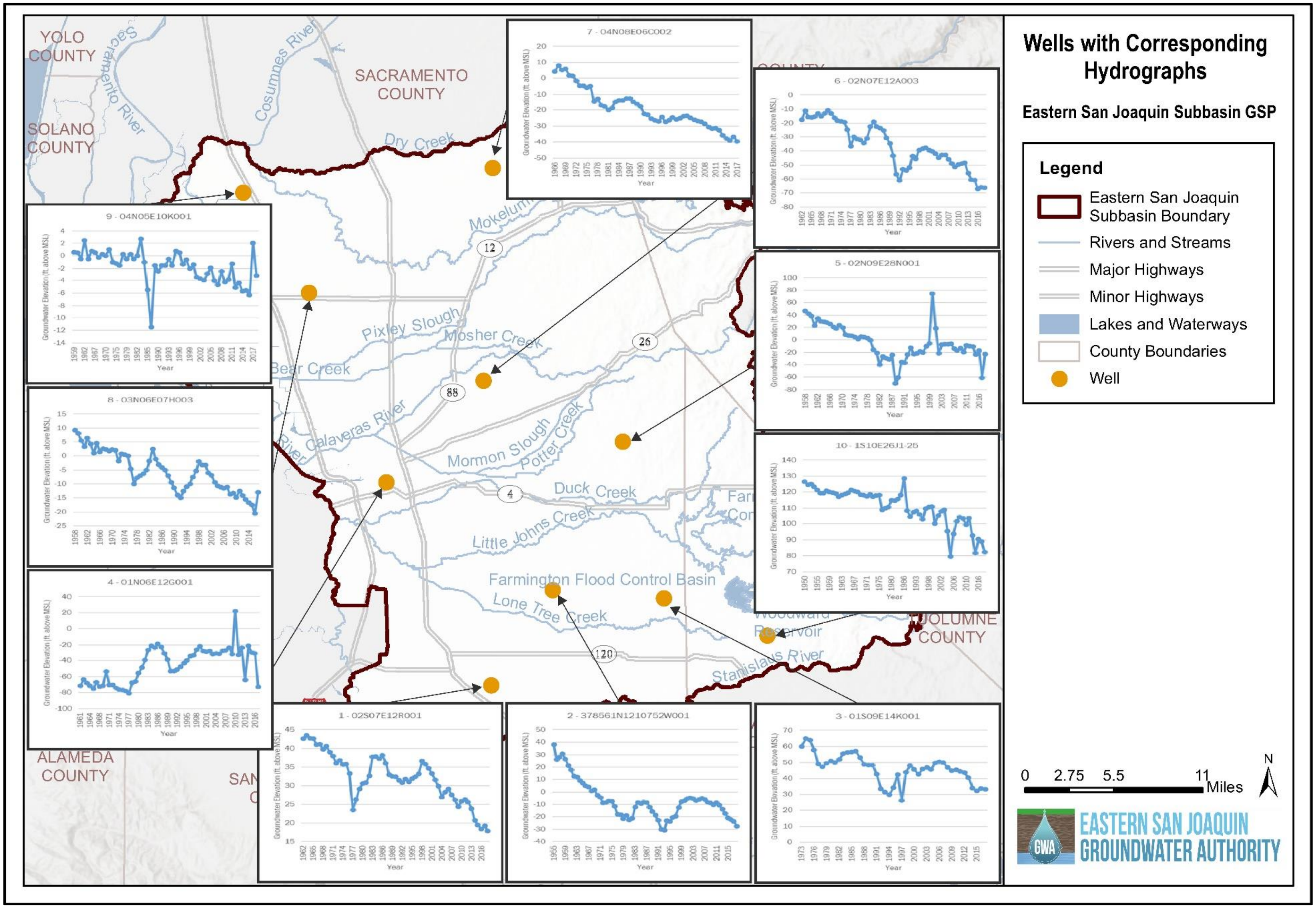
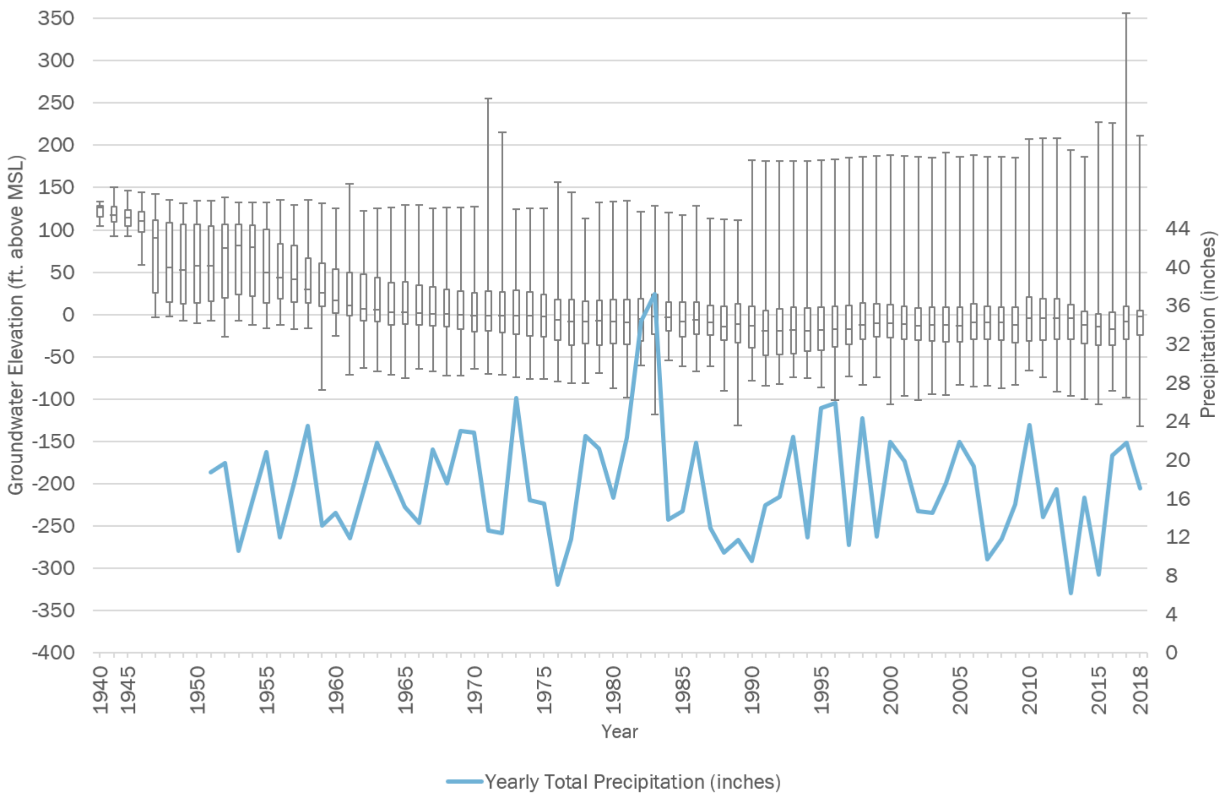


Figure 2-43 shows the distribution of the groundwater elevations from the CASGEM and San Joaquin County databases compared to average precipitation in and near the Subbasin. Figure 2-43 shows an overall decreasing trend in groundwater elevation levels with larger variability over time. The increasing 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 2-42.

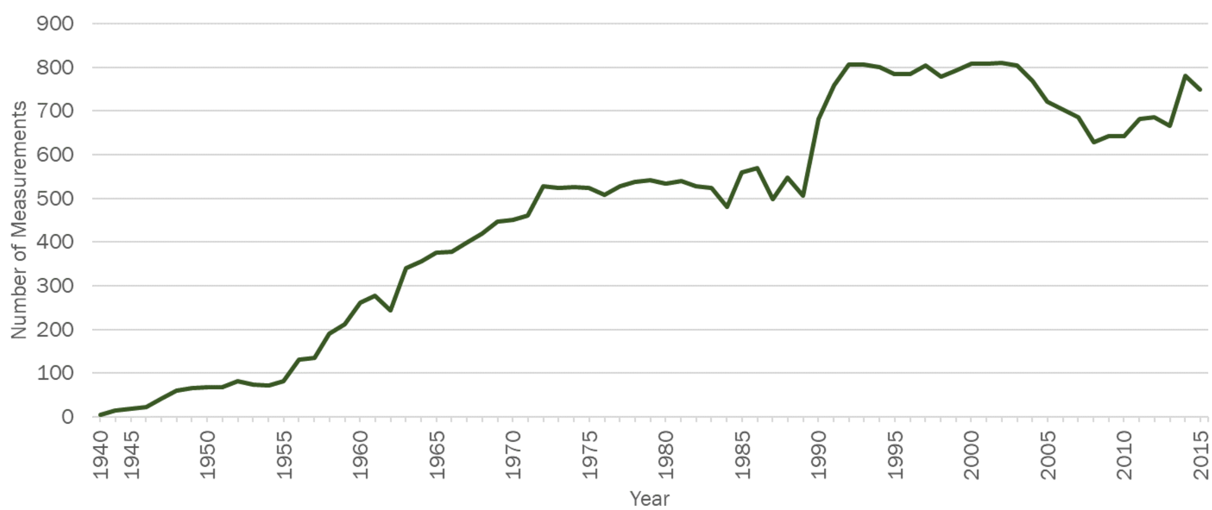
Periods of increases in groundwater elevation moderately correspond to the amount of precipitation in the Eastern San Joaquin Subbasin. A correlating trend can be seen with groundwater elevation increases in several hydrographs in the early 1980s and late 1990s, associated with periods of high precipitation.

Figure 2-43: Summary of Groundwater Elevation Data, 1940-2018

(a) Box-and-Whisker Plot with Precipitation

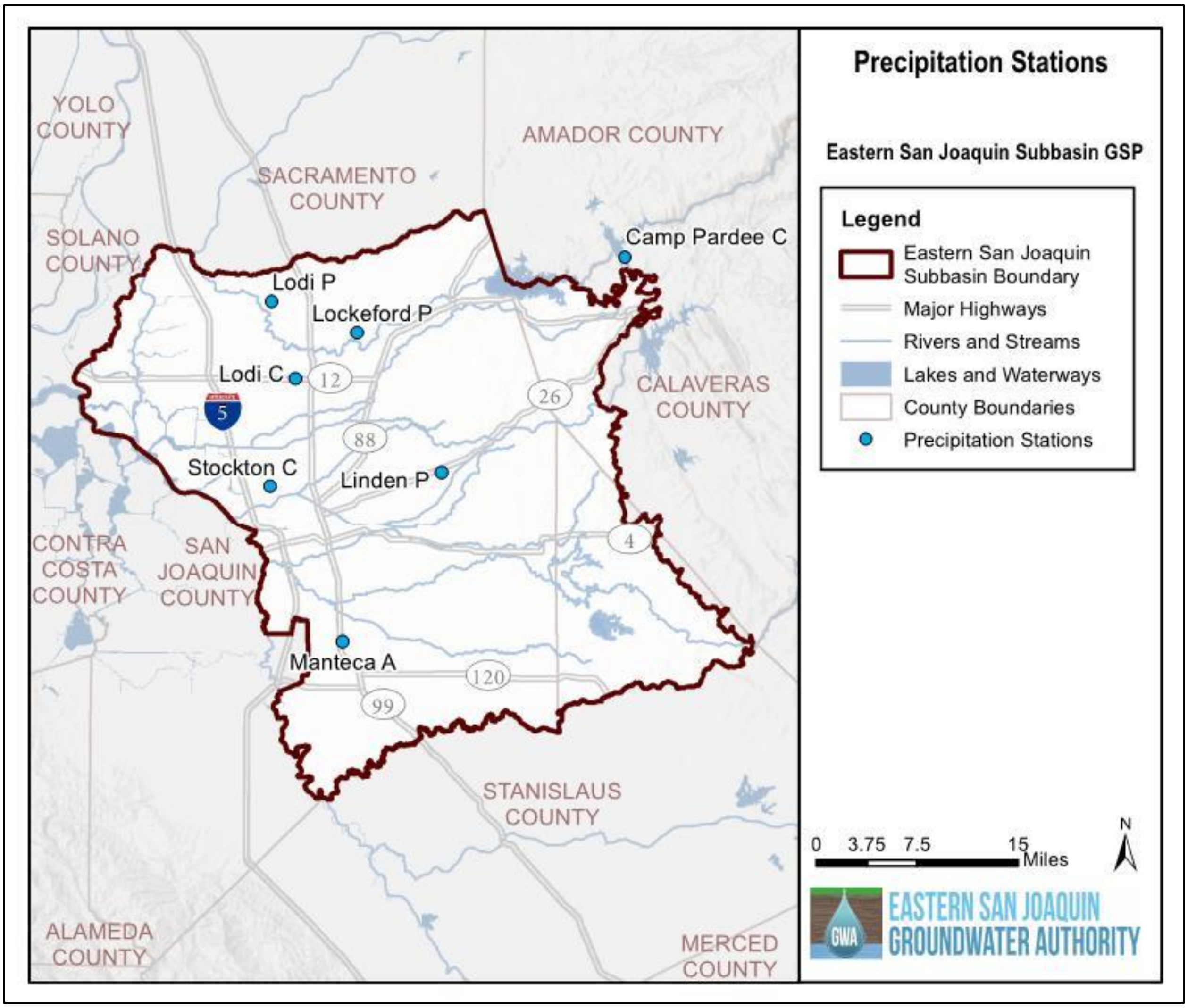


(b) Number of Groundwater Level Measurements



1. Each vertical bar in Figure 2-43 (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 2-43 (a) began in 1951.
3. The average annual precipitation line presented in Figure 2-43 (b) is based on an average of data collected at 7 stations which are mapped in Figure 2-44.

Figure 2-44: 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 Conditions as of 2019: Groundwater Elevations

For the purposes of the 2020 GSP, current groundwater elevation conditions were characterized as first quarter 2017 (seasonal high, measured in spring 2017) and fourth quarter 2017 (seasonal low, measured in fall 2017) groundwater elevation measurements. At the time of the 2020 GSP, those records constituted the most complete dataset. Groundwater elevations were mapped using the CASGEM dataset (including voluntarily monitored wells) and the San Joaquin County dataset.

Figure 2-45 and Figure 2-46 show the groundwater elevations for the first and fourth quarters of 2017, respectively. A pumping depression at the center of the Subbasin, east of the City of Stockton, existed 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 of 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 ranged from approximately 21 feet per mile (ft/mi) during the seasonal high to 16 ft/mi during the seasonal low. Along the western side of the Subbasin, the lateral gradient rangef 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 are primarly due to the steeper topography in that area.

Figure 2-45: First Quarter 2017 Groundwater Elevation

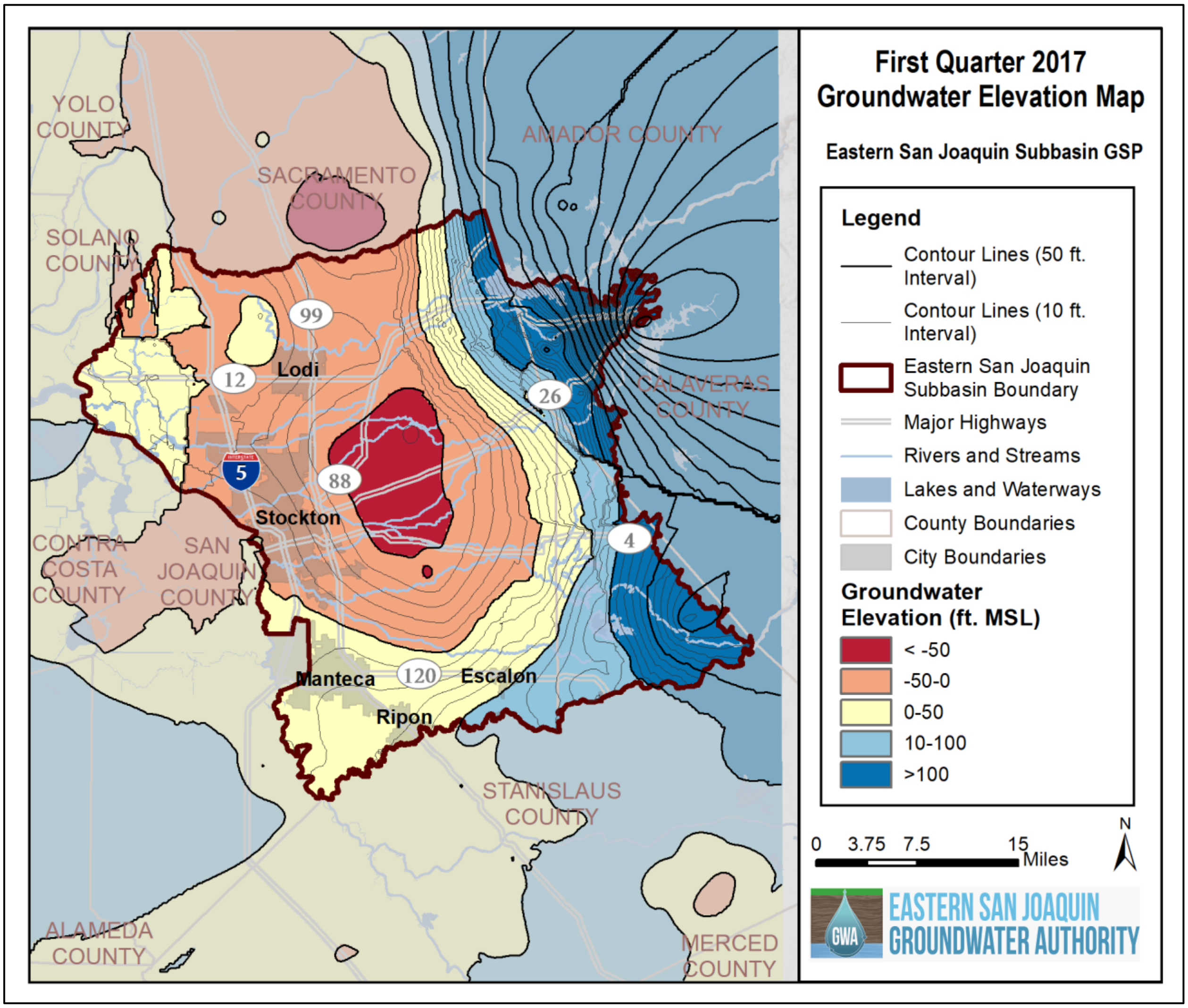
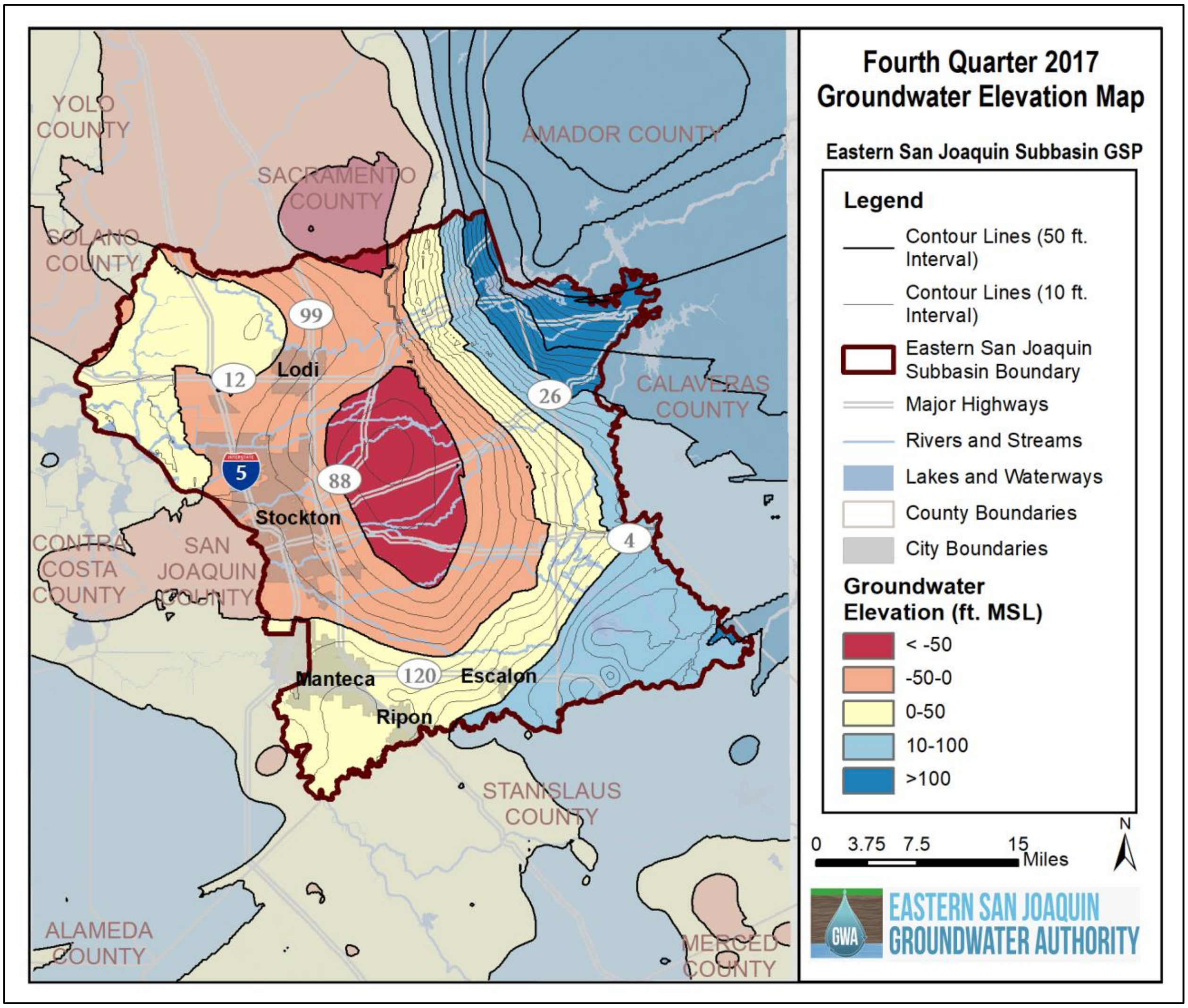


Figure 2-46: Fourth Quarter 2017 Groundwater Levels



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).

As of the 2020 GSP, there were 16 nested and/or clustered well sites located in the Eastern San Joaquin Subbasin. The locations of the wells are shown in Figure 2-47. 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 2-48 through Figure 2-63. 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 2-47: Map of Nested and/or Clustered Well Sites (as of 2020 GSP Development)

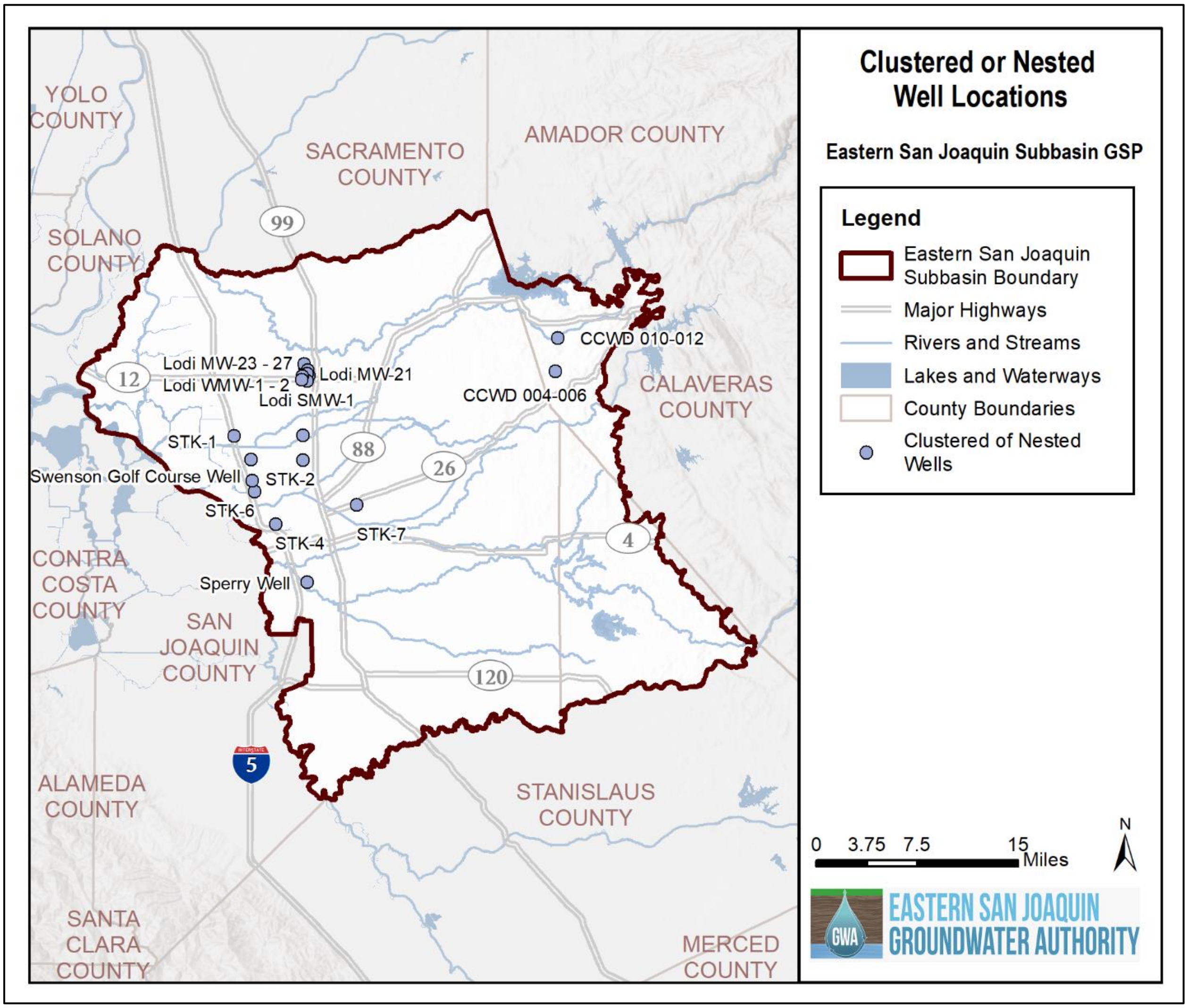


Figure 2-48: Nested Well Hydrographs: CCWD 004-006 (as of 2020 GSP Development)

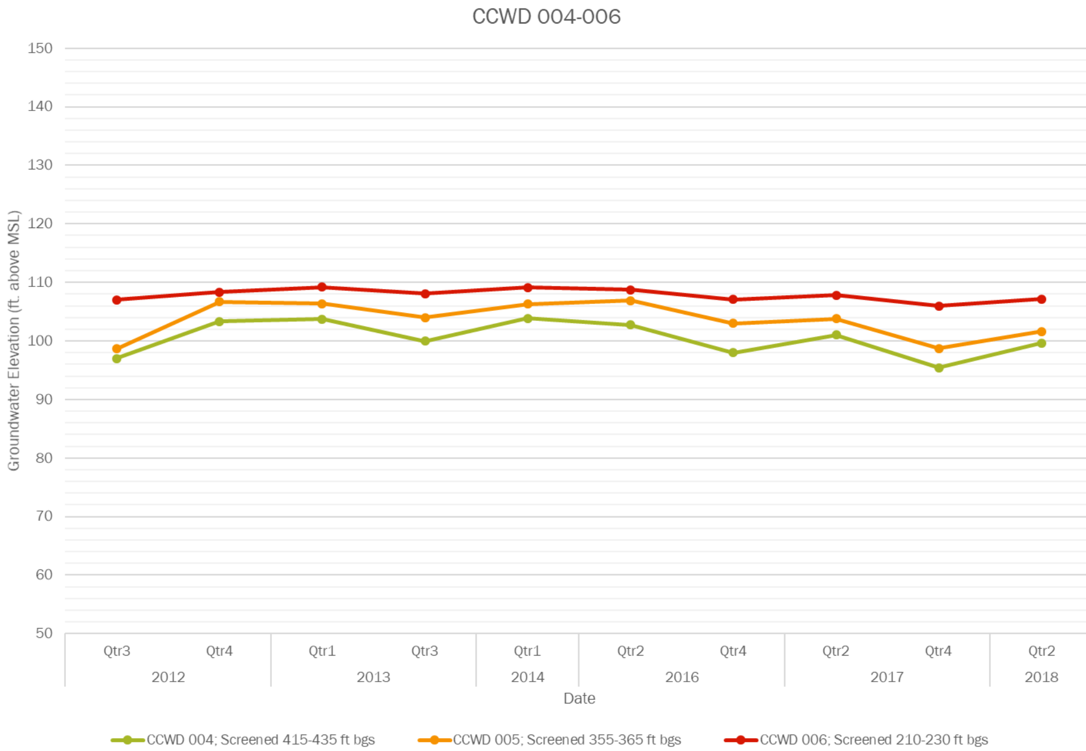


Figure 2-49: Nested Well Hydrographs: CCWD 010-012 (as of 2020 GSP Development)

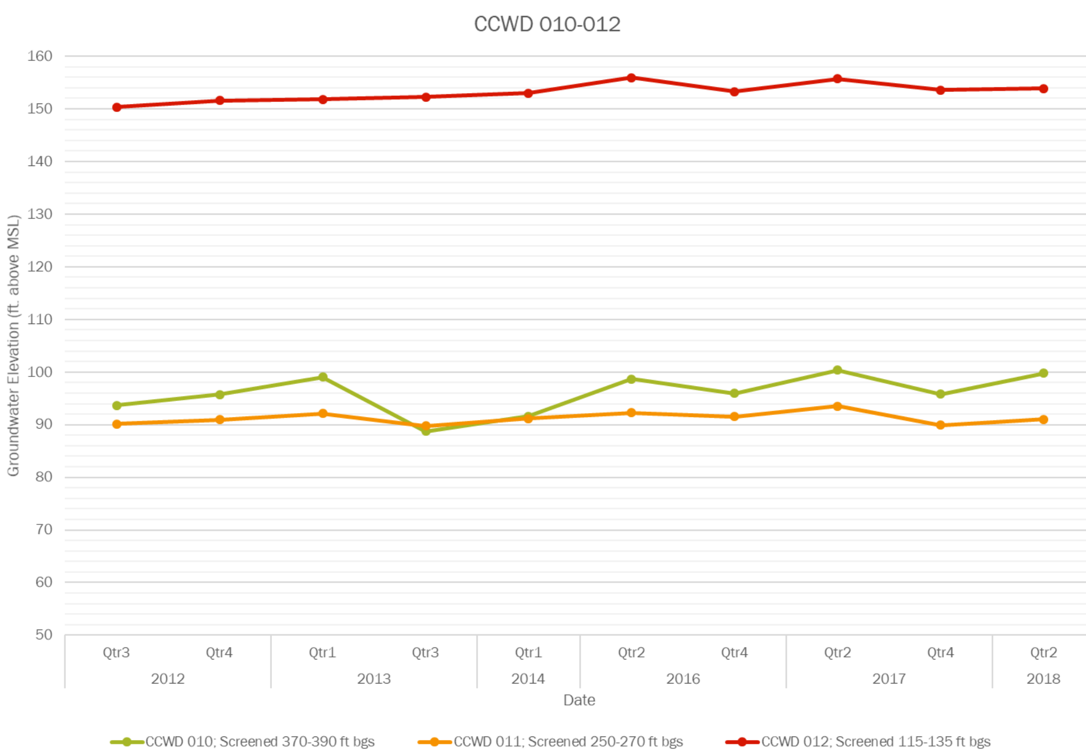


Figure 2-50: Nested Well Hydrographs: Sperry Well (as of 2020 GSP Development)

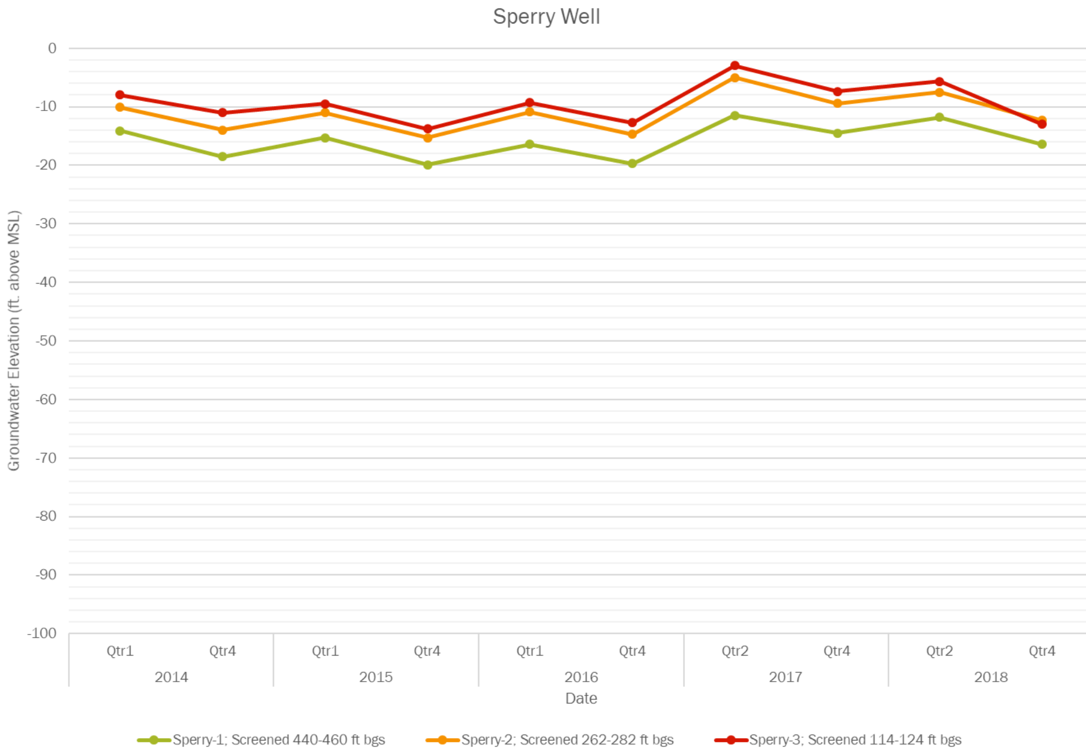


Figure 2-51: Nested Well Hydrographs: Swenson Golf Course (as of 2020 GSP Development)

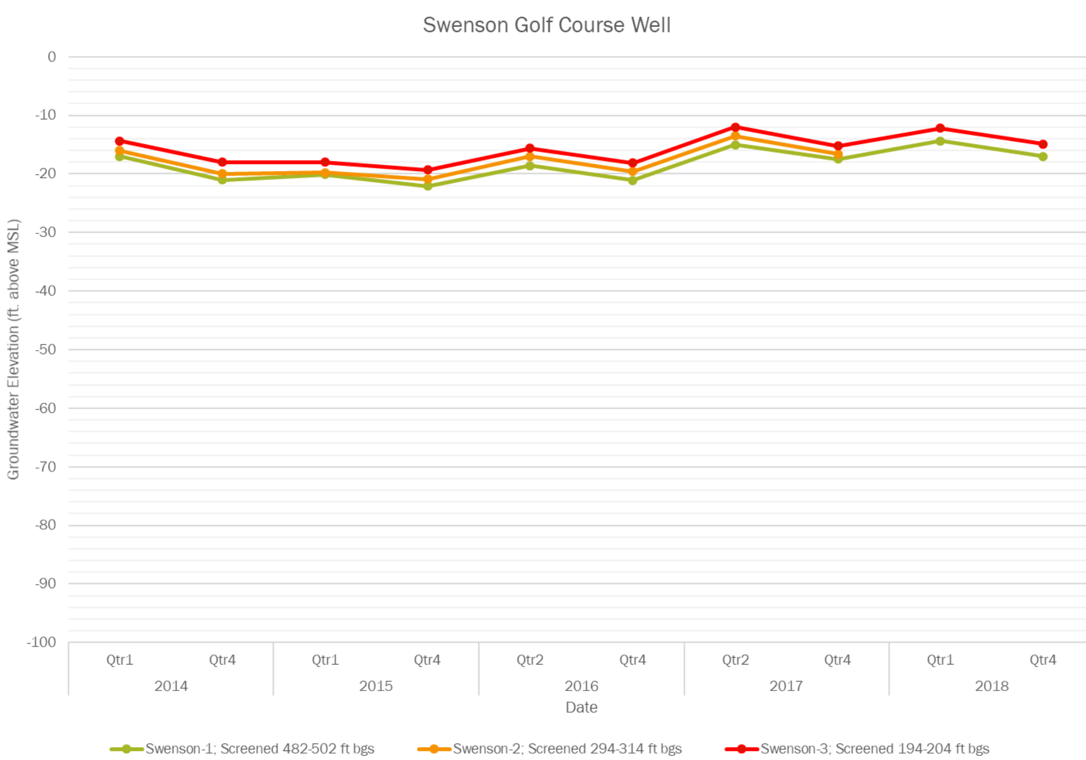


Figure 2-52: Nested Well Hydrographs: STK-1 (as of 2020 GSP Development)

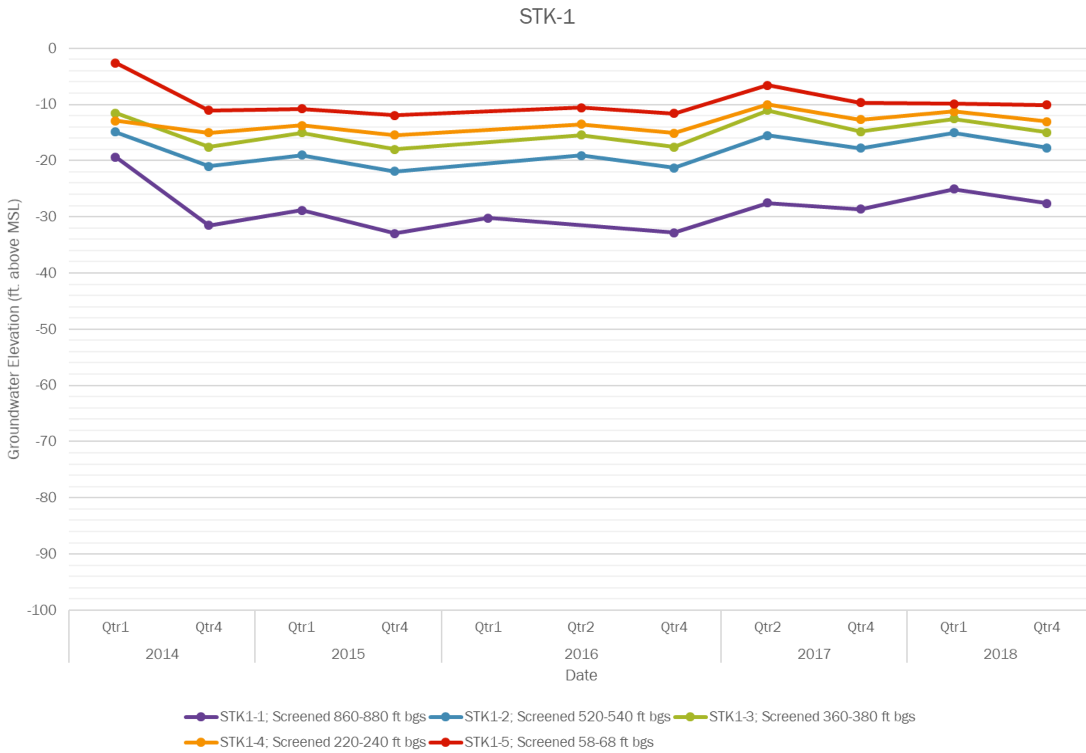


Figure 2-53: Nested Well Hydrographs: STK-2 (as of 2020 GSP Development)

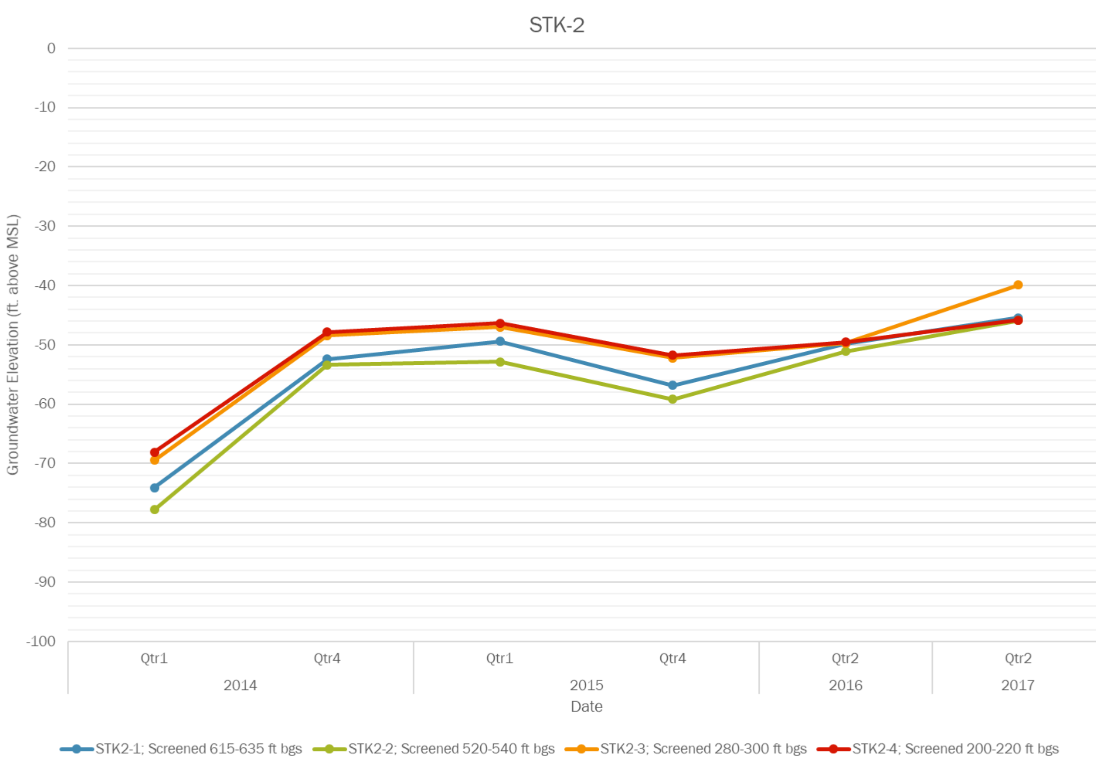


Figure 2-54: Nested Well Hydrographs: STK-4 (as of 2020 GSP Development)

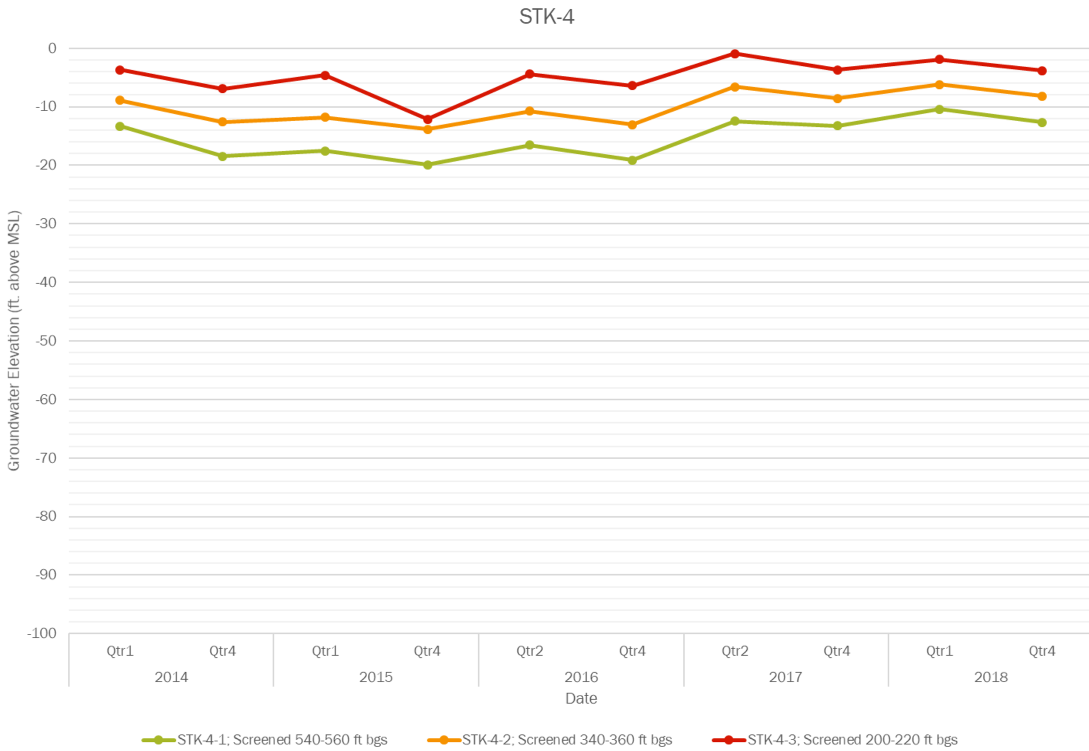


Figure 2-55: Nested Well Hydrographs: STK-5 (as of 2020 GSP Development)

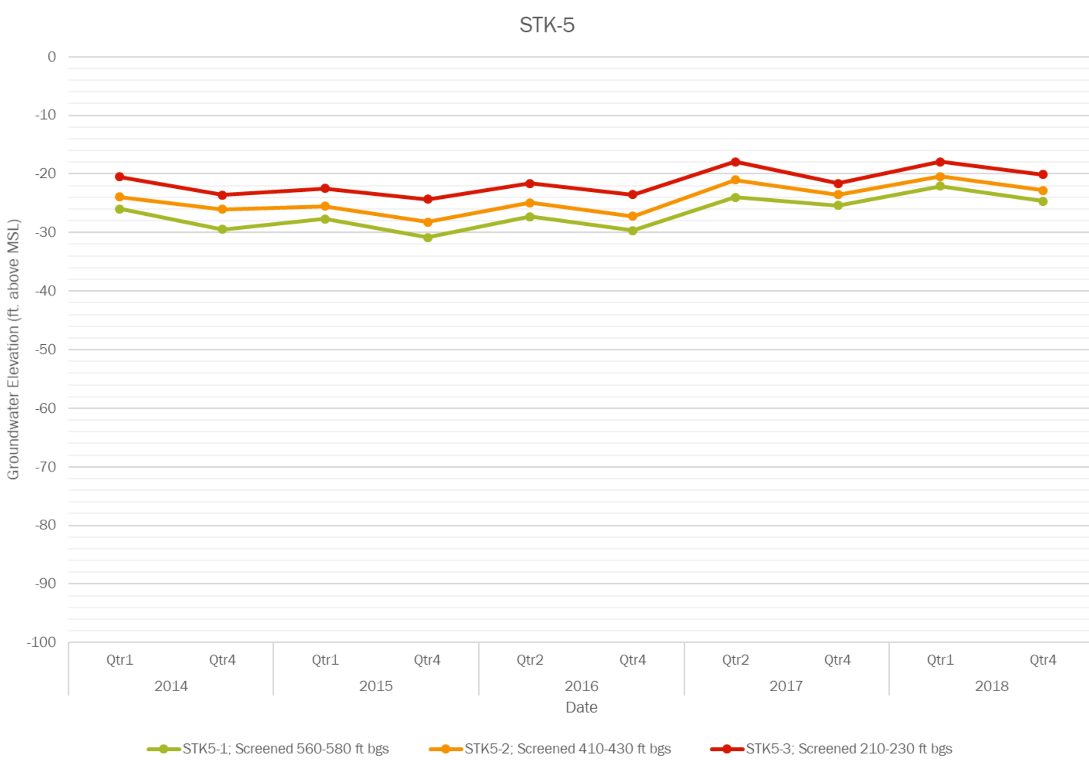


Figure 2-56: Nested Well Hydrographs: STK-6 (as of 2020 GSP Development)

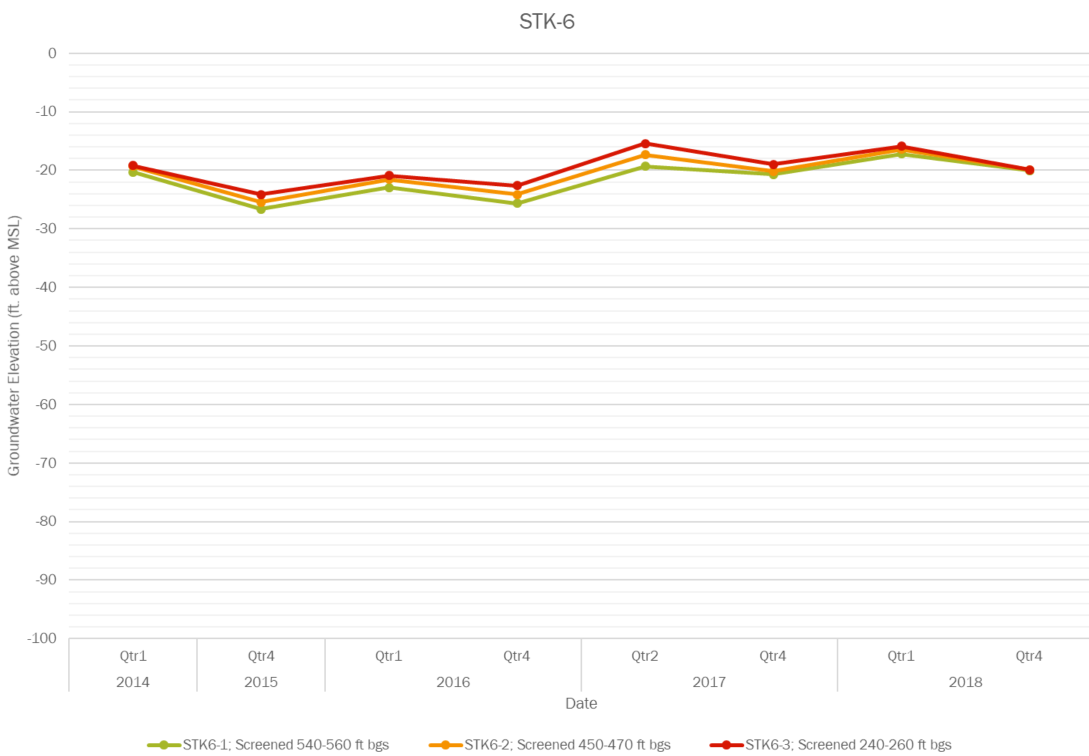


Figure 2-57: Nested Well Hydrographs: STK-7 (as of 2020 GSP Development)

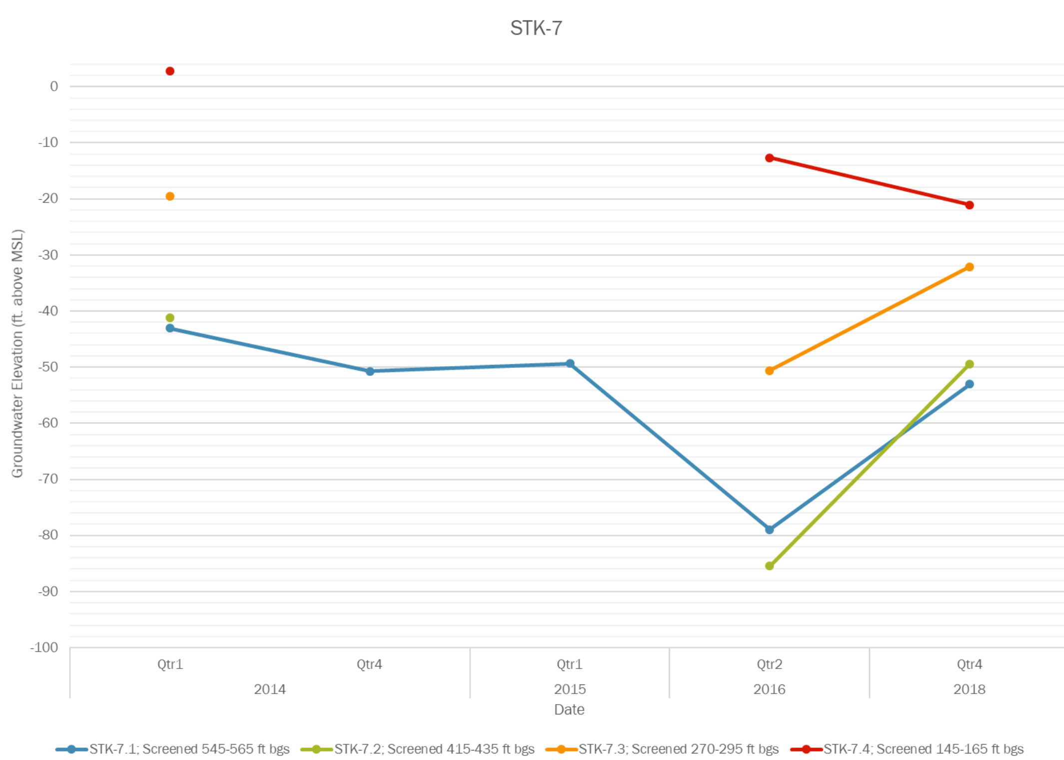


Figure 2-58: Nested Well Hydrographs: Lodi MW-21 (as of 2020 GSP Development)

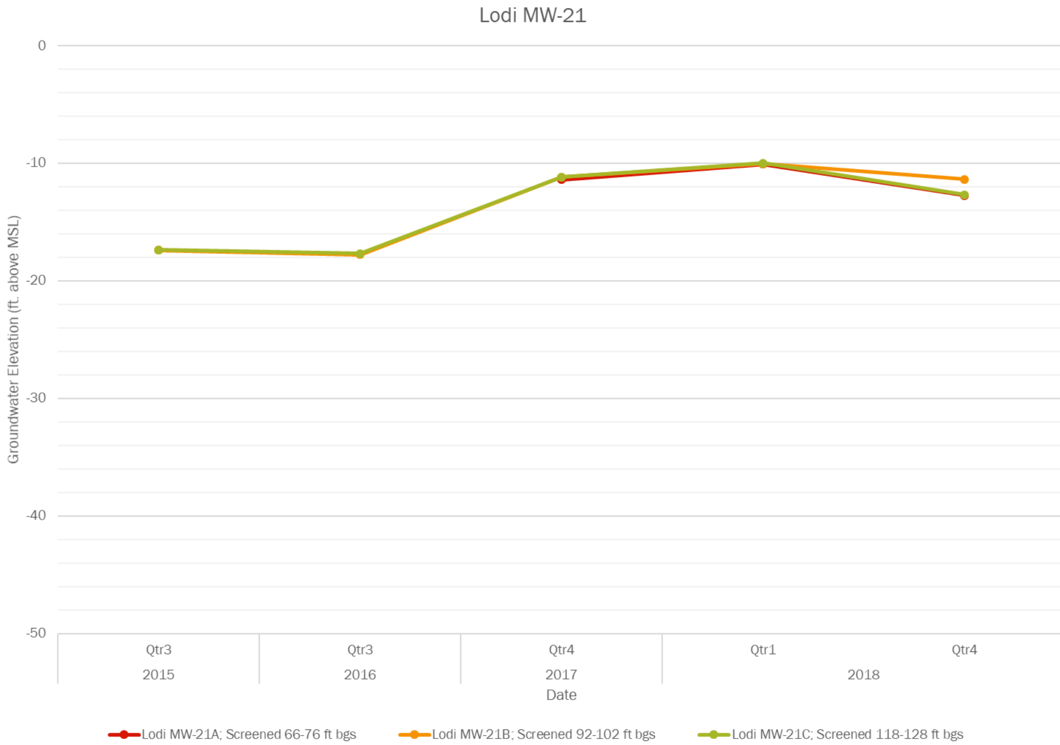


Figure 2-59: Nested Well Hydrographs: Lodi MW-24 (as of 2020 GSP Development)

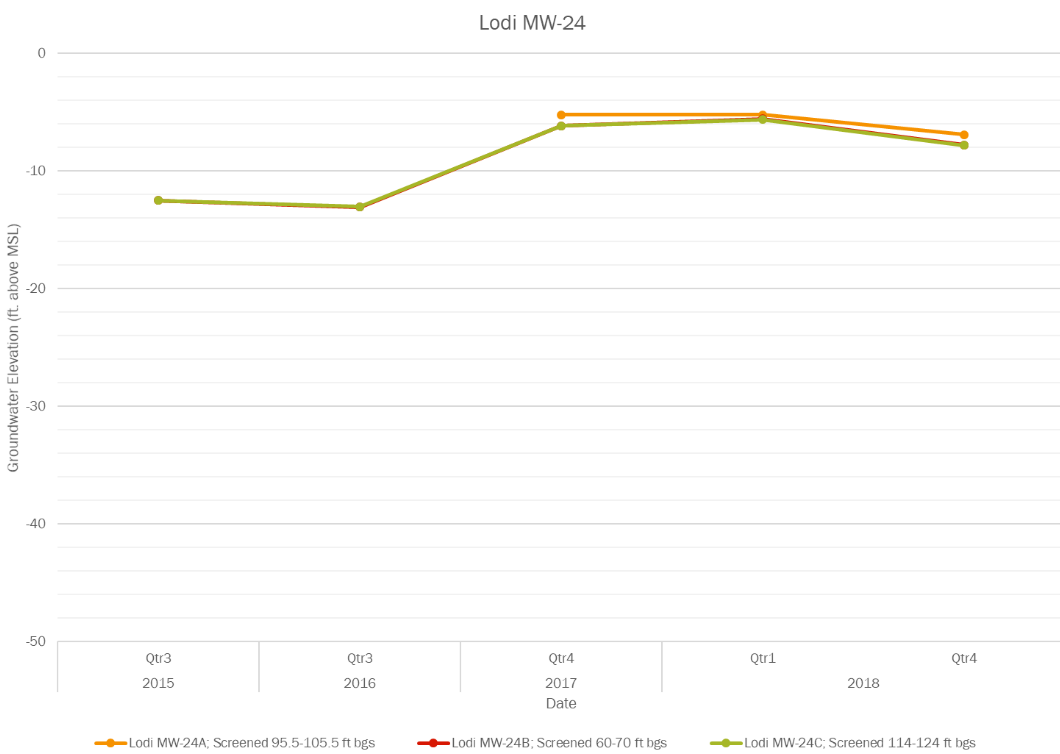


Figure 2-60: Nested Well Hydrographs: Lodi MW-25 (as of 2020 GSP Development)

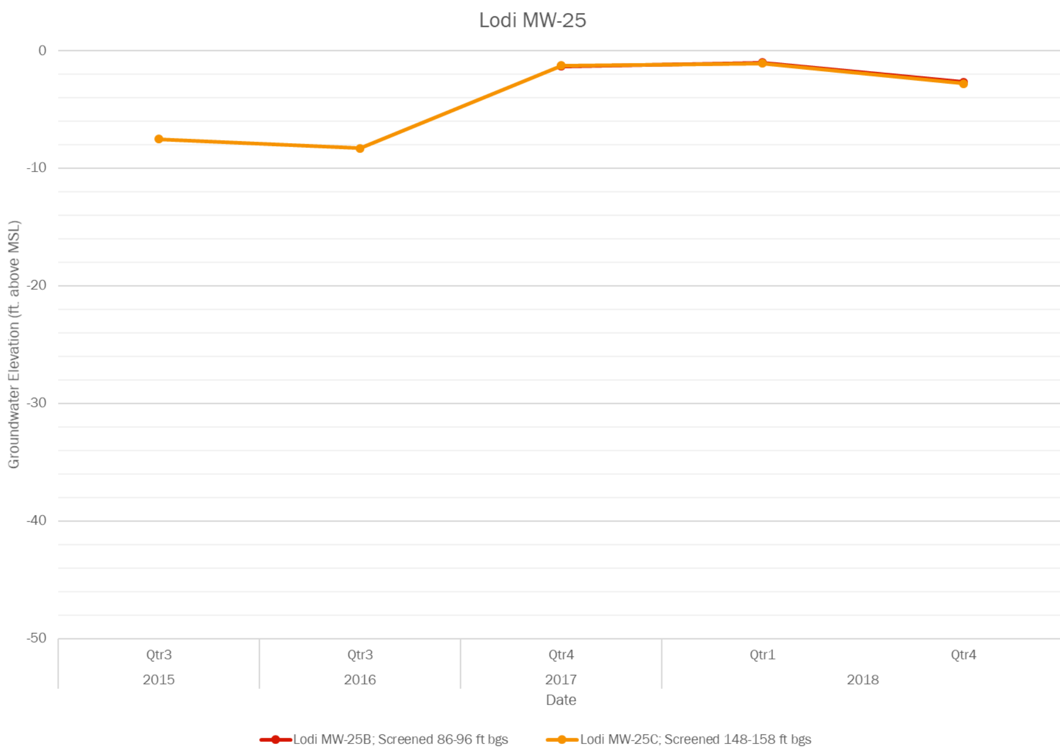


Figure 2-61: Nested Well Hydrographs: Lodi SMW-1 (as of 2020 GSP Development)

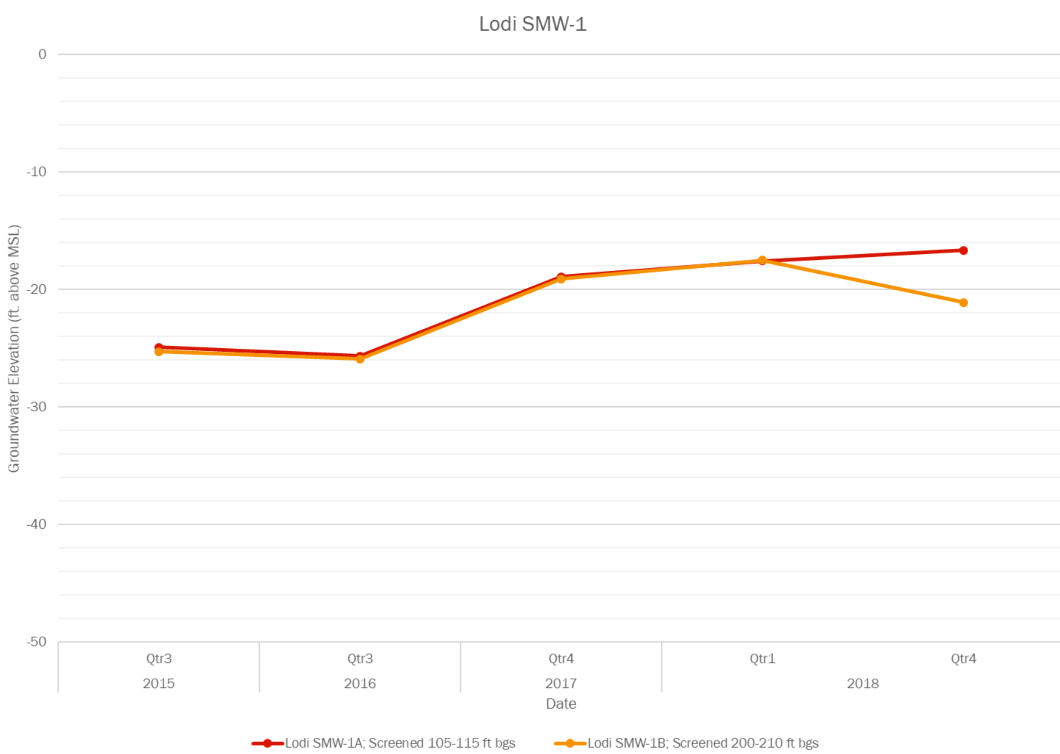


Figure 2-62: Nested Well Hydrographs: Lodi WMW-1 (as of 2020 GSP Development)

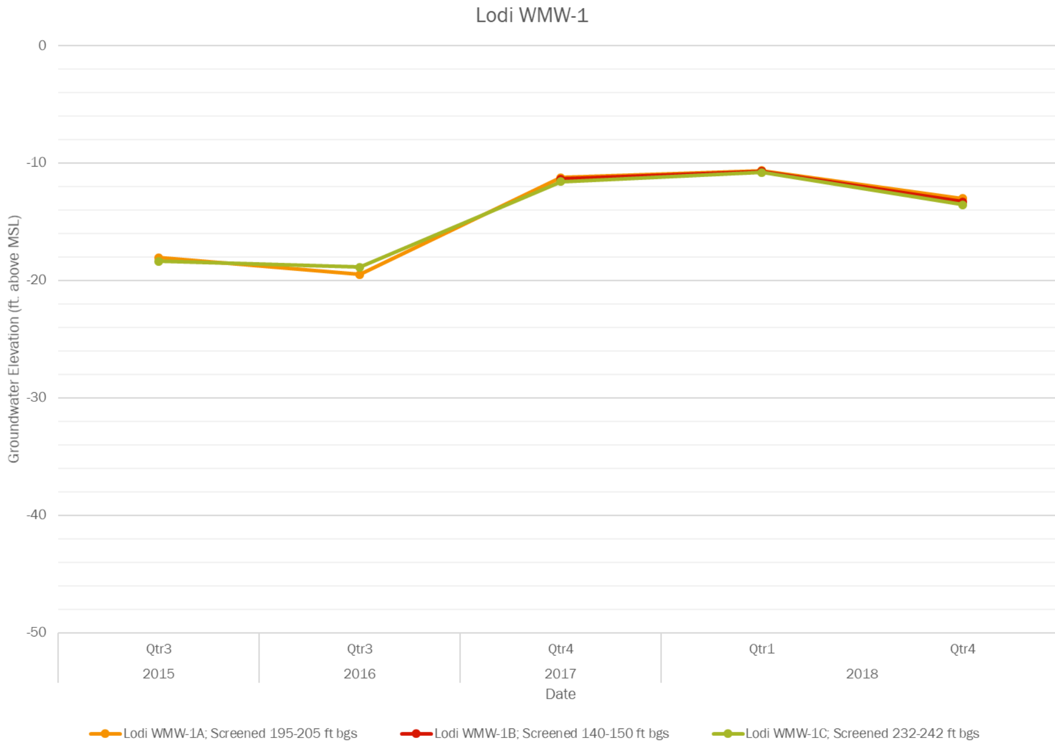


Figure 2-63: Nested Well Hydrographs: Lodi WMW-2 (as of 2020 GSP Development)

2.2.2 Groundwater Storage

The ESJWRM was used to estimate historical change in storage of the Eastern San Joaquin Subbasin from 1995-2023. Figure 2-64 shows annual total storage for the combined ESJWRM Version 3.0 fresh groundwater layers (not including the deep saline layer). Figure 2-65 shows the cumulative change in storage against annual storage change and water year type. In 2015, the total fresh groundwater storage was estimated as 74.0 million acre-feet (MAF). An additional 95.0 MAF in the deepest simulated layer of the model (not pictured) is saline water. More information about the layers of the ESJWRM Version 3.0 and calculation of storage changes can be found in model documentation in Appendix 2-C.

Figure 2-64: Historical Modeled Change in Storage

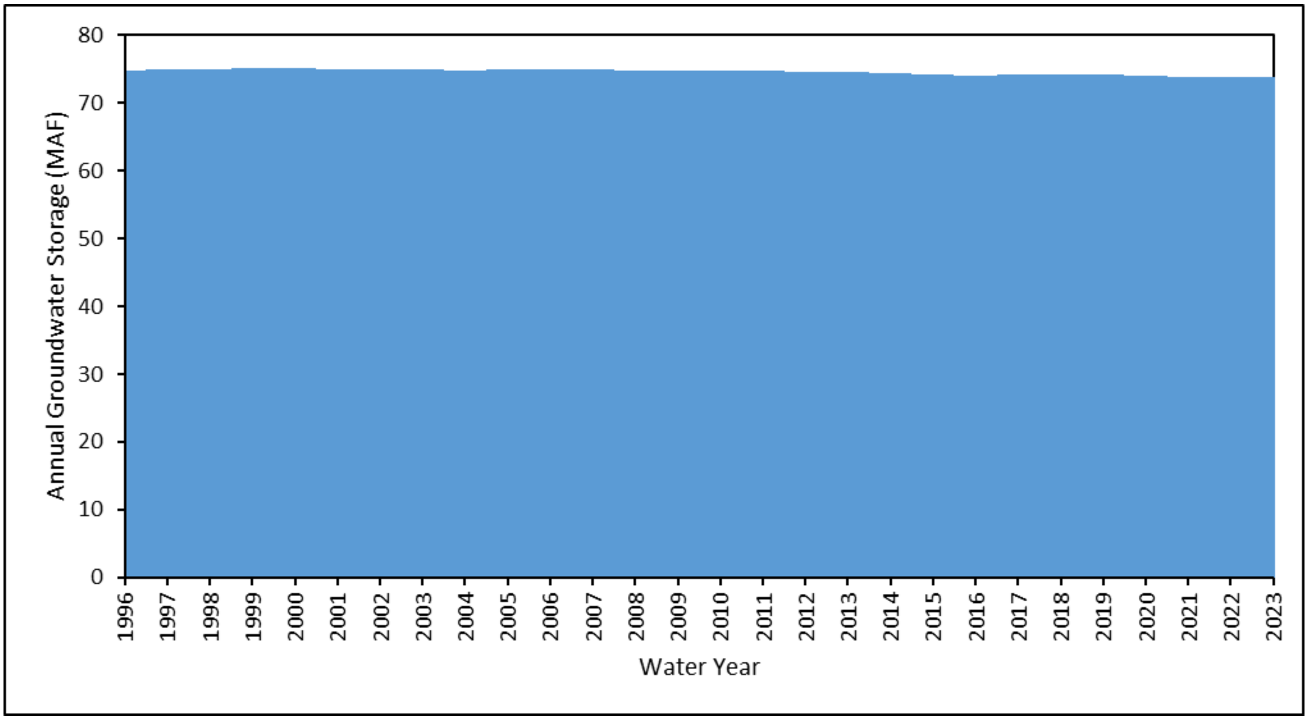
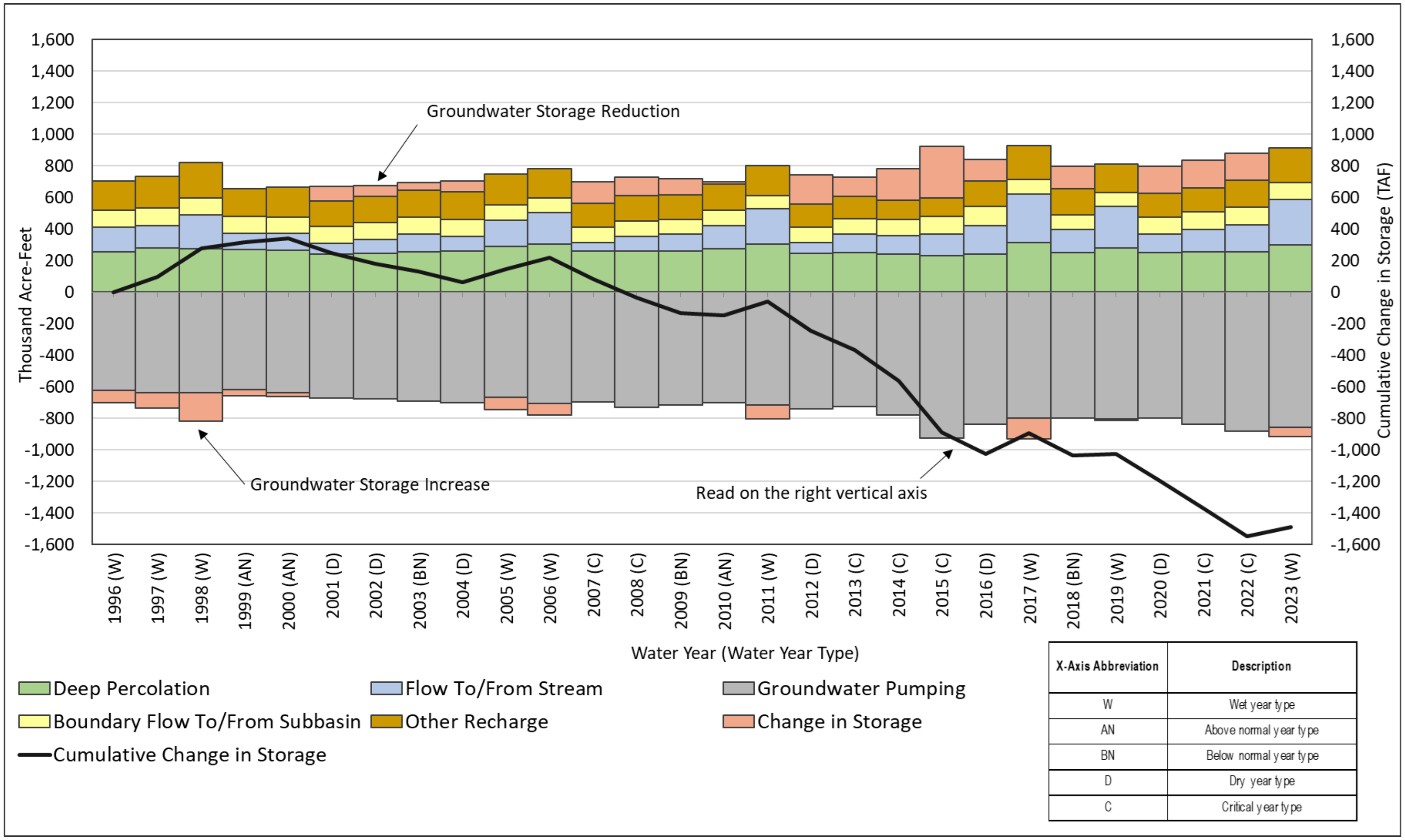


Figure 2-65: Historical Modeled Change in Annual Storage with Water Use and Year Type



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, 2024)
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 Conditions as of 2019: 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 the primary water quality constituents related to human activity include nitrates, salinity, and various point-source contaminants.

The sections herein provide information on the historical and current (as of the 2020 GSP) 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 (Historical Groundwater Conditions) and Section 2.3 (Current 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, 2018). 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 2-66, the majority of observed chloride concentrations above 250 mg/L occur on the western side of the Subbasin. As shown in Figure 2-67, the number of measurements with observed concentrations above 250 mg/L has decreased since the 1970s. The GAMA dataset was used for analysis.

Figure 2-66: Maximum Chloride Concentration Greater Than 250 mg/L (1940s-2010s)

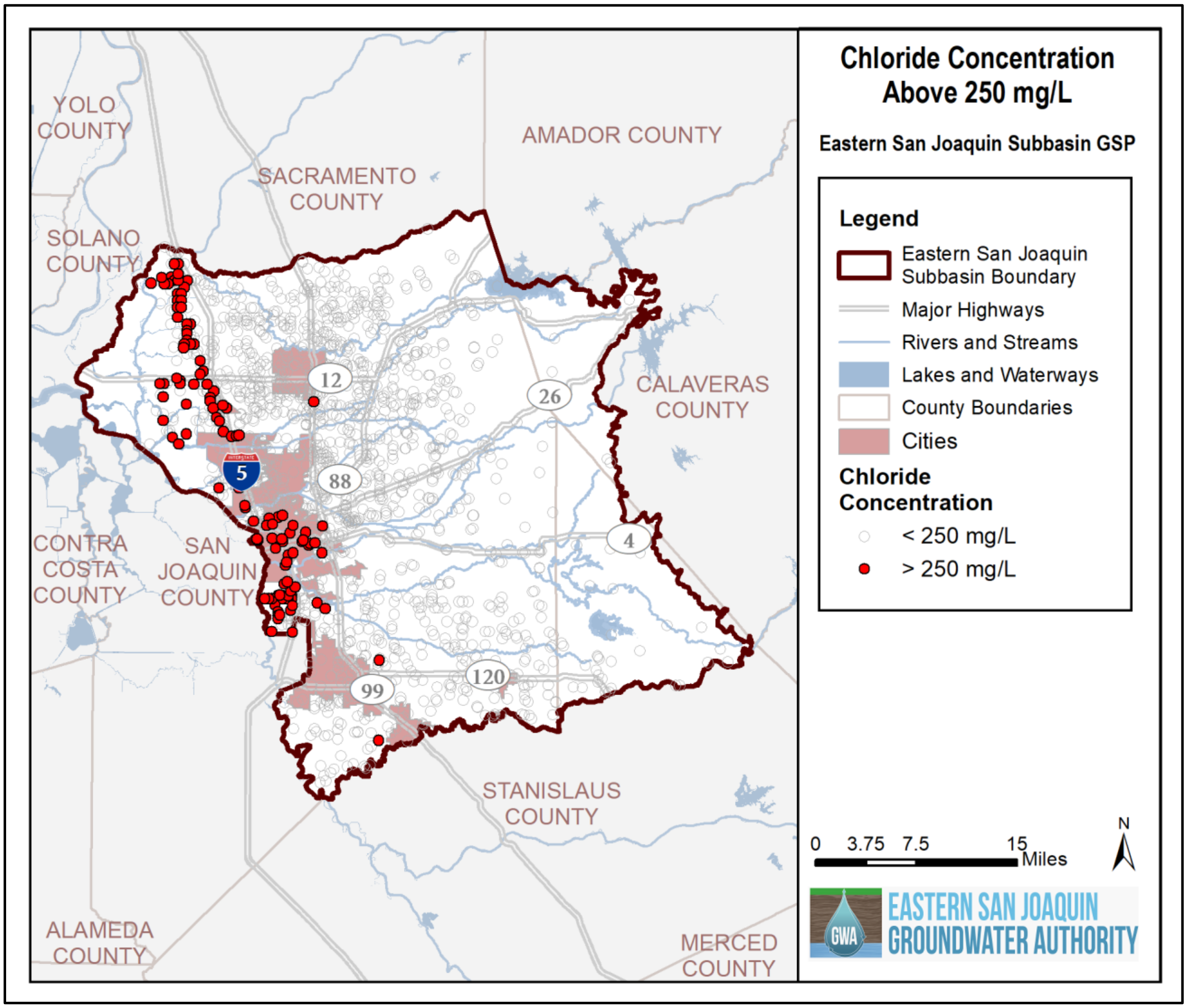


Figure 2-67: Maximum Chloride Concentration Above 250 mg/L by Decade

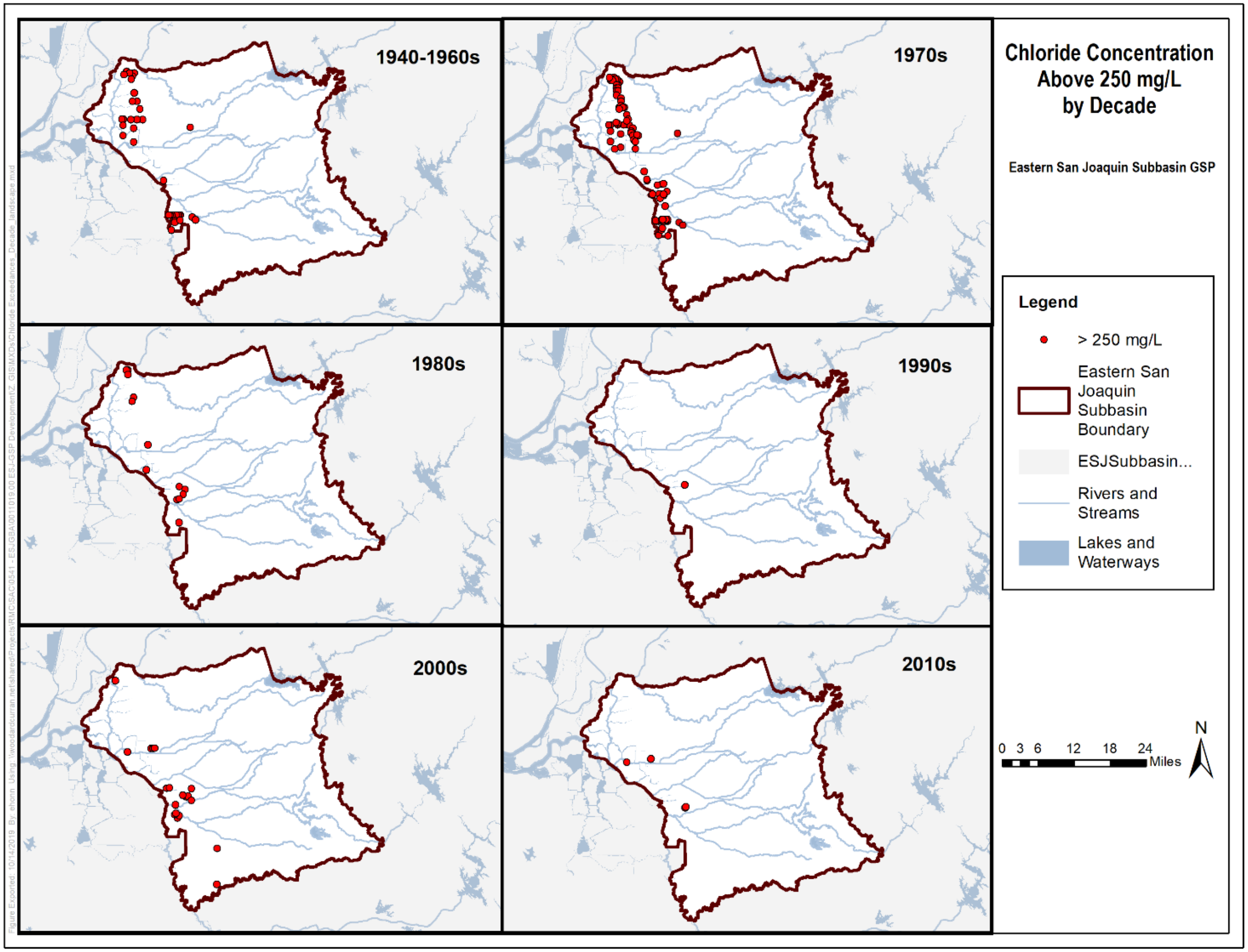


Table 2-5 shows occurrence of chloride measurements greater than 250 mg/L by decade. Chloride records have been observed above 250 mg/L both historically and more recently. Sampling frequencies increased in the 1970s and 2000s.

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

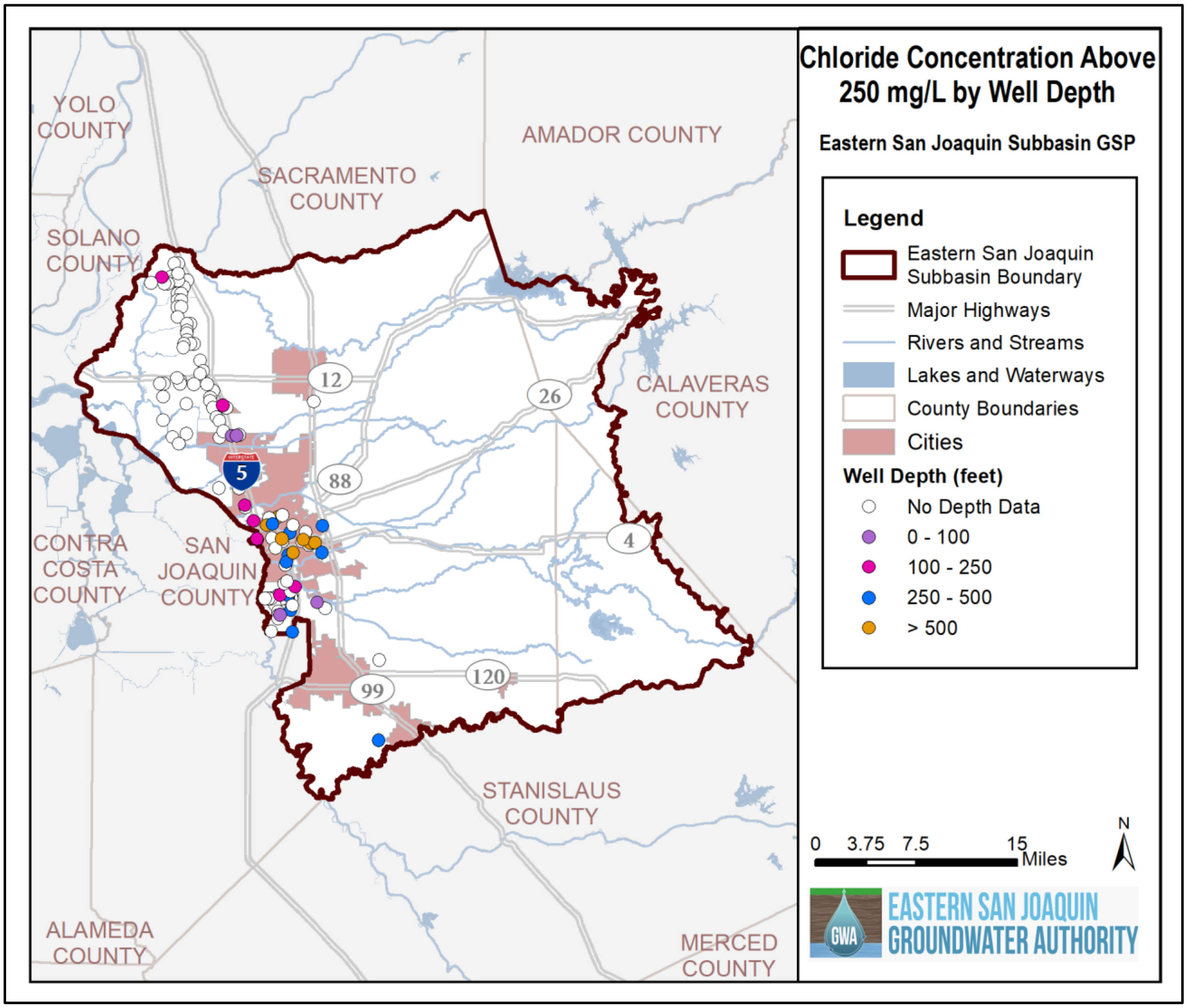
Table 2-6 shows chloride occurrences of concentrations greater than 250 mg/L by well depth. The highest proportion of readings above 250 mg/L occur in the shallowest wells, less than 100 feet deep (8 percent). The highest maximum value also occurred at this depth range (up to 2,050 mg/L).

Figure 2-68 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 2-68: 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.

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 2-69 shows the maximum and Figure 2-70 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 the State Water Resources Control Board (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 2-69: Maximum TDS Concentrations 2015-2018

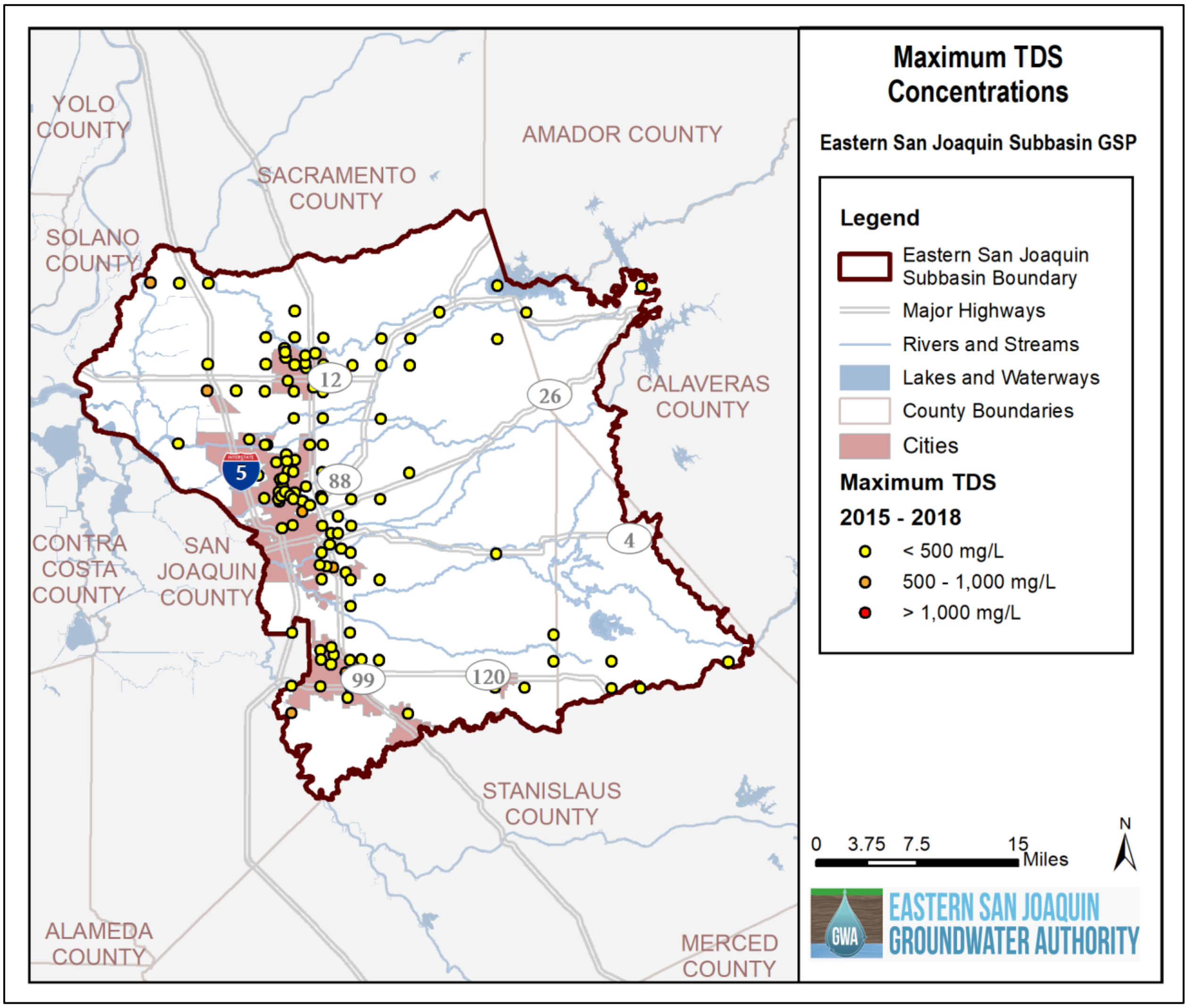
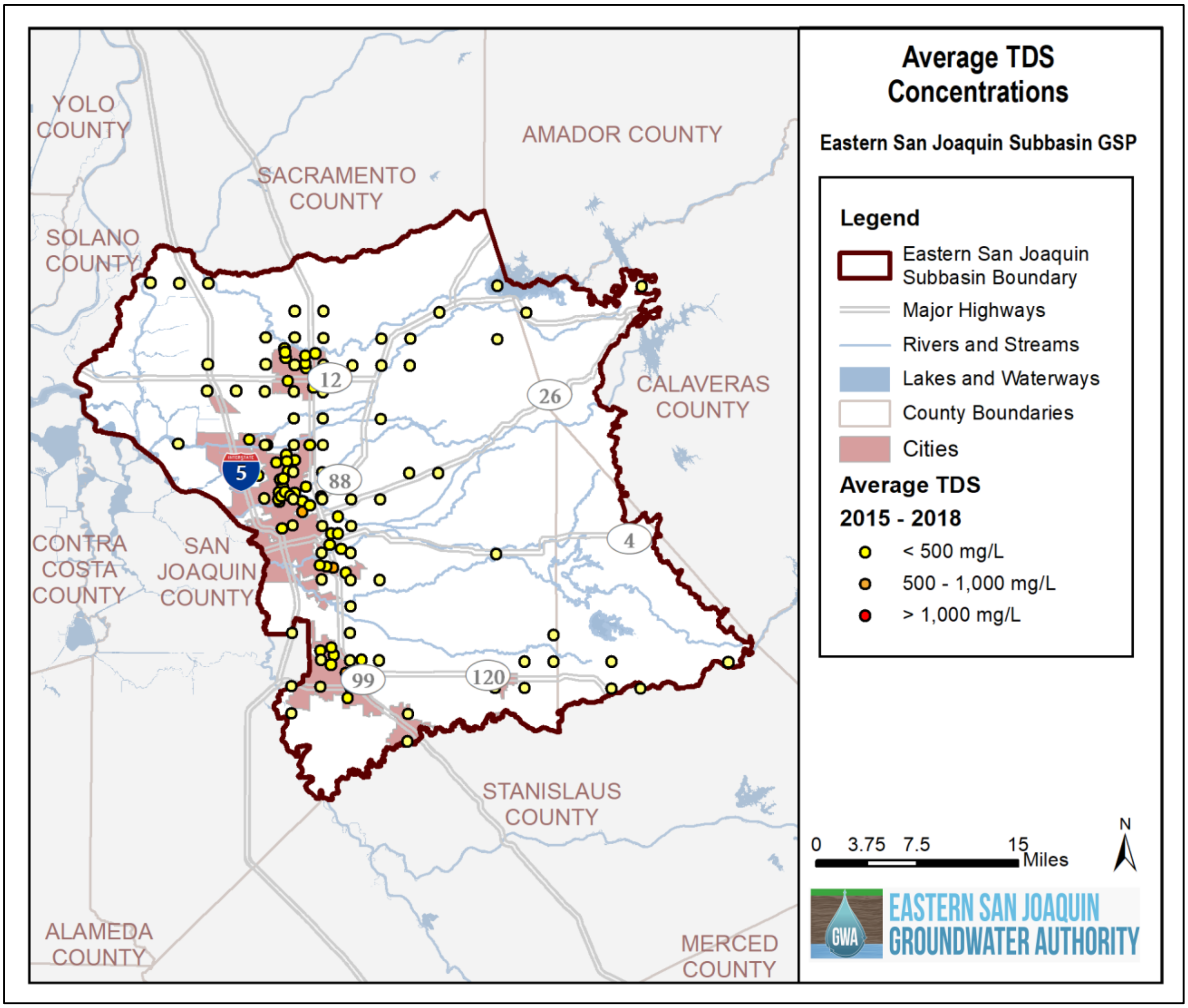


Figure 2-70: Average TDS Concentrations 2015-2018



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 2-71 shows the maximum TDS concentrations for shallow wells in the Eastern San Joaquin Subbasin from years 2015 to 2018, and Figure 2-72 shows the maximum TDS concentrations for deep wells in the same timeframe. As with chloride measurements, depth-dependent TDS data are not widely available.

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 2-71: Maximum TDS Concentrations in Shallow Wells 2015-2018

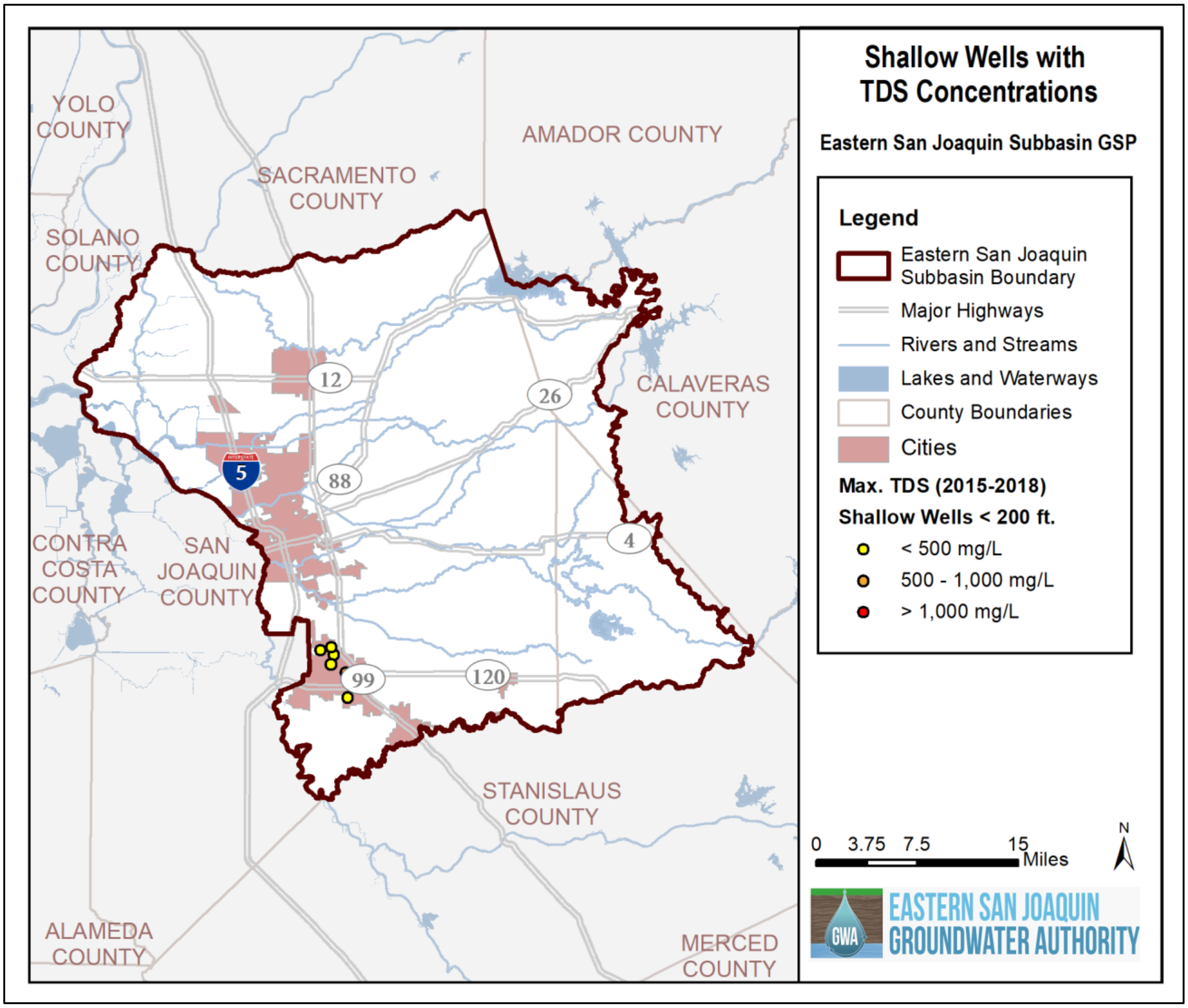
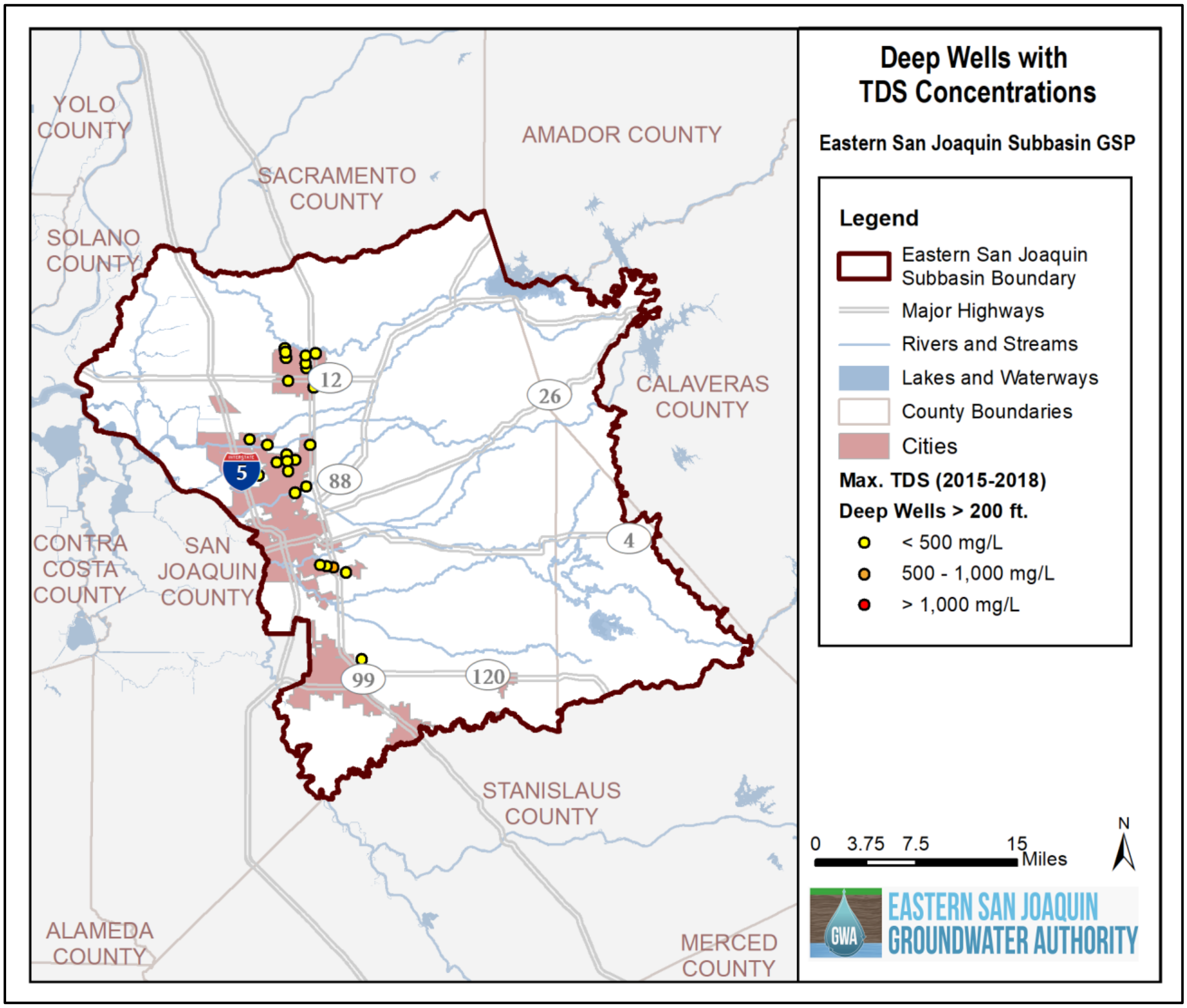


Figure 2-72: Maximum TDS Concentrations in Deep Wells 2015-2018



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 more 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

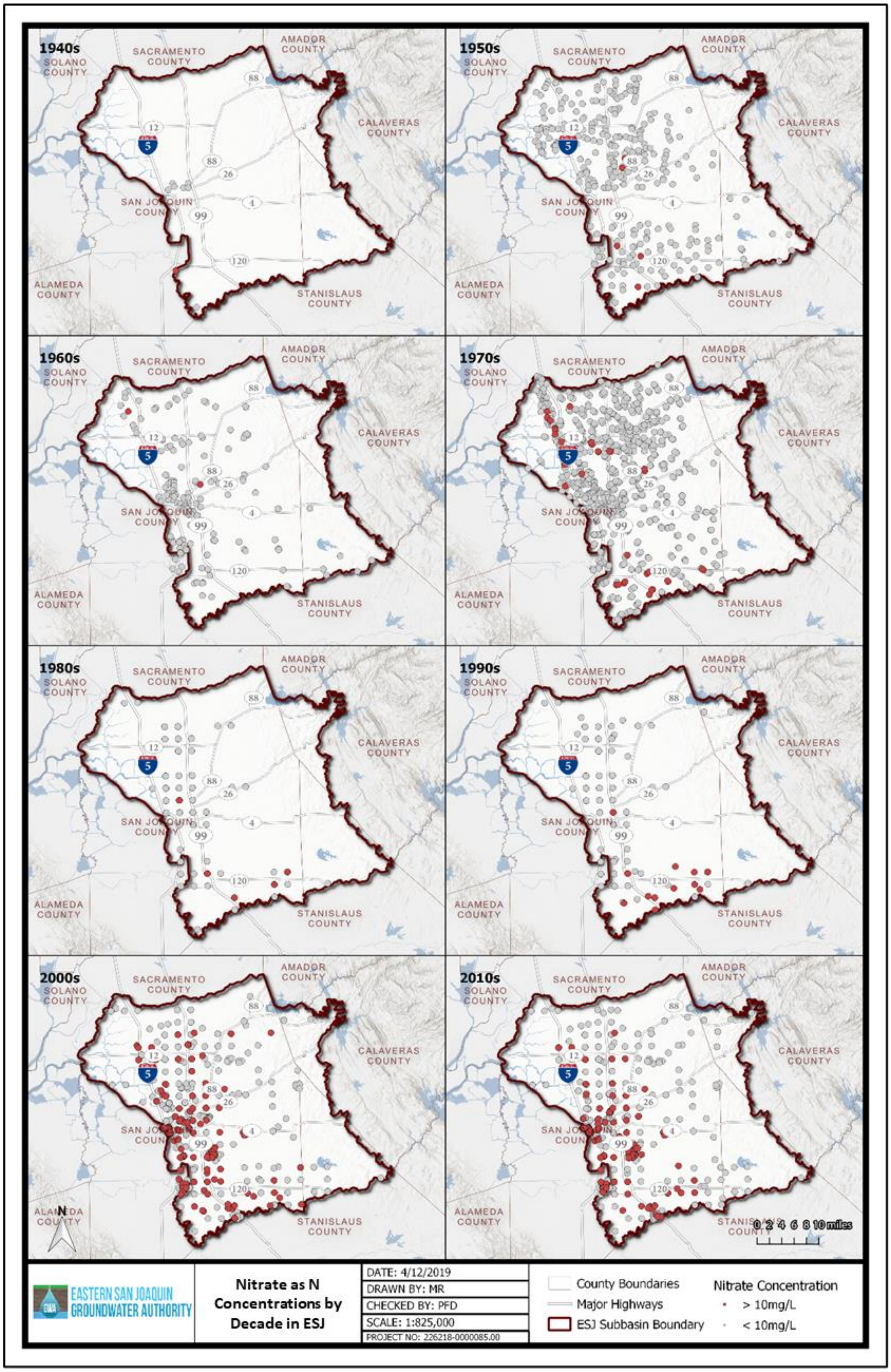
Figure 2-73 shows the historical spatial distribution of nitrate samples and detections by decade. During the 1940s, the earliest decade with nitrate measurements, very few records exist, and no significant conclusions can be made from this timeframe. The 1950s and 1960s have larger datasets, but measurements 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 (as of 2019) 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 3.3 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 2-73: 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 2-74 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 (as of 2019) arsenic samples show measurements above 10 µg/L similar to the overall trends (see Figure 2-75). 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.

Figure 2-74: Arsenic Concentrations by Decade

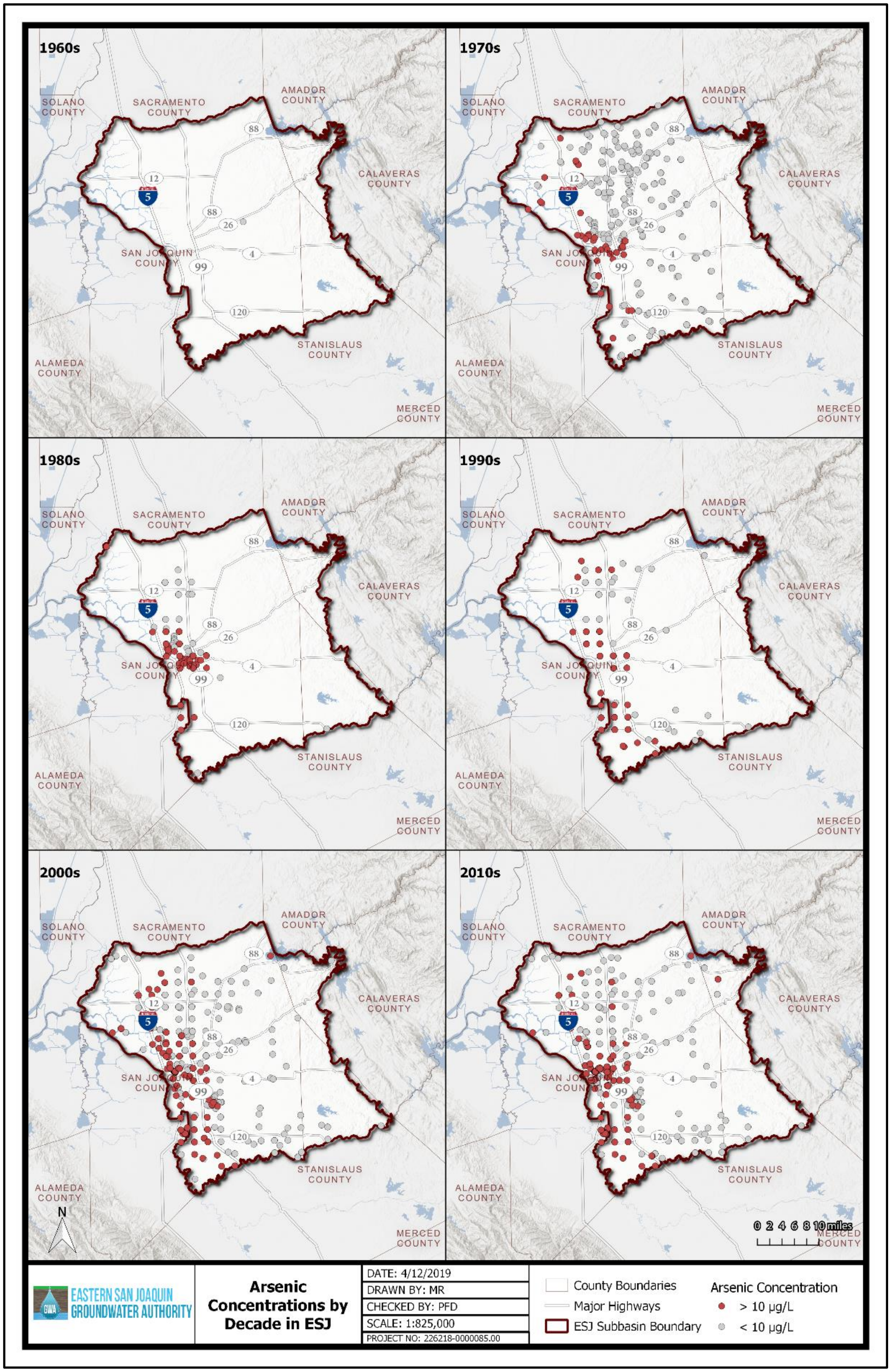
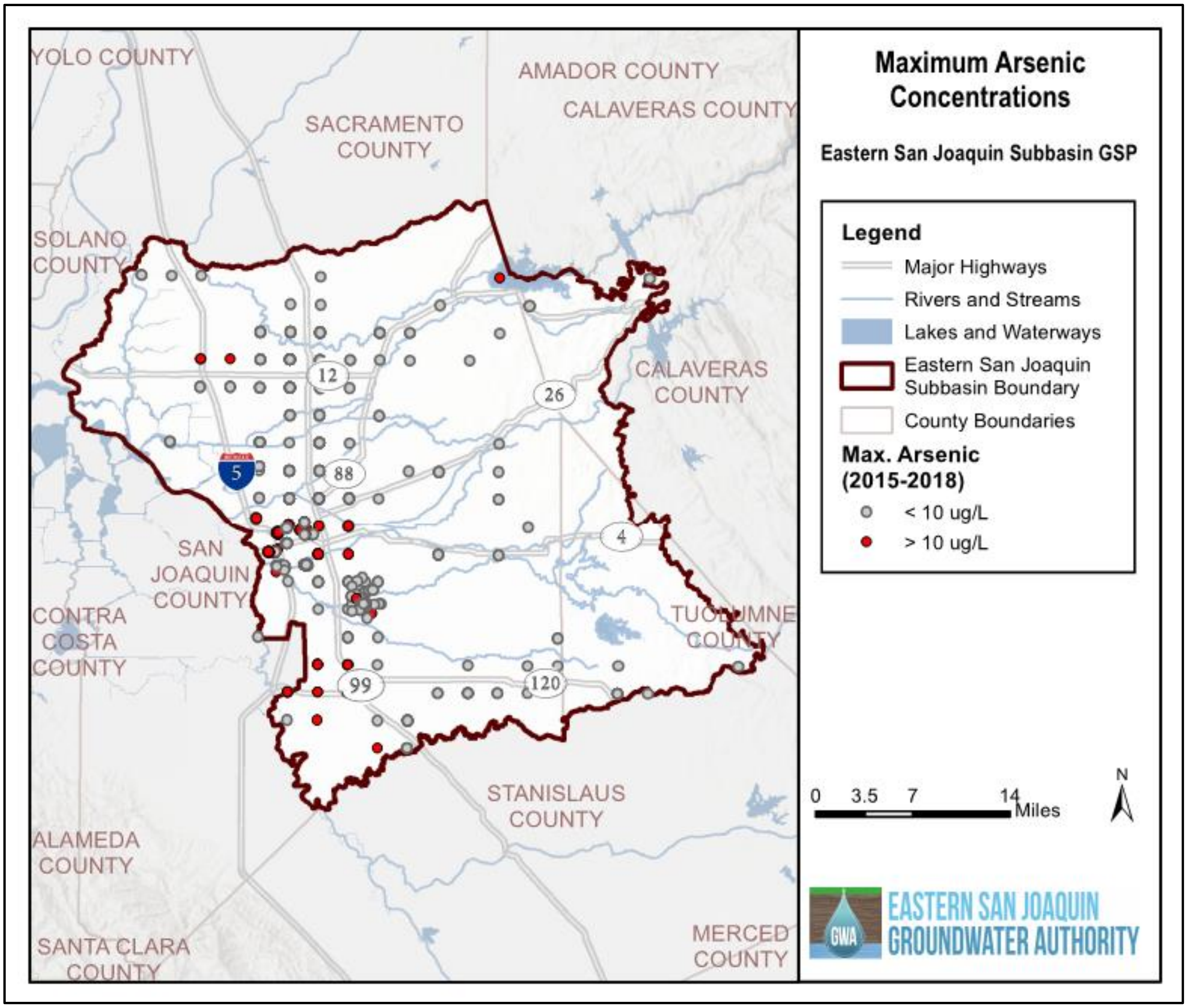


Table 2-9: Arsenic Concentrations by Decade

	% of Samples		
Decade	**<10 µg/L**	**>10 µg/L**	**Number of Arsenic Samples**
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 2-75: 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 2-76 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 2-76, 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 2-77, 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 2-76: Active Investigation and Remediation Sites as of 2019

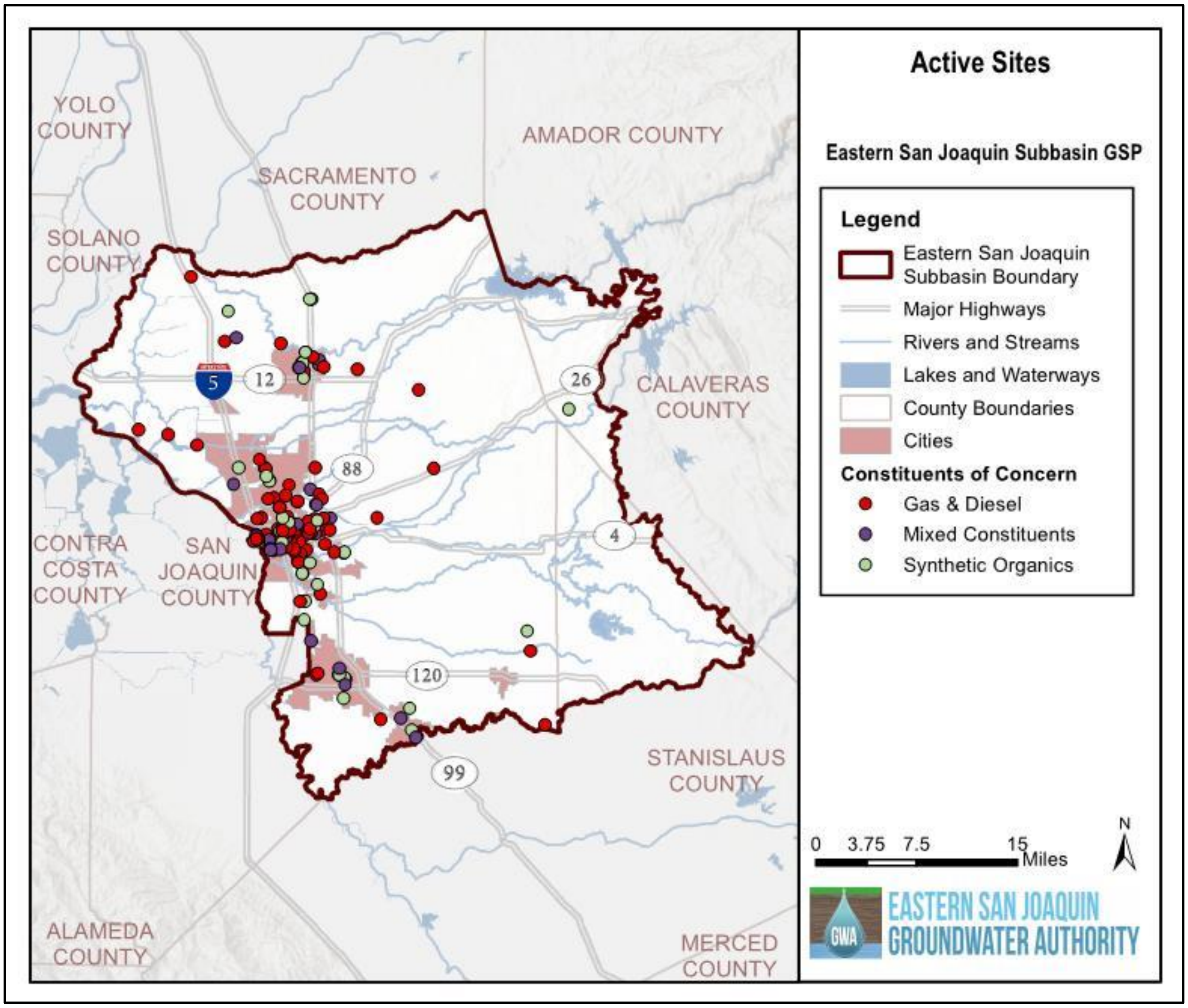
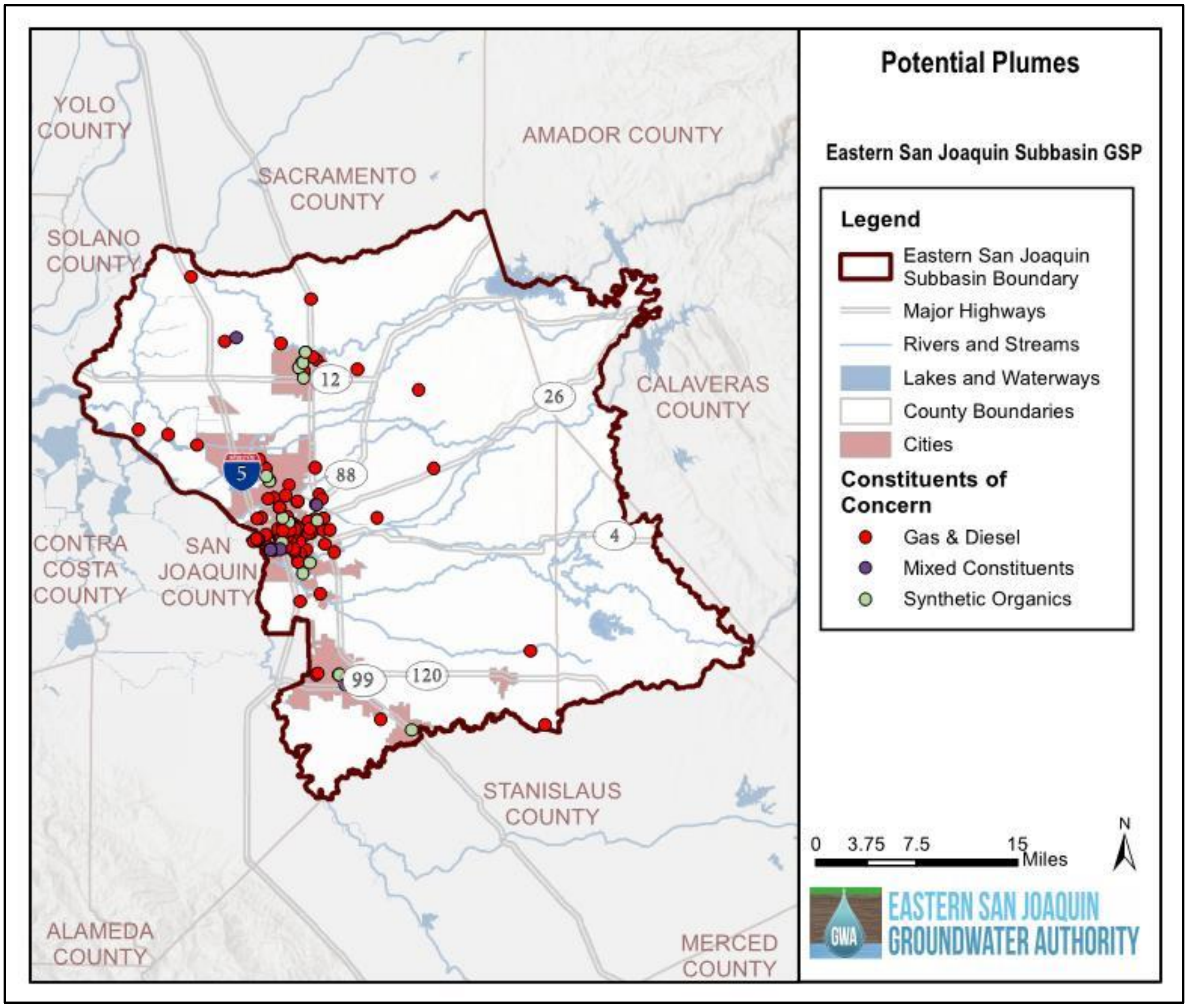


Figure 2-77: Active Sites with the Potential to Cause Plumes



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) (CVRWQCB, 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).

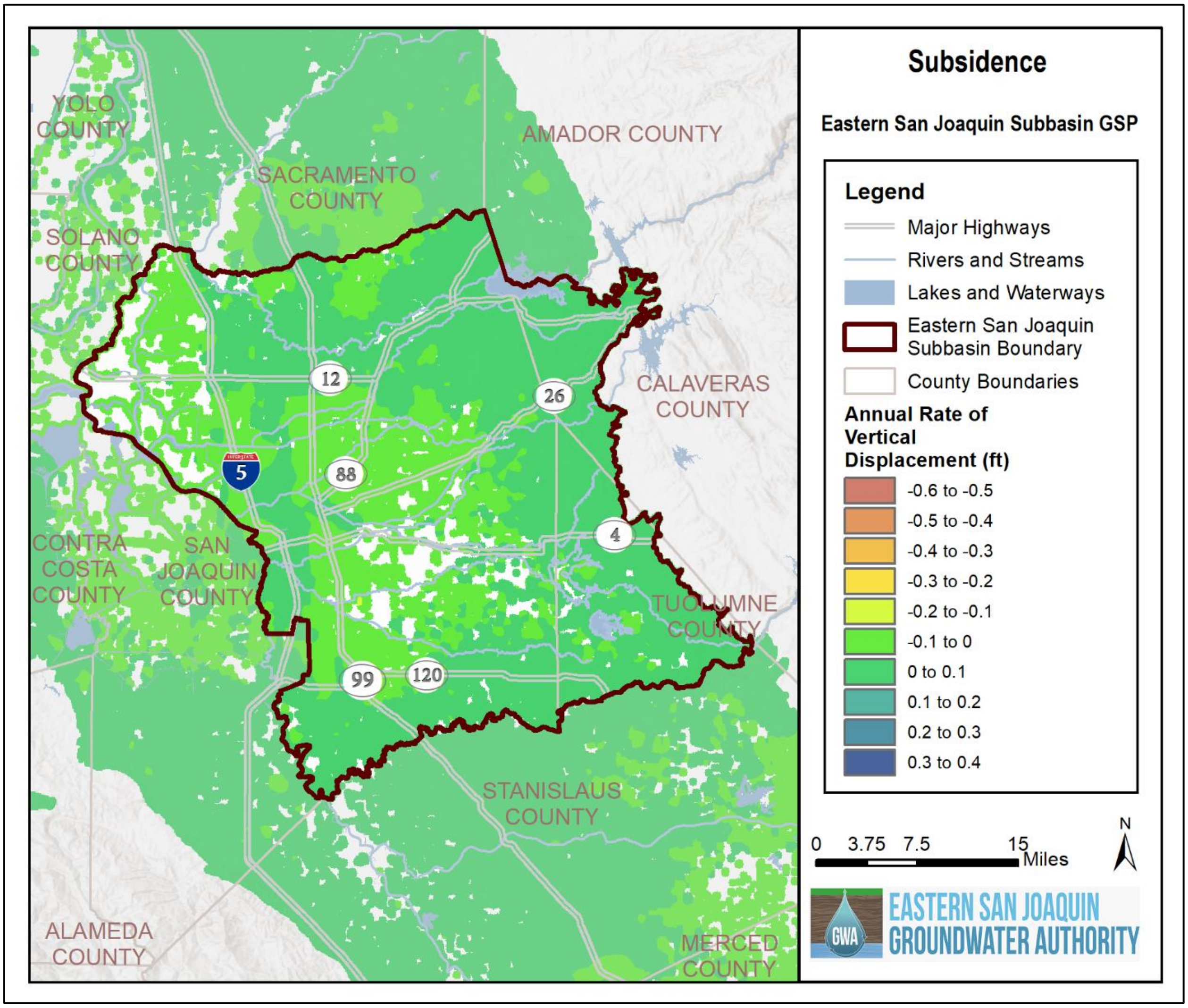
1,2,3-Trichloropropane (1,2,3-TCP) is a solvent and is typically found in industrial or hazardous waste sites. Along with an industrial solvent, 1,2,3-TCP is a cleaning and degreasing agent and associated with pesticide products. Though there is currently no federal MCL, the MCL for 1,2,3-TCP in California 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 Conditions in 2019: 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 2-78 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 2-78: 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 Conditions in 2019: Interconnected Surface Water Systems

Interconnected surface waters (ISW) 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.

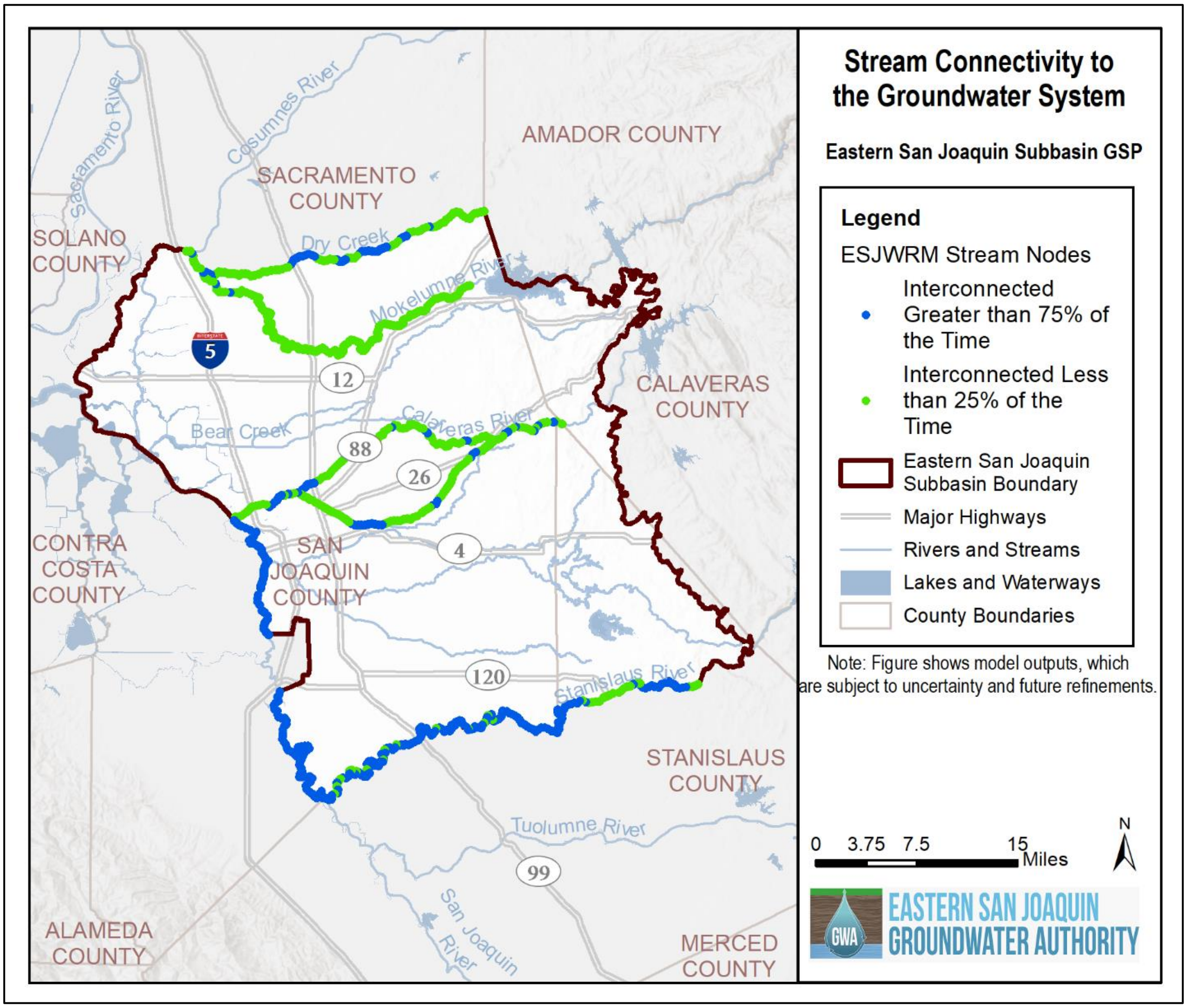
In the Eastern San Joaquin Subbasin, stream connectivity was analyzed by comparing monthly groundwater elevations from the historical calibration of the ESJWRM to streambed elevations along the streams represented in ESJWRM. This analysis was based on modeling results from the historical calibration 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 2-79 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 2-80 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 2-79 and Figure 2-80. 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 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. The analysis in this section includes the results from the 2019 model and Appendix 3-G details an updated analysis.

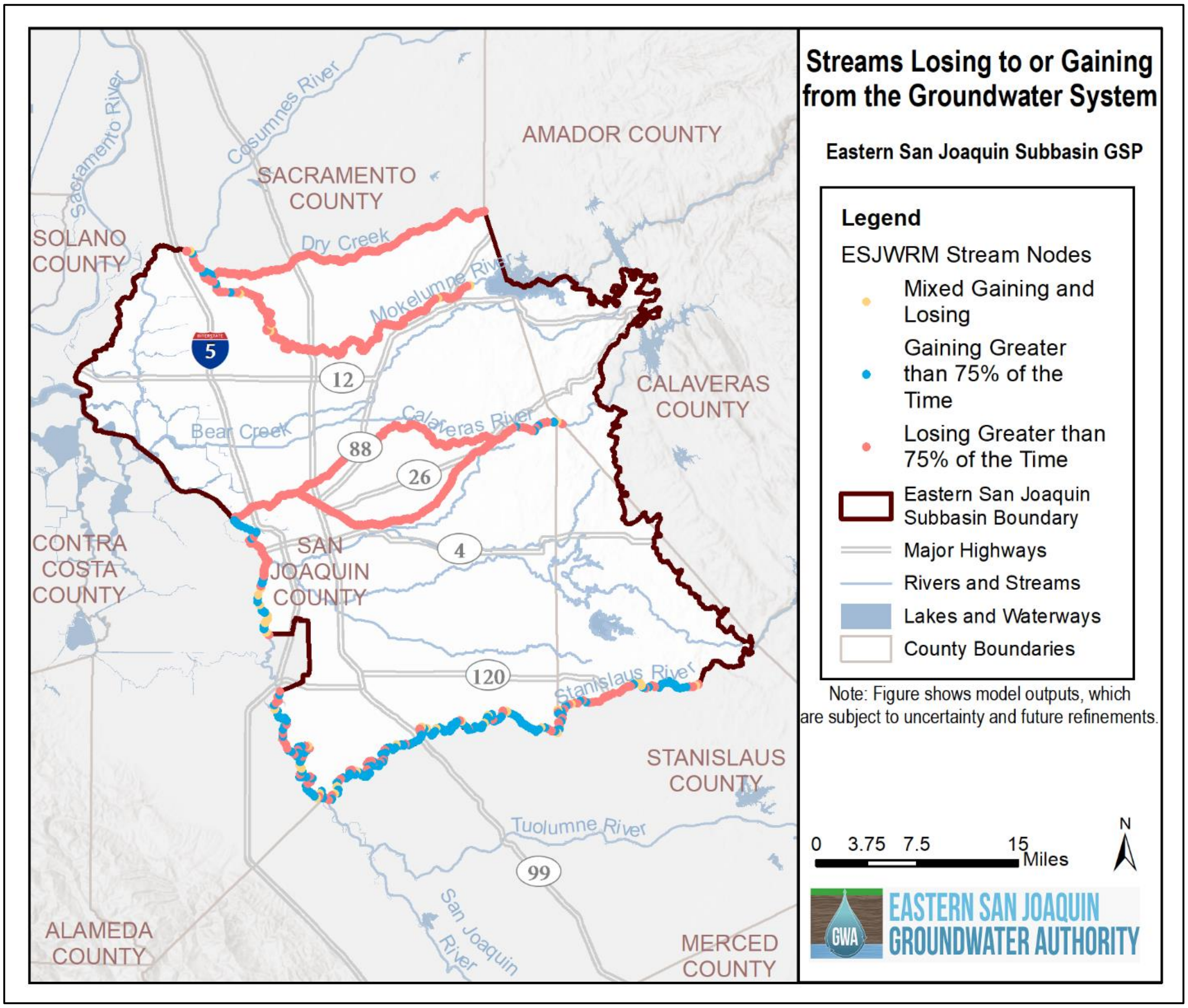
Figure 2-79 and Figure 2-80 are illustrations to describe model outputs, which are subject to uncertainty and future refinements and are not intended for regulatory purposes beyond the use in this Plan.

Figure 2-79: 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 2-80: 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 Conditions in 2019: Groundwater-Dependent Ecosystems

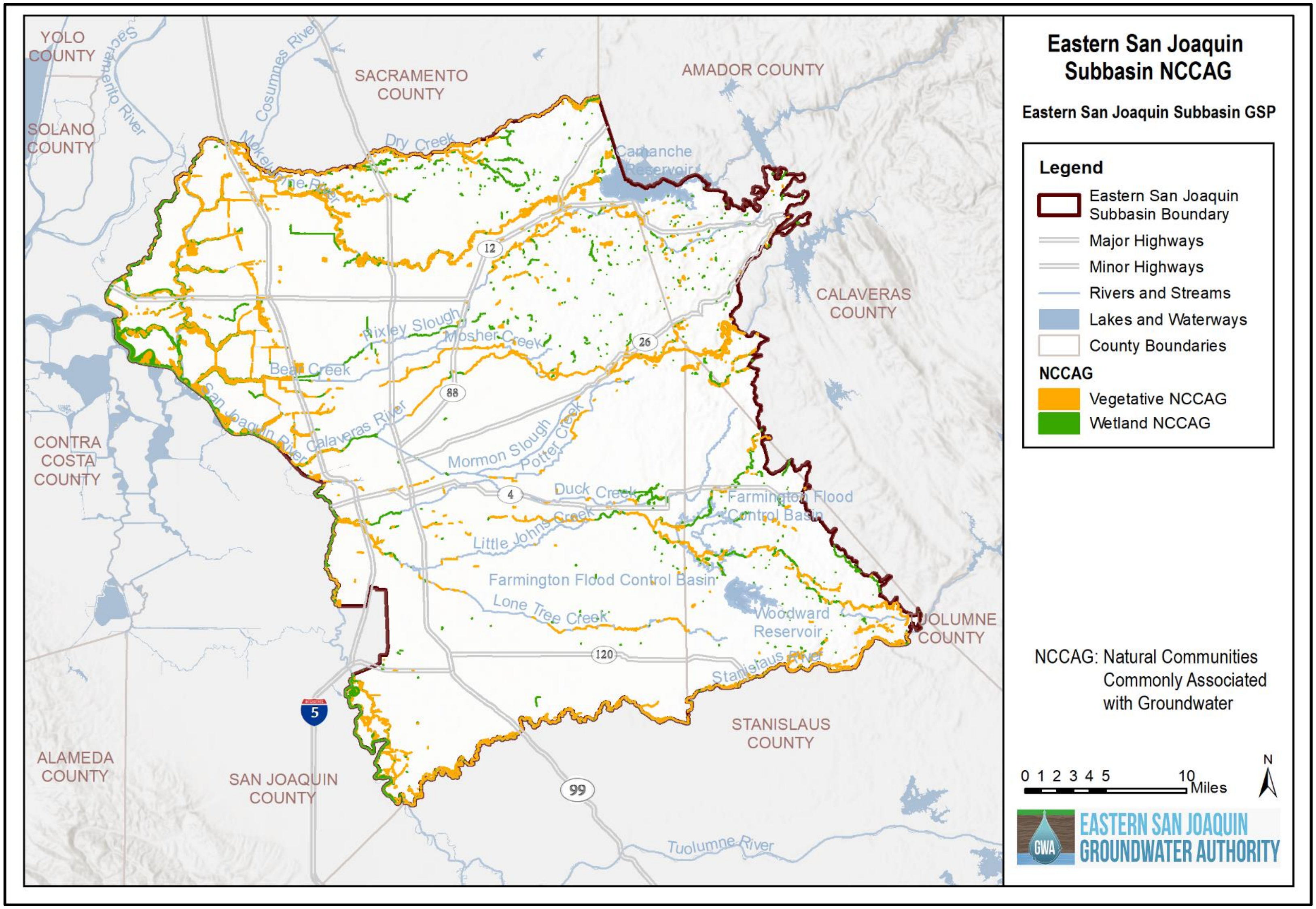
Groundwater-dependent ecosystems (GDEs) are defined in the GSP regulations as "ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface." SGMA requires the identification of GDEs. SGMA does not require that additional sustainable 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 2-81 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-H. Instream flows for rivers and streams interconnected with groundwater are evaluated through the Depletions of Interconnected Surface Water sustainability indicator (see Section 3.3.6).

Figure 2-81: 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 potential GDEs. To identify NCCAG areas that are potential 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 2-82 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 2-82 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 2-82 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).

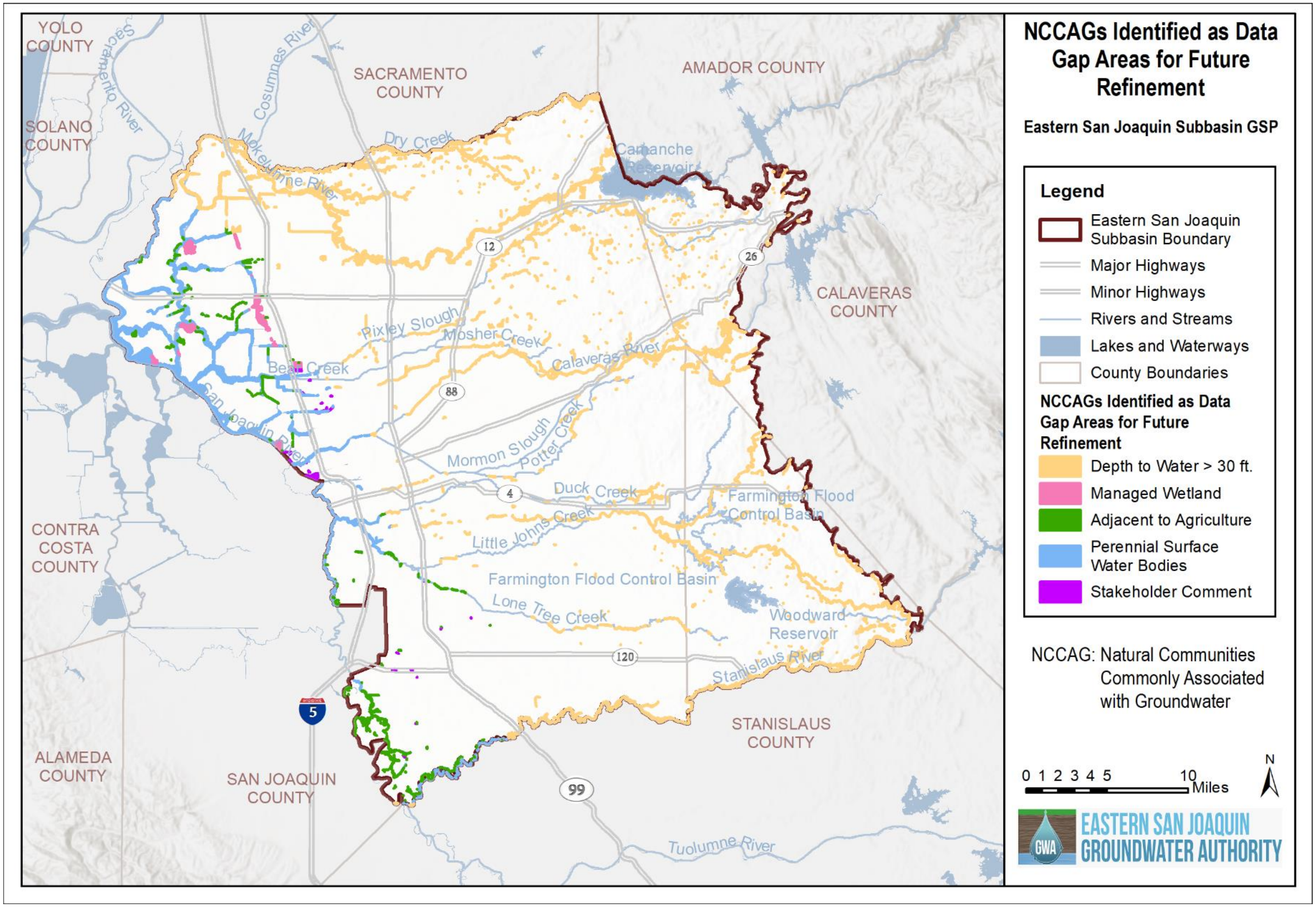
tailwater. Areas within 150 feet of such surface water bodies are assumed to be able to access that surface water regardless of the condition of the underlying aquifer. Areas father than 150 feet from such surface water bodies that meet the other GDE criteria in this section are assumed to be dependent 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 2-82 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 electronically 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 2-82 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.

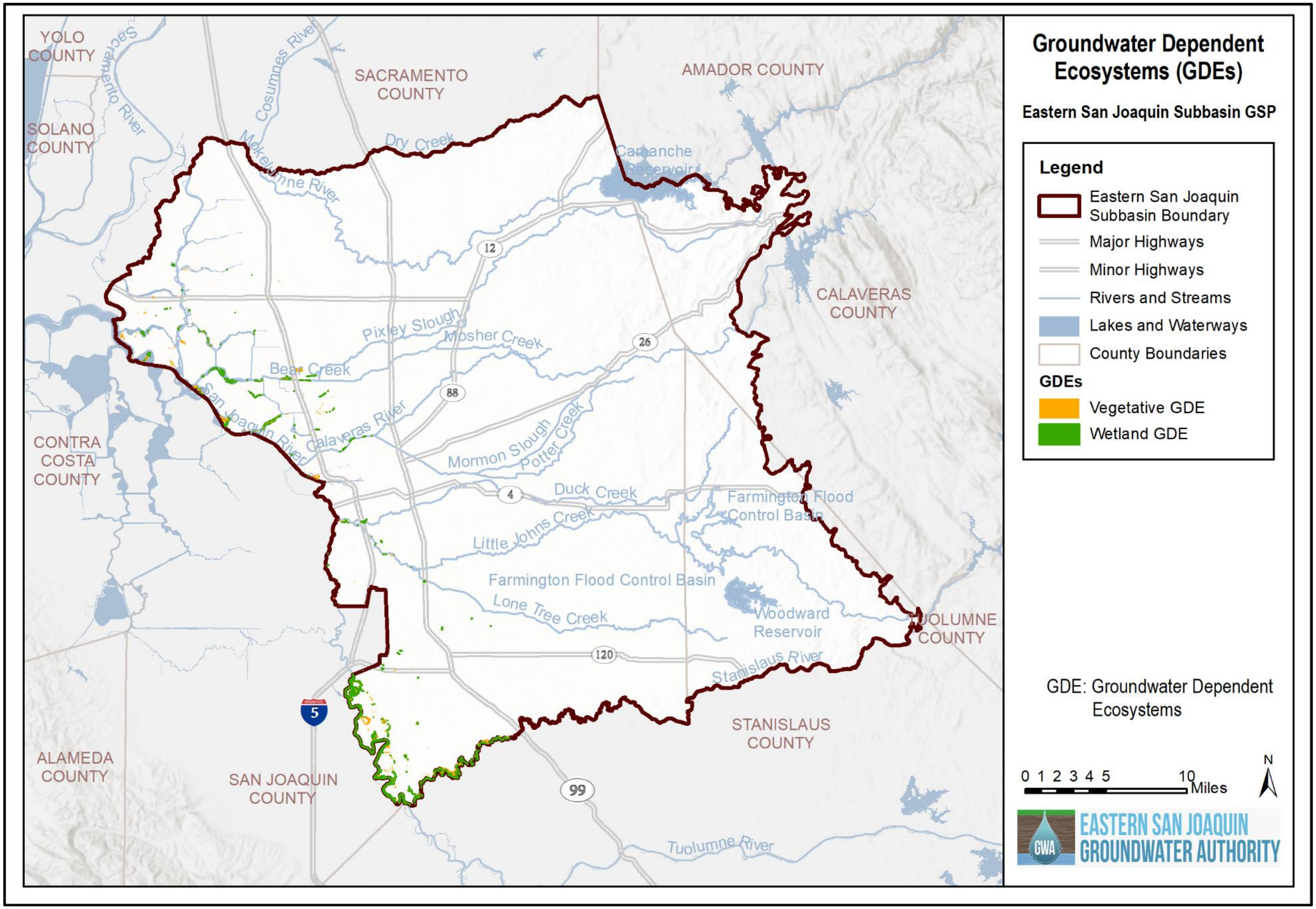
Figure 2-82: NCCAGs Identified as Data Gap Areas for Future Refinement, Likely to Access Non-groundwater Water Supplies



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 2-83.

Figure 2-83: Areas Identified as GDEs



2.3 CURRENT GROUNDWATER CONDITIONS

This section describes the current groundwater conditions in the Eastern San Joaquin Subbasin since development of the 2020 GSP.

As required by the GSP regulations, the current groundwater conditions section includes:

- Definition of current 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

Current conditions are generally assumed to be the conditions of the Subbasin roughly between WY 2020 and WY 2023, unless otherwise noted in the below sections.

2.3.1 Groundwater Elevation

2.3.1.1 Groundwater Levels

For the purposes of the 2024 GSP, the most current groundwater elevation conditions were characterized as fourth quarter 2022 (recent seasonal low, measured in fall 2022) and first quarter 2023 (recent seasonal high, measured in spring 2023) groundwater elevation measurements. However, WY 2023 represented a wetter than average water year. For comparison, fourth quarter 2019 and first quarter 2020 of WY 2020 are also included. WY 2020 was a dry year. Groundwater elevations were mapped using wells with available data in WDL.

Figure 2-84 and Figure 2-85 show the groundwater elevations for WY 2020. Figure 2-86 and Figure 2-87 show the groundwater elevations for WY 2023. A pumping depression at the center of the Subbasin, east of the City of Stockton, generally exists during periods of lower groundwater elevations, as shown in Fourth Quarter 2019, First Quarter 2020, and Fourth Quarter 2022. In wetter years, this pumping depression can recover, as shown in First Quarter 2023. Similar to historical conditions, groundwater generally flows from the outer edges of the Subbasin towards the depression in the middle of the Subbasin. The predominant hydraulic gradient across the Subbasin is from east to west.

Figure 2-84: Fourth Quarter 2019 Groundwater Elevation (WY 2020)

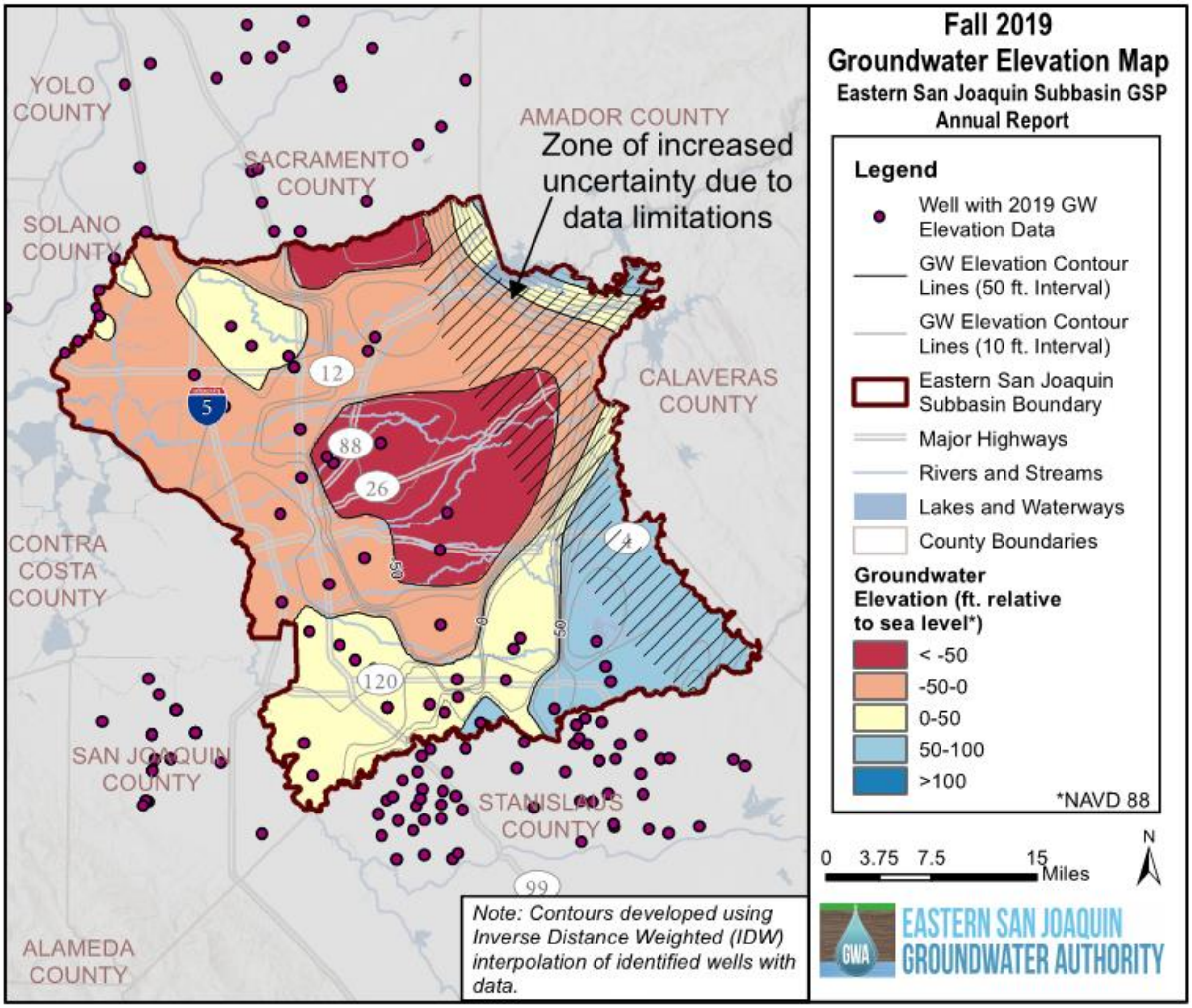


Figure 2-85: First Quarter 2020 Groundwater Levels (WY 2020)

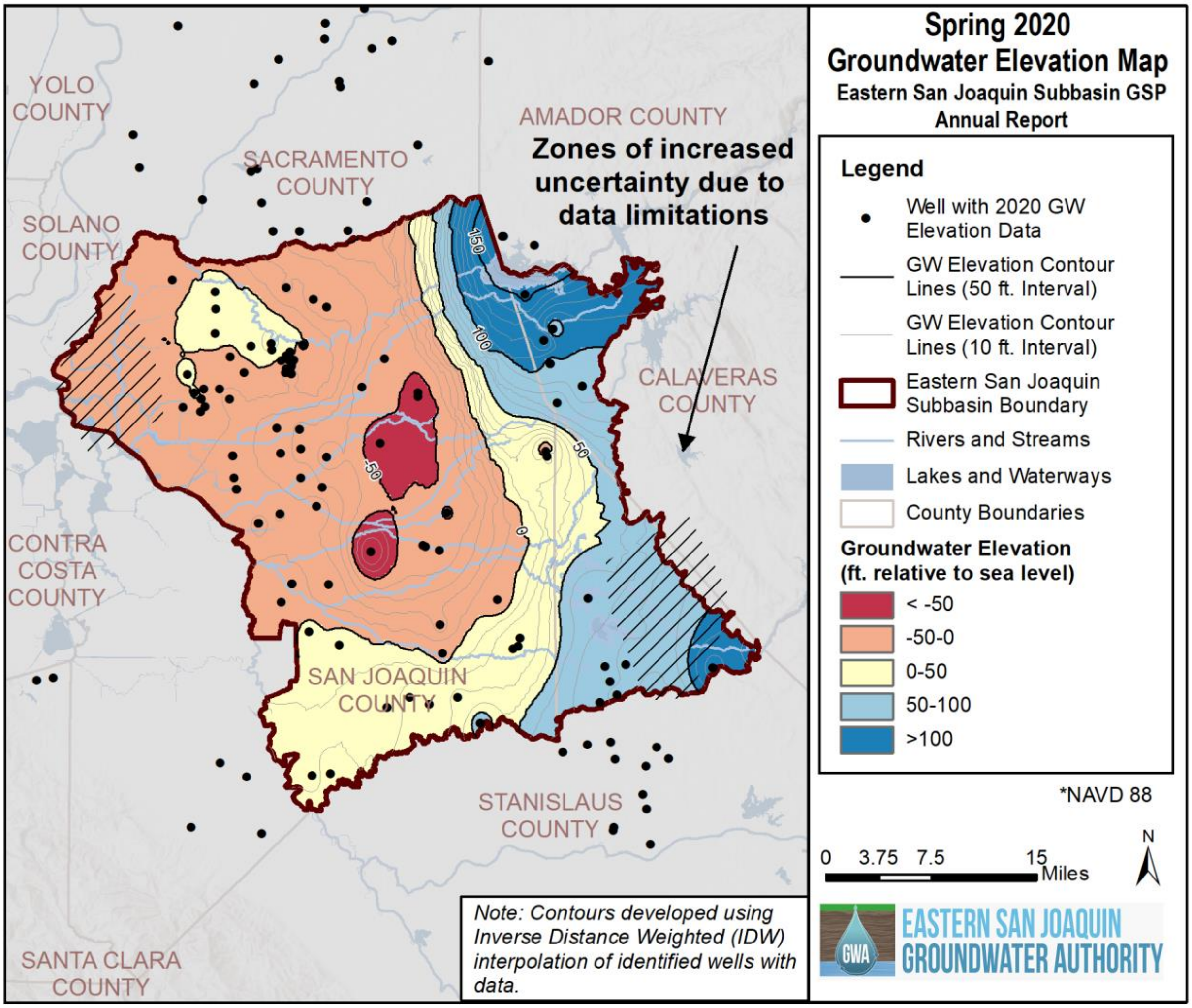


Figure 2-86: Fourth Quarter 2022 Groundwater Elevation (WY 2023)

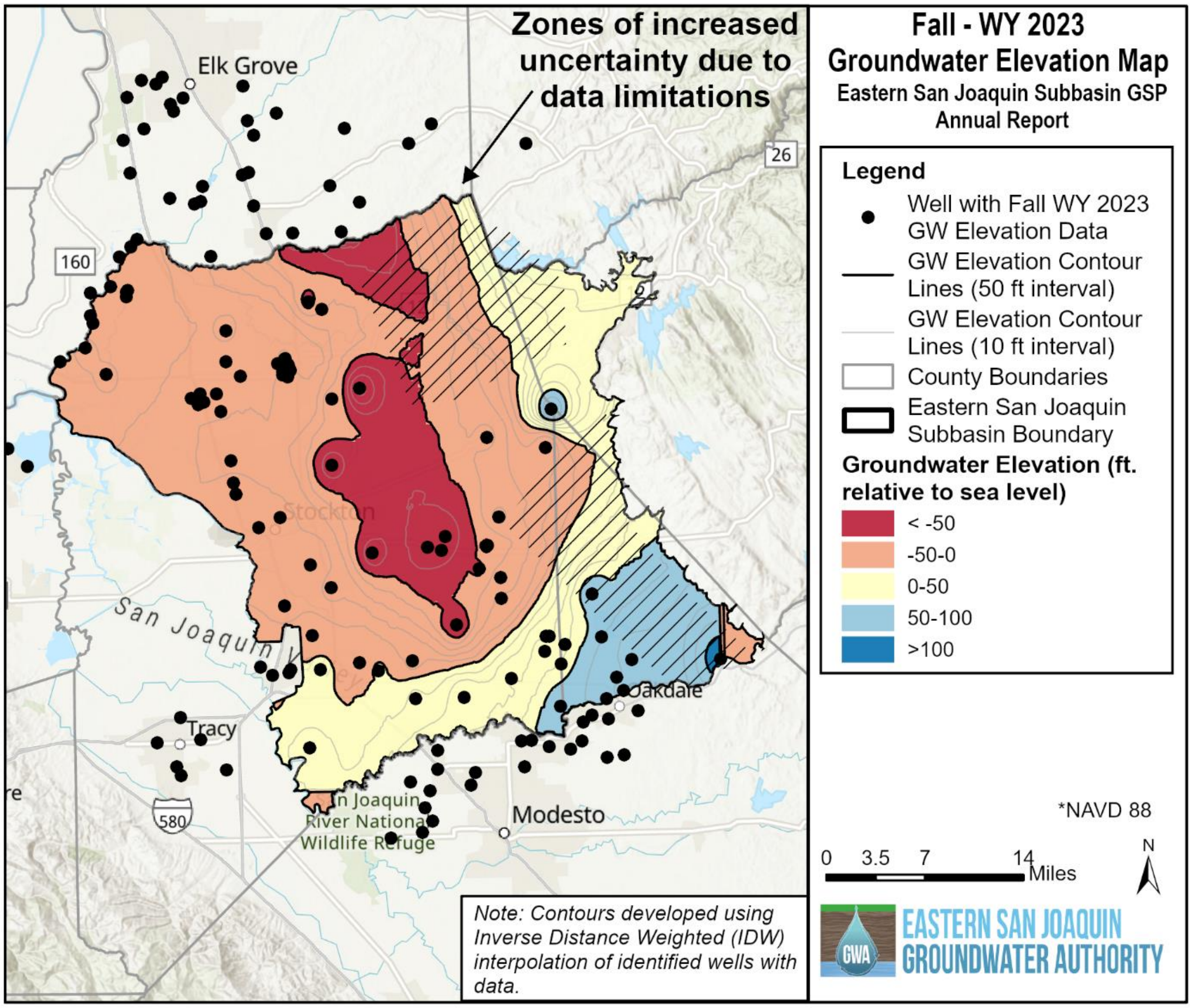
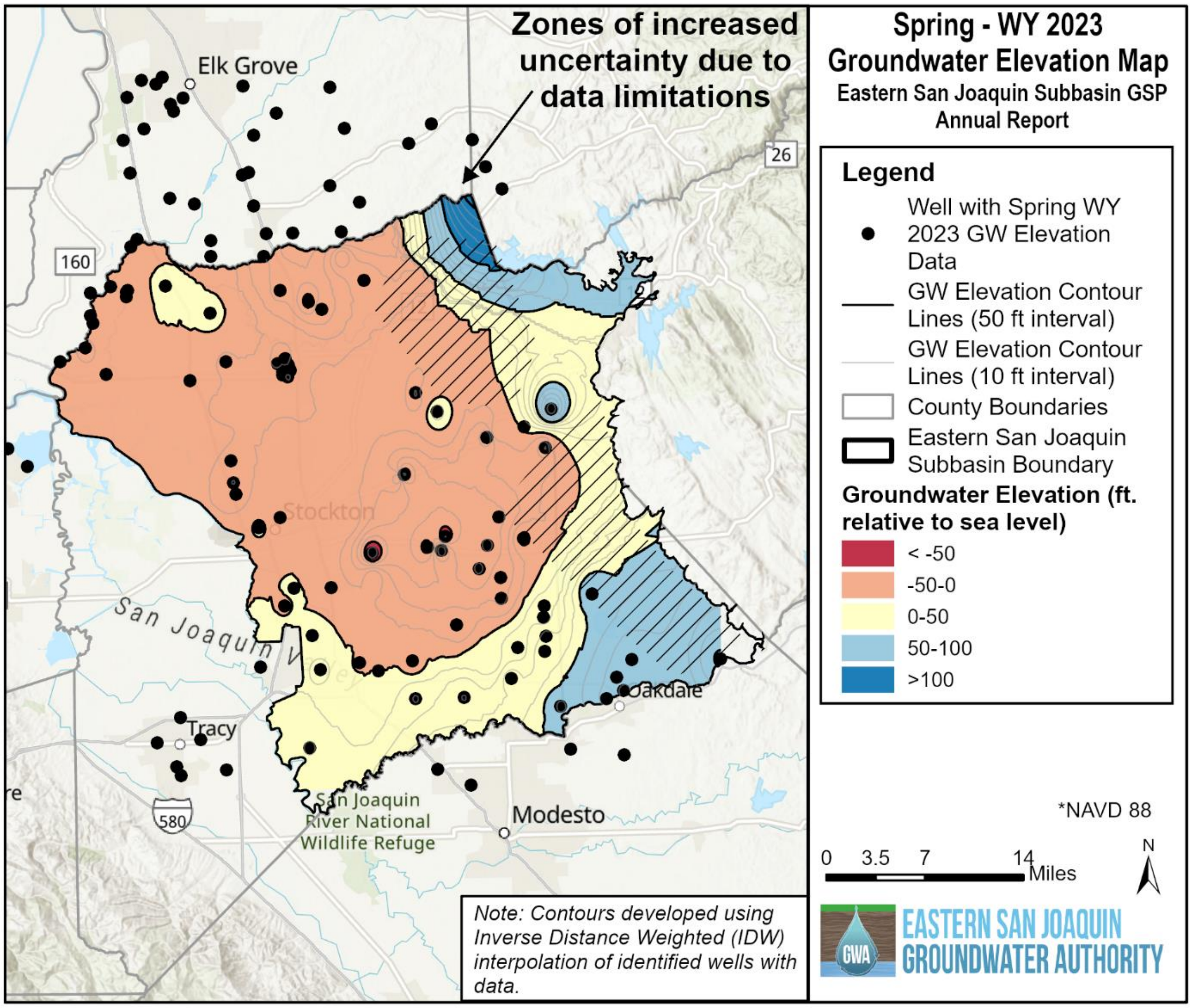


Figure 2-87: First Quarter 2023 Groundwater Levels (WY 2023)

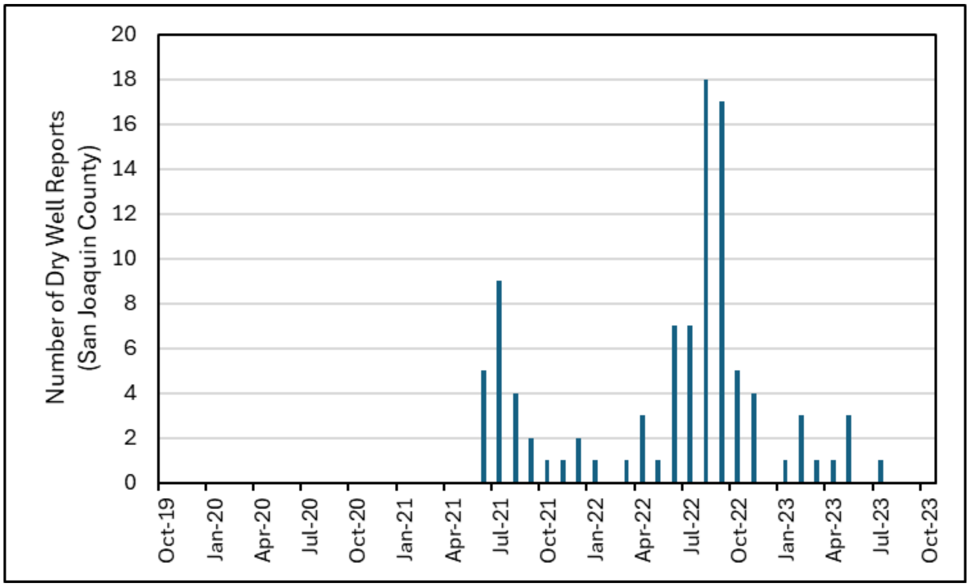


Hydrographs are reported annually to DWR in the Annual Reports for 76 single completion wells and 52 nested wells. The most recent hydrographs for these wells can be found in the WY 2023 ESJ Subbasin Annual Report, available on DWR's SGMA Portal (https://sgma.water.ca.gov/portal/). All hydrographs show yearly cycles of groundwater level declines in summer due to typical patterns in groundwater pumping and recharge during winter recovery.

2.3.1.2 Reported Dry Wells

According to DWR's Dry Well Reporting System, San Joaquin County has had 106 reported dry wells since the start of WY 2020 (CA Department of Water Resources, 2023). Figure 2-88 shows the number of reports made to DWR by month between WY 2020 and WY 2023. However, it is important to note that dry wells are reported for many reasons other than a failure due to increasing depth to groundwater. Staff interviews with DWR confirmed that the system does not determine the cause of the well failure unless monitored by outside parties. As expected, reports of dry wells were higher in the critical years of WY 2021 and 2022 than in WY 2023, a wet year.

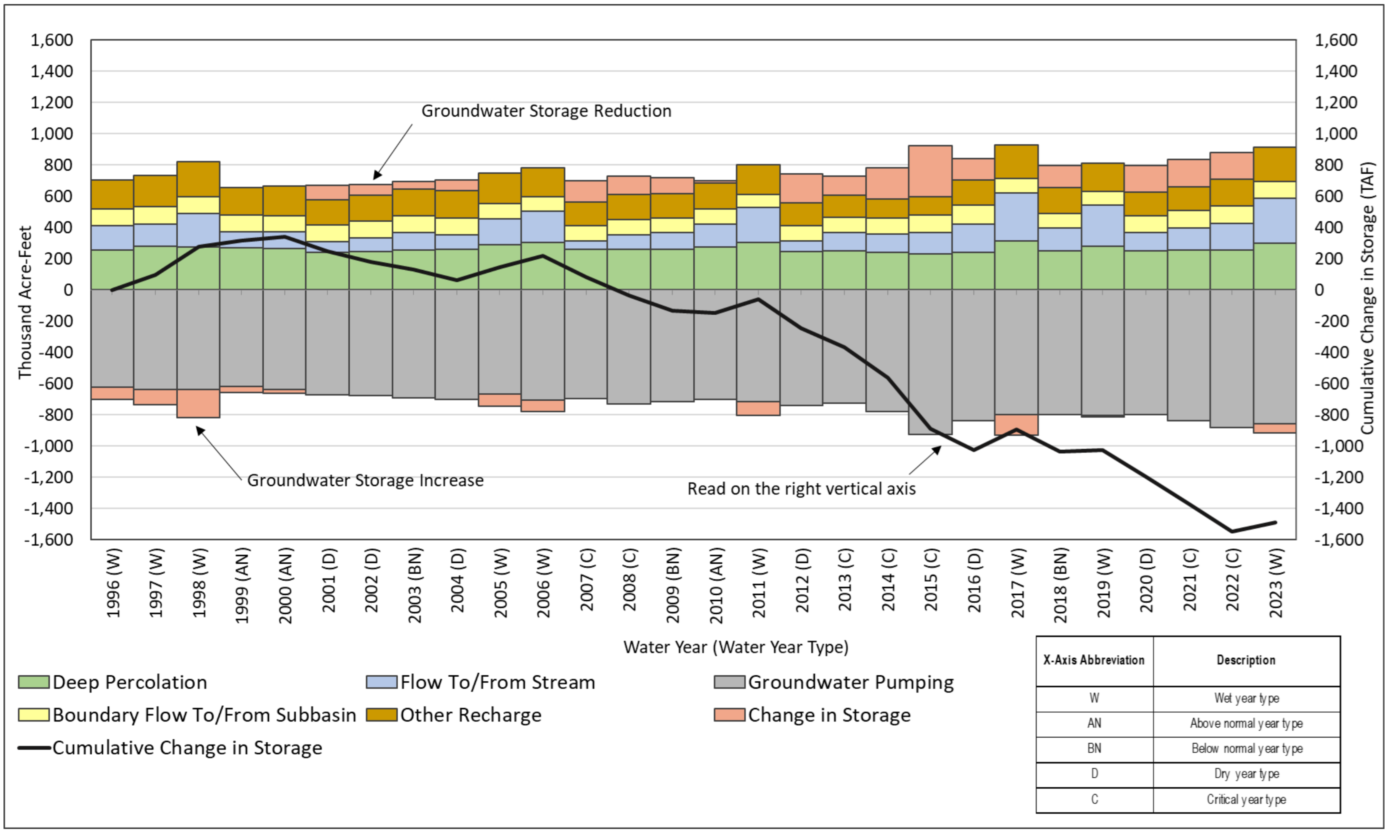
Figure 2-88 : Number of Reported Dry Wells in San Joaquin County between WY 2020-2023



2.3.2 Groundwater Storage

The ESJWRM was used to estimate historical change in storage of the Eastern San Joaquin Subbasin from 1995-2023. Figure 2-89 shows the cumulative change in storage against annual storage change and water year type, including current condition years WY 2020 through 2023. The cumulative change in storage from 1996 to 2023 was estimated as on average -0.34 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-C.

Figure 2-89: Modeled Change in Annual Storage with Water Use and Year Type



Notes:

4. Water Year Types based on San Joaquin Valley Water Year Index (CA DWR, 2024)
5. "Other Recharge" includes managed aquifer recharge, recharge from unlined canals and/or reservoirs, and recharge from ungauged watersheds.
6. "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.

2.3.3 Seawater Intrusion

The northwest corner of the Eastern San Joaquin (ESJ) Subbasin overlies a portion of the Delta. The Delta originally experienced groundwater fluctuations closely tied to tidal cycles, with a mix of brackish, saline ocean water, and fresh streamflow typical of an inland river delta and estuary. However, after decades of land reclamation and the implementation of managed operations as a result of the State Water Project and Central Valley Project, the Delta is now managed as a freshwater body. Saline water is no longer able to migrate eastward beyond the extensive network of levees and engineering alterations to the original natural channels. As a result, seawater intrusion has not historically been observed within the Subbasin nor is it likely to occur in the future.

The following section provides analysis supporting this claim, demonstrating that:

1. The Delta is managed as a freshwater body in the Subbasin
2. There is minimal pumping near the Delta
3. There are relatively low chloride concentrations in the Subbasin

Further detail can be found in Appendix 3-F.

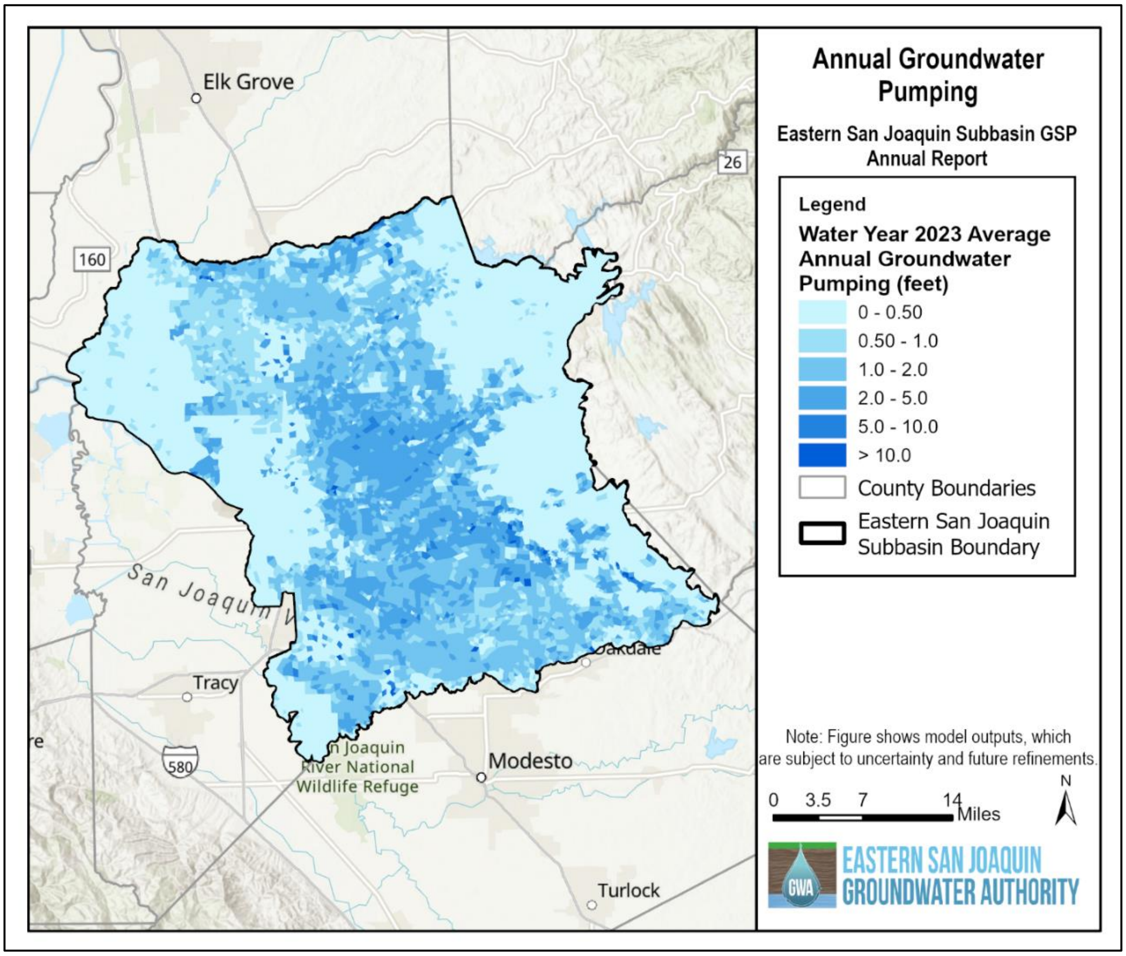
2.3.3.1 Delta is Managed to Maintain Freshwater Flows

The Subbasin is located in the Delta region. Prior to the construction of the Shasta Dam in 1943, brackish water had entered the surface waterways throughout the Delta. The Delta ecosystem naturally adapted to a salinity cycle that brought brackish tidal water from the San Francisco Bay. However, the construction of levees for agricultural development, followed by the development and operation of the Central Valley Project and the State Water Project, has changed the pattern of seawater movement into the Delta (Water Education Foundation, 2019). Historically, some saltwater may have infiltrated the aquifers locally affecting groundwater quality. Current management practices aim to maintain freshwater flows in the Delta through a combination of hydraulic and physical barriers and modifications to existing channels (Water Education Foundation, 2019). The "X2" barrier, where the salinity is approximately 2 parts per thousand (ppt), is located well outside of the Subbasin boundary further downstream in the Delta (Cloern, 2012). (For reference purposes, the salinity of the ocean is about 35 ppt.) Various agencies and regulations, such as the Delta Protection Commission (DPC), Delta Stewardship Council, San Joaquin County & Delta Water Quality Coalition, and State Water Board Resolution No. 2009-011, contribute to managing and maintaining salinity conditions in the Delta region.

2.3.3.2 Minimal Groundwater Pumping Near the Delta

Figure 2-90 presents the Subbasin's 2023 average groundwater pumping in feet across the Subbasin. The majority of pumping is in the northwest portion of Subbasin, areas adjacent to the Delta pump less than half a foot of groundwater per year.

Figure 2-90: 2023 Annual Groundwater Pumping



This figure reflects groundwater pumping from the 2023 Eastern San Joaquin Annual Report. Results may vary with the updated 2024 Eastern San Joaquin Water Resources Model.

2.3.3.3 Low Chloride Concentrations

Historical and current chloride concentrations were analyzed in the Subbasin. A variety of groundwater quality data were collected and examined. The datasets used for this analysis include (1) the Groundwater Ambient Monitoring and Assessment (GAMA) database, (2) The National Water (NWQMC) database, (3) the region's Opti Data Management System (DMS), and (4) SGMA Data Viewer (DWR). From these datasets, 4,000 unique wells were utilized with approximately 19,500 chloride observations.

Most wells had chloride concentrations well below the SMCL of 250 mg/L for chloride. (Secondary MCLs are established as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. Contaminants with SMCLs are not considered to present a risk to human health and are not enforced.) Chloride concentrations throughout the Subbasin have remained relatively low. Table 2-12 shows the percentage of chloride measurements after 2015 that exceed thresholds of 250 mg/L, 500 mg/L, and 2,000 mg/L. Notably, the majority of measurements (80%) fell within the 0–250 mg/L range, indicating low chloride levels throughout the Subbasin. Additionally, 14% of chloride observations were in the 250–500 mg/L range. Overall, 94% of measurements are below the 500 mg/L threshold. This analysis demonstrates that chloride concentrations in the Subbasin are generally low.

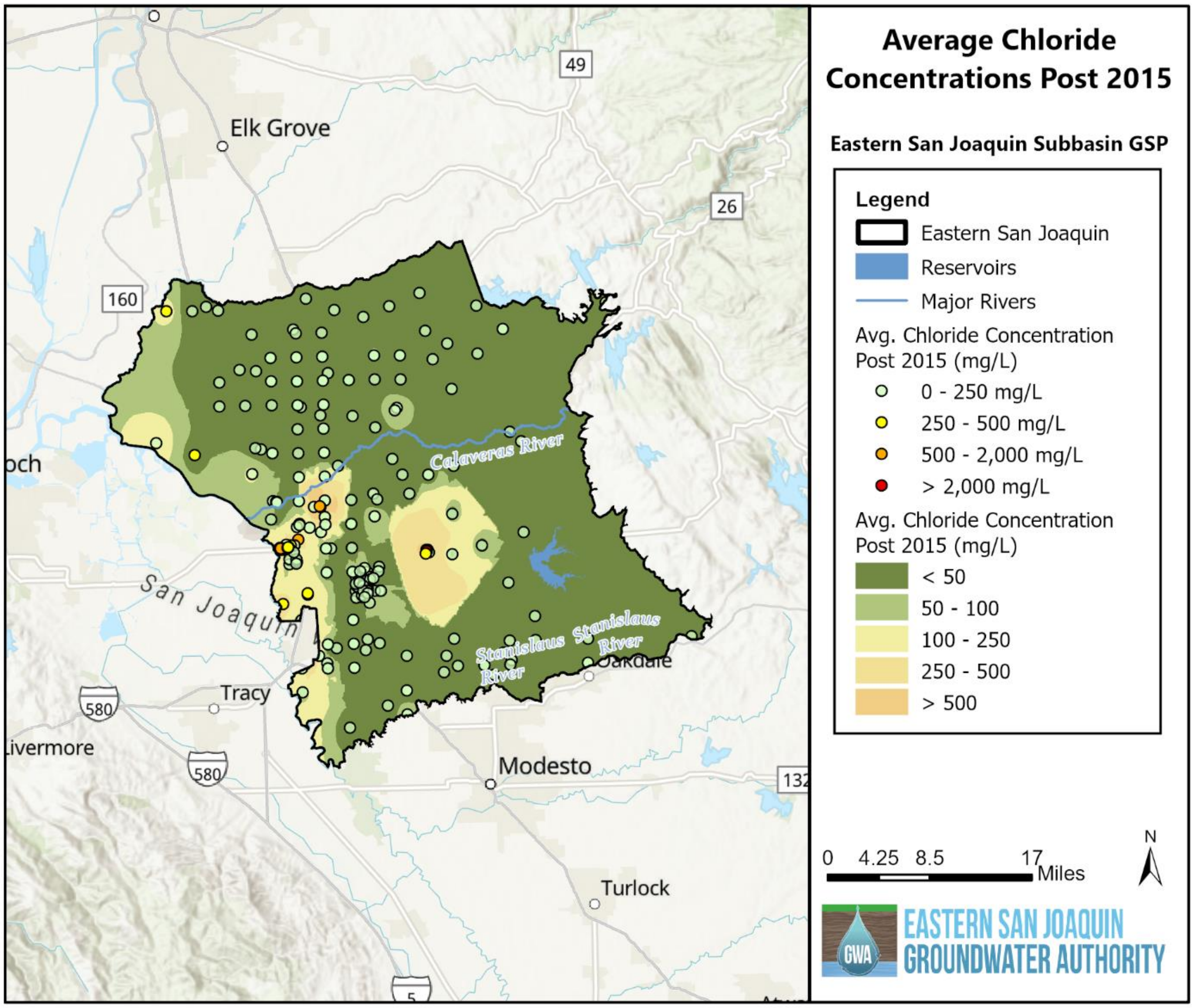
Table 2-12: Chloride Concentrations after 2015

Threshold Concentration	Percentage of Measurements after 2015 above Threshold
250 mg/L	14%
500 mg/L	5%
2,000 mg/L	1%

Chloride measurements in Table 2 are based on approximately 19,500 observations from 4,000 unique wells.

Figure 2-91 shows the average chloride concentration in the Subbasin since January 2015. These results are consistent with the ranges shown in Table 2-12. As shown in Figure 2-91, the majority of chloride concentrations in the Subbasin are within the 0 to 250 mg/L range. There are instances of higher concentrations in the 250 to 500 mg/L range, localized within the central and western regions of the Subbasin. Notably, these areas of relatively higher chloride concentrations are not located only in the Delta area and do not form a seawater intrusion front pattern. Overall, concentrations of chloride in the Subbasin are minimal and seawater intrusion is not occurring in the Subbasin or expected to occur in the future.

Figure 2-91: Average Chloride Concentrations Post-2015



2.3.4 Groundwater Quality

In addition to the chloride data shown in Section 2.3.3, available recent TDS data from the Groundwater Ambient Monitoring and Assessment (GAMA) Program were also analyzed to characterize current groundwater quality conditions. The locations, observations, and concentrations of the new set of monitoring wells were examined, as shown in Figure 2-92 through Figure 2-94.

Figure 2-92 illustrates the count of TDS groundwater quality observations for each well between January 2015 and January 2024. The majority of wells have 10 or fewer observations, indicating that most wells were not sampled on an annual basis. Several wells closer to the City of Stockton have up to 50 groundwater quality observations. The wells with the highest sample count appear to be located near groundwater cleanup sites. Ideally, wells in the representative monitoring network for groundwater quality would have been sampled regularly; however, some wells in the specific areas have not sampled frequently (greater than 10 times) in recent years.

Figure 2-93 displays wells with TDS observations in recent years (2015 through early 2024) by well depth. The threshold between shallow and deep wells was set at 200 feet for consistency with the 2020 GSP. There were several wells without perforation or depth information. Between shallow, deep, and unknown well depths, there is a similar distribution of high- and low-quality groundwater. In other words, TDS was not observed in just the shallow portions or just the deep portions of the aquifer.

Figure 2-94 illustrates the maximum TDS concentrations since January 2015. The majority of wells have TDS concentrations below 600 mg/L (the measurable objective for TDS). However, some wells have recent TDS concentrations above 1,000 mg/L (the minimum threshold for TDS). These wells are primarily located near the City of Stockton. Public water purveyors closely monitor groundwater quality and source and treat their water accordingly.

Figure 2-92: Monitoring Frequency for Wells Measuring Total Dissolved Solids

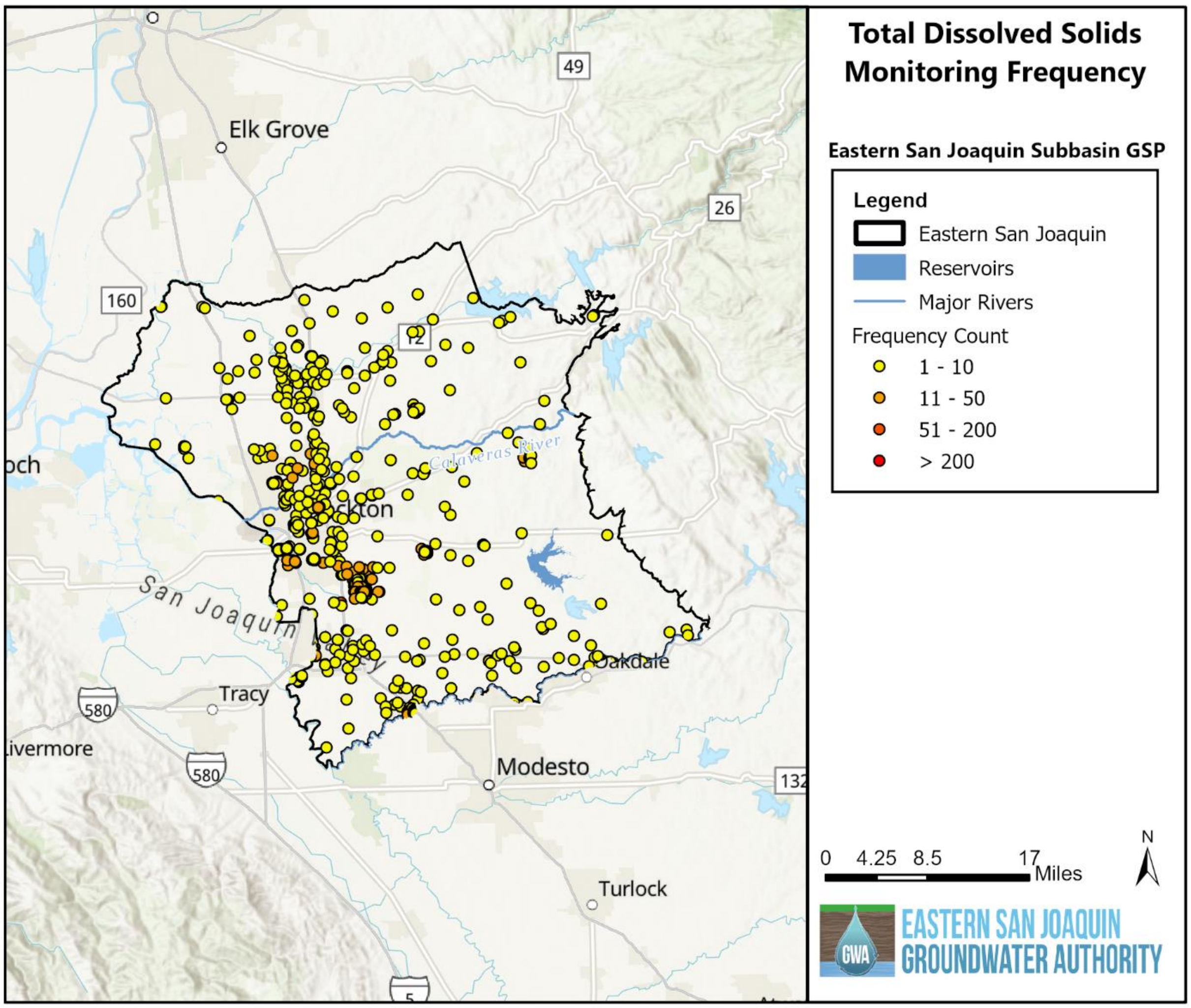


Figure 2-93: Wells with Recent TDS Observations by Well Depth

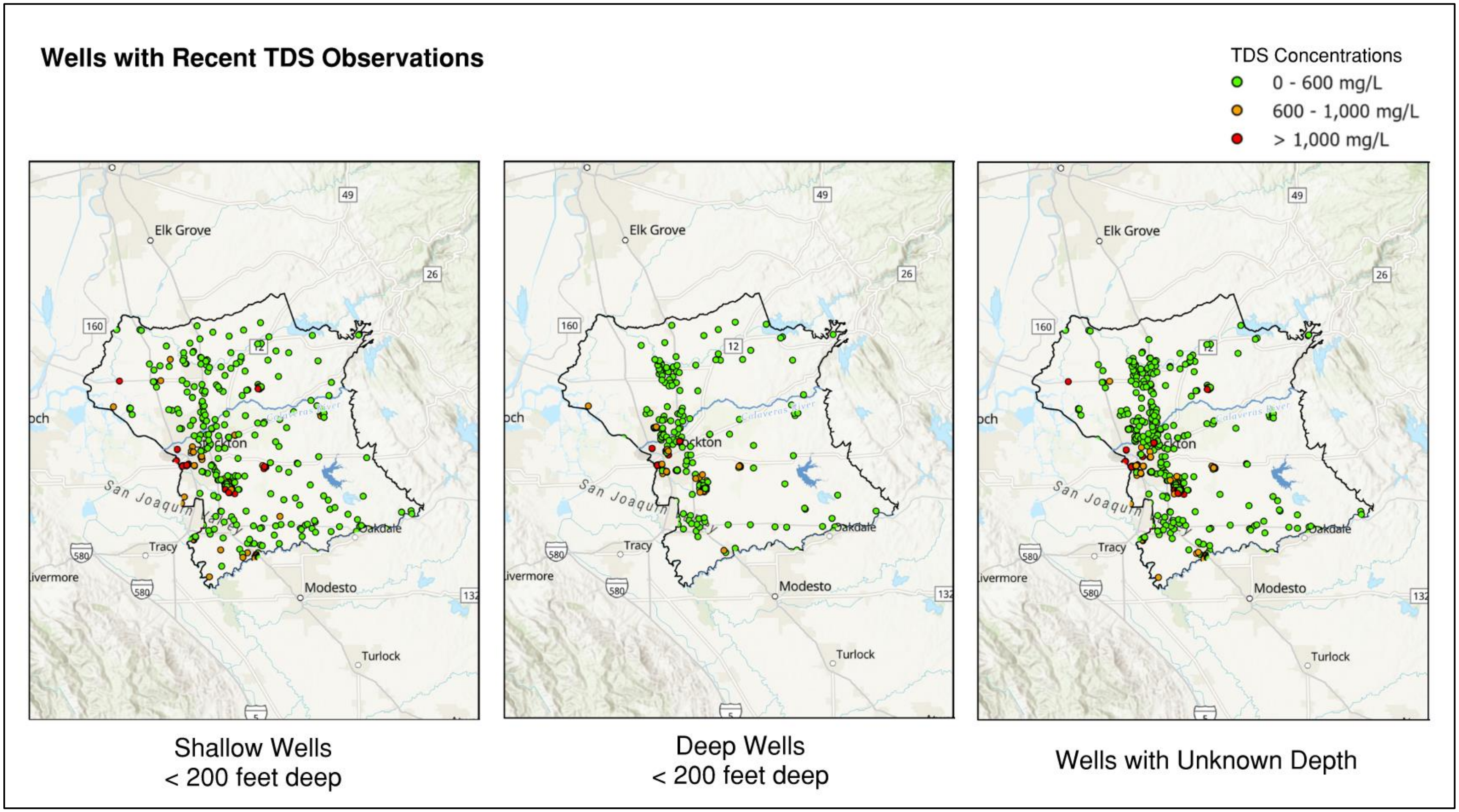
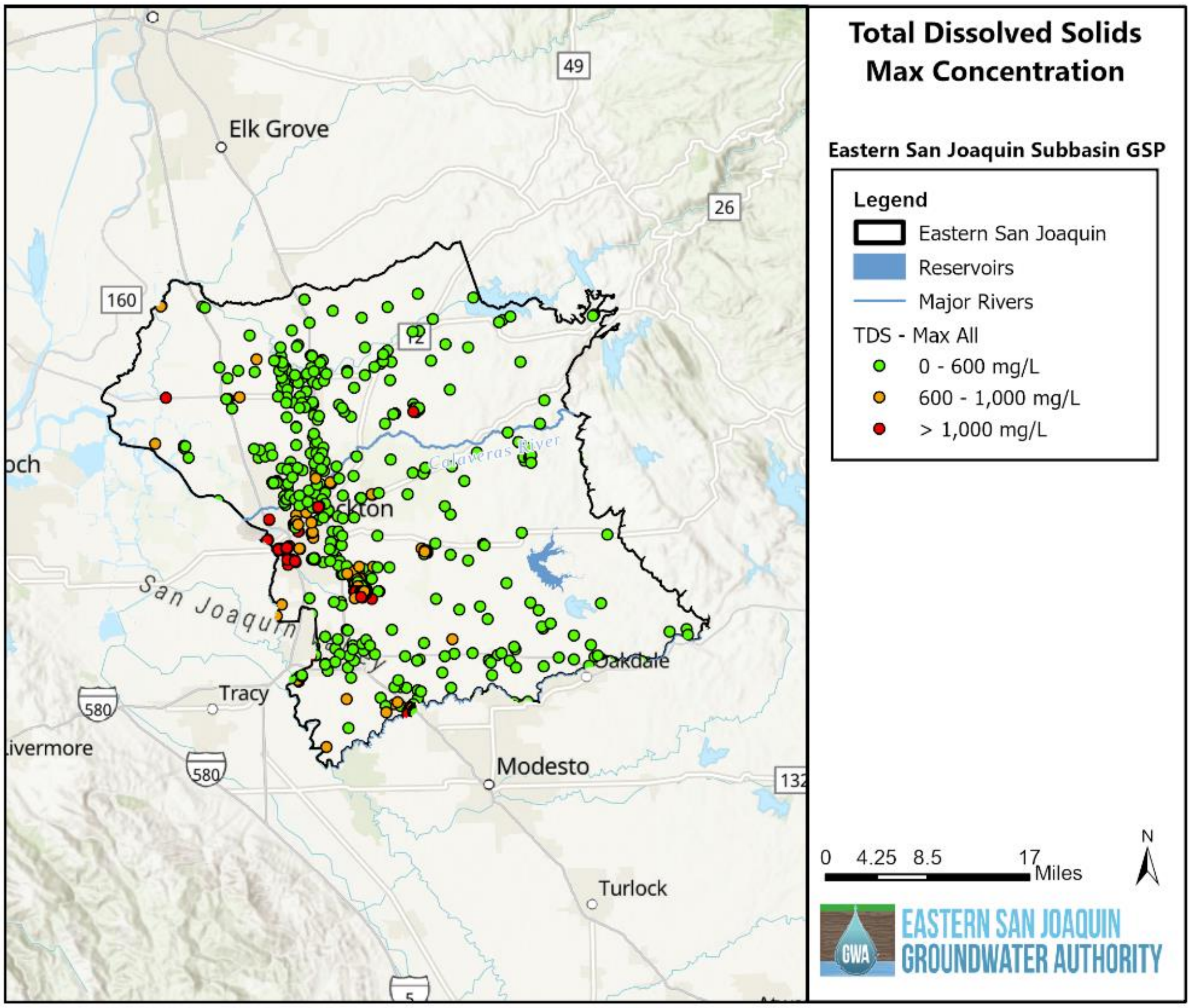


Figure 2-94: Maximum Concentrations for Wells Measuring Total Dissolved Solids



2.3.5 Land Subsidence

SGMA requires monitoring and reporting on inelastic land subsidence. In the Subbasin, subsidence concerns, if any, are focused on the non-Delta area as the Delta region contains peaty soils. Peaty soils can subside due to peaty soil oxidation. Peat oxidation occurs when the peaty soils dewater and come into contact with air, causing the soils to break down and compress, and is not a mechanism caused by groundwater overdraft.

Within the Eastern San Joaquin Subbasin, there are three primary sources of subsidence data, each with different periods of record and methods of data collection:

- CGPS vertical displacement data from the DWR SGMA Data Viewer
- InSAR subsidence rates from the SGMA Data Viewer
- Survey benchmarks from U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers (USACE), California Department of Transportation (CalTrans), the San Joaquin County Department of Public Works, and local agencies.

There are no DWR or USGS extensometers in the Eastern San Joaquin Subbasin. The datasets used are detailed further below.

2.3.5.1 CGPS Data

Vertical displacement data from CGPS stations are available for download from the DWR SGMA Data Viewer (DWR, 2024). Two CGPS stations are monitored by UNAVCO and two by Scripps Orbit and Permanent Array Center (SOPAC). Of the SOPAC stations, Station P309, is the northeast region of the Subbasin north of the Calaveras River and has a period of record from March 4, 2006, to January 19, 2024. Station P273, in the northwest region of the Subbasin, has data from November 10, 2005, to December 28, 2020. P273 lies in the Delta region of the Subbasin.

The two UNAVCO CGPS stations are CNDR and MTWK. CNDR, in the western region of the Subbasin, has data from April 30, 1999, to February 14, 2006, but is no longer monitored. MTWK, in the southern region of the Subbasin south of the city of Manteca, has data from December 12, 2019, to January 19, 2024. This is the closest CGPS station to the location of the Corcoran Clay. Clay-rich zones are prioritized for monitoring since groundwater over-extraction in these areas can lead to dewatering and compression of the clay aquitards, and inelastic land subsidence.

Several additional CGPS stations from the University of Nevada Geodetic Laboratory (UNGL) are also monitored for subsidence (UNGL, 2024). Station CA15 is located north of the city of Stockton and has a continuous period of record between September 2013 and October 2021. Station CMNC is located along the southern edge of the Camanche Reservoir and has observations in 2020 and between February 2022 through January 2024. These locations also provided additional spatial coverage to the UNAVCO and SOPAC CGPS stations.

Figure 2-95 through Figure 2-98 show time series graphs of subsidence for the four CGPS stations in this analysis. Between 2015 and 2023, all of the CGPS stations showed that less than one foot of subsidence was observed throughout the Subbasin. The accuracy of GPS data is estimated to be ± 2 inches (CA DWR, 2017).

Figure 2-95 shows a time series graph of subsidence for CGPS Station MTWK. The graph indicates a slight downward trend, reflecting a small increase in subsidence in the Subbasin. From January 2023 to July 2023, subsidence increased slightly more, though overall subsidence remains minimal. The trend line's slope of -0.0295 inches per month (or -0.354 inches per year) confirms that subsidence is occurring in the Subbasin, but at insignificant levels.

Figure 2-95: CGPS Station MTWK – Subsidence Time Series

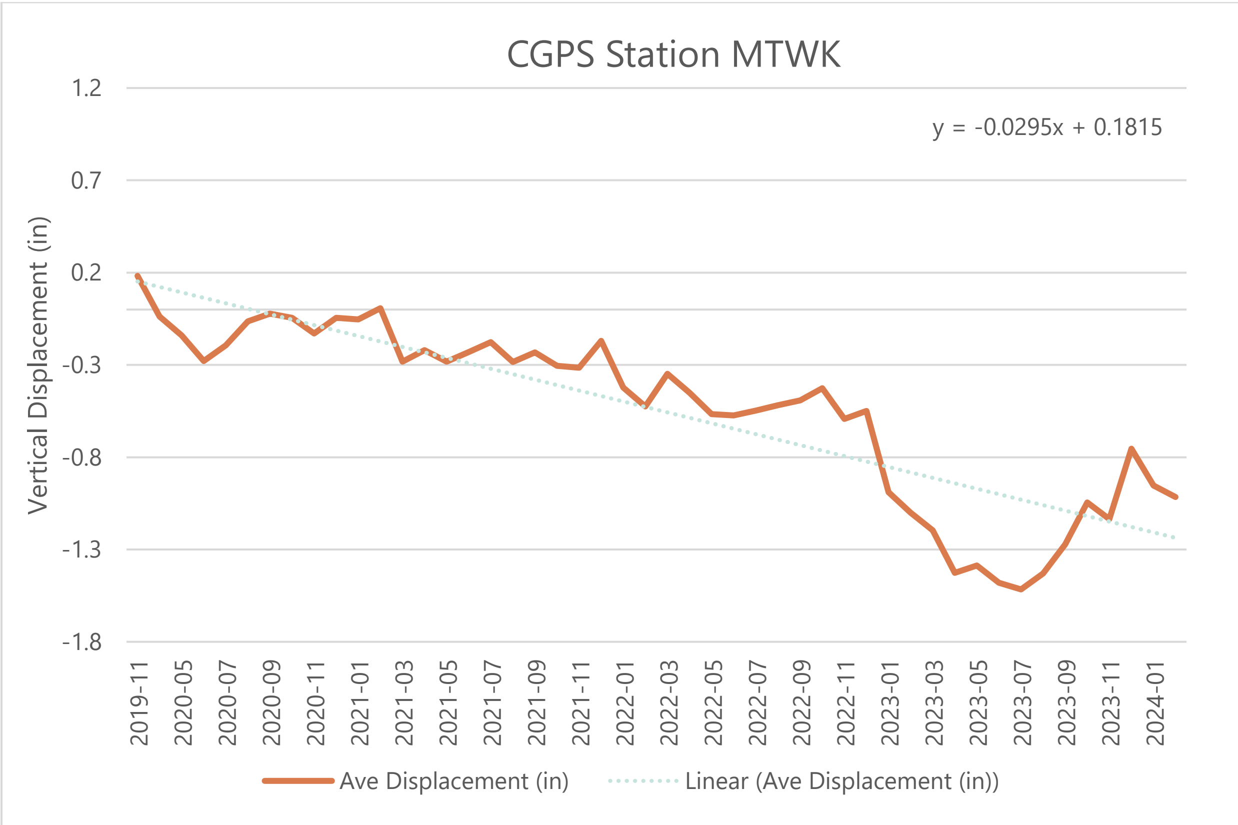


Figure 2-96 shows a time series graph of subsidence for CGPS Station P309. The graph indicates a very slight downward trend, reflecting a small increase in subsidence in the Subbasin. However, the displacement data varies to a great degree, increasing and decreasing throughout 2006 to current conditions. From June 2015 to June 2016, subsidence increased slightly more, with an overall subsidence of approximately 0.7 inches. This data point represents the largest observed subsidence across the four CGPS stations but still shows no inelastic subsidence. The trend line's slope of -0.0004 inches per month (-0.005 inches per year) confirms that subsidence occurring in this region is elastic and negligible.

Figure 2-96: CGPS Station P309 – Subsidence Time Series

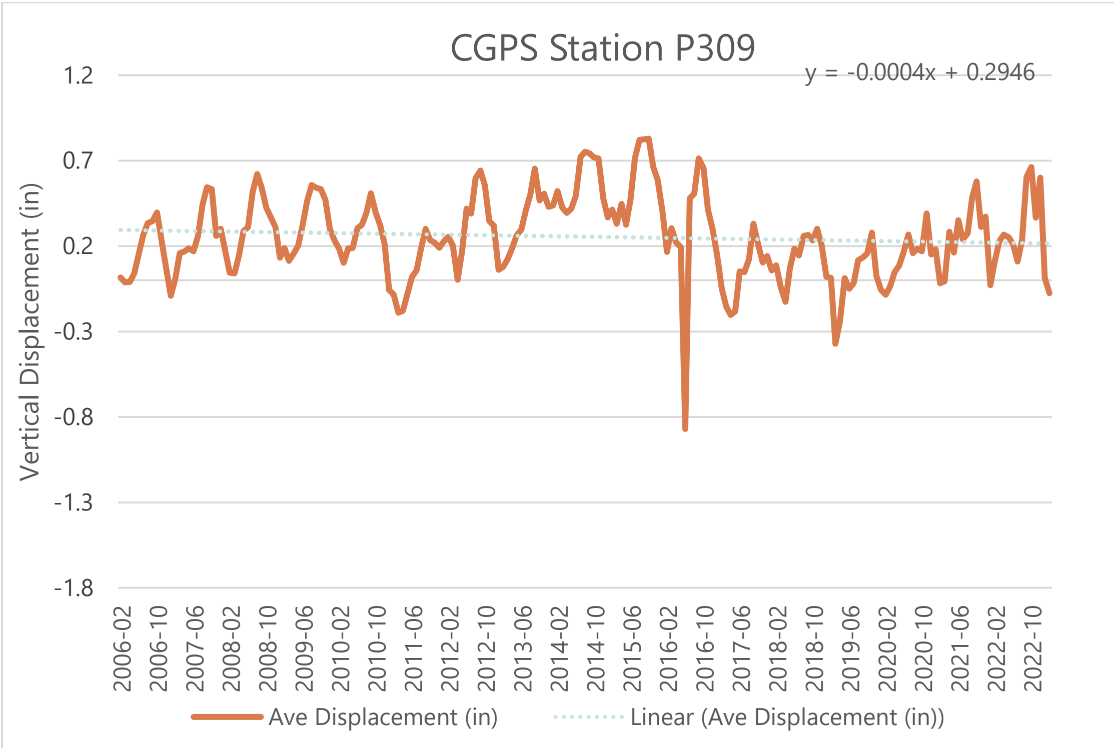


Figure 2-97 shows a time series graph of subsidence for CGPS Station CMNC, located in the northeastern region of the Subbasin, along the southern edge of the Camanche Reservoir. Overall, there is a very slight rise in ground elevation that could be due to several factors, such as swelling of clay soils in wet winters. There is no inelastic subsidence occurring at this CGPS station. As previously mentioned, CPGS Station CMNC is being monitored by UNGL and its data are subject to data gaps and discontinuous monitoring due to its academic nature. While the dataset does not have a long period of record, it supports the observation that subsidence has not historically been an issue in the Subbasin.

Figure 2-97: CGPS Station CMNC – Subsidence Time Series

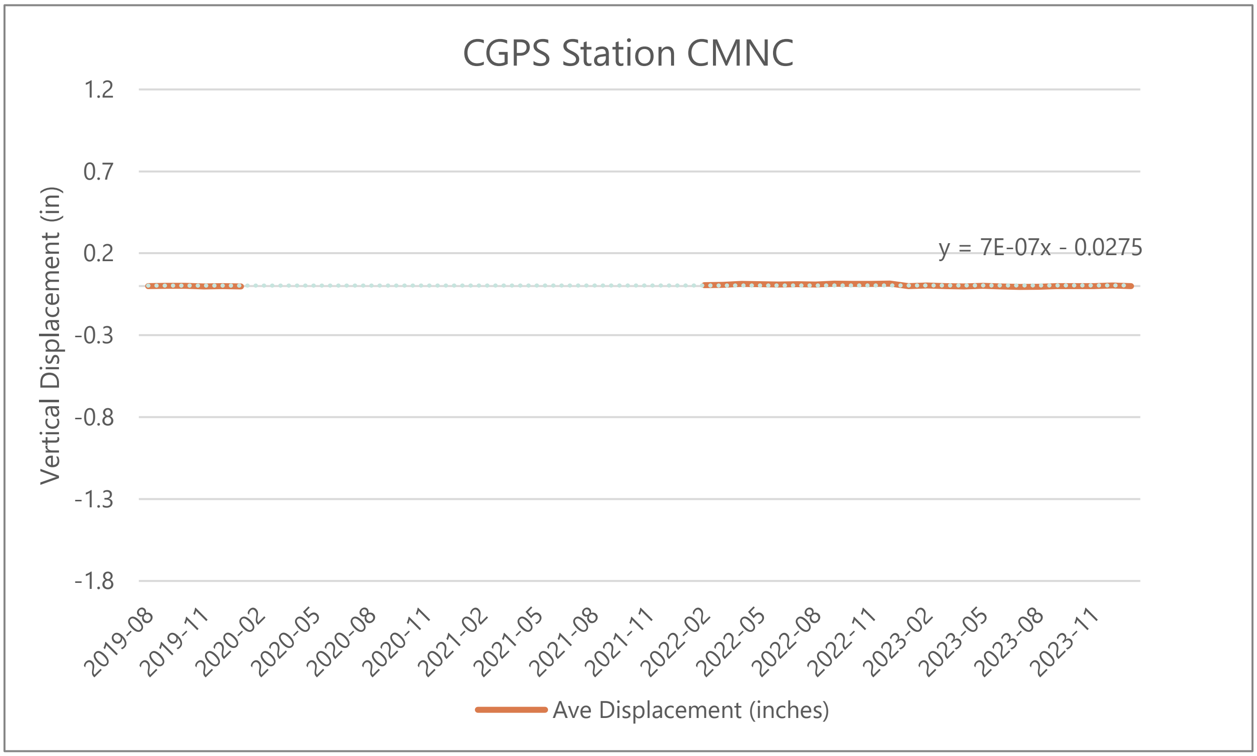
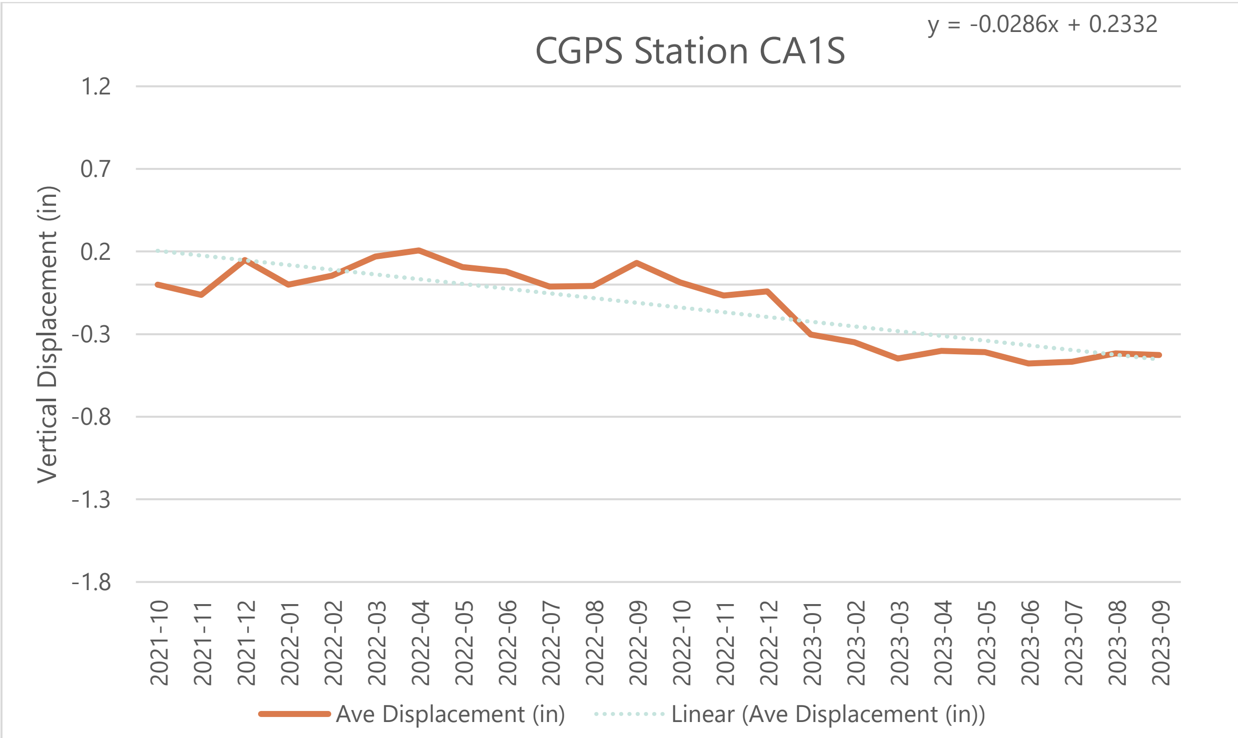


Figure 2-98 shows a time series graph of subsidence for CGPS Station CA1S, located in the western region of the Subbasin, north of the City of Stockton. The graph indicates a downward trend, reflecting a small increase in subsidence in the Subbasin. The subsidence observed for CGPS Station CA1S shows that subsidence was generally increasing in the Subbasin, and this is reflected in the slope of the trendline. The trend line's slope of -0.0286 inches per month (-0.34 inches per year) shows that the rate of subsidence at this region of the Subbasin is relatively greater than that of the other three CGPS stations but is still relatively minimal as compared to the overall accuracy of the data. The largest observed vertical displacement in this period of record was -0.261 inches, from December 2022 to January 2023, which is a small degree of subsidence. Important to note that, like CGPS Station CMNC, this dataset is obtained by UNGL and subject to data gaps and discontinuous monitoring.

Figure 2-98: CGPS Station CA1S – Subsidence Time Series

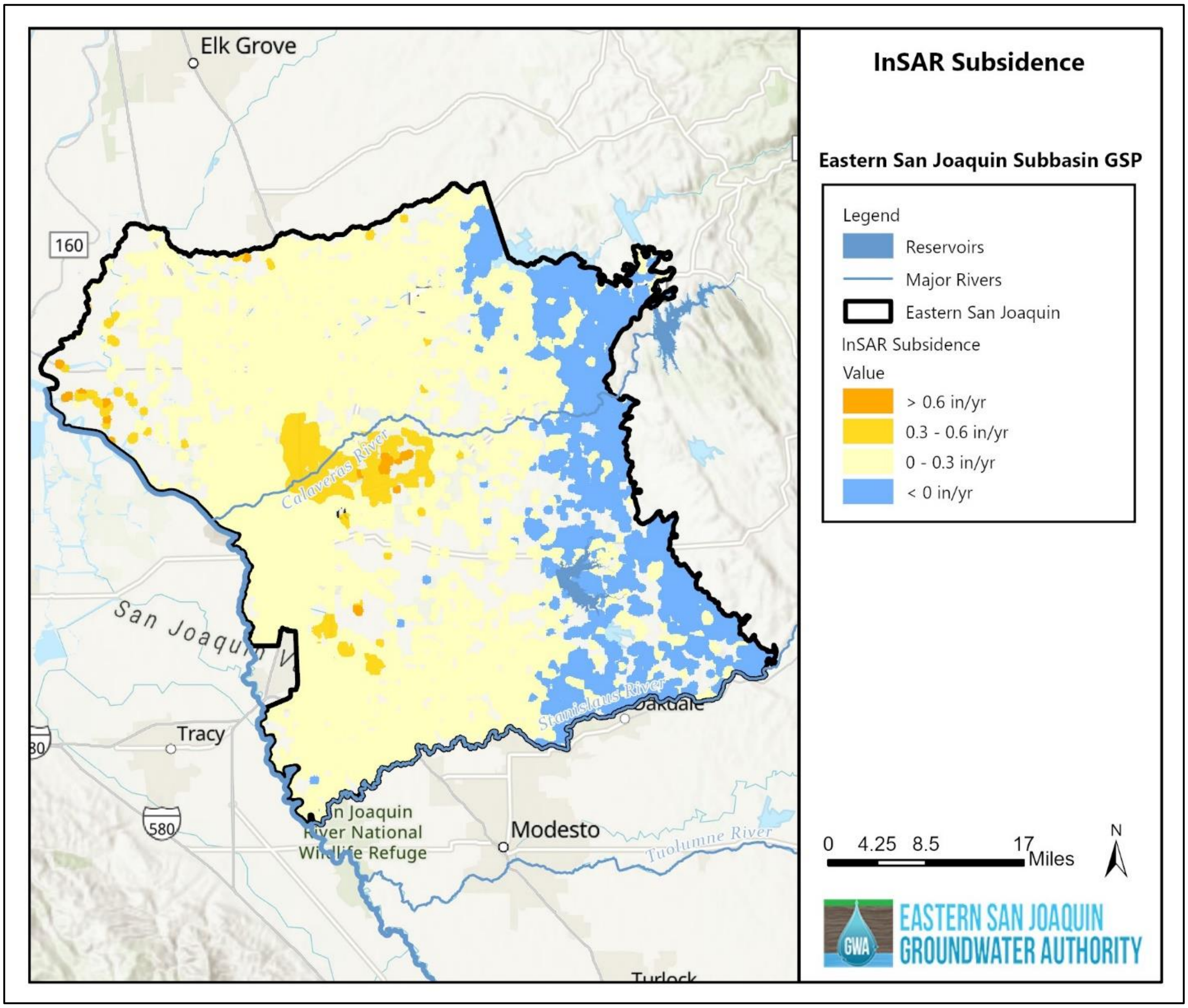


2.3.5.2 InSAR

InSAR data were collected from the SGMA Data Viewer sourced from the California Natural Resources Agency (CNRA). Included in this dataset are point data that represent average vertical displacement values for raster data for total and annual vertical displacement rates in monthly time steps. The longest period of record, at the time of analysis, was from June 13, 2015, to October 1, 2023.

The subsidence analysis using InSAR data revealed minimal subsidence rates across the Subbasin. The highest observed subsidence rate was in the central region, averaging 0.92 inches per year between 2015 and 2023. In contrast, subsidence is not occurring in the eastern region of the Subbasin; instead, the ground elevation has increased due to the swelling of clayey soil in the foothills. This observation is supported by the subsidence analysis for CGPS Station CMNC in the eastern Subbasin which showed positive vertical displacement, indicating a rise in ground elevation. The western region of the Subbasin, adjacent to the Delta, is likely experiencing land subsidence due to peat oxidation rather than groundwater extraction. Figure 2-99 illustrates that the central portion of the Subbasin in the cone of depression area is more prone to land subsidence. Despite this, overall subsidence in the Subbasin remains minimal and is not expected to cause undesirable effects.

Figure 2-99: Subsidence Rates (inches per year) Throughout the Subbasin



Note: InSAR period of the record displayed in the figure above is June 13, 2015, to October 1, 2023

While CGPS data are more accurate than InSAR vertical displacement measurements, InSAR can estimate subsidence rates over a large land area. Compared to CGPS stations, InSAR has a 16 mm vertical accuracy at a 95% confidence level and an estimated 12 mm (0.47 inches) accuracy near Eastern San Joaquin (Towill, 2020).

2.3.5.3 Survey Benchmarks

Survey benchmark data were collected from USGS, ACOE, CalTrans, the San Joaquin County Department of Public Works (DPW), and local agencies. While there is a high density of benchmarks in the Subbasin, they are not surveyed regularly.

In March 2024, Stockton East Water District (SEWD) conducted benchmark surveys for subsidence monitoring. The aim was to verify claims by the DWR that approximately 7 inches of subsidence had occurred in the area over the past seven years. SEWD surveyed the current elevations of six National Geodetic Survey (NGS) benchmarks with published elevations to compare the historical data with current measurements. These benchmarks, all established in 1962, are located along Comstock Road. The survey results indicated that the average subsidence from the published elevations (1962) to current conditions (March 2024) is approximately 9.3 inches, with a range of subsidence spanning 12.72

inches. The greatest subsidence observed was at NGS Survey Benchmark H-956, which showed a subsidence of 16.56 inches over the 62-year period, or 0.27 inches per year. Due to the temporal differences in subsidence observations, this 62-year period does not provide a precise measurement to directly compare with DWR's InSAR 8-year subsidence data from 2015 to 2023 with an average subsidence rate of 0.92 inches per year.

It is also noteworthy that the six surveyed benchmarks are all located in the central region of the Subbasin, where InSAR data indicated the highest subsidence rate of 0.92 inches per year. While the subsidence of 16.56 inches at NGS Survey Benchmark H-956 is significant, it must be considered within the context of the 62-year period. The benchmark survey results suggest that subsidence in the Subbasin is not occurring at significant levels and is not expected to cause undesirable effects.

2.3.5.4 Relationship with Groundwater Levels

Historically, the Subbasin has not had significant or undesirable effects caused by inelastic land subsidence. Examining recent CGPS vertical displacement data, less than one foot of subsidence was observed throughout the Subbasin between 2015 and 2023. While the 2020 GSP originally considered groundwater levels as a proxy for subsidence, a strong correlation was not observed.

Figure 2-100 shows a time series graph of subsidence (vertical displacement of land surface) and groundwater elevation for CGPS Station MTWK, with Manteca 18 as the respective groundwater level RMW. The graph indicates a slight downward trend in land surface elevation, reflecting a small increase in subsidence rates in the Subbasin. From January 2023 to July 2023, land surface elevations increased slightly more when groundwater levels declined, though overall subsidence remains minimal. It is important to note that, while there was a significant drop in groundwater elevations during September 2023, when groundwater levels recovered in the winter of 2024, subsidence reversed. This shows elastic subsidence that can recover with sustainable groundwater levels. Note that the historical groundwater levels in this example did not decline below MT for that RMW.

Figure 2-100: CGPS Station MTWK: Subsidence Time Series

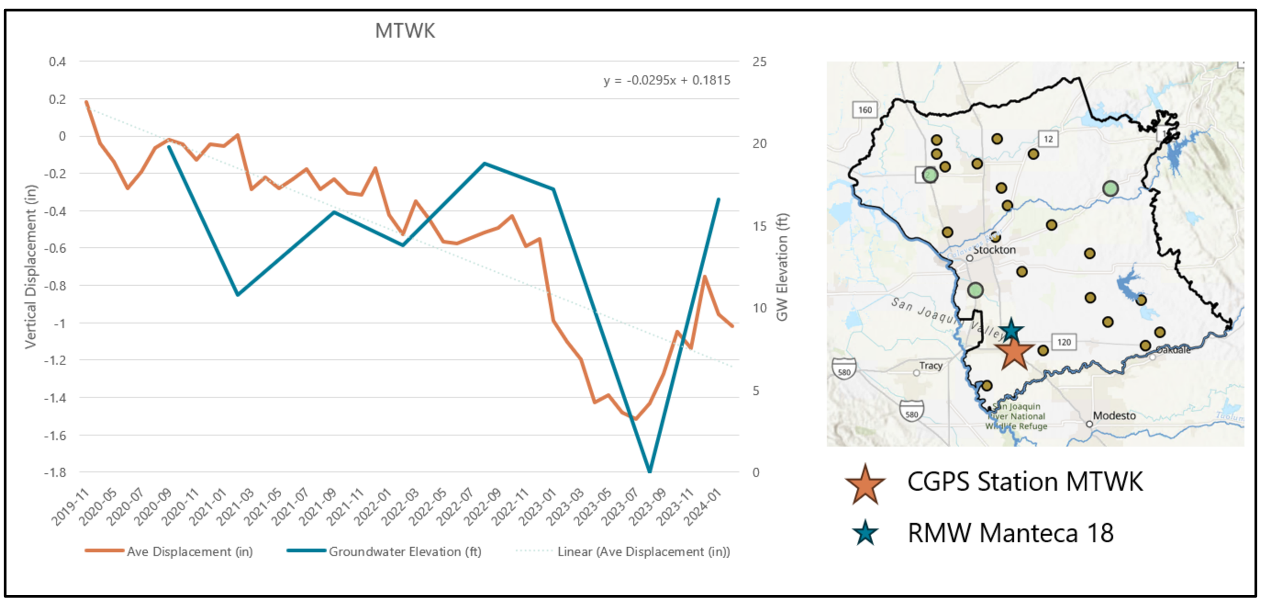
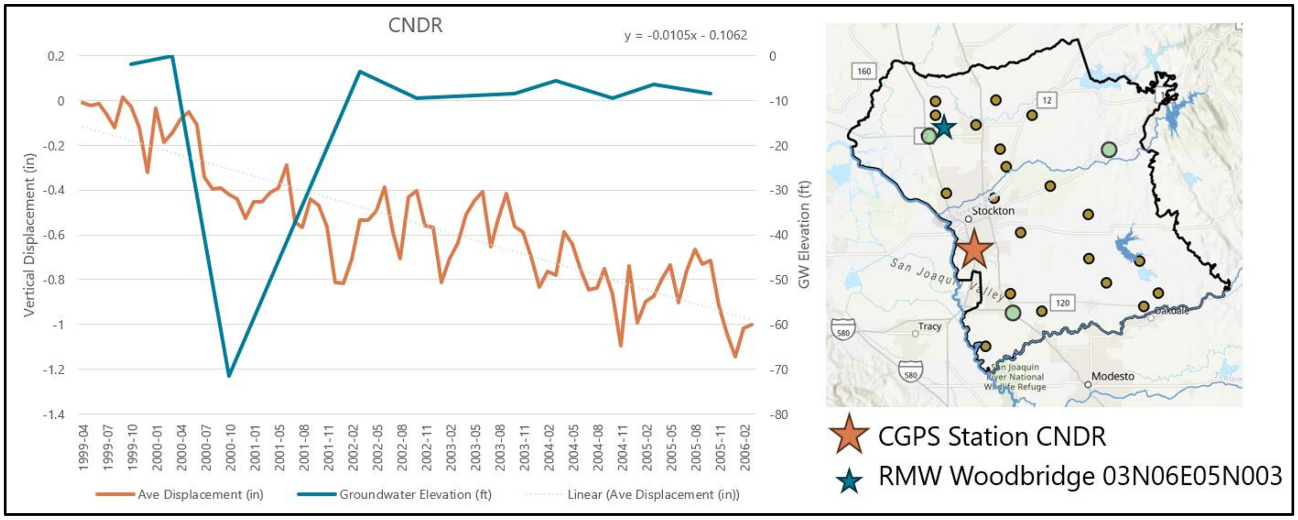


Figure 2-101 shows a time series graph of subsidence (vertical displacement of land surface) and groundwater elevations for CGPS Station CNDR, with Woodbridge 03N06E05N003 as the respective RMW. The graph indicates a slight downward trend in land surface elevations, reflecting a small increase in subsidence in the Subbasin. The trend line's slope of -0.0105 inches per month confirms that subsidence is occurring in the Subbasin, but at very low levels. There was a significant decrease of 70 feet in groundwater elevation between March 1, 2000, and November 1, 2000, at this location; however, it is important to note that while there was a sharp decline in groundwater elevation during October 2000, subsidence appears to be unaffected. The Woodbridge 03N06E05N003 groundwater level representative monitoring well was selected for analysis because it is the only representative monitoring well that has historically declined below its respective minimum threshold. CNDR CGPS station was selected because it is the only CGPS station with historical observations during the period when the groundwater levels were below minimum thresholds.

Figure 2-101: CGPS Station CNDR – Time Series of Subsidence and Groundwater Levels



2.3.6 Interconnected Surface Water Systems

2.3.6.1 Definitions

Section 2.2.6 detailed the original depletions analysis in the 2020 GSP. This section provides an update to that analysis based on guidance provided by DWR and updates to ESJWRM to reflect current conditions as of the development of this 2024 Amended GSP. More detail can be found in Attachment 3-F, including an extensive update to the historical ISW conditions analysis. As described in *Depletions of ISW: An Introduction* (CA DWR, 2024), the first of three guidance documents on ISWs released by DWR, the consideration and interpretation of ISWs can be based on five example cases of nearby groundwater elevation data (Figure 5 of *Depletions of ISW: An Introduction*). Of the examples provided, Figure 5d is most applicable to Eastern San Joaquin Subbasin due to a lack of shallow monitoring wells and associated historic data near the rivers and creeks in the Subbasin (shown in the DWR guidance document and Appendix 3-G). This lack of shallow groundwater level data near surface water courses translates to a low degree of confidence in model calibration around these surface water features and therefore uncertainty around what is or is not a connected reach or model node.

GSP regulations require the identification of ISWs within a basin (and therefore identification of the degree of connectivity) and an estimate of the timing and quantity of depletions of those systems, where depletions are defined as "conditions where groundwater pumping results in reductions in flow or water levels of ISW." However, the DWR guidance document notes that "the definition above differs from how depletions may be defined in other hydrologic contexts, where they can refer to any surface water losses without considering the cause." A good faith effort was conducted to isolate stream depletions in the ESJ Subbasin due solely to groundwater pumping by comparing (1) pumping and no-pumping scenarios and (2) a pumping "pulse" scenario to examine the delayed impact of pumping on stream depletions, both using the integrated Eastern San Joaquin Water Resources Model Version 3.0 (ESJWRM). However, the analyses resulted in an inconclusive understanding of depletions due to pumping since an equilibrium was not reached within the simulation period and depletions were heavily influenced by initial and boundary conditions. Therefore, the analyses relied on the standard definition of depletions as stream losses to the aquifer system regardless of cause. This allows the GSAs to have more confidence in the results and be able to manage and report depletions in future Annual Reports without limitations and uncertainties from the existing toolset. At the time of the 2024 GSP, the additional guidance documents from DWR (*Techniques for Estimating Depletions of Interconnected Surface Water* and *Examples of Approaches for Estimating Depletions of Interconnected Surface Water*) had not yet been released. The timing, location, and volume of depletions in the ESJ Subbasin will be revised at a later time in coordination with further guidance from DWR.

2.3.6.2 Stream Connectivity

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. The reaches in ESJWRM are displayed in Figure 2-102. Layer 1 groundwater levels were used since the new Layer 1 in ESJWRM represents the shallow, generally unconsolidated sediments where stream interaction is happening. Stream connectivity was also analyzed under current conditions, represented by Water Year 2020 through 2024 in the historical ESJWRM model. "75% Connected" streams were defined as Layer 1 groundwater levels at or above the streambed elevation at least 75 percent of the time. The definition of ISWs is not limited to surface waters that the ESJGWM indicates are connected to the shallowest modeled groundwater level at least 75 percent of the time. The GSAs understand that an ISW may be seasonally connected and/or connected in only wetter water year types. The GSAs currently do not have sufficient data to determine if or when streams or reaches are connected to the groundwater table with this level of granularity. The GSAs will be collecting more data with the new ISW monitoring wells to help inform this analysis going forward. Using ESJWRM Version 3.0, which was the best available tool at the time of analysis,

Figure 2-103 shows that the 75 percent connected streams are the Mokelumne River, Stanislaus River, and lower San Joaquin River. Streams that are not connected at least 75 percent of the time are Dry Creek, Calaveras River, and Mormon Slough. Other smaller creeks are not represented in ESJWRM.

Figure 2-102: Stream Reaches in ESJWRM

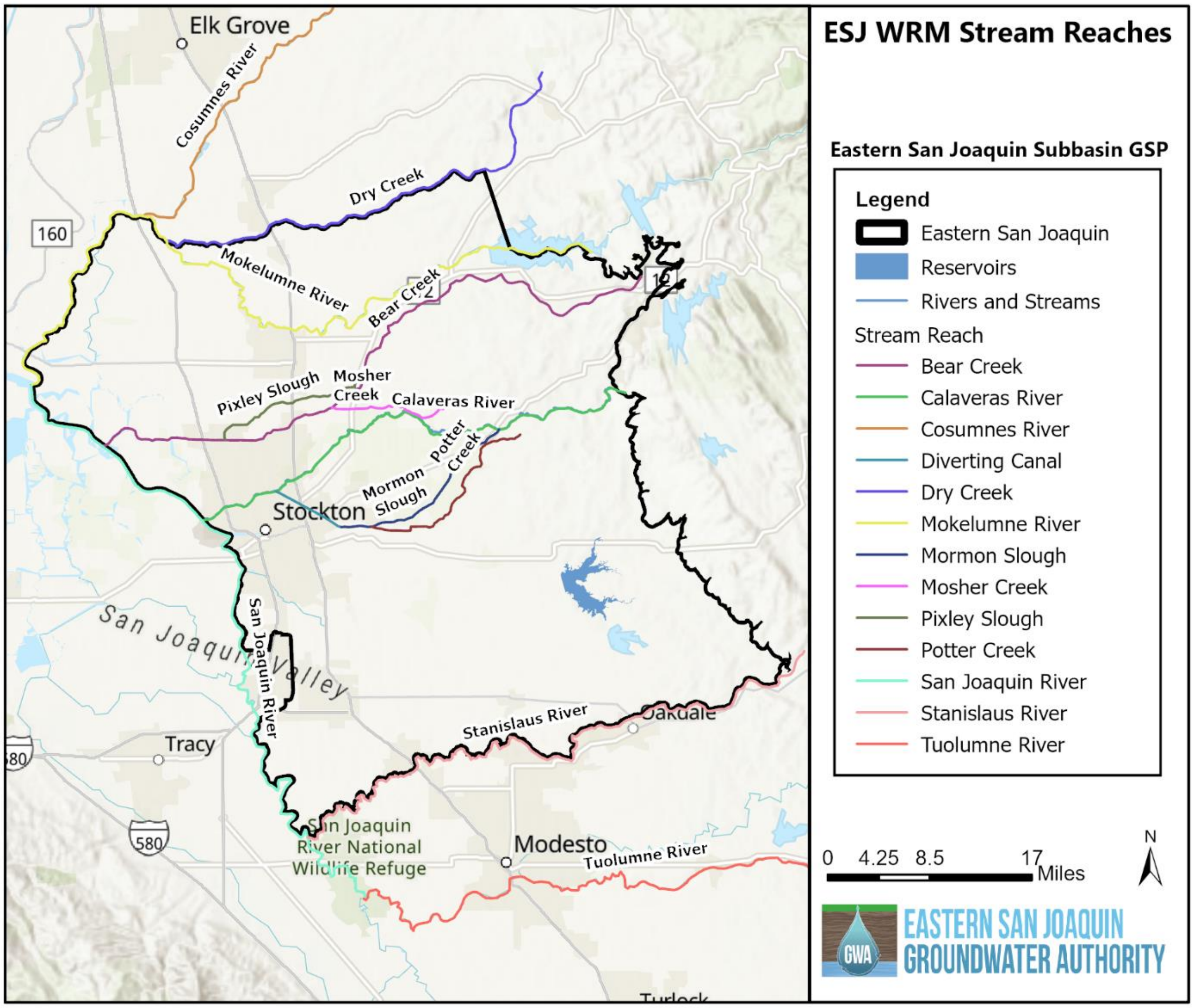
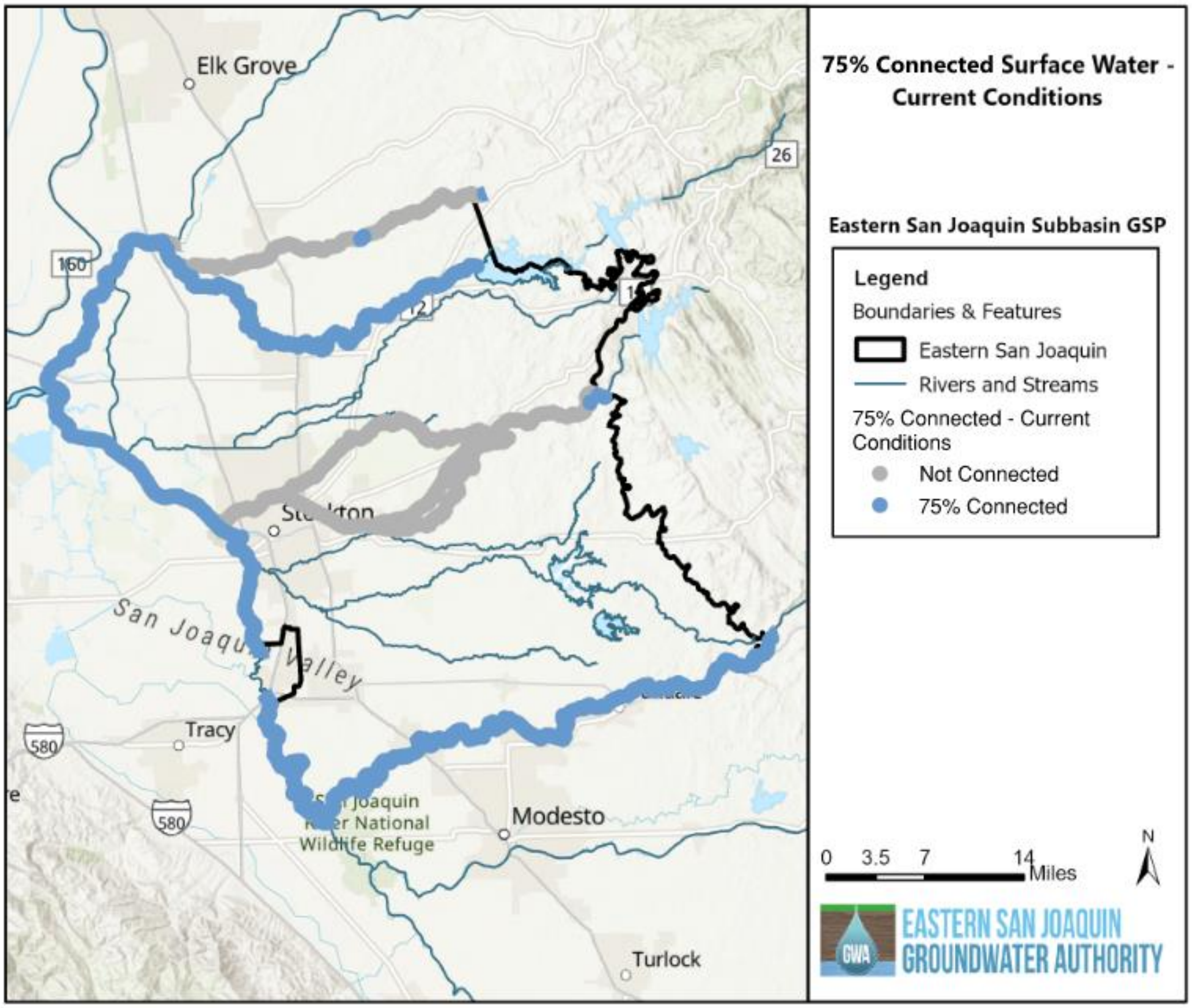


Figure 2-103: Surface Waters Connected with the Groundwater System at least 75% of All Months in ESJWRM under Current Conditions



2.3.6.3 Stream Gains and Losses

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 and stream levels or stage. Figure 2-104, from DWR's *Depletions of ISW: An Introduction* (CA DWR, 2024), illustrates connected gaining streams (on the left) where groundwater levels are higher than the stream stage, and losing streams (on the right) where groundwater levels are lower than the stream stage.

Figure 2-104: Diagram of Gaining and Losing Connected Streams

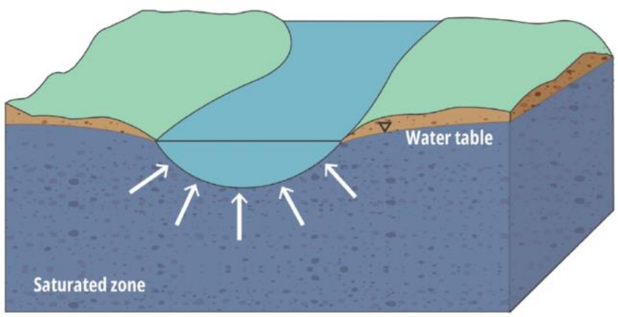
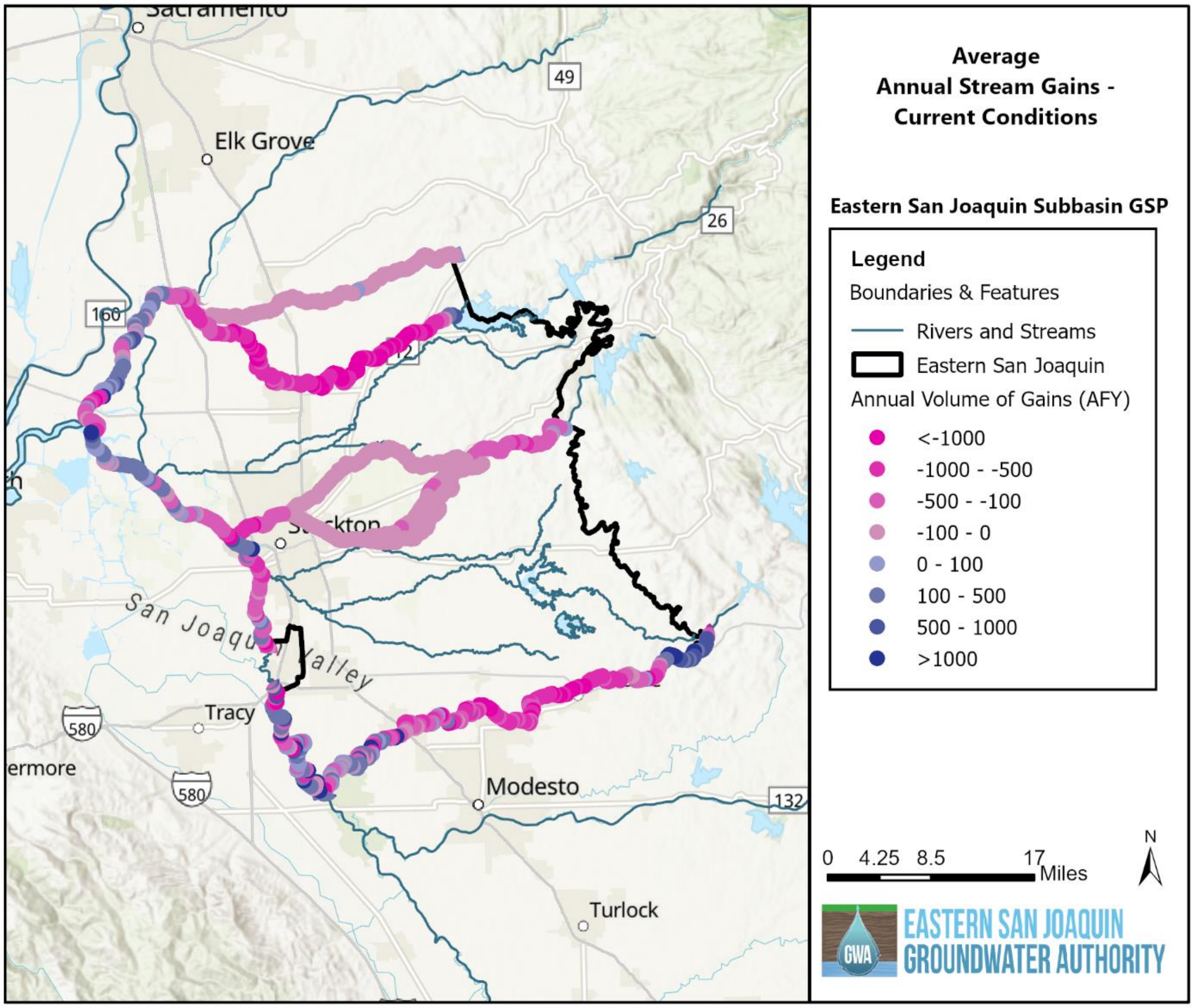


Figure 2-105 shows the average annual volume of stream gains under current conditions (Water Year 2020 through 2023). While the Mokelumne River is a connected river in most years, it is losing water from the stream to the aquifer system upstream of the Cosumnes River, and gaining water from the aquifer system downstream of the Cosumnes River, on average. The Stanislaus River has a high number of stream nodes in the center portion of the river that are losing under current conditions. The lower San Joaquin River is gaining in many sections near the confluence with the Stanislaus River, Calaveras River, and in the Delta region.

Figure 2-105: Current Conditions Average Annual Stream Gains by Stream Node



2.3.7 Groundwater-Dependent Ecosystems

In the Eastern San Joaquin Subbasin, the primary environmental beneficial users are groundwater dependent ecosystems. In the 2020 GSP, potential GDEs were mapped across the Subbasin. The mapping relied on the Natural Communities Commonly Associated with Groundwater (NCCAG) database, from which additional refinements were made to remove areas that met the following criteria:

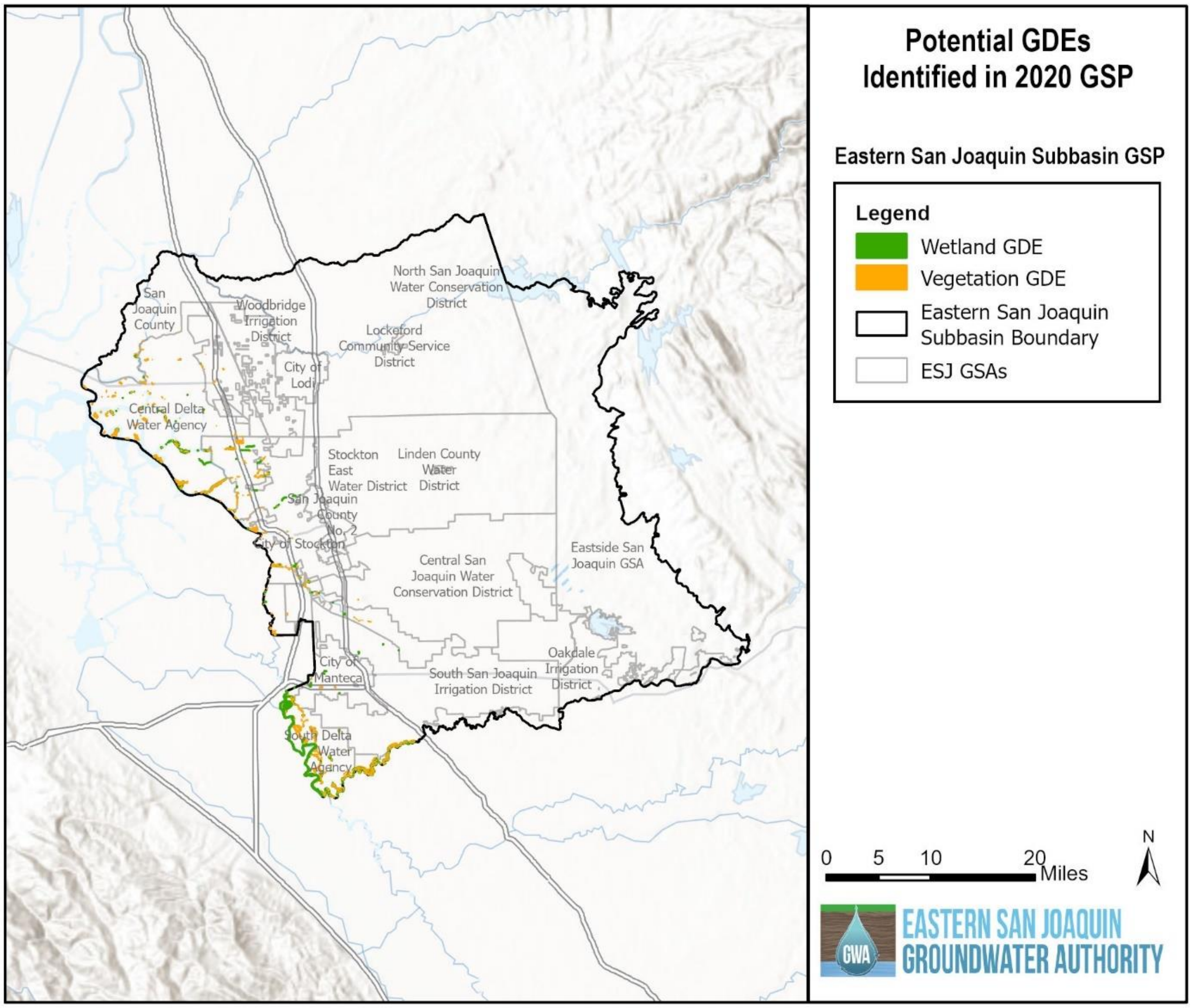
- Areas where groundwater levels were deeper than 30 feet below the ground surface (ft bgs).
- Areas with access to alternate water supplies that may not be dependent on groundwater (i.e., communities close to managed wetlands, irrigated agriculture, or perennial surface water bodies).

The resulting desktop mapping was then considered by GSA staff and technical workgroup members before inclusion in the GSP. Further detail on this approach to mapping potential GDEs is described in Appendix 3-C of this GSP Amendment.

Before conducting the analysis to evaluate the potential impacts of the groundwater level SMC on potential GDEs, it was verified that no changes to the NCCAG dataset within the ESJ Subbasin have been made since 2020. The NCCAG database still represents the most comprehensive source of potential GDEs within this Subbasin. Polygons in the NCCAG dataset were removed where the vegetative community's average maximum rooting depths do not intersect with groundwater. In other words, if the vegetation is not able to access groundwater within its rooting depth, then it is assumed that the ecosystem is not a potential GDE. This average maximum rooting depth is estimated to be 30 feet below ground surface for the majority of phreatophytes (The Nature Conservancy, 2021). The original mapping completed as part of the 2020 GSP was retained in this GSP Amendment.

The map of potential GDEs included in the 2020 GSP is shown in Figure 2-106. This mapping of potential GDEs represents a desktop analysis that will continue to be improved through field verification.

Figure 2-106: Mapping of Potential Groundwater Dependent Ecosystems

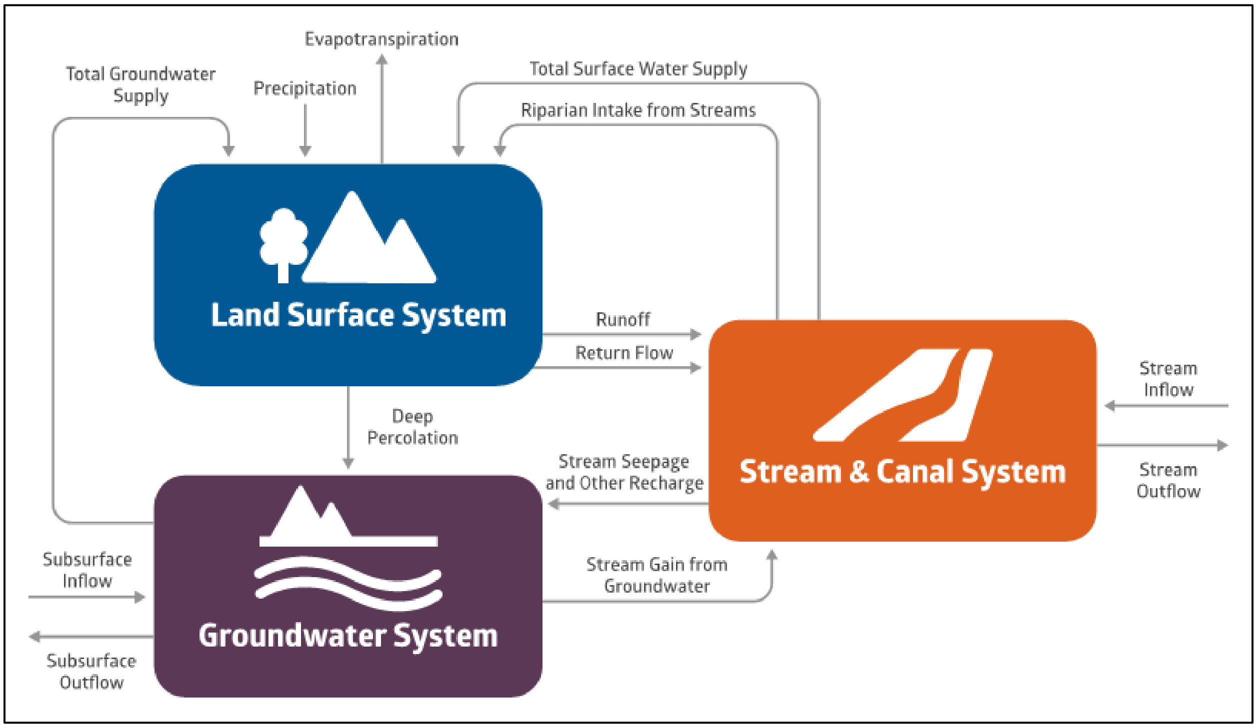


2.4 WATER BUDGETS

2.4.1 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 2-107 depicts the major components of a water budget and their interconnection as presented in the context of stream, land surface, and groundwater systems.

Figure 2-107: 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 of 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 primary 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., 2024a and Dogrul et al,. 2024b). Using data from federal, state, and local resources, the ESJWRM was originally calibrated for the 20-year hydrologic period of October 1995 to September 2015 (water years 1996 through 2015) for the 2020 GSP 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. The Historical ESJWRM has undergone nine updates to date, of which three were major updates:

1. **Major Update**: Development and Calibration of Historical ESJWRM Version 1.1 (WY 1995 through 2015) for November 2020 GSP
2. Extension of Data in Historical ESJWRM Version 1.1 from WY 2016 through 2019 for WY 2019 Annual Report
3. Extension of Data in Historical ESJWRM Version 1.1 through WY 2020 for WY 2020 Annual Report
4. **Major Update**: Model Update and Recalibration Resulting in Historical ESJWRM Version 2.0 (WY 1995 through 2020) for Revised June 2022 GSP
5. Extension of Data in Historical ESJWRM Version 2.0 through WY 2021 for WY 2021 Annual Report

6. Updated Monthly Agricultural Demand Distribution in Fall 2022 Resulting in Historical ESJWRM Version 2.2
7. Extension of Data in Historical ESJWRM Version 2.2 through WY 2022 for WY 2022 Annual Report
8. Extension of Data in Historical ESJWRM Version 2.2 through WY 2023 for WY 2023 Annual Report
9. **Major Update**: Model Update and Recalibration Resulting in Historical ESJWRM Version 3.0 for 2024 Periodic Evaluation and GSP Amendment

Only ESJWRM Version 3.0 water budget results are presented in Section 2.4. Version 3.0 development is documented in a report, "Eastern San Joaquin Water Resources Model (ESJWRM) Version 3.0 Update," published in August 2024 and available in Appendix 2-C.

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. The water budget assumptions may be refined in the future, the water budget may change, and the conclusions and recommendations derived from the water budget may also change.

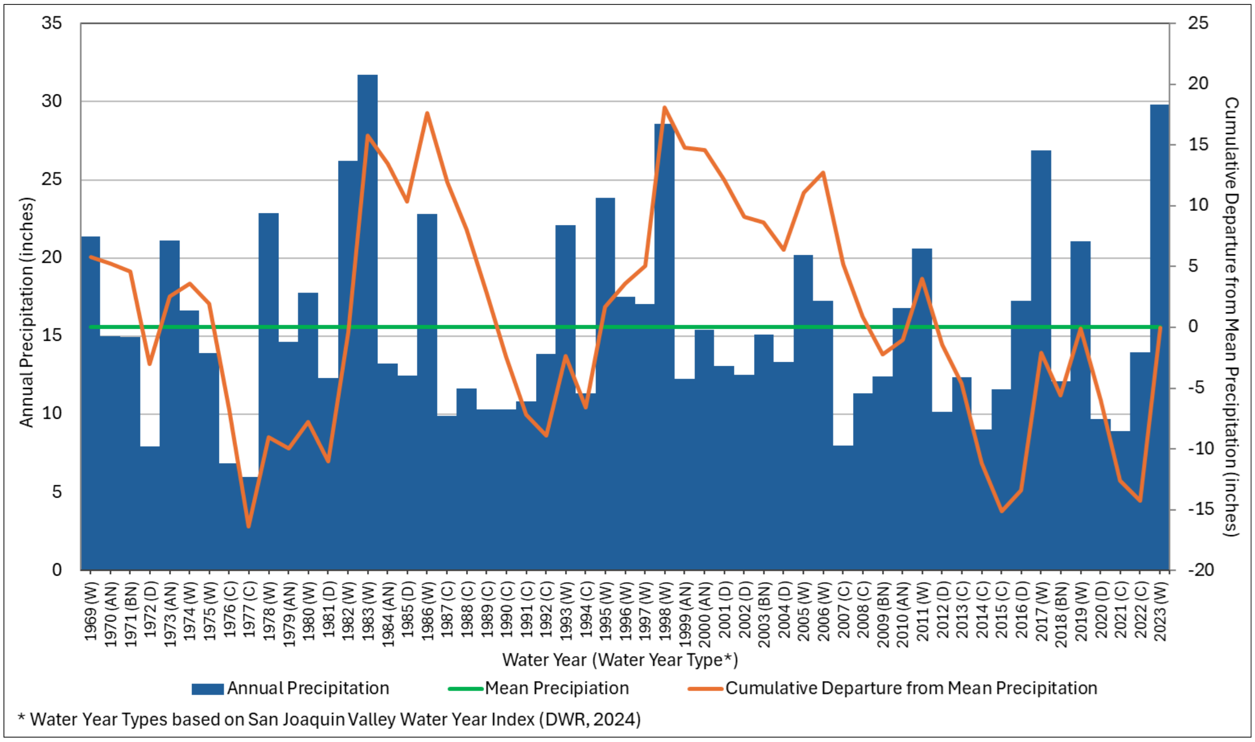
2.4.2 Identification of Hydrologic Periods

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 ESJWRM Version 3.0's 55-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, 2023).

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 2-108 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 2023 and a horizontal line representing the mean precipitation of 15.6 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, 2023), which classifies water years 1901 through 2023 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 2-108). 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 2-108: 55-Year Historical Precipitation and Cumulative Departure from Mean Precipitation



2.4.3 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 Version 3.0 as the underlying framework, four model scenarios were developed representing historical, current, projected, and projected with climate change 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 2023 (28 years).

- **Current water budget** represents an estimate of averaged recent historical conditions in the Subbasin, based on water years 2019 through 2023 (5 years).
- **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 55-year period represented by water years 1969 through 2023).
- **Projected water budget, with climate change** represents the projected water budget, with the impacts of climate change on streamflow, evapotranspiration, and precipitation.

2.4.4 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 2-13

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Table 2-13: Summary of Water Budget Assumptions (Historical, Current, and Projected Periods)

Water Budget Type	Historical[5]	Current	Projected[5]	Projected with Climate Change[5]
Model Version	Historical ESJWRM Version 3.0	Historical ESJWRM Version 3.0	ESJWRM PCBL Version 3.0	ESJWRM PCBL-CC Version 3.0
Scenario	Historical Calibration	Current Conditions	Projected Conditions Baseline	Projected Conditions Baseline with Climate Change
Hydrologic Years	Water Years 1996-2023	Water Years 2019-2023	Water Years 1969-2023	Water Years 1969-2023 with perturbation
Level of Development[1]	Historical	Current	General Plan or Sphere of Influence Buildout	General Plan or Sphere of Influence Buildout
Agricultural Demand[2]	Historical	Current (average of WY 2019-2023)	Current (2022, less urban expansion)	Current (2022, less urban expansion, with increased ET)
Urban Demand[3]	Historical	Current	Projected based on UWMP data	Projected based on UWMP data
Water Supplies[4]	Historical	Current	Projected based on local information	Projected based on local information (with an adjustment for climate change impact on precipitation and streamflow)

Notes:

1 The level of development describes the footprint of the urban areas. Historical is the footprint in the historical model period (water years 1996-2023), current is the footprint at the end of the historical model period (water years 2019-2023), 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. Projected agricultural cropping patterns are assumed to be consistent with DWR's statewide crop mapping of 2022, less urban buildout. For the current and projected water budgets, future evapotranspiration rates are assumed to remain the same as historical.

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 average demands and population between WY 2019-2023. 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 2019-2023 in the historical records.

5 For more information on historical and projected modeling, see the published model report (Appendix 2-C).

2.4.4.1 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 1996-2023. The hydrologic period has an average annual precipitation of approximately 15.5 inches and includes the recent 2012-2015 and 2020-2022 droughts, the wetter years of 1996-2000, 2017, and 2023, 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 28-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-C).

The historical calibration includes the following:

- Hydrologic period: Water Years 1996-2023 (28-year hydrology)
- Stream Flows for Water Years 1996-2023:
    - 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-FG v1.01) were used for water years 1996-2015 . For 2015-2023, an average of historical data by month and water year type was used.
    - 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), and the recent, comprehensive, and Subbasin-wide land use survey from DWR as prepared by Land IQ from 2016-2022 (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 2016, 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 2020 Urban Water Management Plans (Cal Water; Calaveras County Water District [CCWD], Cities of Lodi, Manteca, 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; NSJWCD's Tracy Lakes Recharge Project; NSJWCD's CALFED groundwater recharge project; Tecklenburg Recharge Project; and NSJWCD's FloodMAR recharge projects
  - Riparian diversions: CCWD, Delta areas, and data from C2VSim-FG for riparian diversions off major streams (Dry Creek, Mokelumne River, Calaveras River and related streams, Stanislaus River, San Joaquin River) (C2VSim-FG v1.01)
- 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).

2.4.4.2 Assumptions Used in the Current Water Budget

A current conditions estimate using the Historical ESJWRM Version 3.0 was developed for use in estimating the current water budget. The current conditions estimate is comprised of the average of historical model water years 2019-2023 in order to estimate current inflows and outflows for the Subbasin. Current conditions are not necessarily indicative of one year and are instead a compilation of data assumed representative of Subbasin recent conditions. The definition of current conditions, by nature, will continuously change. The current water budget represents the current conditions as of the time of the 2024 GSP.

2.4.4.3 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 55-year hydrologic period of water years 1969-2023. 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 2.4.4.4.

The projected conditions scenario includes the following conditions:

- Hydrologic Period: Water Years 1969-2023 (55-year hydrology)
- Stream Flows for Water Years 1969-2023:
  - Dry Creek: No streamflow gaging stations were available for Dry Creek; as such, flow estimates from the DWR's C2VSim-FG were used (C2VSim-FG v1.01)
  - 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 2020 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 or 2045).
  - Urban center population projections from the San Joaquin Council of Governments.
- Surface water delivery projections for the 55-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).

Additional details of the data used in the development of the projected conditions baseline can be found in the published model report (Appendix 2-C).

2.4.4.4 Assumptions Used in the Projected Water Budget, with Climate Change

The projected water budget with climate change is intended to assess the conditions of the Subbasin under future conditions of water supply and agricultural and urban demand, with the additional impact of climate change on the available water supply and agricultural demand. The projected conditions scenario with climate change is based on the projected conditions scenario without climate change and therefore all assumptions listed in Section 2.4.4.3 remain, except where noted below. A future scenario of 2070 climate forecasts was evaluated in this analysis, consistent with DWR guidance. 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 (DWR, 2018a). The 2070 central tendency (2070 CT) among these projections serves to assess impacts of climate change over the long-term planning and implementation period.

The following model inputs were adjusted in the 2070 CT climate change scenario:

- Stream Flow: Flows for Central Valley rivers are divided into impaired and unimpaired. In the Subbasin, Dry Creek and Mokelumne River are unimpaired rivers. Projected conditions scenario stream flows are modified by applying perturbation factors provided by DWR. Calaveras, San Joaquin, and Stanislaus Rivers are all impaired rivers. CalSim II estimated flows, also provided by DWR, were used to simulate stream flows under climate change for impaired rivers.
- Precipitation: Precipitation was modified using the perturbation factors provided by DWR, where available.
- Evapotranspiration: Evapotranspiration (ET) was modified using the perturbation factors provided by DWR, where available.

Additional details of the data used in the development of the projected conditions with climate change scenario can be found in the published model report (Appendix 2-C).

2.4.4.5 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 2023. Specifically, the following data sets were updated in ESJWRM:

- The hydrologic period was extended to include WY 2016-2023 with the precipitation data mapped accordingly.
- Model layering was updated based on Airborne Electromagnetic (AEM) data
- Changes to land use were made with the simulated land uses mapped to the statewide crop mapping released by DWR in 2016 through 2022. USDA CropScape data was removed from the model and interpolation was updated from 1995 to 2016 datasets.
- Stream inflows were extended through WY 2023 using the same data sources as in the original version.
- Populations were updated for WY 2016 through 2023, and urban demands revised accordingly. Rural residential urban demand was updated to use
- Surface water deliveries were extended to WY 2023 and additional surface water deliveries that were not previously simulated were added to the model, including Farmington Reservoir seepage.
- Groundwater pumping volumes were extended to WY 2023 and the Modesto Subbasin wells, additional OID, Cal Water, Manteca, and SSJID wells were added to the model.
- Agricultural water operations were updated to extend through WY 2023.

The ESJWRM simulation period was extended to simulate Water Years 1995 through 2023 and the model recalibrated for the extended period. As a result of the two major model updates, both the historical and projected water budgets were revised in 2021 and 2024 to reflect the new data sets used in the model. See Appendix 2-C for additional details on the updates made to the ESJWRM.

2.4.5 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:

- <u>Inflows</u>:
  - Stream inflows
  - Stream gain from the groundwater system
  - Runoff to the stream system from precipitation
  - Return flow to the stream system from irrigation water
- <u>Outflows</u>:

- 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 revised ESJWRM Version 3.0 estimated water budgets for the historical, current conditions, projected conditions, and projected conditions with climate change scenarios are provided below, with results summarized in Table 2-14 through Table 2-16. Differences between the original and revised scenarios are discussed further in the documentation in Appendix 2-C.

Table 2-14: Average Annual Water Budget for Revised ESJWRM (Version 3.0) – Stream System (AF/year)

Component	Historical Calibration (AF/year)	Current Conditions (AF/year)	Projected Conditions (AF/year)	Projected Conditions with Climate Change (AF/year)
Model Version	**Historical ESJWRM Version 3.0**	**Historical ESJWRM Version 3.0**	**ESJWRM PCBL Version 3.0**	**ESJWRM PCBL-CC Version 3.0**
Hydrologic Period	**Water Years 1996-2023 (28-Year period)**	**Water Years 2019-2023 (5-Year average)**	**Water Years 1969- 2023 (55-Year period)**	**Water Years 1969- 2023 (55-Year period)**
Inflows				
Stream Inflows[1]	4,221,000	4,224,000	4,519,000	4,929,000
Stream Gain from Groundwater[2]	145,000	130,000	121,000	115,000
Eastern San Joaquin Subbasin	75,000	63,000	57,000	53,000
Dry Creek[11]	0	0	0	0
Mokelumne River	14,000	13,000	10,000	8,000
Calaveras River	1,000	1,000	1,000	1,000
Stanislaus River	28,000	18,000	17,000	16,000
San Joaquin River	31,000	31,000	29,000	27,000
Other Subbasins[4]	70,000	67,000	65,000	62,000
Dry Creek	23,000	29,000	28,000	27,000
Mokelumne River	0	0	0	0
Stanislaus River	27,000	19,000	17,000	16,000
San Joaquin River	20,000	20,000	19,000	18,000
Runoff to the Stream System[5]	629,000	741,000	656,000	753,000
Return Flow to Stream System[6]	96,000	95,000	111,000	112,000
Total Inflow[10]	**5,092,000**	**5,190,000**	**5,407,000**	**5,908,000**
Outflows				
Stream Outflows[7]	4,426,000	4,469,000	4,655,000	5,108,000
Stream Seepage[2]	284,000	331,000	374,000	420,000
Eastern San Joaquin Subbasin	236,000	267,000	298,000	330,000
Dry Creek	2,000	2,000	2,000	2,000
Mokelumne River	125,000	135,000	150,000	160,000
Calaveras River	37,000	37,000	39,000	41,000
Stanislaus River	36,000	55,000	67,000	82,000
San Joaquin River	37,000	37,000	40,000	45,000
Other Subbasins[4]	47,000	65,000	76,000	90,000
Dry Creek	2,000	2,000	2,000	2,000
Mokelumne River	3,000	3,000	3,000	4,000
Stanislaus River	30,000	47,000	56,000	69,000
San Joaquin River	12,000	12,000	14,000	14,000
Surface Water Diversions[8]	340,000	353,000	340,000	340,000

Riparian Intake from Streams[9]	42,000	37,000	37,000	40,000
Total Outflow[10]	**5,092,000**	**5,190,000**	**5,407,000**	**5,908,000**

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.

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. Projected scenarios and even current condition averages represent lower groundwater levels, causing less stream interaction.

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 28-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 historical, 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 2-15: Average Annual Water Budget for Revised ESJWRM – Land Surface System (AF/year)

Component	Historical Calibration (AF/year)	Current Conditions (AF/year)	Projected Conditions (AF/year)	Projected Conditions with Climate Change (AF/year)
Model Version	Historical ESJWRM Version 3.0	Historical ESJWRM Version 3.0	ESJWRM PCBL Version 3.0	ESJWRM PCBL-CC Version 3.0
Hydrologic Period	Water Years 1996-2023 (28-Year period)	Water Years 2019-2023 (5-Year average)	Water Years 1969- 2023 (55-Year period)	Water Years 1969- 2023 (55-Year period)
Inflows				
Precipitation[1] (Precipitation, inches)	988,000 (15.5)	1,063,000 (16.7)	992,000 (15.6)	1,087,000 (17.1)
Total Surface Water Supply[2]	568,000	562,000	525,000	525,000
Agricultural	512,000	497,000	452,000	452,000
Urban and Industrial	56,000	65,000	73,000	73,000
Total Groundwater Supply[3]	732,000	830,000	799,000	879,000
Agricultural	666,000	777,000	732,000	812,000
Urban and Industrial	66,000	53,000	67,000	67,000
Riparian Intake from Streams[4]	30,000	26,000	26,000	29,000
Total Inflow[10]	***2,318,000***	***2,481,000***	***2,342,000***	***2,521,000***
Outflows				
Evapotranspiration[5]	1,309,000	1,352,000	1,302,000	1,384,000
Agricultural	1,006,000	1,080,000	999,000	1,089,000
Municipal and Domestic	59,000	58,000	80,000	81,000
Refuge, Native, and Riparian	243,000	213,000	214,000	214,000
Runoff to the Stream System[6]	629,000	741,000	656,000	753,000
Return Flow to the Stream System[7]	96,000	95,000	111,000	112,000
Agricultural	22,000	22,000	25,000	26,000
Municipal and Domestic	75,000	73,000	86,000	86,000
Deep Percolation[8]	275,000	284,000	270,000	268,000
Precipitation	60,000	53,000	55,000	52,000
Applied Surface Water – Agricultural	85,000	82,000	73,000	70,000
Applied Surface Water – Urban and Industrial	9,000	11,000	12,000	11,000
Applied Groundwater – Agricultural	111,000	129,000	119,000	125,000
Applied Groundwater – Urban and Industrial	11,000	9,000	11,000	10,000
Other Flows[9]	8,000	9,000	4,000	5,000
Total Outflow[10]	***2,318,000***	***2,481,000***	***2,342,000***	***2,521,000***

Notes:

1 Precipitation is discussed in the identification of the hydrologic periods in 2.4.2. The projected conditions scenarios utilize the same 55 years of hydrology (water years 1969-2023) with perturbations in the climate change scenario causing more precipitation. The historical calibration has a shorter hydrologic period (28 years from 1996-2023) with slightly less precipitation on average. Current conditions represent recent years with 2 wet years (2019 and 2023) and 3 dry or critical years (2020, 2021, and 2022).

[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 historical, 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 2-16: Average Annual Water Budget for Revised ESJWRM – Groundwater System (AF/year)

Component	Historical Calibration (AF/year)	Current Conditions (AF/year)	Projected Conditions (AF/year)	Projected Conditions with Climate Change (AF/year)
Model Version	**Historical ESJWRM Version 3.0**	**Historical ESJWRM Version 3.0**	**ESJWRM PCBL Version 3.0**	**ESJWRM PCBL-CC Version 3.0**
Hydrologic Period	**Water Years 1996-2023 (28-Year period)**	**Water Years 2019-2023 (5-Year average)**	**Water Years 1969- 2023 (55-Year period)**	**Water Years 1969- 2023 (55-Year period)**
Inflows				
Deep Percolation[1]	275,000	284,000	270,000	268,000
Precipitation	60,000	53,000	55,000	52,000
Applied Surface Water – Agricultural	85,000	82,000	73,000	70,000
Applied Surface Water – Urban and Industrial	9,000	11,000	12,000	11,000
Applied Groundwater – Agricultural	111,000	129,000	119,000	125,000
Applied Groundwater – Urban and Industrial	11,000	9,000	11,000	10,000
Stream Seepage[2]	236,000	267,000	298,000	330,000
Dry Creek	2,000	2,000	2,000	2,000
Mokelumne River	125,000	135,000	150,000	160,000
Calaveras River	37,000	37,000	39,000	41,000
Stanislaus River	36,000	55,000	67,000	82,000
San Joaquin River	37,000	37,000	40,000	45,000
Other Recharge	170,000	174,000	165,000	168,000
Carriage/Canal Recharge	103,000	109,000	98,000	98,000
Managed Aquifer Recharge	5,000	9,000	11,000	11,000
Reservoir Seepage	17,000	14,000	14,000	14,000
Ungauged Watershed Drainage	45,000	42,000	45,000	48,000
Subsurface Inflow[3]	176,000	188,000	204,000	222,000
Cosumnes Subbasin	28,000	34,000	35,000	35,000
Sierra Nevada Mountains	55,000	54,000	57,000	55,000
Modesto Subbasin	30,000	32,000	37,000	41,000
South American Subbasin	3,000	4,000	5,000	6,000
Solano Subbasin	19,000	19,000	22,000	27,000
East Contra Costa Subbasin	9,000	10,000	11,000	13,000
Tracy Subbasin	31,000	34,000	37,000	44,000
Total Inflow[5]	**857,000**	**912,000**	**937,000**	**988,000**
Outflows				
Groundwater Outflow to Streams[2]	75,000	63,000	57,000	53,000
Dry Creek[6]	0	0	0	0
Mokelumne River	14,000	13,000	10,000	8,000
Calaveras River	1,000	1,000	1,000	1,000
Stanislaus River	28,000	18,000	17,000	16,000
San Joaquin River	31,000	31,000	29,000	27,000
Groundwater Pumping[4]	732,000	830,000	799,000	879,000
Agricultural	666,000	777,000	732,000	812,000
Urban and Industrial	66,000	53,000	67,000	67,000
Subsurface Outflow[3]	96,000	104,000	110,000	111,000
Cosumnes Subbasin	27,000	32,000	36,000	37,000
Modesto Subbasin	40,000	44,000	44,000	46,000

Component	Historical Calibration (AF/year)	Current Conditions (AF/year)	Projected Conditions (AF/year)	Projected Conditions with Climate Change (AF/year)
Model Version	**Historical ESJWRM Version 3.0**	**Historical ESJWRM Version 3.0**	**ESJWRM PCBL Version 3.0**	**ESJWRM PCBL-CC Version 3.0**
Hydrologic Period	**Water Years 1996-2023 (28-Year period)**	**Water Years 2019-2023 (5-Year average)**	**Water Years 1969- 2023 (55-Year period)**	**Water Years 1969- 2023 (55-Year period)**
South American Subbasin[6]	1,000	1,000	0	0
Solano Subbasin	11,000	11,000	11,000	10,000
East Contra Costa Subbasin	2,000	2,000	2,000	2,000
Tracy Subbasin	16,000	14,000	17,000	16,000
Total Outflow[5]	**903,000**	**997,000**	**965,000**	**1,043,000**
Change in Groundwater Storage (Inflows Minus Outflows)				
Change in Groundwater Storage[5]	**(48,000)**	**(89,000)**	**(30,000)**	**(56,000)**

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 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.

4 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.

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

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

2.4.5.1 Historical Water Budget Estimates (Historical ESJWRM Version 3.0)

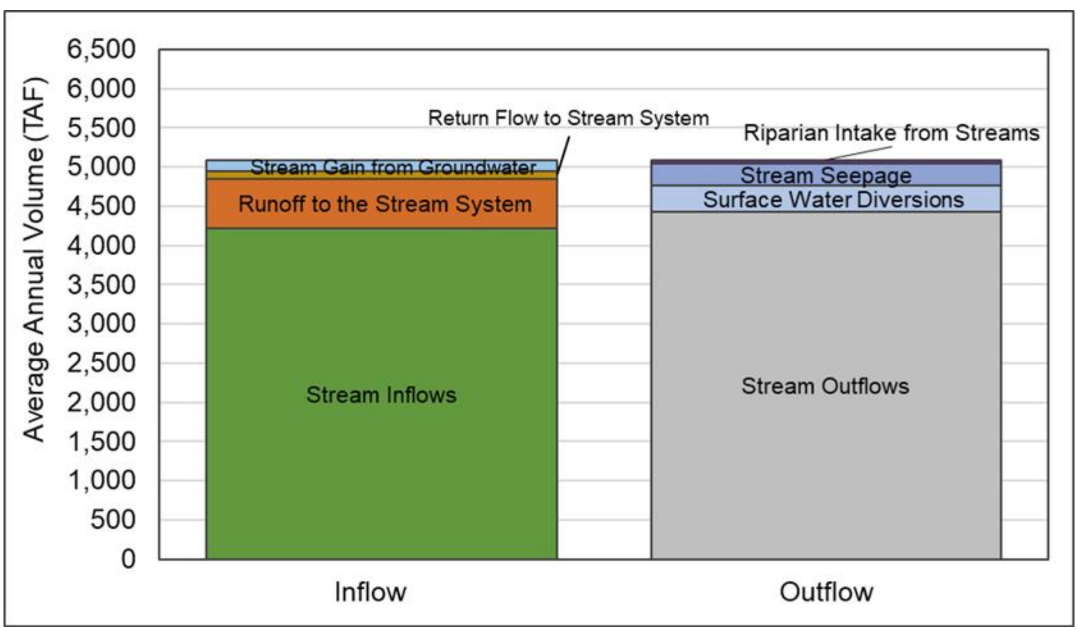
The historical water budget is a quantitative tabulation of the historical surface and groundwater supply represented in the historical calibration of the ESJWRM covering the 28-year period of water years 1996-2023. The ESJGWA selected this period as the representative hydrologic period to calibrate 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 1996 through 2020. It was then updated again in 2024 to extend the simulation period from WY 1996 through 2023. These model updates, recalibration, and the associated results are documented in Appendix 2-C of this 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 2-13 and Figure 2-109 not only quantifies the surface water system within the Subbasin, but also estimates contributions from adjoining subbasins.

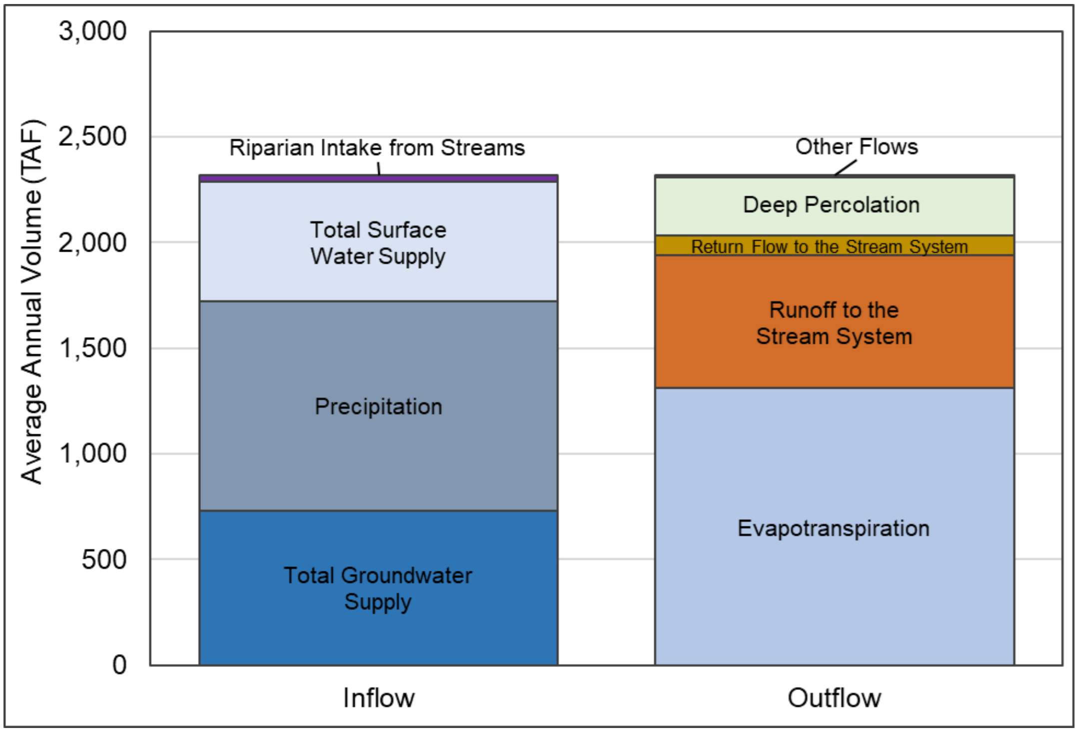
The stream system inflows through or along the Subbasin boundary simulated in the historical calibration average is 5.1 MAF/year. The majority of these flows, almost 4.2 MAF/year, enter the Subbasin as stream inflows to the Subbasin. Three other surface water inflows are estimated stream gains from the groundwater system (145,000 AF/year), runoff of precipitation to the stream system (629,000 AF/year), and return flow of applied water to the stream system (96,000 AF/year). Outflows of the Eastern San Joaquin Subbasin stream system total 5.1 MAF/year and include downstream outflows leaving the Subbasin (almost 4.4 MAF/year), stream seepage to the groundwater system (284,000 AF/year), surface water diversions (340,000 AF/year), and riparian vegetation intake from streams (42,000 AF/year).

Figure 2-109: 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 2-110, estimates almost 2.3 MAF/year of inflows, a combination of precipitation (988,000 AF/year), surface water supply (568,000 AF/year), groundwater supply (732,000 AF/year), and riparian intake from streams (30,000 AF/year). The outflow from the land surface system in the historical calibration estimates evapotranspiration (close to 1.3 MAF/year), runoff of precipitation to the stream system (629,000 AF/year), return flow of applied water to the stream system (96,000 AF/year), deep percolation of precipitation or applied water (275,000 AF/year), and a small component representing other flows (8,000 AF/year), which includes uncertainties in other components due to land expansion and temporary storage in the root-zone and unsaturated (vadose) zones.

Figure 2-110: Historical Average Annual Water Budget – Land Surface System

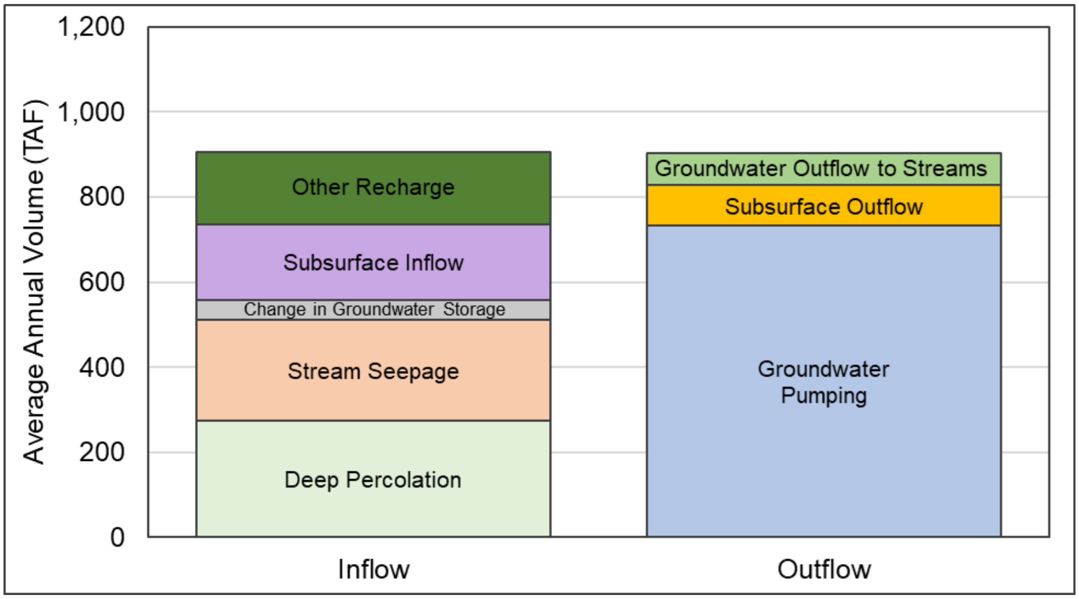


The groundwater system of the Eastern San Joaquin Subbasin includes 905,000 AF/year of inflows in the historical calibration (not including change in groundwater storage), of which 275,000 AF/year is deep percolation of precipitation or applied water. There is also stream seepage (236,000 AF/year), other recharge (170,000 AF/year), and subsurface inflows (176,000 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 (732,000 AF/year), followed by groundwater outflow to streams (75,000 AF/year), and subsurface outflow to the neighboring groundwater subbasins (96,000 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 48,000 AF/year. Figure 2-111 summarizes the average historical calibration groundwater inflows and outflows of the Eastern San Joaquin Subbasin.

A groundwater change in storage, or overdraft, estimate of 48,000 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 2-111: 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 2-17breaks 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 28 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 55-year hydrologic period allows for greater repetition of the water year types, the projected conditions results presented later in Section 2.4.5.3 are more consistent with the trends expected when averaging by water year type.

Table 2-17: 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	28-Year
Number of Years[2]	**9**	**3**	**2**	**7**	**7**	**28**
Precipitation, AF/year (Precipitation, inches)	**1,409,000 (22.1)**	**944,000 (14.8)**	**867,000 (13.6)**	**805,000 (12.6)**	**684,000 (10.7)**	**988,000 (15.5)**
Water Demand (AF/year)						
Ag Demand[3]	1,143,000	1,114,000	1,168,000	1,167,000	1,225,000	1,168,000
Urban Demand[4]	117,000	122,000	122,000	125,000	123,000	122,000
Total Demand[7]	***1,260,000***	***1,236,000***	***1,290,000***	***1,293,000***	***1,348,000***	***1,290,000***
Water Supply (AF/year)						
Total Surface Water Supply[5]	556,000	597,000	557,000	572,000	569,000	568,000
Agricultural	503,000	544,000	501,000	517,000	507,000	512,000
Urban and Industrial	53,000	53,000	56,000	55,000	62,000	56,000
Total Groundwater Supply[6]	713,000	648,000	741,000	731,000	791,000	732,000
Agricultural	648,000	578,000	675,000	660,000	728,000	666,000
Urban and Industrial	65,000	70,000	67,000	71,000	62,000	66,000
Total Supply (AF/year)[7]	***1,268,000***	***1,245,000***	***1,298,000***	***1,303,000***	***1,360,000***	***1,300,000***
Change in Groundwater Storage (AF/year)[7]	***78,000***	***13,000***	***-82,000***	***-105,000***	***-170,000***	***-48,000***

Notes:

1 There was only two below normal water yeas in the historical calibration (water year 2003 and 2018), so averages are just based on model results for two water years. Since there weren't any more below normal years to use in the average, results for the below normal water year type may not follow expected trends.

2 List of historical water budget water years by water year type:
Wet: 1996, 1997, 1998, 2005, 2006, 2011, 2017, 2019, 2023
Above Normal: 1999, 2000, 2010
Below Normal: 2003, 2018
Dry: 2001, 2002, 2004, 2009, 2012, 2016, 2020
Critical: 2007, 2008, 2013, 2014, 2015, 2021, 2022

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.

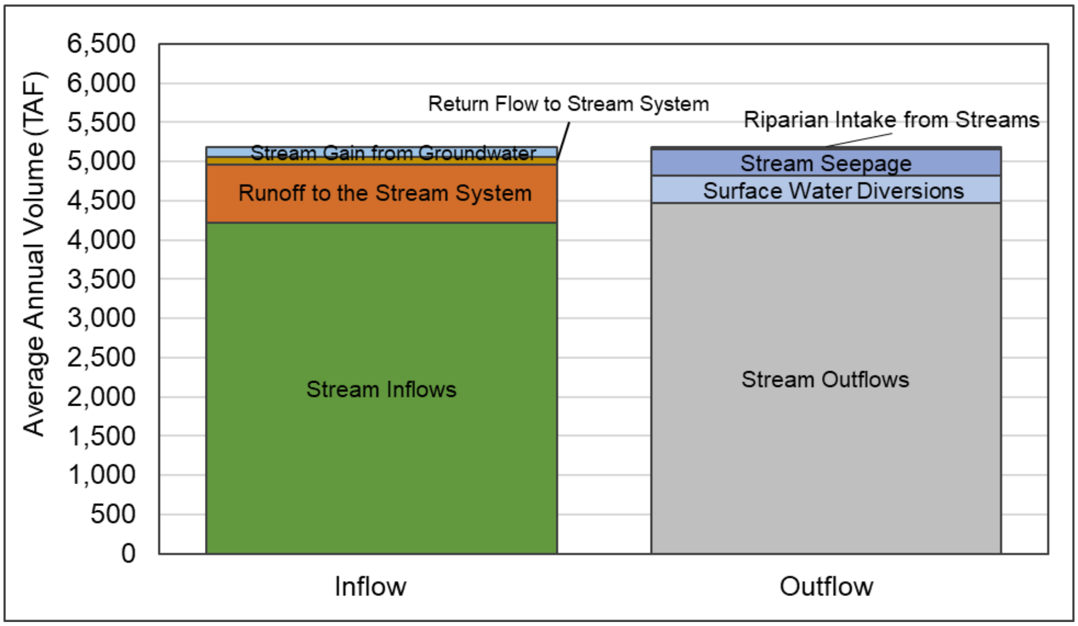
2.4.5.2 Current Water Budget Estimates (Historical ESJWRM Version 3.0)

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.

The outflows from the stream system in the current conditions scenario include 353,000 AF/year of surface water diversions occurring in the Subbasin from simulated streams. In addition, on average, over 4.5 MAF/year leaves the Subbasin's stream system as downstream outflow of the San Joaquin River and Mokelumne River, 331,000 AF/year is lost as stream seepage to the groundwater system, and 37,000 AF/year is used by riparian vegetation as riparian intake from streams.

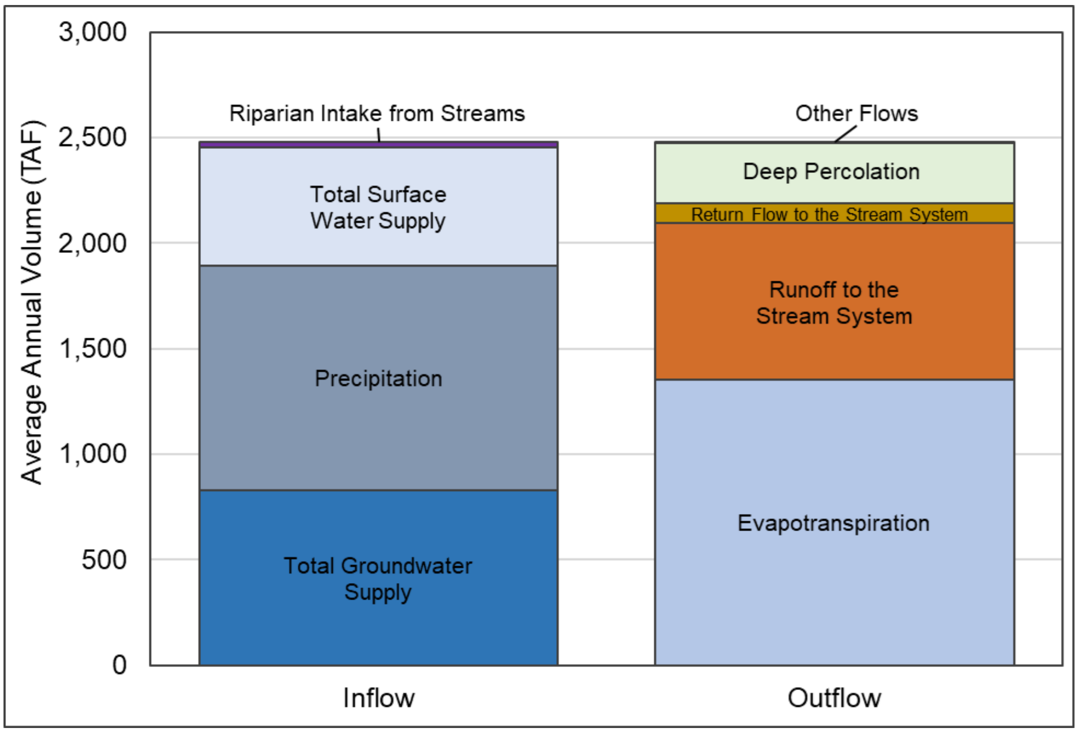
These demands are met by an estimated 4.2 MAF/year of stream inflows, 741,000 AF/year of runoff of precipitation to the stream system, 95,000 AF/year of return flow of applied water to the stream system, and 130,000 AF/year of stream gain from the groundwater system. Figure 2-112 summarizes the average annual inflows and outflow of the current conditions scenario in the Eastern San Joaquin Subbasin stream network.

Figure 2-112: Current Average Annual Water Budget Estimates – Stream System



Over the 5-year recent hydrologic period, the current conditions land surface water budget shows average annual inflows of almost 2.5 MAF/year, including 1.1 MAF/year of precipitation, 1.4 MAF/year of applied water (562,000 AF/year of surface water supply and 830,000 AF/year of groundwater supply), and 26,000 AF/year of riparian intake from the stream system. Approximately 2.5 MAF/year of outflows include evapotranspiration (1.4 MAF/year), runoff to the stream system of precipitation (741,000 AF/year), return flow to the stream system of applied water (95,000 AF/year), deep percolation (284,000 AF/year), and other flows due to land expansion and temporary storage in the root-zone and vadose zones (9,000 AF/year). Figure 2-113 summarizes the average annual current conditions inflows and outflows in the land surface budget for the Eastern San Joaquin Subbasin.

Figure 2-113: Current Average Annual Water Budget Estimates – Land Surface System

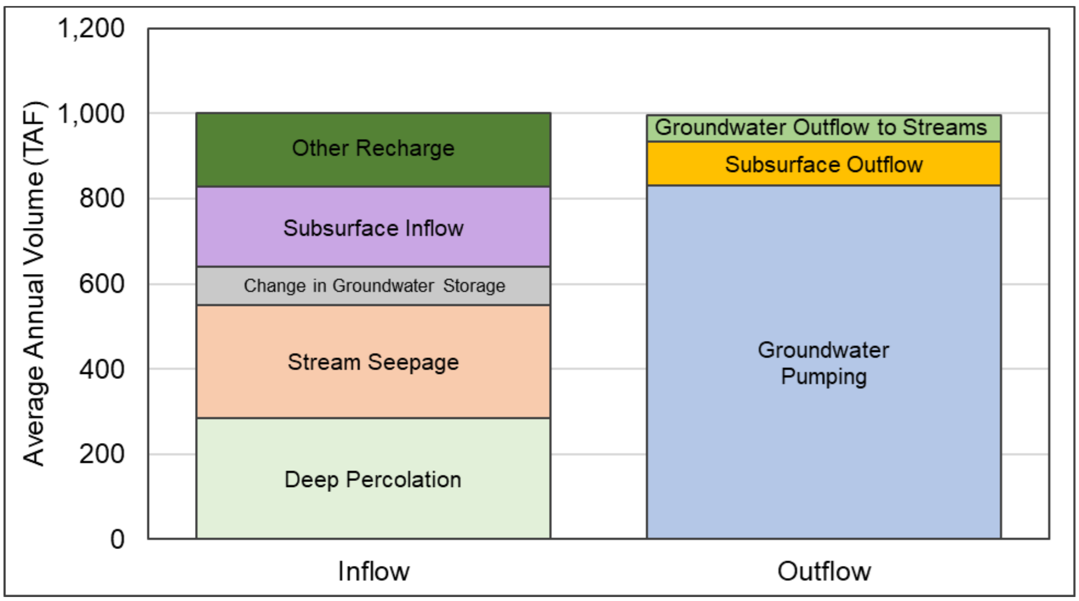


The current conditions scenario averages 5 years of recent hydrology with conditions approximately reflective of current Subbasin management and activities., The current conditions groundwater system water budget shows average annual inflows of 1 MAF/year, including 284,000 AF/year of deep percolation, 267,000 AF/year of stream seepage, 174,000 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 188,000 AF/year.

Similar to the historical water budget, average groundwater system outflows exceed the inflows under current conditions. Groundwater pumping (830,000 AF/year) remains the largest portion of aquifer discharge, with subsurface outflows to surrounding subbasins (104,000 AF/year) and groundwater outflow or losses to the stream system (63,000 AF/year), bringing the total system outflows to under 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 89,000 AF/year. Figure 2-114 summarizes the average current conditions groundwater inflows and outflows in the Eastern San Joaquin Subbasin.

Figure 2-114: Current Average Annual Water Budget Estimates – Groundwater System



2.4.5.3 Projected Water Budget Estimates (ESJWRM PCBL Version 3.0)

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 1969-2023. Results of the projected conditions scenario under potential climate change conditions (changes to precipitation, stream flows, and evapotranspiration) are presented in Section 2.4.5.4.

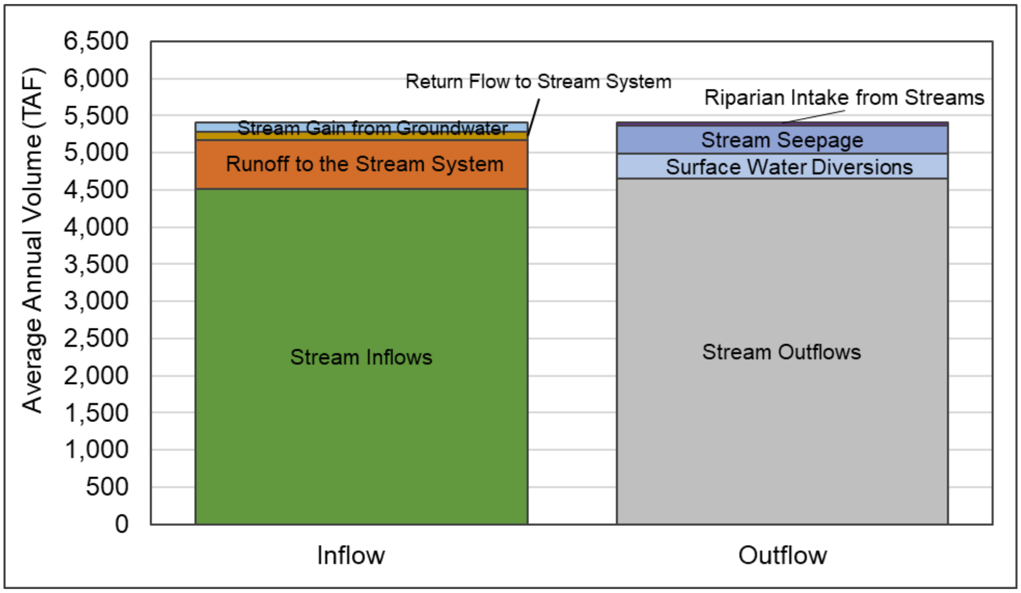
Subsequent to completion and submittal of the GSP in January of 2020, refinements and enhancements were made to the historical data for the updated historical ESJWRM, which in turn, required an update to the projected conditions baseline ESJWRM. The updated version of the Projected Conditions Baseline (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-C 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 2020 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 22,000 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 5.4 MAF/year in the projected conditions scenario. Under projected conditions, stream inflows of almost 4.5 MAF/year are augmented by stream gains from groundwater of 121,000 AF/year and runoff of precipitation to the stream system (656,000 AF/year) and return flow of applied water to the stream system (111,000 AF/year). Of these inflows, it is anticipated that 340,000 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 4.6 MAF/year), stream seepage (374,000 AF/year), and riparian intake from streams (37,000 AF/year).

Figure 2-115 summarizes the average projected inflows and outflows in the Eastern San Joaquin Subbasin stream system.

Figure 2-115: 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 2,342,000 AF/year. Inflows consist of precipitation (992,000 AF/year), surface water supply (525,000 AF/year), groundwater supply (799,000 AF/year), and riparian intake from streams (26,000 AF/year). The balance of this is the summation of average annual evapotranspiration (1,302,000 AF/year), runoff of precipitation to the stream system (656,000 AF/year), return flow of applied water to the stream system (111,000 AF/year), deep percolation (270,000 AF/year), and other flows due to land expansion and temporary storage in the root-zone and unsaturated (vadose) zones (4,000 AF/year). A summary of these flows can be seen below in Figure 2-116.

Figure 2-116: Projected Average Annual Water Budget Estimates – Land Surface System

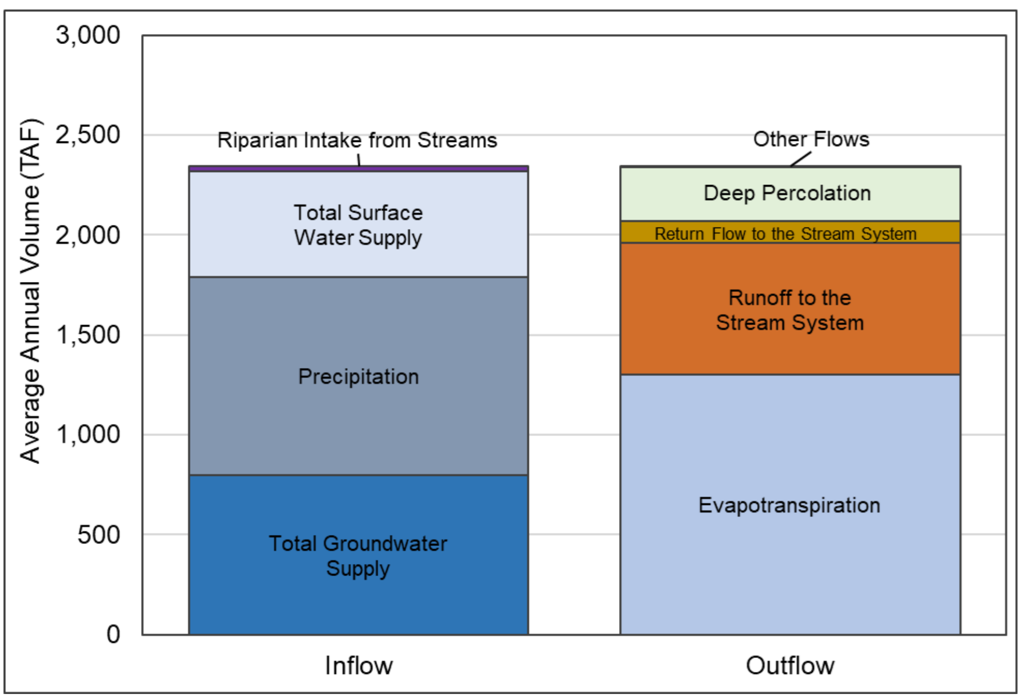
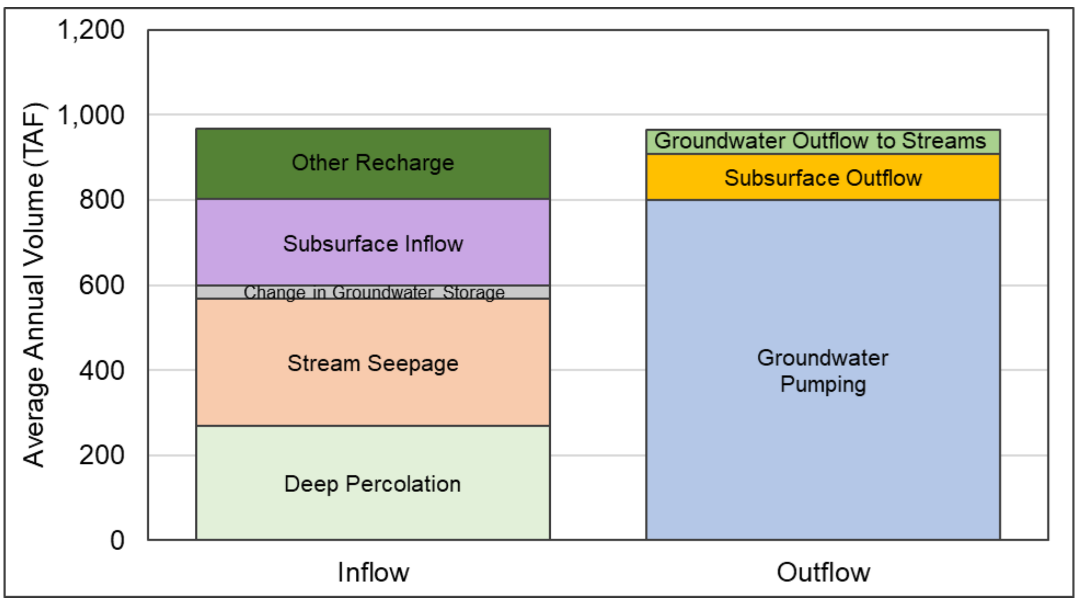


Figure 2-117 below shows how anticipated expansion in surface water supplies is reflected by decreases to groundwater pumping (799,000 AF/year) relative to historical conditions estimates. Subsurface outflow to neighboring subbasins (57,000 AF/year) and stream gain from groundwater (110,000 AF/year) bring the total Subbasin discharges to 966,000 AF/year.

Under projected conditions, the groundwater system of the Eastern San Joaquin Subbasin experiences an average of 967,000 AF/year of inflows each year, of which 270,000 AF/year is deep percolation. There is also stream seepage (298,000 AF/year), as well as other recharge which includes recharge from canals, reservoirs, and MAR projects (165,00 AF/year), and subsurface inflows (204,000 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 30,000 AF/year. Figure 2-117 summarizes the average projected groundwater inflows and outflows in the Eastern San Joaquin Subbasin.

Figure 2-117: Projected Average Annual Water Budget Estimates – Groundwater System



As seen previously in Table 2-17 for the historical calibration, Table 2-18 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 55-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 2-18: 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	55-Year
Number of Years[1]	**19**	**7**	**3**	**10**	**16**	**55**
Precipitation, AF/year (Precipitation, inches)	**1,402,000 (22.0)**	**987,000 (15.5)**	**895,000 (14.0)**	**772,000 (12.1)**	**662,000 (10.4)**	**992,000 (15.6)**
Water Demand (AF/year)						
Ag Demand	1,156,000	1,186,000	1,183,000	1,178,000	1,182,000	1,173,000
Urban Demand	138,000	137,000	137,000	142,000	145,000	140,000
Total Demand[2]	***1,293,000***	***1,323,000***	***1,319,000***	***1,320,000***	***1,327,000***	***1,313,000***
Water Supply (AF/year)						
Total Surface Water Supply	564,000	562,000	567,000	518,000	460,000	525,000
Agricultural	478,000	476,000	481,000	448,000	407,000	452,000
Urban and Industrial	86,000	86,000	86,000	70,000	53,000	73,000
Total Groundwater Supply	736,000	769,000	761,000	817,000	883,000	799,000
Agricultural	685,000	719,000	709,000	740,000	787,000	732,000
Urban and Industrial	52,000	52,000	52,000	74,000	94,000	67,000
Total Supply (AF/year)[2]	***1,300,000***	***1,331,000***	***1,328,000***	***1,335,000***	***1,343,000***	***1,324,000***
Change in Groundwater Storage (AF/year)[2]	***165,000***	***-24,000***	***-4,000***	***-125,000***	***-209,000***	***-30,000***

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, 2019, 2023
Above Normal: 1970, 1973, 1979, 1984, 1999, 2000, 2010
Below Normal: 1971, 2003, 2018
Dry: 1972, 1981, 1985, 2001, 2002, 2004, 2009, 2012, 2016, 2020
Critical: 1976, 1977, 1987, 1988, 1989, 1990, 1991, 1992, 1994, 2007, 2008, 2013, 2014, 2015, 2021, 2022

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

2.4.5.4 Projected Water Budget with Climate Change Estimates (ESJWRM PCBL-CC Version 3.0)

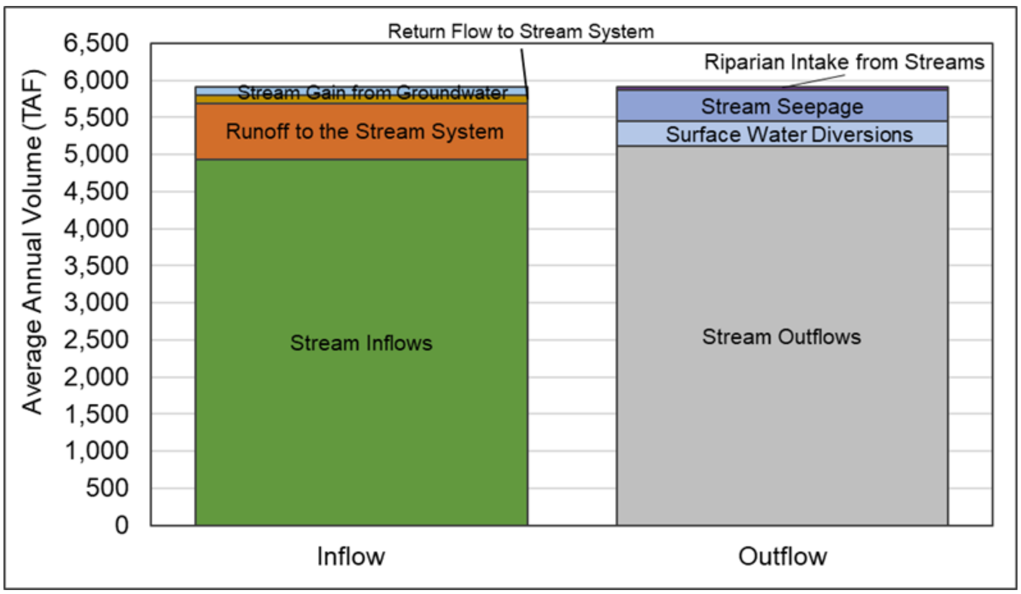
The projected water budget with climate change is used to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation, with the additional effects of climate change on available water supply and increasing agricultural demand. The projected conditions scenario with climate change in the ESJWRM is used to evaluate the water budget assuming a 2040 level of development and using hydrology from water years 1969-2023, adjusted for climate change impacts.

Subsequent to completion and submittal of the GSP in January of 2020, refinements and enhancements were made during two major updates to the historical data for the updated historical ESJWRM, which in turn, required updates to the projected conditions baseline ESJWRM. As in all previous sections, ESJWRM Version 3.0 water budgets are included in the following section. This projected water budget with climate change updates and the associated results are documented in Appendix 2-C of this revised GSP.

Average annual surface water inflows to the Eastern San Joaquin Subbasin's stream system total an average of just under 6.0 MAF/year in the projected conditions with climate change scenario. Under projected conditions with climate change, stream inflows of 4.9 MAF/year are augmented by stream gains from groundwater of 115,000 AF/year and runoff of precipitation to the stream system (753,000 AF/year) and return flow of applied water to the stream system (112,000 AF/year). Of these inflows, it is anticipated that 340,000 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 (5.1 MAF/year), stream seepage (420,000 AF/year), and riparian intake from streams (40,000 AF/year).

Figure 2-115 summarizes the average projected inflows and outflows in the Eastern San Joaquin Subbasin stream system.

Figure 2-118: Projected Average Annual Water Budget Estimates with Climate Change – Stream System



The land surface water budget for the projected conditions with climate change scenario has annual average inflows and outflows of 2,520,000 AF/year. Inflows consist of precipitation (1,087,000 AF/year), surface water supply (525,000 AF/year), groundwater supply (879,000 AF/year), and riparian intake from streams (29,000 AF/year). The balance of this is the summation of average annual evapotranspiration (1,384,000 AF/year), runoff of precipitation to the stream system (753,000 AF/year), return flow of applied water to the stream system (112,000 AF/year), deep percolation (268,000 AF/year), and other flows due to land expansion and temporary storage in the root-zone and unsaturated (vadose) zones (5,000 AF/year). A summary of these flows can be seen below in Figure 2-116.

Figure 2-119: Projected Average Annual Water Budget Estimates with Climate Change – Land Surface System

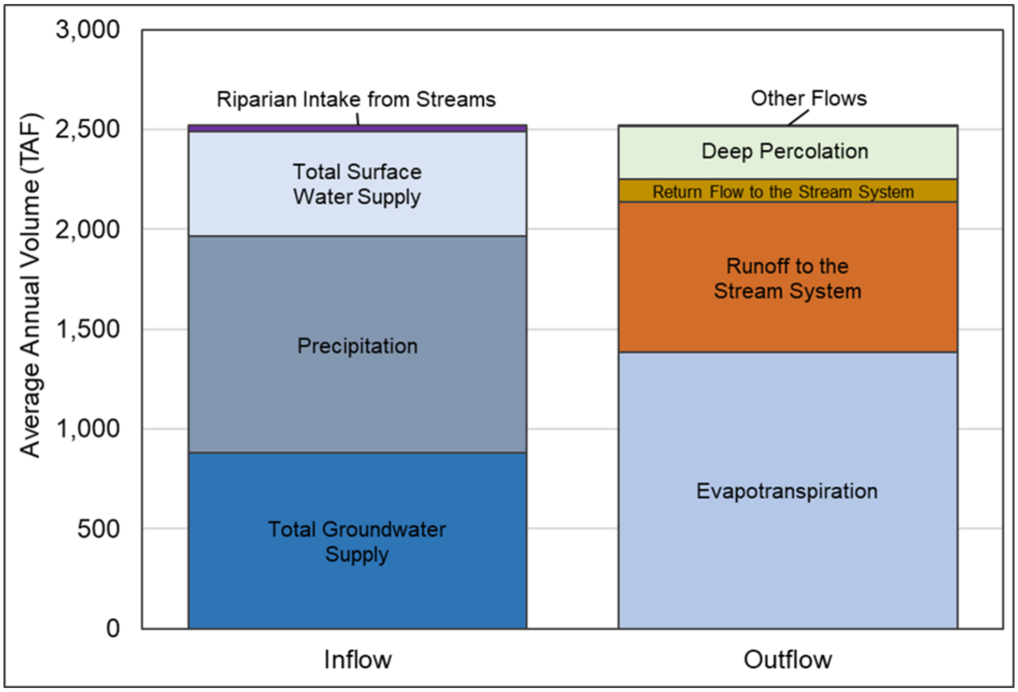


Figure 2-120 below shows how effects due to climate change are reflected by increases to groundwater pumping (879,000 AF/year) relative to the project conditions scenario. Subsurface outflow to neighboring subbasins (111,000 AF/year) and stream gain from groundwater (53,000 AF/year) bring the total Subbasin discharges to 1,043,000 AF/year.

Under projected conditions with climate change, the groundwater system of the Eastern San Joaquin Subbasin experiences an average of 1,044,000 AF/year of inflows each year, of which 268,000 AF/year is deep percolation. There is also stream seepage (330,000 AF/year), as well as other recharge which includes recharge from canals, reservoirs, and MAR projects (168,00 AF/year), and subsurface inflows (222,000 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 56,000 AF/year. Figure 2-120 summarizes the average projected groundwater inflows and outflows in the Eastern San Joaquin Subbasin.

Figure 2-120: Projected Average Annual Water Budget Estimates with Climate Change – Groundwater System

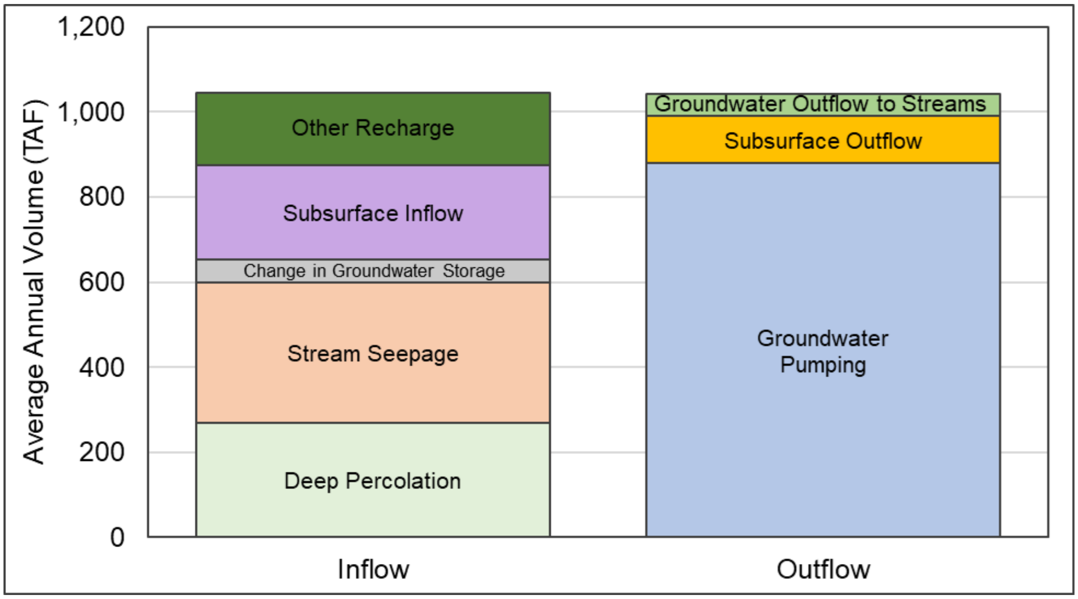


Table 2-19 shows the projected conditions with climate change's water demands, supplies, and change in groundwater storage averaged based on the San Joaquin Valley Water Year Hydrologic Classification or water year type. As expected, in wet years there is more precipitation and surface water to meet 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.

Table 2-19: Average Annual Values for Key Components of Projected Conditions with Climate Change Water Budget by Year Type

Component	Water Year Type (San Joaquin River Index)					
	Wet	Above Normal	Below Normal	Dry	Critical	55-Year
Number of Years[1]	**19**	**7**	**3**	**10**	**16**	**55**
Precipitation, AF/year (Precipitation, inches)	**1,547,000 (24.3)**	**1,124,000 (17.6)**	**952,000 (14.9)**	**829,000 (13.0)**	**712,000 (11.2)**	**1,087,000 (17.1)**
Water Demand (AF/year)						
Ag Demand	1,238,000	1,261,000	1,262,000	1,258,000	1,263,000	1,253,000
Urban Demand	138,000	137,000	136,000	142,000	145,000	139,000
Total Demand[2]	***1,376,000***	***1,398,000***	***1,398,000***	***1,400,000***	***1,408,000***	***1,392,000***
Water Supply (AF/year)						
Total Surface Water Supply	564,000	562,000	566,000	518,000	459,000	525,000
Agricultural	478,000	476,000	481,000	448,000	407,000	452,000
Urban and Industrial	86,000	86,000	85,000	69,000	53,000	73,000
Total Groundwater Supply	818,000	844,000	841,000	897,000	964,000	879,000
Agricultural	768,000	795,000	790,000	821,000	869,000	812,000
Urban and Industrial	52,000	52,000	52,000	74,000	94,000	68,000
Total Supply (AF/year)[2]	***1,382,000***	***1,406,000***	***1,407,000***	***1,415,000***	***1,423,000***	***1,404,000***
Change in Groundwater Storage (AF/year)[2]	***139,000***	***-55,000***	***-39,000***	***-150,000***	***-233,000***	***-56,000***

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, 2019, 2023
Above Normal: 1970, 1973, 1979, 1984, 1999, 2000, 2010
Below Normal: 1971, 2003, 2018
Dry: 1972, 1981, 1985, 2001, 2002, 2004, 2009, 2012, 2016, 2020
Critical: 1976, 1977, 1987, 1988, 1989, 1990, 1991, 1992, 1994, 2007, 2008, 2013, 2014, 2015, 2021, 2022

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

2.4.6 Projected Water Budget with Demand Reduction Estimates (ESJWRM PCBL-DR Version 3.0)

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)). Groundwater pumping under sustainable conditions for the Eastern San Joaquin Subbasin was calculated through development of an ESJWRM sustainable conditions scenario in which the goal was to generate a long-term (55-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. From 2040, the 55 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 2.4.4.3 and Figure 2-117) 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 production under sustainable conditions. 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 production under sustainable conditions and an initial estimate of the adjustment that would be required to achieve the production under sustainable conditions over the 55-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 results of the Subbasin ESJWRM Projected Condition BaseLine with Demand Reduction (PCBL-DR) are summarized below. Detailed assumptions and results for the PCBL-DR are included in Appendix 2-C of this updated GSP. As with the PCBL, the projected conditions with demand reduction scenario of the ESJWRM assumes a 2040 level of development and hydrology from water years 1969-2023.

2.4.6.1 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-DR Version 3.0 water demand for the Subbasin within the 55-year simulation period is 1,199 thousand acre-feet per year (TAFY), consisting of approximately 1,059 TAFY of agricultural demand and 140 TAFY of urban demand. This demand is met by an annual average of 526 TAFY of surface water deliveries (452 TAFY of agricultural and 73 TAFY of urban deliveries) and is supplemented by 693 TAFY of groundwater production (628 TAFY of agricultural and 65 TAFY of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is 21 TAFY 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 2-20. The annual land and water use budgets across the ESJ Subbasin are shown in Figure 2-121 and Figure 2-122 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands plotted with water supplies.

Table 2-20 also includes the PCBL Version 3.0 results and a demand reduction benefit calculated as the PCBL-DR Version 3.0 results minus the PCBL Version 3.0 results. For urban areas, the 15% reduction in urban demand that was applied to the PCBL-DR Version 3.0 across all major agencies in the Subbasin is reflected in the reduction in urban demand of 16 TAFY compared to the PCBL Version 3.0. For agricultural areas, the PCBL-DR Version 3.0 has 26 thousand acres less of agricultural area, which results in 95 TAFY reduction in agricultural demand compared the PCBL Version 3.0. This represents a comparable reduction in agricultural groundwater pumping of 93 TAFY.

Table 2-20: ESJ Subbasin Land and Water Use Budget Annual Average Comparison Between PCBL Version 3.0 and PCBL-DR Version 3.0

Land and Water Use Budget Component	Annual Average		
	PCBL Version 3.0	PCBL-DR Version 3.0	DR Benefit (PCBL-DR Version 3.0 minus PCBL Version 3.0)
Agricultural Area (thousand acres)	365	340	-26
Agricultural Demand (TAFY)	1,153	1,059	-95
Agricultural Groundwater Pumping (TAFY)	721	628	-93
Agricultural Surface Water Deliveries (TAFY)	452	452	0
Agricultural Surplus (TAFY)[1]	19	21	2
Urban Area (thousand acres)	129	129	0
Urban Demand (TAFY)	156	140	-16
Urban Groundwater Pumping (TAFY)	67	64	-3
Urban Surface Water Deliveries (TAFY)	73	73	0
Urban Shortage (TAFY)[1]	16	2	-14

[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 2-121: ESJ Subbasin Projected Agricultural Demand in the PCBL-DR Version 3.0

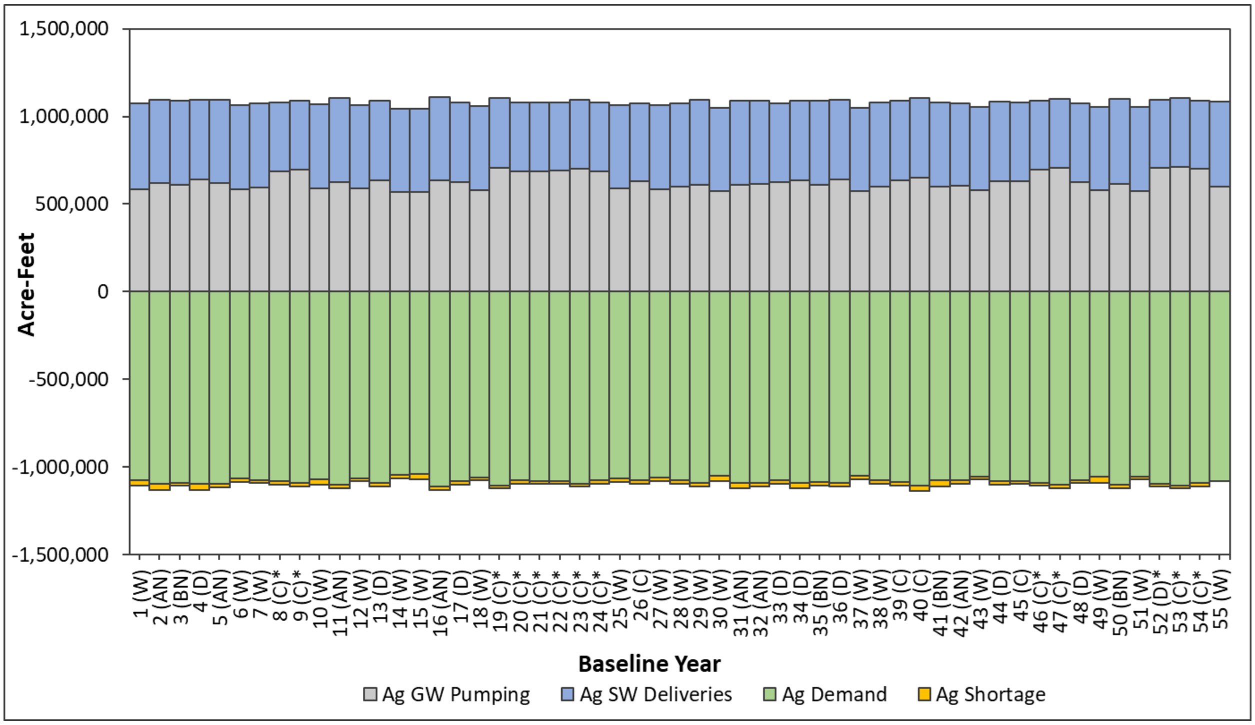
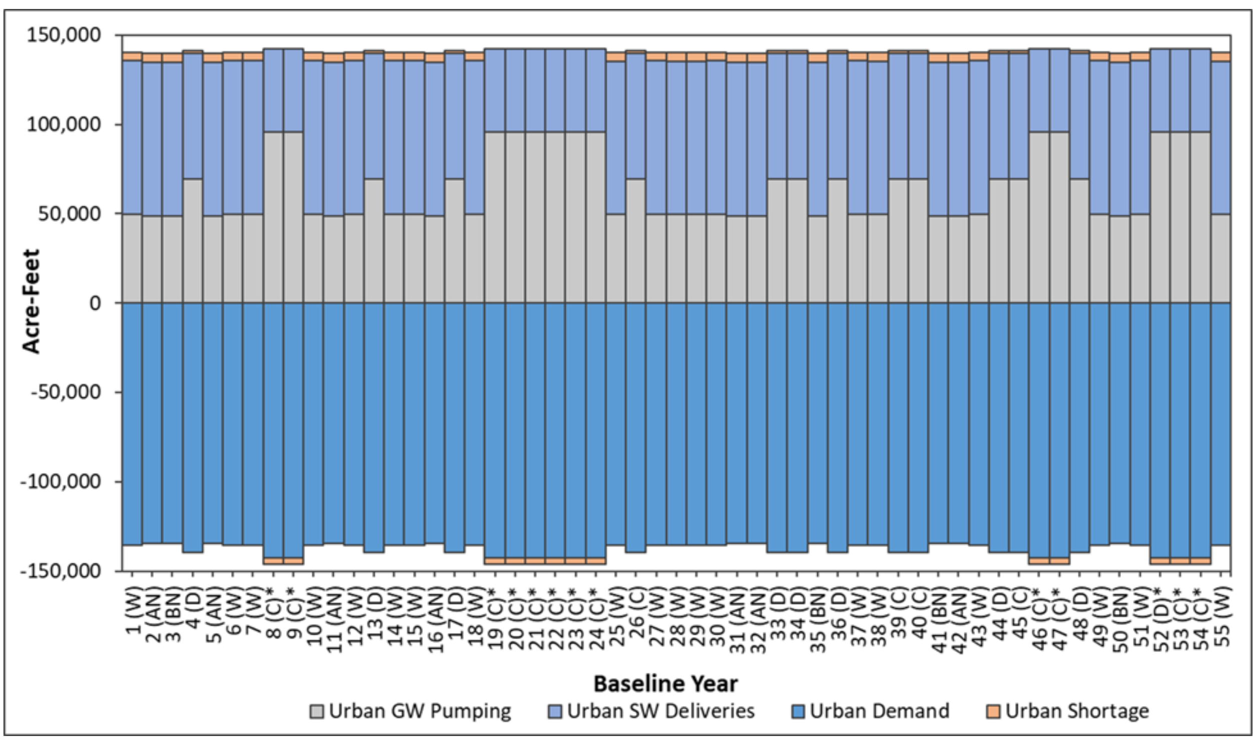


Figure 2-122: ESJ Subbasin Projected Urban Demand in the PCBL-DR Version 3.0



2.4.6.2 Hydrologic Groundwater Water 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-DR Version 3.0 remains the largest component in the groundwater budget with an annual average 704 TAFY. The PCBL-DR Version 3.0 offsets this pumping with 247 TAFY of deep percolation, a net gain from stream of 211 TAFY, 165 TAFY of other recharge, and a total subsurface inflow of 81 TAFY. The cumulative change in groundwater storage can be calculated from the average 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-DR Version 3.0 is -200 AFY, with the negative sign actually indicating an absence of groundwater overdraft and an increase in storage over the 55 years of the PCBL-DR Version 3.0. These annual averages are shown in Table 2-21. The groundwater budget, with cumulative change in storage, is shown for the ESJ Subbasin in Figure 2-123.

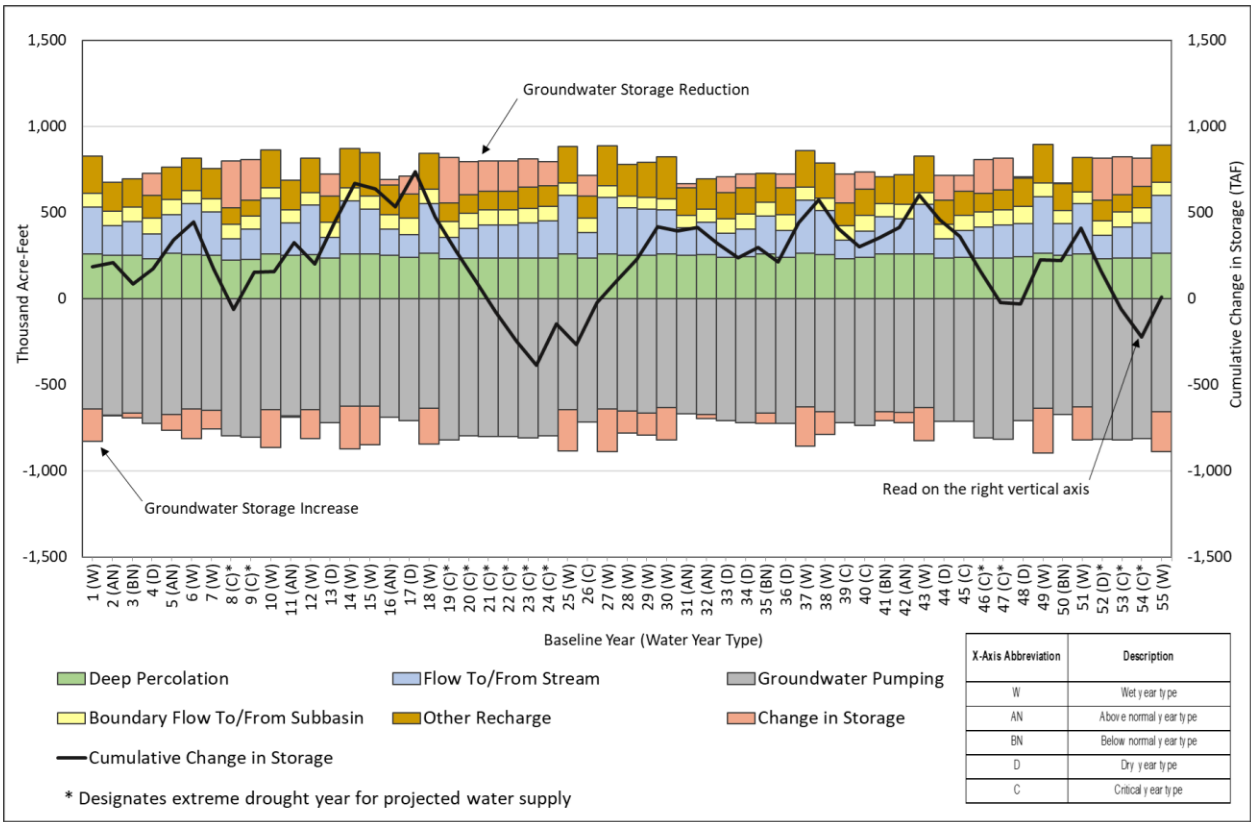
Table 2-21 also includes the PCBL Version 3.0 results and a demand reduction benefit calculated as PCBL-DR Version 3.0 results minus the PCBL Version 3.0 results. The simulated results indicate that the demand reduction may resolve the PCBL Version 3.0 Subbasin overdraft condition when impacts due to climate change are not included. Without the demand reduction, the modeling shows an average overdraft of 30 TAFY over the 55 years of the PCBL Version 3.0 simulation. With the demand reduction in place, the modeling shows approximately 0 TAFY in projected overdraft on average in the PCBL-DR Version 3.0. The PCBL-DR Version 3.0 shows an average increase of 30 TAFY of groundwater in storage when compared to the PCBL.

Compared to PCBL Version 3.0, the PCBL-DR Version 3.0 has 95 TAFY less groundwater pumping due to the percentage reduction in urban per capita water use and agricultural areas, and 29 TAFY less stream seepage into the groundwater system due to higher groundwater levels. Other hydrologic groundwater budget component differences are small between the PCBL Version 3.0 and PCBL-DR Version 3.0.

Table 2-21: ESJ Subbasin Hydrologic Groundwater Budget Annual Average Comparison Between PCBL Version 3.0 and PCBL-DR Version 3.0

Hydrologic Groundwater Budget Component	Annual Average		
	PCBL Version 3.0	PCBL-DR Version 3.0	DR Benefit (PCBL-DR Version 3.0 minus PCBL Version 3.0)
Deep Percolation (TAF)	270	247	-23
Other Recharge (TAF)	165	165	0
Net Stream Seepage (TAF)	240	211	-29
Net Boundary Inflow (TAF)	94	81	-13
Groundwater Pumping (TAF)	799	704	-95
Change in Groundwater Storage (TAF)	-30	0	30

Figure 2-123: ESJ Subbasin Projected Hydrologic Groundwater Budget in PCBL-DR Version 3.0



The sustainable conditions scenario results in groundwater outflows almost equal to groundwater inflows, bringing the long-term (55-year) average change in groundwater storage to close to zero. Based on this analysis, to achieve a simulated long-term average change in storage of 0 AFY, the Subbasin-wide pumping would be approximately is 704,000 AF/year ± 10 percent. This assumes that hydrology and surface water conditions continue as modeled and no projects are implemented.

In order to achieve a net-zero change in groundwater storage over a 55-year planning period, approximately 95,000 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 conditions level, without consideration to impacts of climate change. This number (95,000 AF/year) is larger than the estimated annual overdraft of the projected conditions scenario (30,000 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.

2.4.7 Projected Water Budget with Climate Change and Demand Reduction Estimates (ESJWRM PCBL-CC-DR Version 3.0)

2.4.7.1 Land and Water Use Water Budget

To assess the impact of climate change on the sustainable conditions run, climate change impacts, described in Section 2.4.4.4, were incorporated into the PCBL-DR scenario.

The average annual PCBL-CC-DR Version 3.0 water demand for the Subbasin within the 55-year simulation period is 1,214 TAFY, consisting of approximately 1,074 TAFY of agricultural demand and 140 TAFY of urban demand. This demand is met by an annual average of 526 TAFY of surface water deliveries (453 TAFY of agricultural and 73 TAFY of urban deliveries) and is supplemented by 702 TAFY of groundwater production (637 TAFY of agricultural and 65 TAFY of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is about 16 TAFY 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 2-22. The annual land and water use budgets across the ESJ Subbasin are shown in Figure 2-124 and Figure 2-125 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands plotted with water supplies.

Table 2-22 also includes the PCBL-CC Version 3.0 results and a demand reduction benefit calculated as PCBL-CC-DR Version 3.0 results minus PCBL-CC Version 3.0 results. For urban areas, the 15% reduction in urban demand that applied to the PCBL-CC-DR Version 3.0 across all major agencies in the Subbasin is reflected in the reduction in urban demand of 17 TAFY compared to the PCBL-CC Version 3.0. For agricultural areas, the PCBL-CC-DR Version 3.0 has 44 thousand acres less agricultural area, which results in 166 TAFY less agricultural demand compared to the PCBL-CC. This represents a comparable reduction in agricultural groundwater pumping of 164 TAFY.

Table 2-22: ESJ Subbasin Land and Water Use Budget Annual Average Comparison Between PCBL-CC Version 3.0 and PCBL-CC-DR Version 3.0

Land and Water Use Budget Component	Annual Average		
	PCBL-CC Version 3.0	PCBL-CC-DR Version 3.0	DR Benefit (PCBL-CC-DR Version 3.0 minus PCBL-CC Version 3.0)
Agricultural Area (thousand acres)	365	321	-44
Agricultural Demand (TAF)	1,240	1,074	-166
Agricultural Groundwater Pumping (TAF)	801	637	-164
Agricultural Surface Water Deliveries (TAF)	452	453	1
Agricultural Surplus (TAF)[1]	14	16	2
Urban Area (thousand acres)	129	129	0
Urban Demand (TAF)	156	140	-16
Urban Groundwater Pumping (TAF)	67	65	-3
Urban Surface Water Deliveries (TAF)	73	73	0
Urban Shortage (TAF)[1]	16	2	-14

[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 2-124: ESJ Subbasin Projected Agricultural Demand in the PCBL-CC-DR Version 3.0

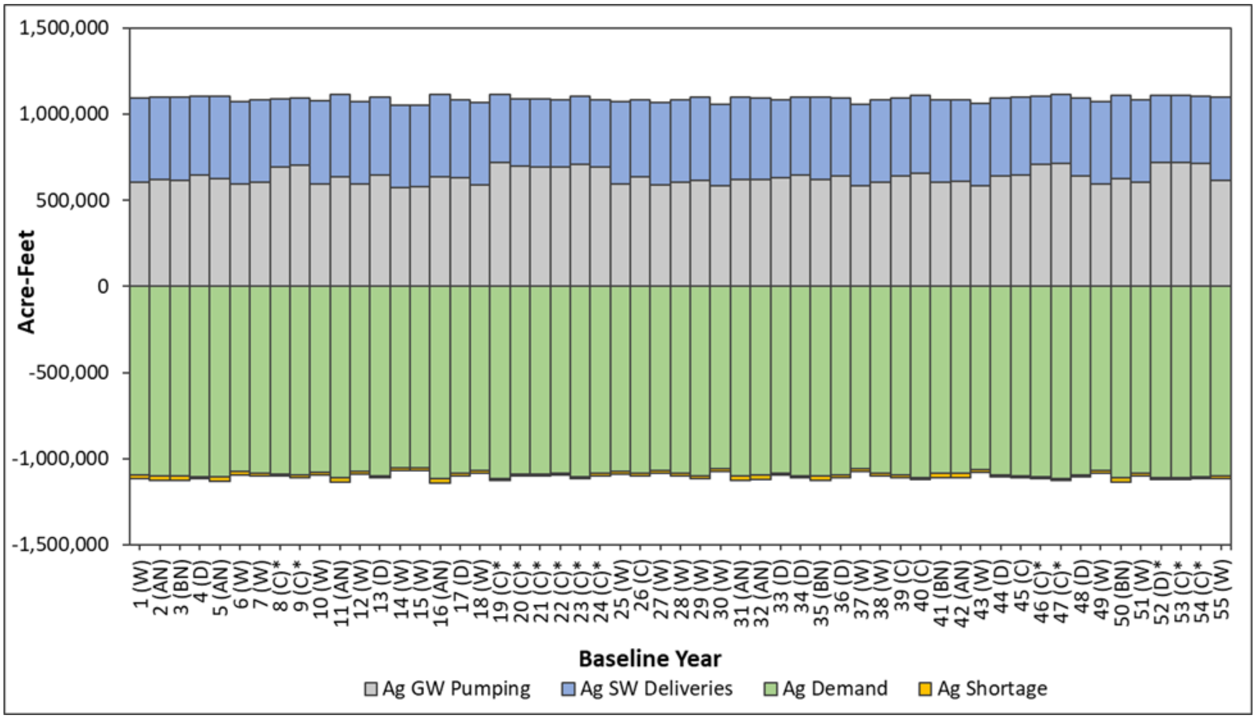
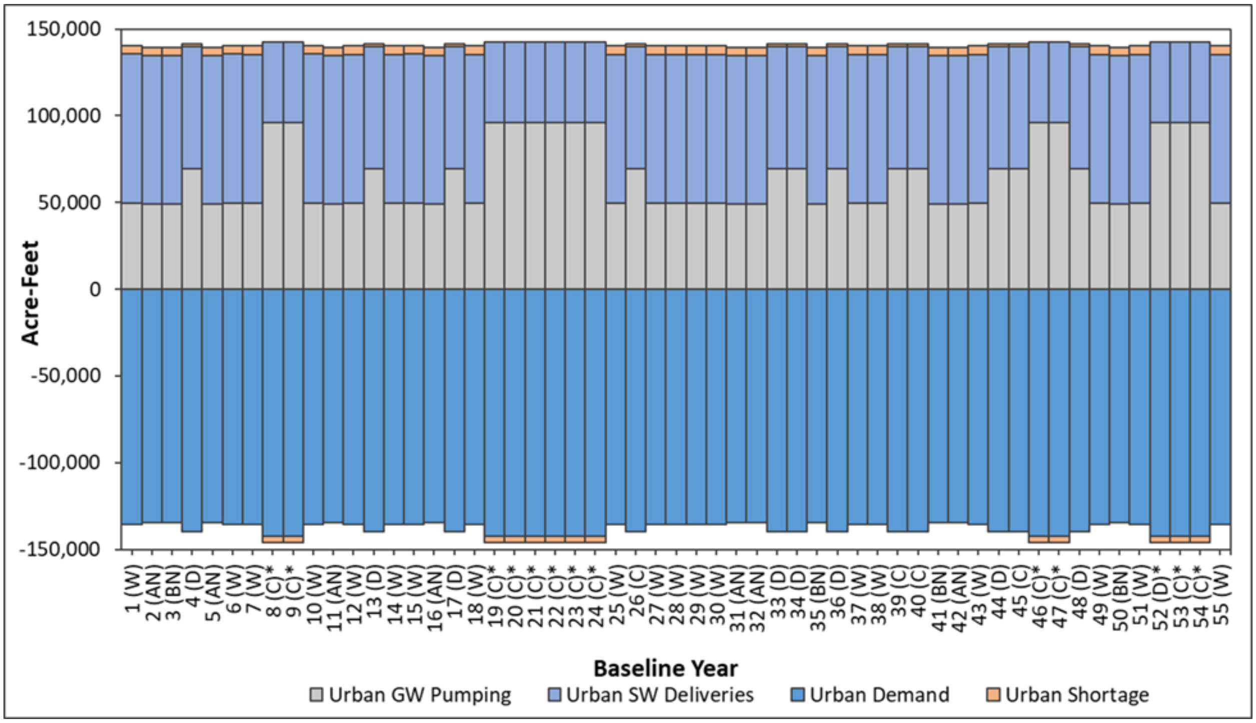


Figure 2-125: ESJ Subbasin Projected Urban Demand in the PCBL-CC-DR Version 3.0



2.4.7.2 Hydrologic Groundwater Water Budget

Pumping in the PCBL-CC-DR Version 3.0 remains the largest component in the groundwater budget with an annual average 713,200 AFY. The PCBL-CC-DR Version 3.0 offsets this pumping with 233,600 AFY of deep percolation, a net gain from stream of 223,200, 167,700 AFY of other recharge, and a total subsurface inflow of 88,600 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. Even with this uncertainty, the projected long-term average annual the groundwater storage deficit in ESJ Subbasin in the PCBL-CC-DR Version 3.0 is 0 AFY. These annual averages are shown in Table 2-23. The groundwater budgets, with average cumulative change in storage, are shown for the ESJ Subbasin in Figure 2-126.

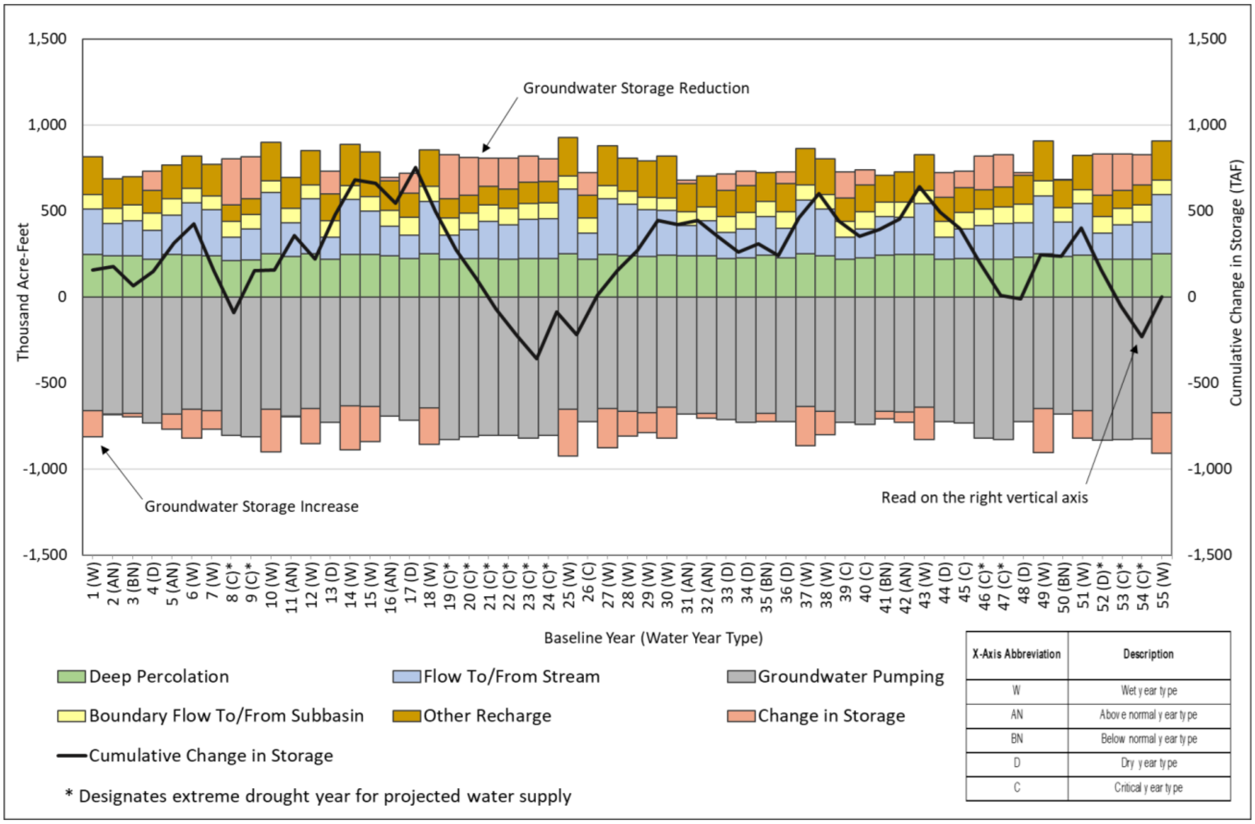
Table 2-23 also includes the PCBL-CC results and a demand reduction benefit calculated as the PCBL-CC-DR Version 3.0 results minus the PCBL-CC results. The results indicate that the demand reduction will resolve the PCBL-CC Subbasin overdraft condition when impacts due to climate change are included. Without the demand reduction, the modeling shows an average overdraft of 56,200 AFY over the 55 years of the PCBL-CC simulation. With the demand reduction in place, the modelling shows a projected overdraft of 0 AFY on average in the PCBL-CC-DR Version 3.0. The PCBL-CC-DR Version 3.0 shows an average increase of 56,200 AFY of groundwater in storage when compared to the PCBL-CC.

Compared to the PCBL-CC, with the demand reduction modeled, the PCBL-CC-DR Version 3.0 has 166,200 AFY less groundwater pumping due to the percentage reduction in urban per capita water use and agricultural areas, and 53,000 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-DR Version 3.0 simulations.

Table 2-23: ESJ Subbasin Hydrologic Groundwater Budget Annual Average Comparison Between the PCBL-CC and the PCBL-CC-DR Version 3.0

Hydrologic Groundwater Budget Component	Annual Average		
	PCBL-CC	PCBL-CC-DR Version 3.0	DR Benefit (PCBL-CC-DR Version 3.0 minus PCBL-CC)
Deep Percolation (AF)	268,000	233,600	-34,400
Other Recharge (AF)	168,100	167,700	-400
Net Stream Seepage (AF)	276,200	223,200	-53,000
Net Boundary Inflow (AF)	110,900	88,600	-22,300
Groundwater Pumping (AF)	879,400	713,200	-166,200
Change in Groundwater Storage (AF)	-56,200	0	56,200

Figure 2-126: ESJ Subbasin Projected Hydrologic Groundwater Budget in the PCBL-CC-DR Version 3.0



The sustainable conditions scenario with climate change results in groundwater outflows almost equal to groundwater inflows, bringing the long-term (55-year) average change in groundwater storage to close to zero. Based on this analysis, to achieve a simulated long-term average change in storage of 0 AFY, the Subbasin-wide pumping would be approximately is 713,000 AF/year ± 10 percent. This assumes that hydrology and surface water conditions continue as modeled and no projects are implemented.

In order to achieve a net-zero change in groundwater storage over a 55-year planning period, approximately 166,000 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 conditions level, considering the of impacts of climate change.

2.4.8 Projected Water Budget with PMAs Estimates (ESJWRM PCBL-PMA Version 3.0)

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-C of this updated 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 1969-2023. A summary of the 12 Category A PMAs simulated as additional diversions in the PCBL-PMA model is provided in Table 2-24. 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). One PMA was already included in the PCBL as Diversion 55 and is also included in Table 2-24. The remaining 65 PCBL diversions are summarized in the projected documentation (Appendix 2-C).

City of Stockton's Advanced Metering Infrastructure project was added as a Category A project during the public comment period of the 2024 GSP Amendment. Therefore, it is not included in the PMA simulation results shown in the 2024 GSP Amendment. It will be simulated in future iterations of ESJWRM PCBL-PMA. Appendix 2-C details documentation on only the 12 Category A PMAs that were simulated as part of the 2024 GSP Amendment.

2.4.8.1 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-PMA Version 3.0 water demand for the Subbasin within the 55-year simulation period is 1,315 TAFY, consisting of approximately 1,153 TAFY of agricultural demand and 162 TAFY of urban demand. This demand is met by an annual average of 572 TAFY of surface water deliveries (493 TAFY of agricultural and 79 TAFY of urban deliveries) and is supplemented by 755 TAFY of groundwater production (687 TAFY of agricultural and 68 TAFY of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is 28 TAFY 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 2-25

Table 2-25 also includes the PCBL Version 3.0 results and a Category A projects benefit calculated as the PCBL-PMA Version 3.0 results minus the PCBL Version 3.0 results. The PCBL-PMA Version 3.0 has an average of 41 TAFY more surface water for agricultural purposes and 6 TAFY more surface water for urban areas compared to the PCBL Version 3.0. For urban areas, this represents a reduction in groundwater pumping of 600 AFY. For agricultural areas, the increased surface water results in 34 TAFY 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 2-24: 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	
55	OID In-lieu and Direct Recharge Project	Import (outside of ESJWRM)	Landowners outside of OID's eastern boundary	Ag	0%	0%	100%	3,000
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%	13,300
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%	20,500
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%	12,200
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%	94%	3,700
73	North San Joaquin WCD South System Modernization	Mokelumne River	NSJWCD South System	Ag	0%	0%	100%	6,900

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Average Annual Diversion*** (acre- feet)
					RL*	NL**	Delivery	
74	North San Joaquin WCD Tecklenburg Recharge Project	Mokelumne River	Recharge basin located in NSJWCD South System	Recharge	100%	0%	0%	1,300
75	North San Joaquin WCD South System Groundwater Banking with EBMUD	Mokelumne River	NSJWCD South System	Ag	0%	0%	100%	2,800
76	North San Joaquin WCD North System Modernization/Lasko Recharge	Mokelumne River	NSJWCD North System	Ag	50%	0%	50%	4,000
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
82	North San Joaquin WCD Private Pump Partnerships	Mokelumne River	Riparian areas along Mokelumne River within NSJWCD	Recharge	50%	0%	50%	3,000

*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 2-25: ESJ Subbasin Land and Water Use Budget Annual Average Comparison Between PCBL Version 3.0 and PCBL-PMA Version 3.0

Land and Water Use Budget Component	Annual Average		
	PCBL Version 3.0	PCBL-PMA Version 3.0	PMA Benefit (PCBL-PMA Version 3.0 minus PCBL Version 3.0)
Agricultural Area (thousand acres)	365	365	0
Agricultural Demand (TAFY)	1,153	1,153	0
Agricultural Groundwater Pumping (TAFY)	721	687	-34
Agricultural Surface Water Deliveries (TAFY)	452	493	41
Agricultural Surplus (TAFY)[1]	19	28	8
Urban Area (thousand acres)	129	129	0
Urban Demand (TAFY)	156	162	6
Urban Groundwater Pumping (TAFY)	67	68	1
Urban Surface Water Deliveries (TAFY)	73	79	6
Urban Shortage (TAFY)[1]	16	16	0

[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 2-127: ESJ Subbasin Projected Agricultural Demand in the PCBL-PMA

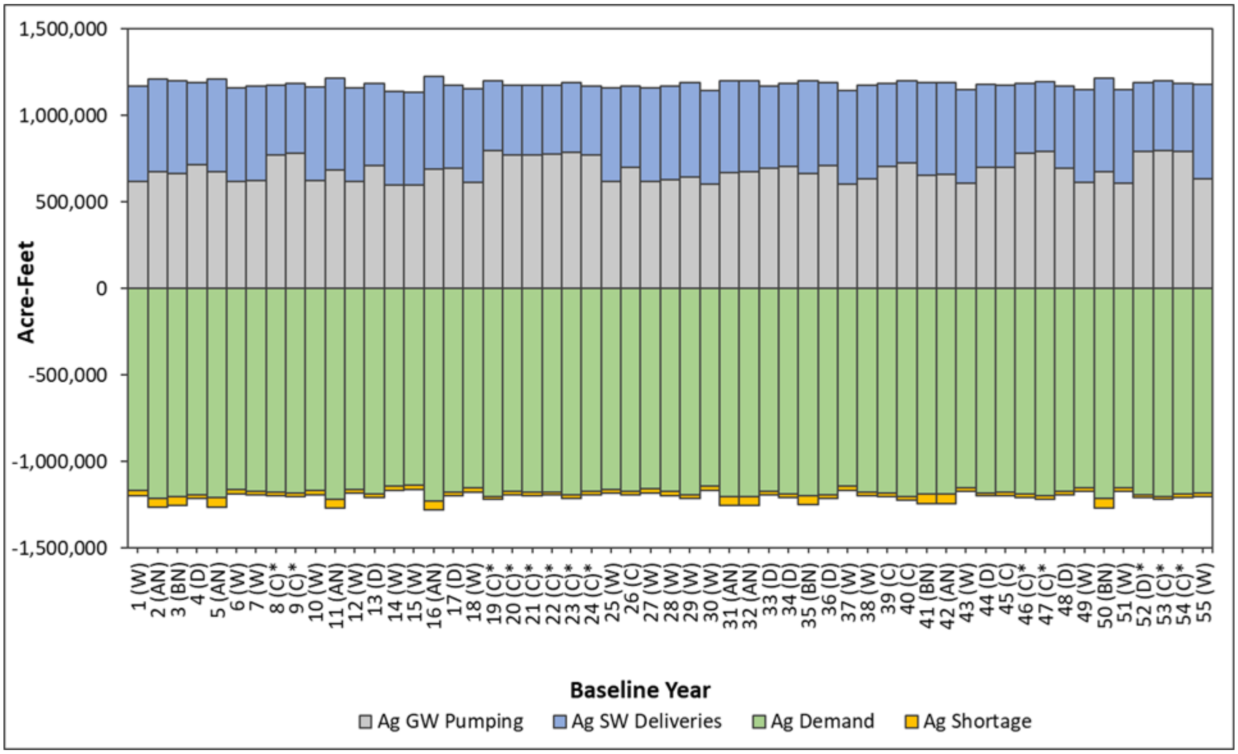
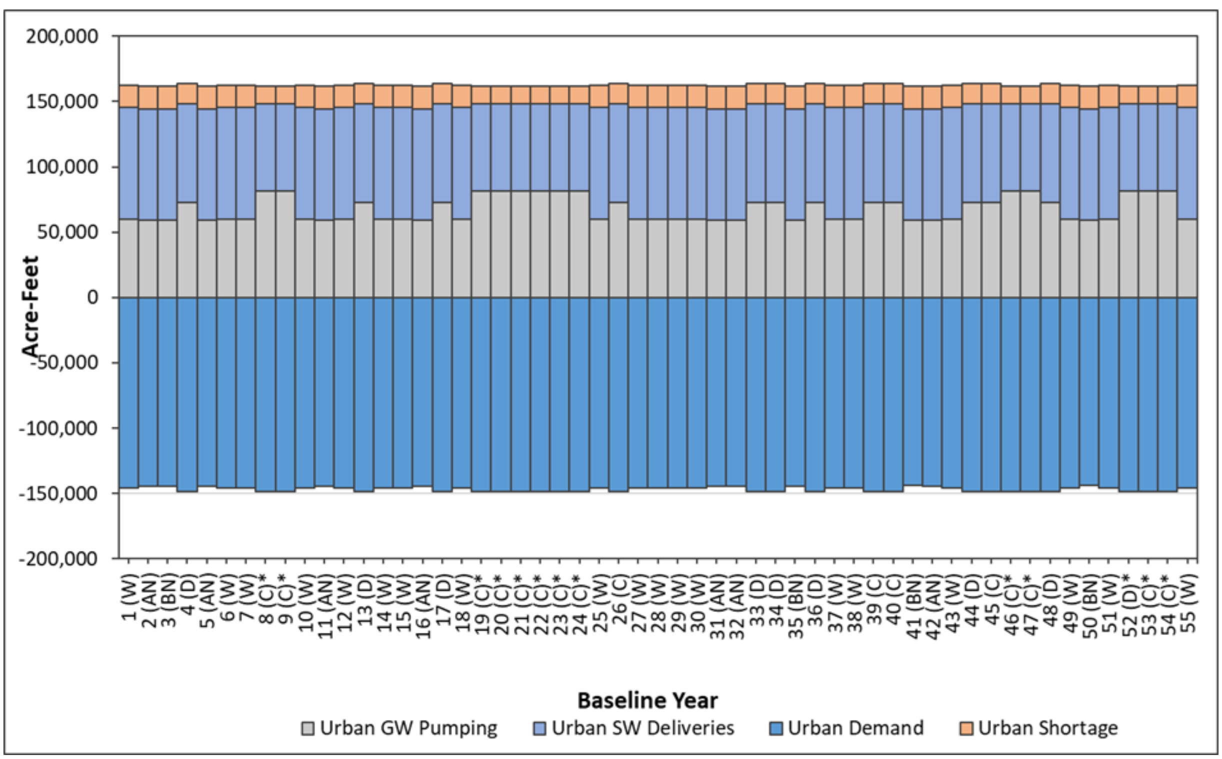


Figure 2-128: ESJ Subbasin Projected Urban Demand in the PCBL-PMA



2.4.8.2 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)

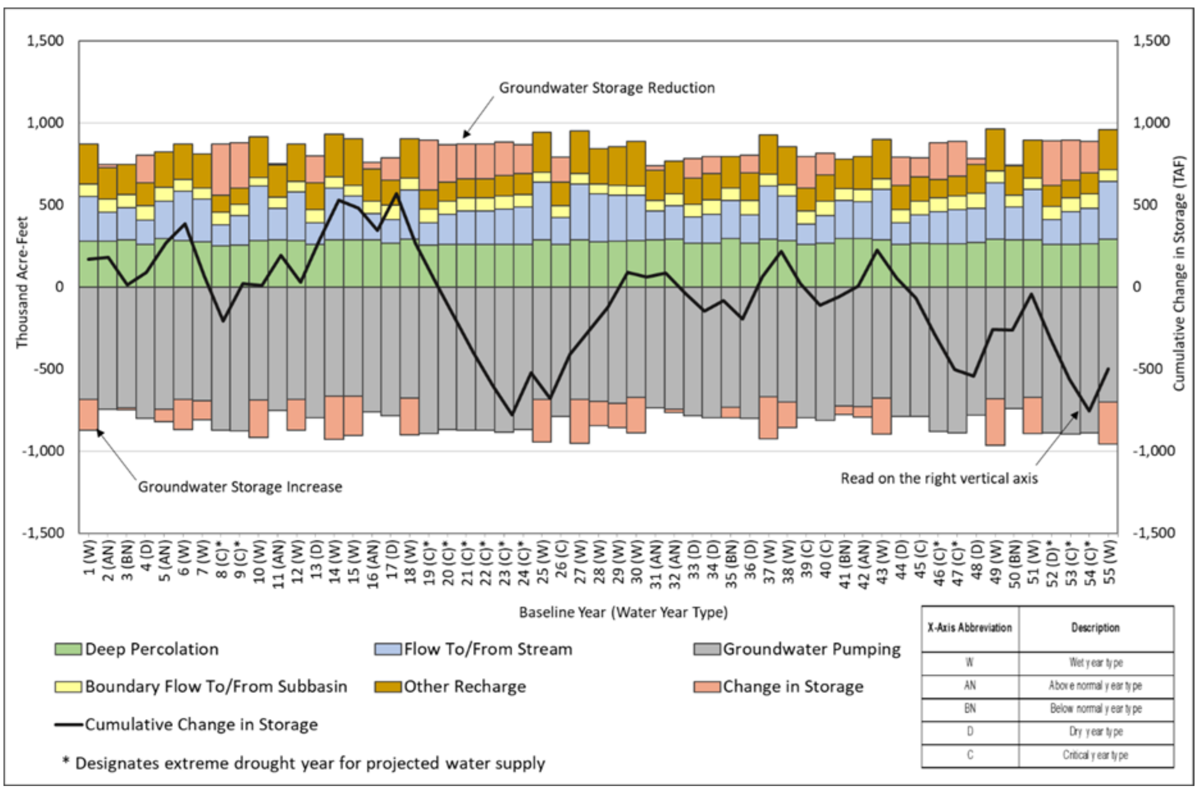
Pumping in the PCBL-PMA Version 3.0 remains the largest component in the groundwater budget with an annual average 766 TAFY. The PCBL-PMA Version 3.0 offsets this pumping with 275 TAFY of deep percolation, a net gain from stream of 223 TAFY, 184 TAFY of other recharge, and a total subsurface inflow of 75 TAFY. 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 Version 3.0 is 9 TAFY, indicating that some groundwater overdraft is still occurring even with the Category A projects. These annual averages are shown in Table 2-26. The groundwater budgets, with average cumulative change in storage, are shown for the ESJ Subbasin in Figure 2-129.

Table 2-26 also includes the PCBL Version 3.0 results and a Category A projects benefit calculated as the PCBL-PMA Version 3.0 results minus the PCBL Version 3.0 results. The results indicate that the Category A projects will resolve the PCBL Version 3.0 Subbasin overdraft condition when impacts due to climate change are not included. Without projects, the modeling shows an average overdraft of 30 TAFY over the 55 years of the PCBL Version 3.0 simulation. With Category A projects in place, the modelling shows a projected overdraft of -9 TAFY on average in the PCBL-PMA Version 3.0. The PCBL-PMA Version 3.0 shows an average increase of 21 TAFY of groundwater in storage when compared to the PCBL Version 3.0. Compared to the PCBL Version 3.0, with Category A projects modeled, the PCBL-PMA Version 3.0 has 33 TAFY less groundwater pumping due to the new in-lieu recharge projects, 19 TAFY more recharge (both direct recharge projects and canal seepage losses for the in-lieu recharge projects), and 17 TAFY less stream seepage into the groundwater system due to higher groundwater levels. Other hydrologic groundwater budget component differences are small between the PCBL Version 3.0 and PCBL-PMA Version 3.0 simulations.

Table 2-26: ESJ Hydrologic Groundwater Budget Annual Average Comparison Between the PCBL (Version 3.0) and the PCBL-PMA (Version 3.0)

Hydrologic Groundwater Budget Component	Annual Average		
	PCBL Version 3.0	PCBL-PMA Version 3.0	PMA Benefit (PCBL-PMA Version 3.0 minus PCBL Version 3.0)
Deep Percolation (TAF)	270	275	6
Other Recharge (TAF)	165	184	19
Net Stream Seepage (TAF)	240	223	-17
Net Boundary Inflow (TAF)	94	75	-19
Groundwater Pumping (TAF)	799	766	-33
Change in Groundwater Storage (AF)	-30	-9	21

Figure 2-129: ESJ Subbasin Projected Hydrologic Groundwater Budget in the PCBL-PMA Version 3.0



2.4.9 Projected Water Budget with Climate Change and PMAs Estimates (ESJWRM PCBL-CC-PMA Version 3.0)

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-C 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 1969-2023 with the 2070 Central Tendency climate change dataset. A summary of the 13 Category A PMAs simulated as additional diversions in the PCBL-CC- PMA model is provided in Table 2-24, 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).

2.4.9.1 Land and Water Use Water Budget

The average annual PCBL-CC-PMA Version 3.0 water demand for the Subbasin within the 55-year simulation period is 1,401 TAFY, consisting of approximately 1,238 TAFY of agricultural demand and 162 TAFY of urban demand. This demand is met by an annual average of 572 TAFY of surface water deliveries (493 TAFY of agricultural and 79 TAFY of urban deliveries) and is supplemented by 835 TAFY of groundwater production (767 TAFY of agricultural and 68 TAFY of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is about 22 TAFY 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 2-27. The annual land and water use budgets across the ESJ Subbasin are shown in

Figure 2-130 and Figure 2-131 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands plotted with water supplies.

Table 2-27 also includes the PCBL-CC Version 3.0 results and a Category A projects benefit calculated as the PCBL-CC-PMA Version 3.0 results minus the PCBL-CC Version 3.0 results. The PCBL-CC-PMA Version 3.0 has an average of 41 TAFY more surface water for agricultural purposes and 6 TAFY more surface water for urban areas compared to the PCBL-CC Version 3.0. For urban areas, this represents a reduction in groundwater pumping of 600 AFY. For agricultural areas, the increased surface water results in 34 TAFY 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 Version 3.0 and PCBL-CC-PMA Version 3.0 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 2-25 and Table 2-27.

Table 2-27: ESJ Subbasin Land and Water Use Budget Annual Average Comparison Between PCBL-CC Version 3.0 and PCBL-CC-PMA Version 3.0

Land and Water Use Budget Component	Annual Average		
	PCBL-CC Version 3.0	PCBL-CC-PMA Version 3.0	PMA Benefit (PCBL-CC-PMA Version 3.0 minus PCBL-CC Version 3.0)
Agricultural Area (thousand acres)	365	365	0
Agricultural Demand (TAF)	1,240	1,238	-1
Agricultural Groundwater Pumping (TAF)	801	767	-34
Agricultural Surface Water Deliveries (TAF)	452	493	41
Agricultural Surplus (TAF)[1]	14	22	8
Urban Area (thousand acres)	129	129	0
Urban Demand (TAF)	156	162	6
Urban Groundwater Pumping (TAF)	67	68	1
Urban Surface Water Deliveries (TAF)	73	79	6
Urban Shortage (TAF)[1]	16	16	0

[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 2-130: ESJ Subbasin Projected Agricultural Demand in the PCBL-CC-PMA Version 3.0

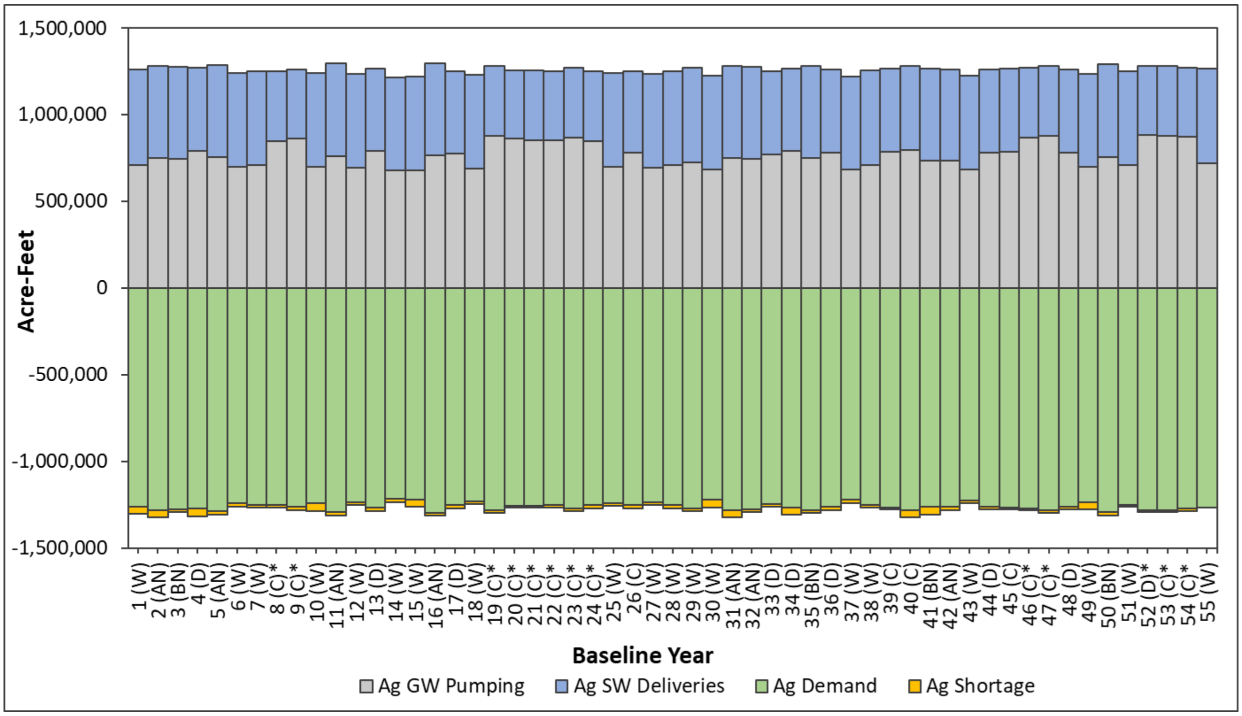
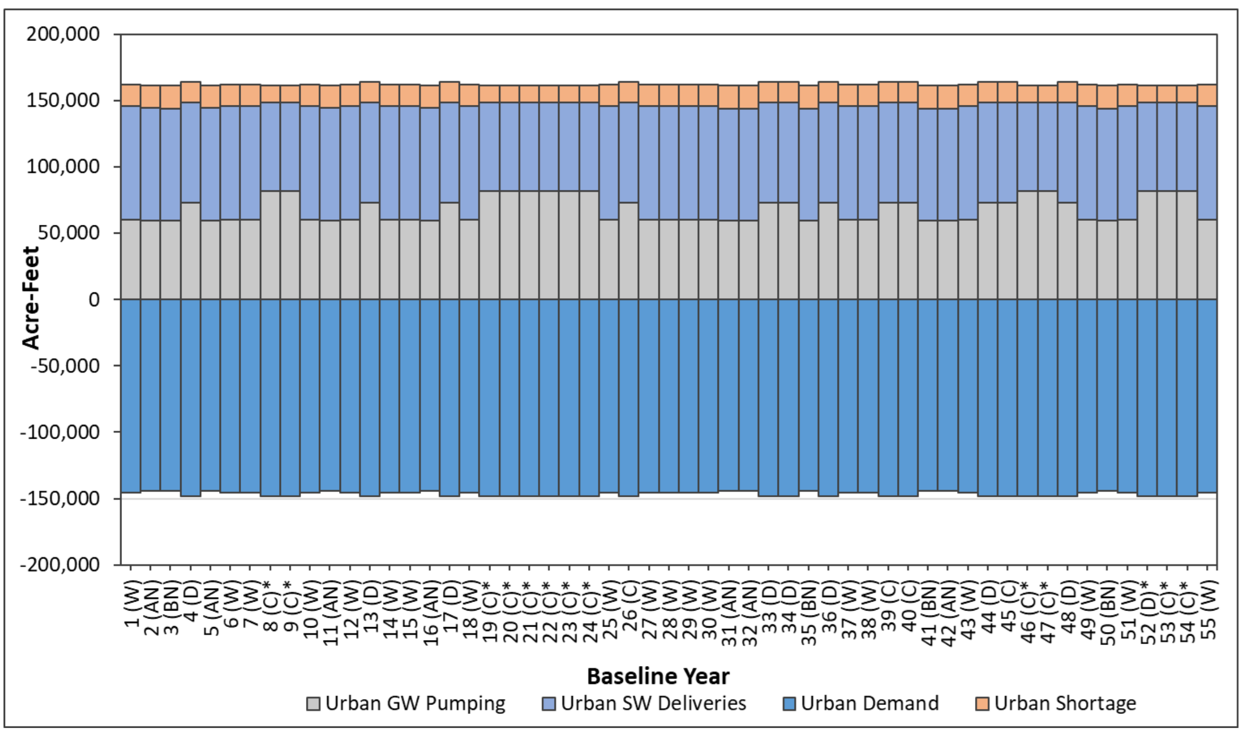


Figure 2-131: ESJ Subbasin Projected Urban Demand in the PCBL-CC-PMA Version 3.0



2.4.9.2 Hydrologic Groundwater Budget

Pumping in the PCBL-CC-PMA Version 3.0 remains the largest component in the groundwater budget with an annual average 846 TAFY. The PCBL-CC-PMA Version 3.0 offsets this pumping with 274 TAFY of deep percolation, a net gain from stream of 260 TAFY, 187 TAFY of other recharge, and a total subsurface inflow of 91 TAFY 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 groundwater storage deficit in ESJ Subbasin in the PCBL-CC-PMA Version 3.0 is 34 TAFY, 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 2-28. The groundwater budgets, with average cumulative change in storage, are shown for the ESJ Subbasin in Figure 2-132.

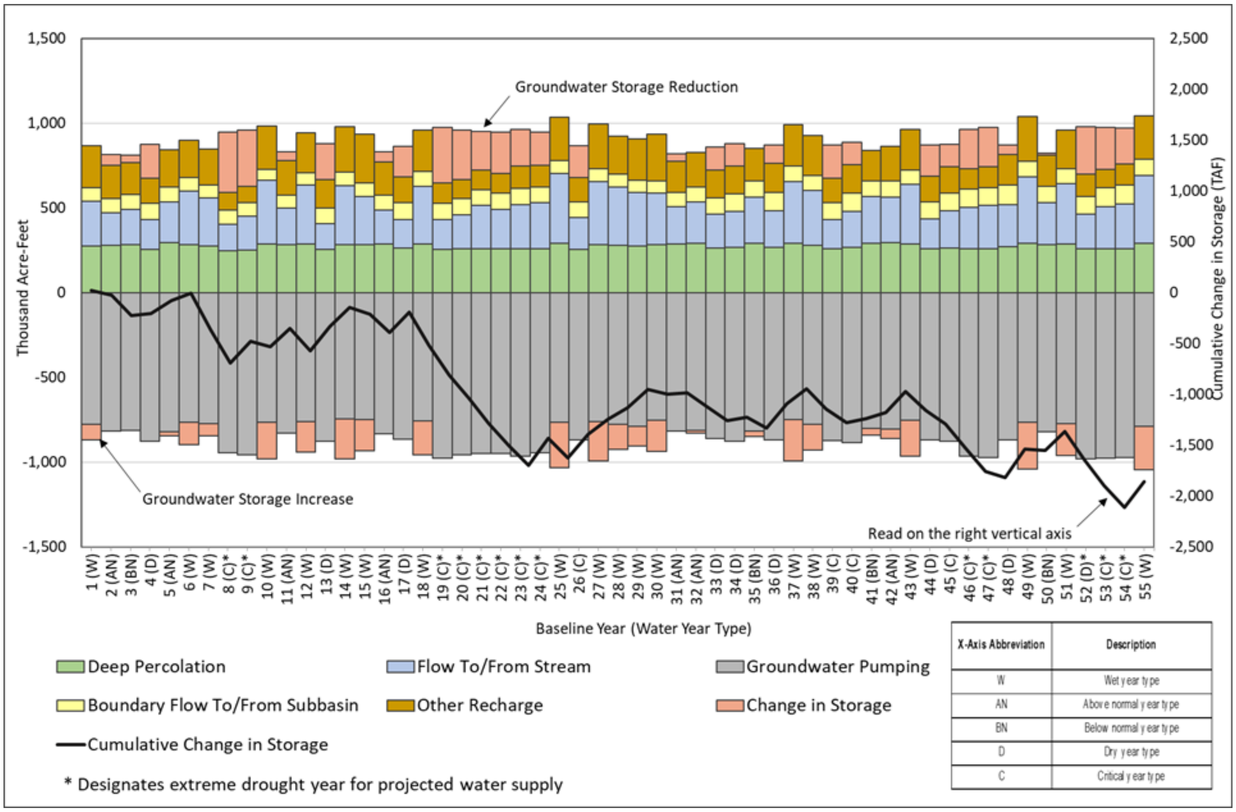
Table 2-28 also includes the PCBL Version 3.0 results and a Category A projects benefit calculated as the PCBL-PMA Version 3.0 results minus the PCBL Version 3.0 results. While the groundwater storage deficit in the PCBL Version 3.0 is projected to be corrected through the implementation of Category A projects as seen in PCBL-PMA Version 3.0, the modeling shows that when climate change is factored in for the PCBL-CC-PMA Version 3.0, 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 Version 3.0 has a projected overdraft of 56 TAFY. When projects are added in, as simulated in PCBL-CC-PMA Version 3.0, this overdraft amount is reduced to 34 TAFY.

Compared to the PCBL-CC Version 3.0, with Category A projects modeled, the PCBL-CC-PMA Version 3.0 has 34 TAFY less groundwater pumping due to the new in-lieu recharge projects, 19 TAFY more recharge (both direct recharge projects and canal seepage losses for the in-lieu recharge projects), and 17 TAFY less stream seepage into the groundwater system due to higher groundwater levels. Other hydrologic groundwater budget component differences are small between the PCBL-CC Version 3.0 and PCBL-CC-PMA Version 3.0 simulations.

Table 2-28: ESJ Hydrologic Groundwater Budget Annual Average Comparison Between the PCBL-CC and the PCBL-CC-PMA Version 3.0

Hydrologic Groundwater Budget Component	Annual Average		
	PCBL-CC	PCBL-CC-PMA Version 3.0	PMA Benefit (PCBL-CC-PMA Version 3.0 minus PCBL-CC)
Deep Percolation (AF)	268	274	6
Other Recharge (AF)	168	187	19
Net Stream Seepage (AF)	276	260	-17
Net Boundary Inflow (AF)	111	91	-20
Groundwater Pumping (AF)	879	846	-34
Change in Groundwater Storage (AF)	-56	-34	22

Figure 2-132: Eastern San Joaquin Subbasin Projected Hydrologic Groundwater Budget in the PCBL-CC-PMA



For a comparison of the PCBL water budget results with and without PMAs and with and without climate change, please see Appendix 2-C of this updated GSP.

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 (ESJ) GSP developed these criteria based on information about the Subbasin developed in the hydrogeologic conceptual model (Section 2.1), the descriptions of historical and current groundwater conditions (Section 2.2 and 2.3, respectively), the water budget (Section 2.4), 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 and were revised to address Recommended Corrective Actions (RCAs) presented by the California Department of Water Resources (DWR) in their July 6, 2023 determination letter approving the 2022 Eastern San Joaquin GSP.

This amended 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 and eliminates seawater intrusion as an applicable sustainability criterion.

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 2.4.6) and the sustainability goal will be achieved.

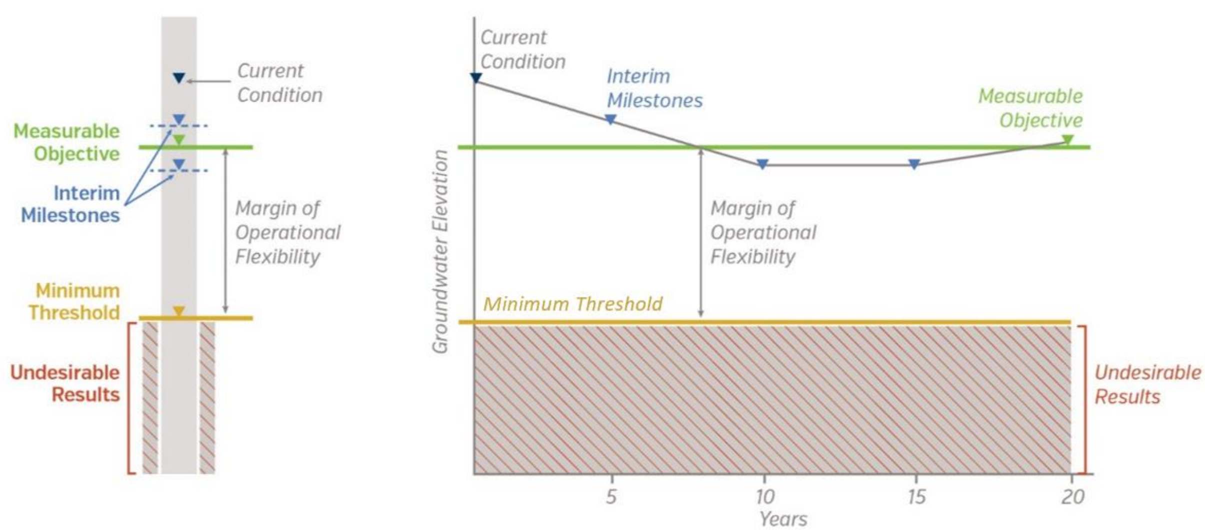
An explanation of how the goal will be achieved is included in Chapter 6: Projects and Management Actions.

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-A) from DWR. The Letter identified two potential deficiencies with the Eastern San Joaquin Groundwater Subbasin (Subbasin) GSP which precluded 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. Revisions to the sustainability indicators and sustainable management criteria were subsequently incorporated into the 2020 Eastern San Joaquin GSP and a revised GSP submitted to DWR on July 27, 2022. In a July 6, 2023 letter, DWR staff concluded that the GSAs had taken sufficient actions to correct deficiencies identified by DWR and approved the 2022 Plan (see Appendix 3-B).

In their July 2023 letter, DWR identified the eight RCAs for the GSAs to consider during preparation of its 5-year Periodic Evaluation. Per DWR's October 2023 guidance entitled *Groundwater Sustainability Plan Implementation: A Guide to Annual Reports, Periodic Evaluations, & Plan Amendments*, "Plan Amendments are completed at the discretion of the GSAs. SGMA and the GSP Regulations do not establish when an amendment is required, nor do they describe what components of the Plan should be amended. In general, however, the more significant or material a change to a GSP or its implementation, the more likely a Plan Amendment is warranted." As the 2024 ESJ Subbasin Periodic Evaluation and associated consideration of DWR's RCAs as contained in their July 2023 determination letter resulted in substantive changes to both sustainable management criteria (SMC) and representative monitoring networks (RMNs), the ESJ GSAs have opted to amend their 2022 GSP. This amended GSP chapter incorporates the responses and associated work to address DWR's eight RCAs, reflecting changes made to the Subbasin sustainability indicators and SMC. Documentation of modifications made to Subbasin sustainability indicators and SMC and additional explanation as to how the Subbasin sustainability indicators and SMC were determined can be found in the appendices as follows:

- RCA No. 1(a) through 1(d) addressed in Appendix 3-C
- RCA No. 2 addressed in Appendix 3-D
- RCA No. 3 addressed in Appendix 3-E
- RCA No. 4 addressed in Appendix 3-E
- RCA No. 5 addressed in Appendix 3-F
- RCA No. 6 addressed in Appendix 3-G
- RCA No. 7 addressed in Appendix 3-F
- RCA No. 8 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, Project Management Committee, and members of the public. During development of and revisions to 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 21[10] 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 2020 GSP used the Eastern San Joaquin Water Resources Model (ESJWRM) results under the projected conditions baseline scenario to evaluate impacts associated minimum threshold exceedances. The model results considered in determining that a 25 percent exceedance threshold were sufficient to determine that undesirable results would occur subbasin-wide (e.g., were not a localized event). The 25% exceedance threshold was further evaluated in response to DWR's comments in their 2022 Determination letter, specifically as it relates to both domestic and municipal supply wells and GDEs in the Subbasin. See Appendix 1-G for

[10] Three wells have been added to the representative monitoring network for groundwater levels since the 2020 GSP. One well has historical data (01S10E04C001M) and SMC have been established for that well. The other two were newly constructed under the TSS program and do not have established SMC as of this Amended GSP due to a lack of data.

analyses around potential domestic and public supply well impacts and GDE impacts associated with the 25 percent exceedance portion of the definition of undesirable results.

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” (Eastern San Joaquin County GBA, 2014). 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. However, current databases were used in updated mapping of GDEs and the associated analysis of potential impacts as a result of the undesirable results definition for this sustainability parameter. See Appendix 1-G for more information.

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:

- 2015 groundwater level low 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.[11,12]

As a starting point, a potential minimum threshold was considered for each representative monitoring well based on groundwater level data collected in 2015, if available. A buffer was subtracted from the minimum 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 addition of the buffer provides a range of

[11] A radius of 2 miles was used for well 03N07E21L003 to reflect domestic well depths in close proximity to the Mokelumne River.

[12] 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.

operational flexibility 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 avoids significant and unreasonable impacts to groundwater levels.

The ESJGWA Board determined that dewatering of domestic wells and impacts to small community drinking water systems may be a potential undesirable result that could be used to confirm the adequacy of the minimum threshold methodology. Domestic wells and those associated with small community water systems are generally shallower than agricultural and municipal wells and thus more sensitive to undesirable effects such as dry wells. 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 around each representative monitoring well (including the 2-mile radius of monitoring well 03N07E21L003 and the two additional radii that do not contain representative monitoring wells), includes over 4,000 domestic wells, 165 public supply wells and 58 community water systems 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 and public water system 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 (predominantly) 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. This updated representative monitoring network includes two new multi-completion wells constructed in 2021 by DWR under the Technical Support Services (TSS) program. 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-H and 3-I.

The basis for design and selection of the 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 of 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.

For the two new multi-completion wells have been added to the representative monitoring network for groundwater levels, and for any new monitoring wells that may be added to the representative monitoring network in the future, SMCs for these new wells will be established after at least four years of data have been collected, including data for at least one wet year and one dry or critical year during that time period. If wet and dry/critical years do not occur during this initial period, then additional years of data collection may be required before establishing SMCs.

Minimum thresholds for these and other new wells that may be constructed in the future will be established based on adjusted recent groundwater levels from a dry/critical year. The adjustment of groundwater levels is the difference in simulated groundwater levels in ESJWRM between Water Year 2015 (a dry year) and the recent dry/critical year when groundwater level observations are measured. The calculation for the minimum threshold is:

$$Minimum\ Threshold = Observed\ Recent\ Dry/Critical\ GWL - (Simulated\ Recent\ Dry\ Year\ GWLs - Simulated\ 2015\ GWLs)$$

As a hypothetical example, suppose Water Year 2027 is a critical year and the observed groundwater elevation for Well A is 75 feet mean sea level (msl) in 2027. Assuming that the simulated groundwater elevations in ESJWRM at Well A increase by 8 feet between 2015 and 2027. The minimum threshold would be 75 feet minus 8 feet, or 67 feet msl. In the absence of historical data, this methodology is meant to estimate historical conditions as closely as possible.

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 (including a demand reduction 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, such as the Subbasin's domestic well mitigation program (Appendix 3-J) to mitigate such impacts (as described in Appendix 3-C). The ESJGWA and GSAs will evaluate other programs as part of the adaptive management strategy, and annual program evaluation and reporting.

The future amendments to the Subbasin 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

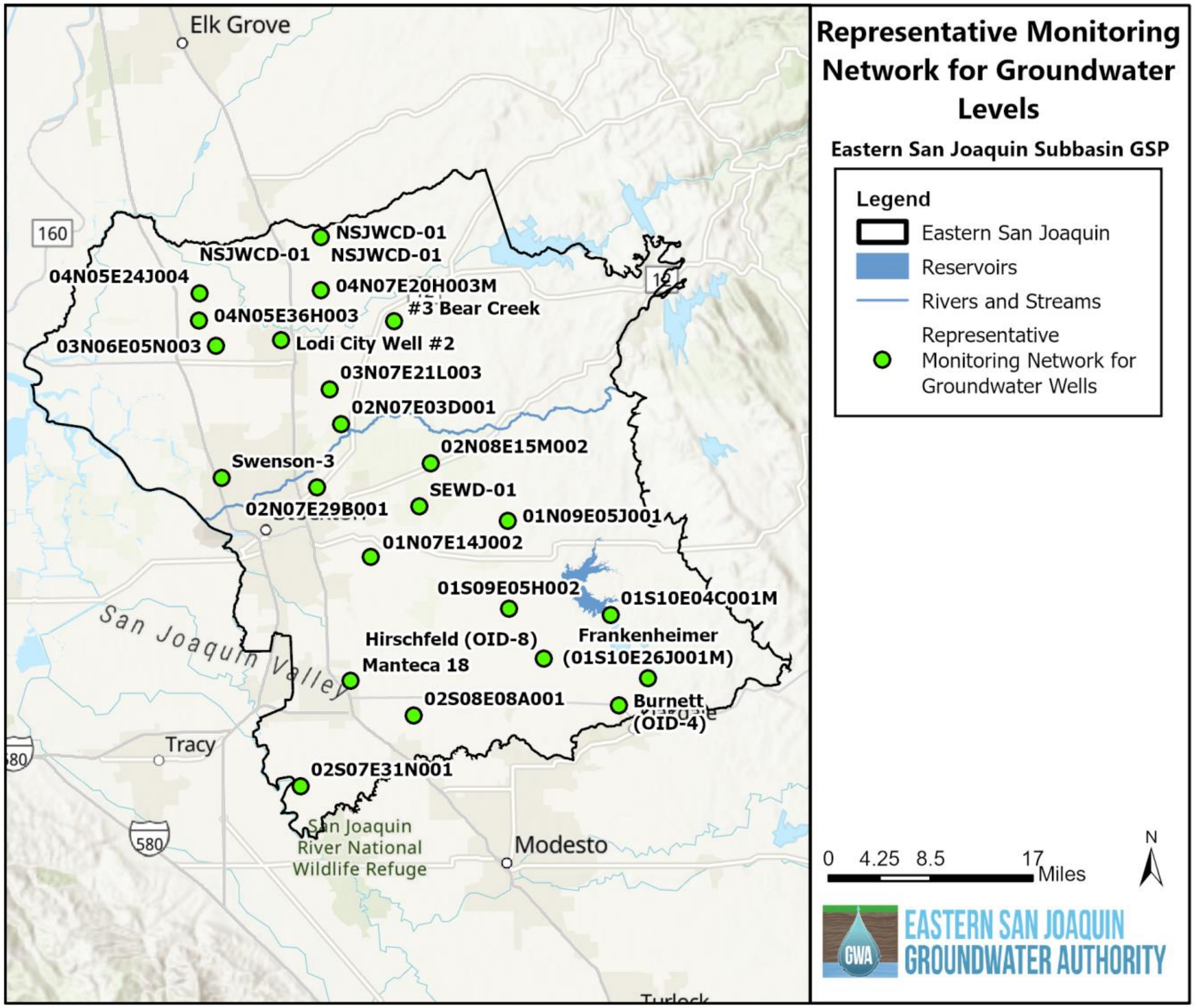


Table 3-1: Minimum Thresholds for Chronic Lowering of Groundwater Levels

Narrative Description

The minimum threshold is set at the 2015 groundwater level low 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	-93.9	2015 groundwater level with a buffer of 100 percent of historical range
City of Lodi	Lodi City Well #2	-34.4	2015 groundwater level with a buffer of 100 percent of historical range
City of Manteca	Manteca 18	-19.0	2015 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
Eastside GSA	01S10E04C001M	54.7	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	-73.8	2015 groundwater level with a buffer of 100 percent of historical range
NSJWCD	04N07E20H003M	-80.5	2015 groundwater level with a buffer of 100 percent of historical range
NSJWCD	03N07E21L003	-94.0	2015 groundwater level with a buffer of 100 percent of historical range
NSJWCD	NSJWCD-01[2]	TBD	New SMC methodology
OID	Hirschfeld (OID-8)	7.9	2015 groundwater level with a buffer of 100 percent of historical range
OID	Burnett (OID-4)	60.8	2015 groundwater level with a buffer of 100 percent of historical range
SDWA	02S07E31N001	0.8	2015 groundwater level with a buffer of 100 percent of historical range
SSJ GSA	02S08E08A001	0.6	2015 groundwater level with a buffer of 100 percent of historical range
SEWD	02N07E03D001	-113.7	10th percentile domestic well depth
SEWD	01N09E05J001	-86.8	10th percentile domestic well depth
SEWD	02N07E29B001	-130.1	10th percentile domestic well depth
SEWD	SEWD-01[2]	TBD	New SMC methodology
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).

2 New multi-completion well constructed in 2021 under the DWR Technical Support Services (TSS) program.

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 2015 groundwater level low 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 2015 groundwater level low.		
Numeric Measurable Objectives		
GSA Well is Located in	**Well ID**	**Measurable Objective (feet MSL)**
CSJWCD	01S09E05H002	-8.6
CSJWCD	01N07E14J002	-49.9
City of Lodi	Lodi City Well #2	0.6
City of Manteca	Manteca 18	2.8
City of Stockton	Swenson-3	-19.3
Eastside GSA	01S10E26J001M	81.7
Eastside GSA	01S10E04C001M	76.4
LCWD	02N08E15M002	-63.2
LCSD	#3 Bear Creek	-51.8
NSJWCD	04N07E20H003M	-35.5
NSJWCD	03N07E21L003	-51.5
NSJWCD	NSJWCD-01[1]	TBD
OID	Hirschfeld (OID-8)	31.5
OID	Burnett (OID-4)	79.7
SDWA	02S07E31N001	12.3
SSJ GSA	02S08E08A001	24.0
SEWD	02N07E03D001	-61.7

Narrative Description		
The measurable objective is set at the 2015 groundwater level low.		
Numeric Measurable Objectives		
GSA Well is Located in	**Well ID**	**Measurable Objective (feet MSL)**
SEWD	01N09E05J001	-22.6
SEWD	02N07E29B001	-80.4
SEWD	SEWD-01[1]	TBD
WID	04N05E36H003	-5.1
WID	03N06E05N003	-14.1
WID	04N05E24J004	-6.2

1. New multi-completion well constructed in 2021 under the DWR Technical Support Services (TSS) program.

Similar to minimum thresholds, for the two new multi-completion wells have been added to the representative monitoring network for groundwater levels, and for any new monitoring wells that may be added to the representative monitoring network in the future, measurable objectives for these new wells will be established after at least four years of data have been collected, including data for at least one wet year and one dry or critical year during that time period. If wet and dry/critical years do not occur during this initial period, then additional years of data collection may be required before establishing SMCs.

For new wells lacking sufficient historical data, measurable objectives will be established from an adjustment in groundwater levels from a wet year. The adjustment will add the difference in simulated groundwater levels from ESJWRM between Water Year 2011 (a wet year) and a recent wet year when groundwater level observations are collected. The calculation for measurable objectives is:

$$Measurable\ Objectives = Observed\ Recent\ Wet\ GWL + \ (Simulated\ Recent\ Wet\ Year\ GWL - Simulated\ 2011\ GWLs)$$

As a hypothetical example, suppose Water Year 2026 is a wet year, and the observed groundwater elevation for Well A is 82 feet msl that year. Suppose that the simulated groundwater elevations in ESJWRM at Well A decrease by 15 feet between Water Year 2011 and 2026. The measurable objective would be 82 feet minus negative 15 feet, equaling 97 feet msl.

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, and the average of fall 2013, fall 2014, and fall 2016 were used where fall 2015 data were not available. For new wells lacking sufficient historical data, interim milestones will be established as appropriate at the time minimum thresholds and measurable objectives are established for the wells. Interim milestones will depend on the date when these other SMC were developed.

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	-8.6	-8.7	-8.7	-8.7
CSJWCD	01N07E14J002	-49.9	-49.9	-49.9	-49.9	-49.9
City of Lodi	Lodi City Well #2	0.6[1]	0.6	0.6	0.6	0.6
City of Manteca	Manteca 18	9.1	2.8	9.1	9.1	6.0
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
Eastside GSA	01S10E04C001M	78.0	76.4	78.0	78.0	77.2
LCWD	02N08E15M002	-63.2	-63.2	-63.2	-63.2	-63.2
LCSD	#3 Bear Creek	-49.3	-51.8	-49.3	-49.3	-50.6
NSJWCD	04N07E20H003M	-35.5	-35.5	-35.5	-35.5	-35.5
NSJWCD	03N07E21L003	-51.5	-51.5	-51.5	-51.5	-51.5
NSJWCD	NSJWCD-01[2]	TBD	TBD	TBD	TBD	TBD
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[1]	12.3	13.8	13.8	13.1
SSJ GSA	02S08E08A001	22.2[1]	24.0	22.2	22.2	23.1
SEWD	02N07E03D001	-61.7	-61.7	-61.7	-61.7	-61.7
SEWD	01N09E05J001	-20.2	-22.6	-20.2	-20.2	-21.4
SEWD	02N07E29B001	-49.8[1]	-80.4	-49.8	-49.8	-65.1
SEWD	SEWD-01[2]	TBD	TBD	TBD	TBD	TBD
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

1. Current Condition is the average of fall groundwater levels for 2013-2016
2. New multi-completion well, constructed in 2021 under the DWR Technical Support Services (TSS) program.

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) Version 1.1 was conducted for the 2020 GSP 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. The updated ESJWRM Version 3.0 was subsequently used to evaluate the range of fluctuations from 1996 to 2023; the results of this modeling showed a similar result. 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. Information on the updated ESJWRM Version 3.0 model can be found in Appendix 2-C.

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 Version 1.1 was run for the 2020 GSP to estimate the volume of groundwater storage needed to meet beneficial uses. This 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 was estimated that overlying pumpers have limited access equating to approximately the shallowest 23 MAF of groundwater storage in the Subbasin; therefore, the 2020 GSP defined an undesirable result would occur if groundwater storage levels were depleted by 23 MAF. However, if 23 MAF of groundwater were removed from the Subbasin, groundwater levels would have to drop substantially below the MTs set for groundwater levels. As such, impacts would be experienced under the definition of undesirable results for groundwater levels long before the 23 MAF would have been removed from the Subbasin.

Given that the chronic lowering of groundwater levels is directly related to overdraft conditions, if an undesirable result for groundwater levels occurs first, then mitigation will be activated to respond to the undesirable result, effectively making groundwater level SMC already protective of beneficial uses of groundwater noted in the original undesirable result definition. And as groundwater levels are directly measurable and groundwater storage is not, it is reasonable to use groundwater levels as a proxy for reductions in groundwater storage. To evaluate the approximate volume of groundwater that could potentially be removed from storage before impacts associated with groundwater level undesirable results were experienced, additional analyses were conducted using the updated ESJWRM Version 3.0 model. Model scenarios were simulated where various groupings of five representative monitoring network wells dropped to their associated minimum thresholds under the Projected Conditions Baseline with Climate Change (PCBL-CC) Version 3.0 scenario. The various well groups were chosen based on proximity to the Subbasin's groundwater depression area, historical sustainable management criteria performance, and spatial distribution throughout the Subbasin. The resulting reduction in groundwater storage from each of these test scenarios was recorded and found to vary from 10 MAF to 13 MAF. As such, the undesirable result for reductions in groundwater storage was updated to be between 10 to13 MAF. Defining a range in storage for this undesirable result acknowledges the uncertainty associated with the model in terms of storage. As the climate change scenario was used in the analysis, it also allows for consideration of the uncertainty associated with how extreme impacts of climate changes may be and where impacts within the Subbasin. Additional detail on the update to the undesirable result for storage can be found in Appendix 3-E.

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, and it is highly likely that the minimum thresholds established for groundwater levels would have been exceeded before this reduction in groundwater in storage would occur. Based on the analysis contained in Appendix 3-E, between approximately 10 and 13 MAF of groundwater would need to be removed from Subbasin storage to trigger undesirable results relating to groundwater levels. And as groundwater levels are a proxy for change in groundwater storage, these values also trigger undesirable results for the reduction in groundwater storage.

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. The ESJWRM Version 3.0 was run to estimate the reduction in groundwater storage that would occur if the chronic lowering of groundwater levels sustainability indicator undesirable result was triggered. The results of this analysis showed that this scenario would result in a reduction of approximately 10 to 13 MAF of storage.[1] Because undesirable results as a result of lowering groundwater levels are anticipated to occur prior to a reduction of 23 MAF, the minimum thresholds for groundwater levels are protective of beneficial uses. Minimum thresholds and measurable

[1] Volumes based on ESJWRM Version 3.0 estimates were calculated using multiple scenarios where five representative monitoring wells for groundwater levels reached their minimum thresholds across the Subbasin. Representative monitoring wells considered to exceed their minimum thresholds were selected based on proximity to the Subbasin's groundwater depression, historical sustainable management criteria performance, and spatial distribution throughout the Subbasin.

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 3.3.1.3.

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 and chlorides (a component of salinity) are the only water quality constituents 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 (called connate water), and irrigation 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.

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. Chloride was also selected as a sustainability indicator for this sustainable management criterion. Chloride is a component (anion) of salinity and an indicator constituent of saltwater intrusion. Given the proximity of the Subbasin to the Delta, and the identification of Delta sediments as a potential source of salinity (O'Leary et. al, 2015), the use of chloride as an indicator of concern was deemed appropriate.

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 ESJGWA, in coordination with the GSAs, will evaluate changes in groundwater quality on a bi-annual basis, in coordination with groundwater level monitoring, 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-F 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 degradation and changes in water levels that may influence water quality, including:

- Falling groundwater levels which may cause migration of already-degraded 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 constituent of concern 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

There are two constituents of concern for the Eastern San Joaquin Subbasin – Total Dissolved Solids (TDS) and chloride (representative of salinity). The minimum threshold for degraded water quality at all representative monitoring well locations is 1,000 milligrams per liter (mg/L) TDS, 250 mg/L chloride, or the groundwater concentration of those constituents as measured in 2015 at that representative monitoring location, whichever is greater. Figure 3-3 shows the representative monitoring locations for groundwater quality.

Minimum thresholds for this sustainability indicator are focused on addressing the major groundwater quality issue of salinity by monitoring TDS and chloride as representative constituents 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 0).

The ESJGWA Board selected a minimum threshold of 1,000 mg/L for TDS and 250 mg/L for chloride, or the constituent concentration as measured in 2015 (whichever is greater), 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. Subsequent communications with Subbasin GSPs and outreach efforts conducted during the preparation of this Amended GSP have confirmed the same concerns regarding salinity concerns as in 2018.

During preparation of this Amended GSP, the inclusion of seawater intrusion as an applicable sustainability criterion was revisited. After further discussions, it was decided that seawater intrusion was not an appropriate sustainability criterion, but chloride was still a constituent of concern. As such, chloride was added as a constituent of concern to be addressed and managed through the groundwater quality sustainability indicator.

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 secondary maximum contaminant levels (SMCLs) for TDS and chloride were considered. As noted in Section 2.2, the SWRCB Division of Drinking Water (DDW) has established SMCLs for both TDS and chloride 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 Recommended SMCL is 500 mg/L, an Upper Limit SMCL is 1,000 mg/L, a Short-Term limit is 1,500 mg/L (SWRCB, 2017). For chloride, the SMCL is 250 mg/L. 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

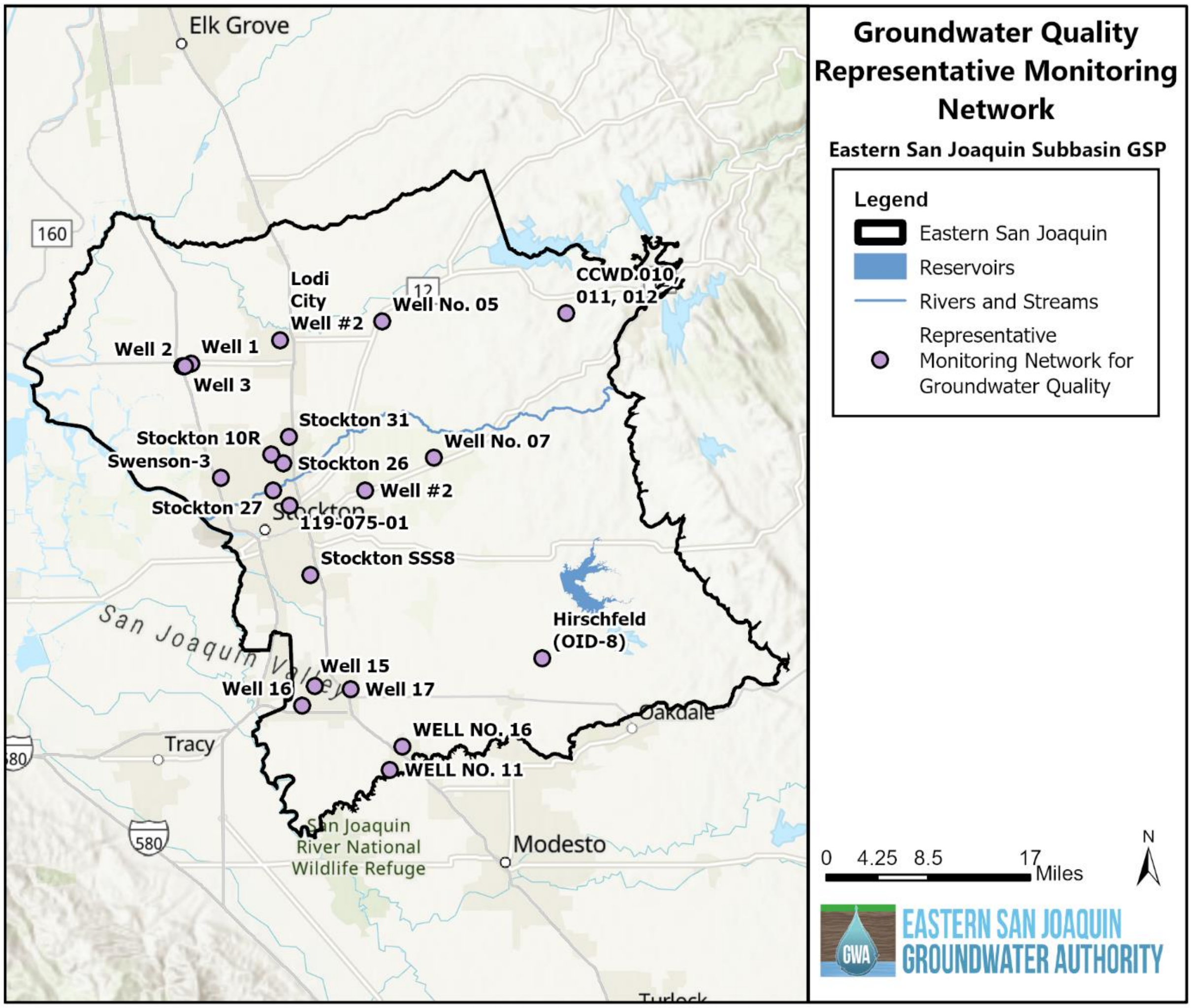
Table 3-4. Because fruit and nut trees and vineyards collectively cover more than half of the acreage of the Subbasin, the minimum threshold was centered on the salinity impact of these crop types. These crop types have lower salinity tolerances, in the range of 900 to 1,000 mg/L TDS. Standards in this 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

As the overall goal of the groundwater quality sustainable management criteria is to avoid worsening groundwater quality from 2015 conditions through basin management activities, the minimum thresholds for both TDS and chloride were set at the respective constituent's SMCL (the Upper Limit for TDS) or 2015 groundwater quality concentration, whichever is greater, thereby acknowledging those portions of the Subbasin where degraded groundwater quality existed prior to 2015.

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 ESJGWA 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) and Subbasin GSAs 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

At all representative monitoring well locations, the measurable objective (MO) for degraded water quality for TDS is 600 mg/L TDS. For chloride, the MO is the maximum recent historical measurement (as measured between 2015 and 2023). The TDS MO of 600 mg/L was developed based on the TDS recommended SMCL for drinking water of 500 mg/L with an added 100 mg/L buffer. A MO of 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. The chloride MO was set equal to the maximum measured chloride concentration as measured during recent historical conditions (between 2015 and 2023), accounting for fluctuations in constituent concentrations with hydrologic conditions.

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 for TDS, which follow along a linear trend between the current condition (defined as the average TDS concentration between 2015 and 2023) and the measurable objective. Similarly,

Table 3-6 shows the 5-year milestones for chloride, which follow along a linear trend between the current condition (defined as the average chloride concentration between 2015 and 2023) and the measurable objective. Interim milestones are based on the measurable objective and will be coordinated with projects and management actions. In two cases (for Well 16 and Well 17), current conditions were calculated by averaging TDS values collected from 2012-2018. Additional detail on the RMN and SMC is included in Appendix 3-F.

Table 3-5: Measurable Objective and Interim Milestones for Degraded Water Quality for Total Dissolved Solids (mg/L TDS)

Narrative Description					
5-year milestones follow along a linear trend between the current condition (average TDS concentration between 2015 and 2023) and the measurable objective.					
Numeric Interim Milestones					
Well ID	**Average Chloride (2015 - 2023)***	**Measurable Objective (mg/L chloride)**	**Interim Milestones**		
			2025	**2030**	**2035**
Well 1	445	600	484	523	562
Well 2 (San Joaquin County)	568	600	576	584	592
Well 3	520	600	540	560	580
119-075-01	360	600	420	480	540
Well 15	310	600	383	456	529
Well 16 (City of Manteca)	250	600	338	426	514
Well 17	305	600	379	453	527
Stockton 27	65	600	199	333	467
Stockton SSS8	330	600	398	466	534
Stockton 31	301	600	376	451	526
Stockton 10R	390	600	443	496	549
Well No. 05	227	600	320	413	506
Well No. 07	173	600	280	387	494
Well #2 (Shady Rest Trailer Court)	323	600	392	461	530
WELL NO. 11[1]	610	600	608	605	602
WELL NO. 16[1] (City of Ripon)	580	600	585	590	595
Swenson-3[2]	NA	600	TBD	TBD	TBD
Lodi City Well #2	190	600	293	396	499
Hirschfeld (OID-8)	200	600	300	400	500
CCWD 010, 011, 012[3]	NA	600	TBD	TBD	TBD

NA – Not Available

* Current Condition is the average TDS value for 2015-2023.

[1] No recent groundwater quality observations. Reported concentration from nearby WELL NO. 3. (CA3910007_003_003) from January 2015, January 2018, and January 2021.

[2] Swenson-3 is currently not accessible, but since it is originally a GWL RMN, it is expected to be accessible going forward. If not, then another well will be selected to replace it. There are no recent groundwater quality observations from this well and the data reported in this table is from nearby well ID CA3910012_030_030 in October 1991.

[3] No recent or nearby groundwater quality observations.

Table 3-6: Measurable Objective and Interim Milestones for Degraded Water Quality for Chloride (mg/L chloride)

Narrative Description
5-year milestones follow along a linear trend between the current condition (average chloride concentration between 2015 and 2023) and the measurable objective.
Numeric Interim Milestones

Well ID	Average Chloride (2015 - 2023)*	Measurable Objective (mg/L chloride)	Interim Milestones		
			2025	2030	2035
Well 1	34.6	36	35	35	35
Well 2 (San Joaquin County)	73	73	73	73	73
Well 3	34.6	36	35	35	35
119-075-01	26.6	30	27	28	29
Well 15	15.8	17	16	16	16
Well 16 (City of Manteca)	12.83	16	14	15	16
Well 17	15.2	17	16	16	16
Stockton 27	10.34	26	14	18	22
Stockton SSS8	38.5	41	39	40	41
Stockton 31	27.4	51	33	39	45
Stockton 10R	18	20	19	20	21
Well No. 05	14.7	17	15	16	17
Well No. 07	3.5	3.8	4	4	4
Well #2 (Shady Rest Trailer Court)	16.3	33	20	24	28
WELL NO. 11[1]	75.5	83	77	79	81
WELL NO. 16[1] (City of Ripon)	75.5	83	77	79	81
Swenson-3[2]	100	100	100	100	100
Lodi City Well #2	6.2	6.2	6	6	6
Hirschfeld (OID-8)	12	12	12	12	12
CCWD 010, 011, 012[3]	NA	TBD	TBD	TBD	TBD

NA – Not Available

* Current Condition is the average chloride value for 2015-2023.

[1] No recent groundwater quality observations. Reported concentration from nearby WELL NO. 3. (CA3910007_003_003) from January 2015, January 2018, and January 2021.

[2] Swenson-3 is currently not accessible, but since it is originally a GWL RMN, it is expected to be accessible going forward. If not, then another well will be selected to replace it. There are no recent groundwater quality observations and the reported data is from nearby well ID CA3910012_030_030 in October 1991.

[3] No recent or nearby groundwater quality observations.

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 suppliers 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

Seawater intrusion is not considered an applicable sustainability indicator for the Eastern San Joaquin Subbasin as the Subbasin is not in a coastal area and seawater intrusion is not currently present and is not reasonably expected to occur due to the active management of the ‘X2’ salinity barrier by the State (see Section 2.3.3). The ‘X2’ barrier, where the salinity is approximately 2 parts per thousand (ppt), is located well outside of the Subbasin boundary further downstream in the Delta (Cloern, 2012). (For reference purposes, the salinity of the ocean is about 35 ppt.) Various agencies and regulations, such as the Delta Protection Commission (DPC), Delta Stewardship Council, San Joaquin County & Delta Water Quality Coalition, and State Water Board Resolution No. 2009-011, contribute to managing and maintaining salinity conditions in the Delta region.

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 and include the San Joaquin River Bridge, Littlejohns Creek Bridge, Mormon Slough Bridge, and the Union Pacific Mossdale Bridge East.

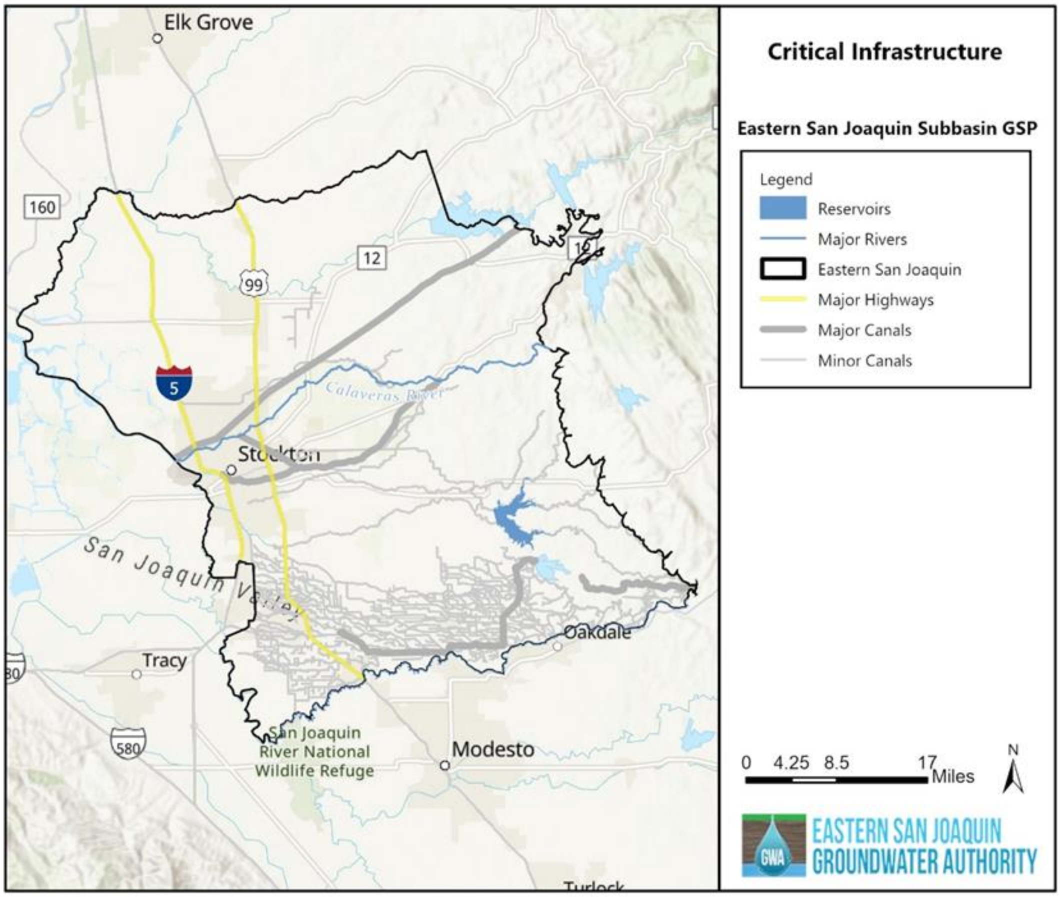
Service buildings within the Subbasin include fire stations, hospitals, jails and correction facilities, police stations, and wastewater plants. The County also maintains 30 water systems with 52 wells, 3 sewage treatment plants, 9 sewage pumping stations, 68 storm drain pumping stations, and over 300 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 and the Subbasin GSAs 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. Through input from the Subbasin GSAs, local infrastructure can typically withstand subsidence ranging between 24 and 36 inches (San Joaquin County, 2017).

For the purposes of this Amended GSP, the major canals selected as critical infrastructure are the East Bay Municipal Utility District's Mokelumne Aqueduct, stretching from the northeast to the western region of the Subbasin; Stockton East's Mormon Slough and Stockton Diverting Canal in the central region; South San Joaquin Irrigation District's Main District Canal in the southcentral region, and Oakdale Irrigation District's North Main Canal in the southeastern corner of the Subbasin. The major roadways considered critical infrastructure include Highway 5 and Highway 99. Figure 3-4 illustrates all the critical infrastructure, including conveyance systems and major roads, across the Subbasin. Most of the minor canals are concentrated in the southern region of the Subbasin and are displayed for reference purposes only.

There are no historical records of significant and unreasonable impacts from subsidence in the Eastern San Joaquin Subbasin (see Figure 2-78). Per InSAR data currently available, 2015-2016 maximum subsidence rates in the Eastern San Joaquin Subbasin ranged from -1.2 inches per year (in/yr) to -2.4 in/yr, and there has been a maximum average subsidence rate of 0.93 in/yr over the last approximately 8 years (2015-2023). Given that approximately 10 years have lapsed since the implementation of SGMA commenced in 2015, and assuming an additional 10 years for achieving significant progress towards the Subbasin's sustainability goal, it has been assumed that an additional 24 inches of subsidence (-1.2 in/yr times 20 years) can occur until 2040 without experiencing undesirable results relating to inelastic land subsidence. However, if land subsidence becomes an area of concern, the ESJGWA will take actions to understand the causes of the subsidence (including localized hydrogeology and groundwater pumping), consider improved monitoring protocols, and identify the next steps for addressing the potential for undesirable results.

Figure 3-4: Defined Critical Infrastructure in the Eastern San Joaquin Subbasin



3.3.5.1.2 Identification of Undesirable Results

An undesirable result occurs when subsidence substantially interferes with the beneficial uses of groundwater and surface land uses. Subsidence, as it relates to groundwater use and management, occurs as a result of the compaction of subsurface materials due to the dewatering of fine-grained geologic materials, such as clay, leading to structural collapse and loss of void spaces. Undesirable results would occur when substantial interference with land use and critical infrastructure occurs (including significant damage to canals, pipes, or other water conveyance facilities) as a result of groundwater basin activities (such as pumping) and management.

Undesirable results related to inelastic land subsidence will be identified through data collected from the Subbasin's representative monitoring network for inelastic land subsidence (using land subsidence data collection efforts conducted by individual GSAs, continuous global positioning system (CGPS) data collected and posted by the United States Geological Survey (USGS), and UNAVCO monitoring data collected and posted by UNAVCO's Plate Boundary Observatory Program) supplemented with InSAR datasets collected and posted by DWR, 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

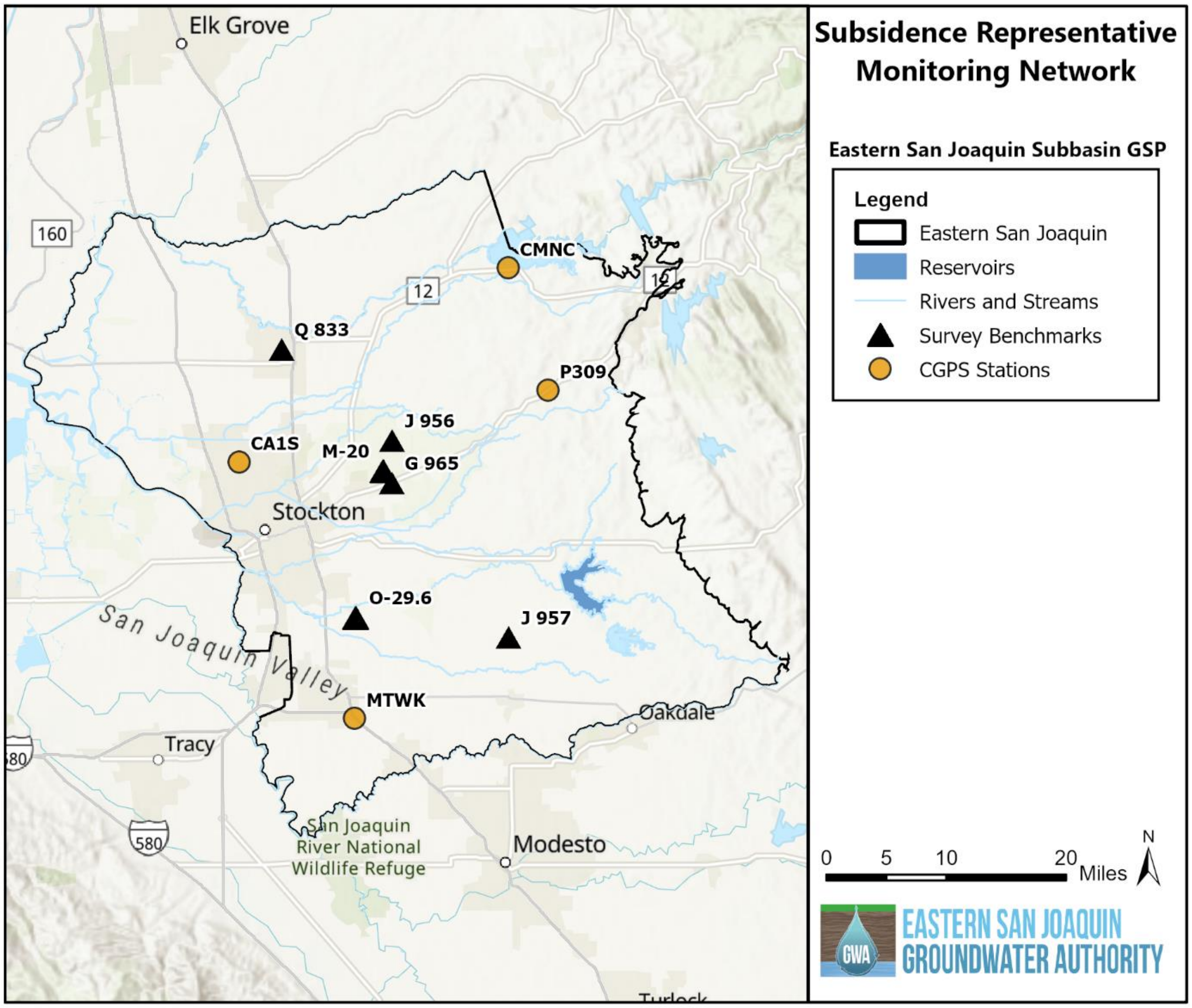
The minimum threshold for land subsidence in the Subbasin is set at no more than 0.2 foot/year [2.4 inches/year] in any five-year period between 2020 and 2040, resulting in no more than a total additional 2 feet (24 inches) of land subsidence by 2040. This is set within the same magnitude of estimated error of the InSAR data (+/- 0.1 foot [0.03 m]), which is currently the most comprehensive tool available for measuring subbasin-wide land subsidence consistently each year, based on historical subsidence rates. The minimum threshold of 24 inches of additional subsidence by 2040 reflects the historical subsidence level with an added buffer, and is in line (both by method and magnitude) with the minimum thresholds established by other nearby basins overlying the Corcoran Clay.

The minimum thresholds selected for land subsidence for the Subbasin have been selected as a preventative measure to ensure the maintenance of current ground surface elevations and as an added safety measure for potential future impacts not presently occurring in the Subbasin and nearby basins. This avoids significant and unreasonable rates of land subsidence in the Subbasin, which are those that lead to a permanent subsidence of land surface elevations that impact infrastructure and agricultural production in the Subbasin and neighboring groundwater subbasins.

Given that the Subbasin is currently at the measurable objective (within the bounds of measurement error) and not expected to experience significant or unreasonable subsidence, it is not anticipated that the land subsidence minimum threshold will significantly affect any beneficial users of groundwater, land uses, or property interests. It is possible, should the current subsidence rates steepen, that there might be an impact to groundwater pumping (e.g., wells could be physically damaged, or conservation measures enacted). However, given the specific nature of the variable aquifer geology across the Subbasin, it would likely be confined to the southwestern portion of the Subbasin where a combination of groundwater overdraft and localized clay layers would operate together to display an inelastic subsidence signal. Nevertheless, neither of these cases are currently anticipated to coexist in the Subbasin at significant and unreasonable levels, especially with the development of projects and management actions that will achieve and maintain the Subbasin's SMC for groundwater levels.

There are currently no other state, federal, or local standards that relate to this sustainability indicator in the Subbasin. Additionally, in coordination with updates as described below for the 5-year interim milestones 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. 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. The current representative monitoring network for inelastic land subsidence is shown in Figure 3-5.

Figure 3-5: Location of Representative Monitoring Sites for Subsidence



3.3.5.3 Measurable Objectives and Interim Milestones

The measurable objective for subsidence is based on the long-term avoidance of land subsidence: 0 ft/year, on a long-term average. This measurable objective is set recognizing the interconnectedness of the Subbasin with surrounding subbasins, and the ability to meet this objective is dependent on the successful management of all nearby subbasins.

Interim milestones are set in 5-year increments to provide time for the GSAs to adequately monitor for and, if necessary, address an issue that is technically complex, not well understood, and that has the potential to result in negative socioeconomic impacts depending on the ultimate solution. The interim milestones are defined as:

- 2025: -0.1 ft/year (1.2 in/yr)
- 2030: -0.05 ft/year (0.6 in/yr)
- 2035: -0.05 ft/year (0.6 in/yr)
- After 2040: 0 ft/yr (0 in/yr)

The land subsidence interim milestone for 2025 was at a rate of -0.2 ft/year (2.4 in/year). This rate is higher than actual subsidence rates experienced throughout the Subbasin between 2015 and 2023 based on InSAR data available from DWR's SGMA Data Viewer. The subsequent interim milestones have reduced subsidence values as projects and management actions are implemented to address groundwater levels and subsidence. These interim milestones are set recognizing that little active subsidence is currently occurring in the Eastern San Joaquin Subbasin, the interconnectedness of the Subbasin with surrounding subbasins (where subsidence may be occurring), and the ability to meet this objective is dependent on the successful management of all nearby subbasins.

3.3.6 Depletions of Interconnected Surface Water

Depletions of interconnected surface waters (ISWs) are defined as "conditions where groundwater pumping results in reductions in flow or water levels of ISW." However, DWR's guidance entitled *Depletions of ISW: An Introduction* (CA DWR, 2024) notes that "the definition above differs from how depletions may be defined in other hydrologic contexts, where they can refer to any surface water losses without considering the cause." In acknowledging this, analyses were conducted using the ESJWRM model to evaluate stream losses to the aquifer system regardless of the cause, and to determine, based on the best available data and tools currently available, the timing, locations and magnitude of depletions that have occurred in the Subbasin or could occur in the future. These analyses are summarized in Appendix 3-G of this Amended GSP.

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 in the Subbasin 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. These effects could result in decreased surface water diversions and/or changes in irrigation practices and crops grown, and could cause adverse effects on property values and the regional economy. Reduced flows and stage, along with potential associated changes in water temperature and quality, could also negatively impact aquatic species and habitats in the rivers and streams and along the riparian environments. 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. It is important to note that the operations of upstream reservoirs are conducted by other entities, such as the U.S. Bureau of Reclamation, U.S. Army Corps of Engineers and East Bay Municipal Utilities District, and are outside the control of the Subbasin GSAs.

3.3.6.2 Minimum Thresholds

Minimum thresholds were established for ISW representative monitoring wells using groundwater levels as a metric. Groundwater level data are used to calculate water table gradients and, therefore, the volume of water gained and lost. Without additional DWR guidance at the time of this Amended GSP or more certainty around stream depletions due to pumping with the existing modeling toolset, the SMCs rely on the best available information at the time of analysis. The ISW SMCs using groundwater levels as a metric aim to be “sufficiently protective to ensure significant and unreasonable occurrences of [stream depletions] will be prevented,” as prescribed in the DWR’s *Best Management Practices for the Sustainable Management of Groundwater: Sustainable Management Criteria* (DWR, 2017).

The ESJ 2020 GSP and 2022 Revised GSP used groundwater level minimum thresholds as a proxy for the depletions of interconnected surface water sustainability indicator. This Amended GSP developed a representative monitoring network (RMN) specific for the interconnected surface water sustainability indicator consisting of a subset of wells from the chronic lowering of groundwater levels RMN combined with new wells constructed specifically to fill data gaps relating to an understanding of ISW. As such, some wells have a data set that allows for the setting of SMC, while others lack data because they are new.

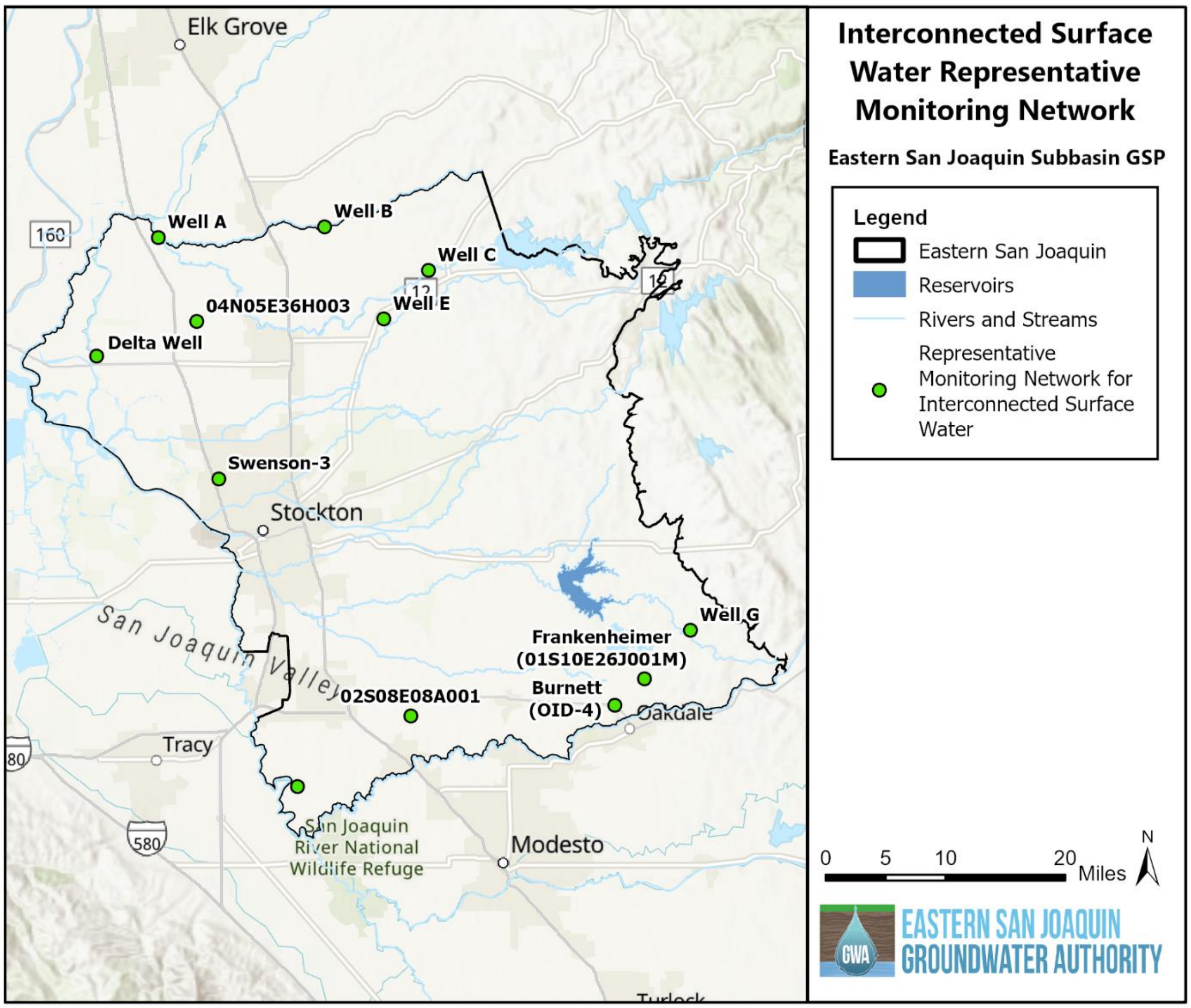
The ISW minimum thresholds for wells with historical groundwater level observations are the same as for the chronic lowering of groundwater levels minimum thresholds. Analyses were conducted to demonstrate that the groundwater level minimum thresholds are protective of stream depletions and stream-aquifer interactions (stream connectivity, stream gains and losses, and stream gains and losses as a percentage of streamflow), and therefore the use of these minimum thresholds is justified. Descriptions of the analyses conducted and the associated results can be found in Appendix 3-G. Minimum thresholds will be established for new representative monitoring sites after at least four years of data have been collected, including data for at least one wet year and one dry or critical year during that time period. If wet and dry/critical years do not occur during this initial period, then additional years of data collection may be required before establishing SMCs. Table 3-7 summarizes the minimum thresholds for the revised ISW representative monitoring network wells. Figure 3-6 shows the revised representative monitoring network for interconnected surface water.

Table 3-7: Minimum Thresholds for Interconnected Surface Water

Well ID	Minimum Threshold (ft msl)
Well A	New well – need to collect data
Well B	New well – need to collect data
Well C	New well – need to collect data
Well E	New well – need to collect data
Well G	New well – need to collect data
Delta Well	New well – need to collect data
04N05E36H003	-31.1
Swenson-3	-26.6

Well ID	Minimum Threshold (ft msl)
Frankenheimer (01S10E26J001M)	43.7
Burnett (OID-4)	60.8
02S07E31N001	0.8
02S08E08A001	0.6

Figure 3-6: Location of Representative Monitoring Sites for Interconnected Surface Water



Establishing minimum thresholds for new monitoring wells requires data; as such, the minimum thresholds for recently constructed new monitoring wells and other new wells that may be constructed in the future will be established based on adjusted recent groundwater levels from a dry/critical year. The adjustment of groundwater levels is the difference in *simulated* groundwater levels in ESJWRM flow model between Water Year 2015 (a dry year) and the recent dry/critical year when groundwater level observations are measured. The calculation for the Minimum Threshold is:

$$Minimum\ Threshold = Observed\ Recent\ Dry/Critical\ GWL - (Simulated\ Recent\ Dry\ Year\ GWLs - Simulated\ 2015\ GWLs)$$

As a hypothetical example, suppose Water Year 2027 is a critical year and the observed groundwater elevation for Well C is 75 feet mean sea level (msl) in 2027. Assuming that the *simulated* groundwater elevations in ESJWRM at Well C increase by 8 feet between 2015 and 2027. The Minimum Threshold would be 75 feet minus 8 feet, or 67 feet msl.

3.3.6.3 Measurable Objectives and Interim Milestones

Similar to minimum thresholds, measurable objectives and interim milestones were established for ISW representative monitoring wells using groundwater levels as a metric, and as with the minimum thresholds for wells with historical groundwater level observations, the measurable objectives and interim milestones are the same as for the chronic lowering of groundwater levels measurable objectives and interim milestones. For new monitoring wells without historical groundwater level data, measurable objectives and interim milestones will be established for new representative monitoring sites after at least four years of data have been collected, including data for at least one wet year and one dry or critical year during that time period. If wet and dry/critical years do not occur during this initial period, then additional years of data collection may be required before establishing SMCs. Table 3-8 summarizes the measurable objectives and interim milestones for the revised ISW representative monitoring network wells.

Table 3-8: Measurable Objectives and Interim Milestones for Interconnected Surface Water

Well ID	Measurable Objective (ft msl)	Interim Milestone (ft msl)		
		2025	2030	2035
Well A	New well – need to collect data			
Well B	New well – need to collect data			
Well C	New well – need to collect data			
Well E	New well – need to collect data			
Well G	New well – need to collect data			
Delta Well	New well – need to collect data			
04N05E36H003	-5.1	-5.1	-5.1	-5.1
Swenson-3	-19.3	-19.3	-19.3	-19.3
Frankenheimer (01S10E26J001M)	81.7	81.7	81.7	81.7
Burnett (OID-4)	79.7	79.7	79.7	79.7
02S07E31N001	12.3	13.8	13.8	13.1
02S08E08A001	24	22.2	22.2	23.1

Establishing measurable objectives and interim milestones for new monitoring wells requires data; as such, the measurable objectives and interim milestones for recently constructed new monitoring wells and other new wells that may be constructed in the future will be established based after sufficient data have been collected. Measurable objectives will be established from an adjustment in groundwater levels from a wet year. The adjustment will add the difference in *simulated* groundwater levels from ESJWRM between Water Year 2011 (a wet year) and a recent wet year when groundwater level observations are collected. The calculation for Measurable Objectives is:

$$\begin{aligned} &Measurable\ Objectives \\ &\quad = Observed\ Recent\ Wet\ GWL + \ (Simulated\ Recent\ Wet\ Year\ GWL \\ &\quad - Simulated\ 2011\ GWLs) \end{aligned}$$

As a hypothetical example, suppose Water Year 2026 is a wet year, and the observed groundwater elevation for Well C is 82 feet msl that year. Suppose that the *simulated* groundwater elevations in ESJWRM at Well C decrease by 15 feet between Water Year 2015 and 2026. The Measurable Objective would be 82 feet minus negative 15 feet, equaling 97 feet msl.

Interim milestones for recently constructed new monitoring wells and other new wells that may be constructed in the future will be calculated as 5-year milestones following a linear trend between the current condition (set as the period in time sufficient data have been collected) and the measurable objective for the time period remaining from the establishment of minimum thresholds and measurable objectives to 2040.

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: two representative networks for water levels (one for the chronic lowering of groundwater levels sustainability indicator and one for the interconnected surface waters sustainability indicator), a representative network for groundwater quality, and a representative network for inelastic subsidence. 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 the Subbasin's 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 the chronic lowering of groundwater levels, degradation in groundwater quality, interconnected surface waters and inelastic subsidence. As discussed in Chapter 3: Sustainable Management Criteria, the reduction in groundwater storage sustainability indicator will be evaluated using groundwater levels as a proxy.

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 network was developed, criteria for selecting dedicated monitoring wells, monitoring frequency, spatial density, and summary protocols. The monitoring network that collects data for groundwater levels is the Representative Monitoring Network (RMN). 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.

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 23 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	Well Location	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	20
01S09E05H002	378824N1210000W001	SJC	256	148–256 (-41 to -149)	1991–2018	7
Burnett (OID4)	377909N1208675W001	Stanislaus County	501	168–249 (21 to -60)	2005–2019	3
02N07E03D001	380578N1212017W001	SJC	484	130–484 (-74 to -428)	1990–2018	1
04N07E20H003M	381843N1212261W001	SJC	180	164–180 (-87to -103)	1972–2019	111
02S07E31N001	377136N1212508W001	SJC	Unknown	Unknown	1991–2018	14
02S08E08A001	377810N1211142W001	SJC	180	50–180 (22 to -108)	1991–2018	8
01N07E14J002	379316N1211665W001	SJC	556	168–556 (-116 to -504)	1991–2018	12
01N09E05J001	379661N1210011W001	SJC	750	100–750 (56 to -594)	2011–2018	13
02N07E29B001	379976N1212308W001	SJC	202	130–202 (-88 to -160)	1989–2018	2
02N08E15M002	380206N1210943W001	SJC	Unknown	Unknown	2011–2013	2
03N07E21L003	380909N1212153W001	SJC	Unknown	Unknown	1991–2013	15
03N06E05N003	381317N1213524W001	SJC	292	252–292 (-225 to -265)	1991–2018	16
04N05E36H003	381559N1213727W001	SJC	112	50–112 (-27 to -89)	1971–2018	4
04N05E24J004	381816N1213723W001	SJC	190	150–190 (-128 to -168)	1991–2018	9
#3 Bear Creek	Not Part of CASGEM Program	Lockeford Community Services District (LCSD)	780	0–780 (96 to -684)	2011–2018	18

Local Well ID	CASGEM Site Code	Well Location	Well Depth (ft.)	Screen Interval in ft. bgs (ft. MSL)	Measurement Period (years)	Measurement Count
Lodi City Well #2	Not Part of CASGEM Program	City of Lodi	315	109–310 (-57 to -258)	1927–2015	17
Hirschfeld (OID8)	Not Part of CASGEM Program	Stanislaus County	408	88–179 (44 to -47)	2005–2016	19
Well 18	Not Part of CASGEM Program	City of Manteca	350	109–349 (-65 to -305)	1997–2018	5
Frankenheimer (01S10E26J001M)	378163N1208321W001	Stanislaus County	Unknown			10
01S10E04C001M	378846N1208816W001	Stanislaus County				
NSJWCD-01	382345N1212261W001 - 06	NSJWCD	1.215	Multiple 165-1,200	NA	0
SEWD-01	379794N1211083W001 - 05	SEWD	1,650	Multiple 190-1,635	NA	0

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.

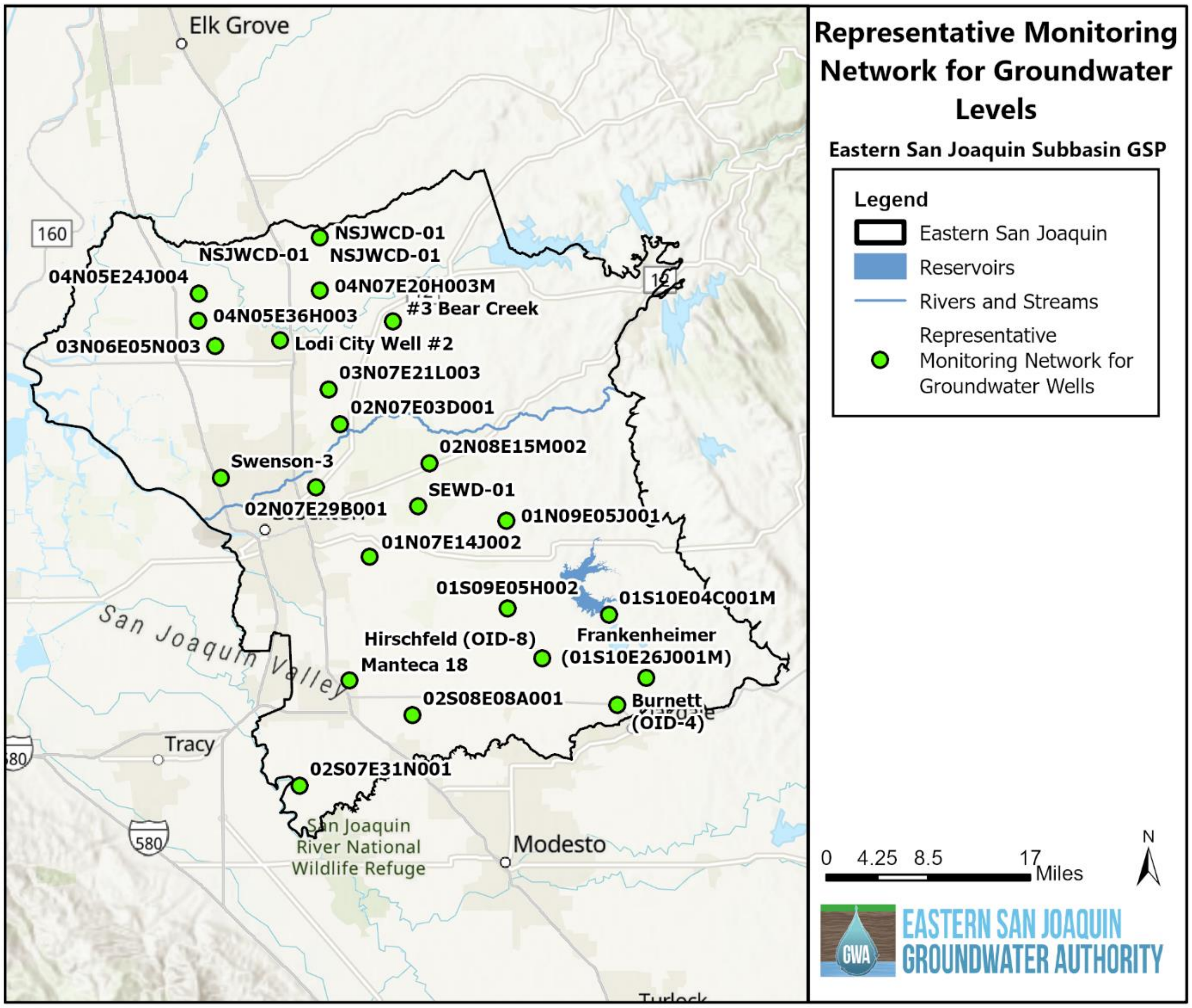
7. **Adequate Well Construction Information –** Well information such as perforation depths, construction date, and well depth was considered and encouraged when considering wells to be included.

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.

Figure 4-1 shows the revised representative monitoring network for groundwater levels.

Figure 4-1: Representative Monitoring Network for Groundwater Levels



4.1.2 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.

4.1.3 Frequency and Timing of Groundwater Level Monitoring

Representative 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.

4.1.4 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 4-2.

Table 4-2: 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

The spatial density of the groundwater level monitoring network was calculated for the representative monitoring network, as summarized in Table 4-3. The density of the representative monitoring network is 1.7 wells per 100 square miles, a total of 23 monitoring wells, which falls into the lower to middle range of DWR's recommendations. However, the Subbasin is continuing to work to expand its representative monitoring network and to construct additional wells to address identified data gaps.

Table 4-3: Groundwater Level Monitoring Network Density

Monitoring Network	No. of Wells	Well Density (Wells per 100 sq. miles)
Representative Monitoring Network	23	1.7

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 a representative groundwater well monitoring network specific for this sustainability indicator. This section provides information on how the monitoring network was developed, criteria for selecting dedicated monitoring wells, monitoring frequency, spatial density, and summary protocols.

The representative monitoring network for groundwater quality is used to determine compliance with minimum thresholds and measurable objectives developed for the degraded water quality sustainability indicator. The network monitoring for water quality tests for total dissolved solids (TDS) and chloride, in addition to field parameters including pH, electrical conductivity (EC), and temperature. Other groundwater quality data are collected from publicly available sources and other ongoing monitoring programs (such as the Irrigated Lands Program) and evaluated for arsenic, nitrate, and other constituents of concern for informational purposes. The GSP does not include sustainability goals, measurable objectives, or minimum thresholds for these other constituents.

4.3.1 Representative Monitoring Network for Groundwater Quality

Twenty-one 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 4-4 identifies and summarizes the agencies with the 21 representative monitoring wells selected for the groundwater quality monitoring network, which is shown in Figure 4-2.

Figure 4-2: Representative Monitoring Network for Groundwater Quality

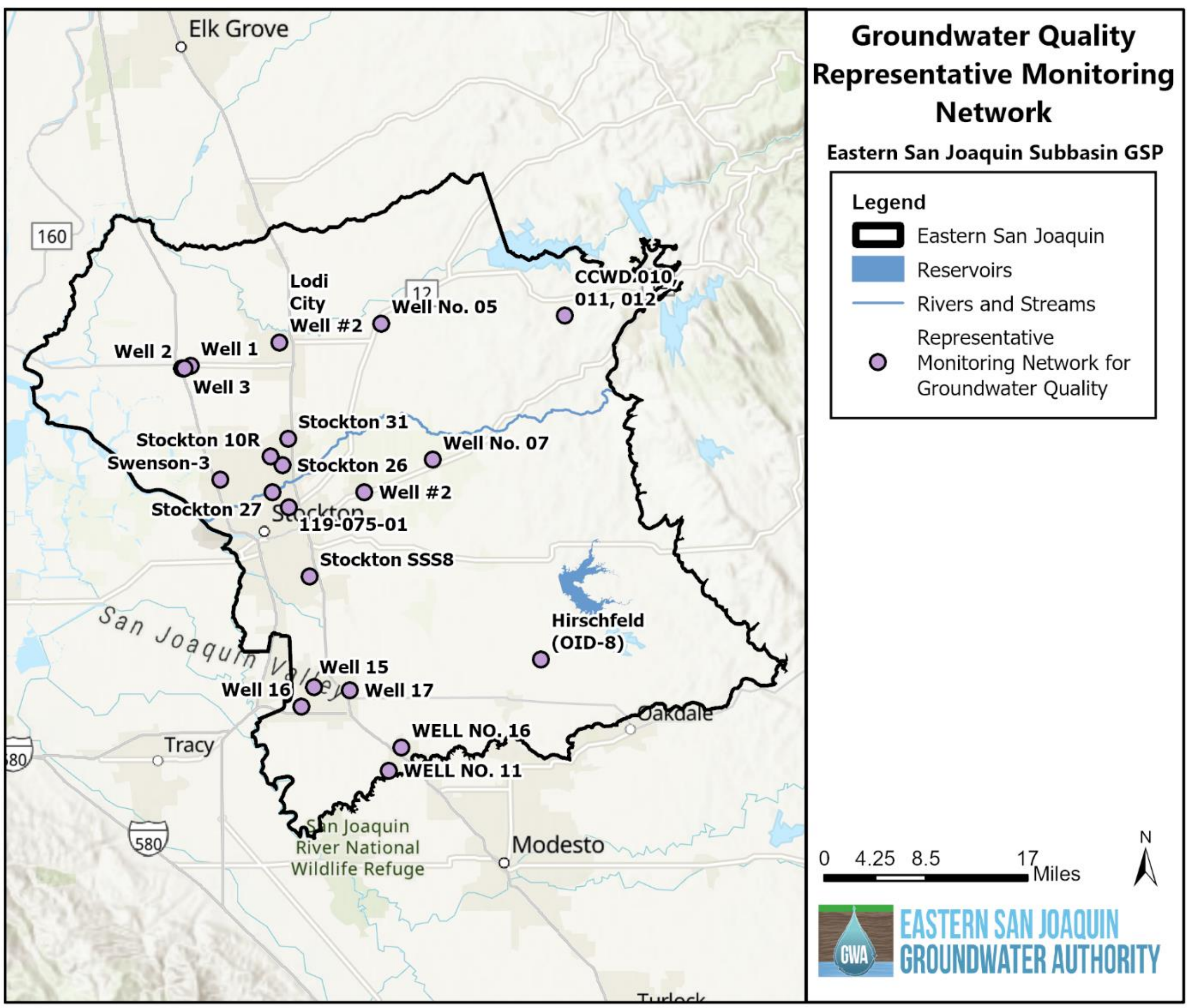


Table 4-4: Representative Monitoring Network Wells for Water Quality

GSP Well ID	CASGEM ID	GM Well ID	Monitoring Agency	Latitude	Longitude	Source	Screen Group	Screen Top (feet bgs)	Screen Bottom (feet bgs)	Well Depth (feet bgs)
Well 1	381154N1213818W001	CA3901248_001_001	San Joaquin County (Flag City)	38.115366	-121.381755	2020 RMW	Shallow (less than 200')	110	170	-
Well 2	381131N1213920W001	CA3901248_002_002	San Joaquin County (Flag City)	38.113064	-121.391997	2020 RMW	Shallow (less than 200')	110	170	-
Well 3	381130N1213887W001		San Joaquin County (Flag City)	38.11299	-121.388682	2020 RMW	Unknown	-	-	-
119-075-01	01N/07E-18D01M	CA3910001_063_063	Cal Water	37.980357	-121.263022	2020 RMW	Deep (greater than 200')	200	560	-
Well 15	378089N1212325W001	CA3910005_015_015	City of Manteca	37.808954	-121.232674	2020 RMW	Both	140	240	-
Well 16	377904N1212476W001	CA3910005_016_016	City of Manteca	37.790339	-121.247724	2020 RMW	Both	137	274	-
Well 17	378059N1211878W001	CA3910005_028_028	City of Manteca	37.805695	-121.18896	2020 RMW	Both	110	230	-
Stockton 27			City of Stockton	37.994542	-121.282878	2023 AR	Shallow (less than 200')	0	200	-
Stockton SSS8	379146N1212401W001	CA3910012_089_089	City of Stockton	37.91465	-121.237343	2020 RMW	Both	158	256	-
Stockton 31		CA3910012_094_094	City of Stockton	38.045846	-121.263778	2023 AR	Both[1]	157	362	380
Stockton 10R	380292N1212843W001	CA3910012_100_100	City of Stockton	38.028706	-121.285004	2020 RMW	Both[2]	164	488	498
Well No. 05		CA3910008_005_005	Lockeford CSD	38.155478	-121.150908	New CA7	Deep (greater than 200')	250	310	-
Well No. 07		CA3910019_007_007	Linden County WD	38.025715	-121.088695	New CA7	Deep (greater than 200')	480	600	-
Well #2		CA3900755_002_002	Shady Rest Trailer Court	37.994757	-121.171349	New CA7	Deep (greater than 200')	200	210	-
WELL NO. 11		CA3910007_012_012	City of Ripon	37.729054	-121.141496	New CA7	Shallow (less than 200')	125	155	163
WELL NO. 16		CA3910007_026_026	City of Ripon	37.7510854	-121.1264178	New CA7	Deep (greater than 200')	232	356	366
Swenson-3	380067N1213458W003			38.0067	-121.3458	GWL RMN	Multiple Wells[3]	194	502	
Lodi City Well #2		CA3910004_003_003	City of Lodi	38.1376	-121.274	GWL RMN	Both	110	309	-
Hirschfeld (OID-8)			Oakdale ID	37.8352	-120.957	GWL RMN	Deep (greater than 200')	-	-	408
CCWD 010, 011, 012			Calaveras County WD	38.16278308	-120.92918	Former Broad Monitoring Network	Multiple Wells[4]	115	390	

[1] *Screened: 157-172, 183-207, 308-328, 337-362 feet deep*
[2] *Screened: 164-172, 180-194, 208-266, 294-306, 358-412, 452-466, 474-488 feet deep*
[3] *Screened 1: 482-502, 2: 294-314; 3:194-204 feet deep*
[4] *Screened 010: 370-390; 011: 250-270; 012: 115-135 feet deep*

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 and chloride levels identified wells to be used as representative monitoring wells that met the following criteria:

1. **Adequate Spatial Distribution –** High TDS and/or chloride 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 and/or chloride concentrations, to observe and monitor TDS and/or chloride trends, and adjacent to high TDS and/or chloride areas, to observe potential TDS and/or chloride movement.

2. **Extensive Historical Data** – Wells with longer records of TDS and/or chloride monitoring were preferentially selected over wells with short or sporadic records. Monitoring wells with historical TDS and/or chloride 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 and/or chloride 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 and/or chloride 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 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.

4.3.3 Frequency and Timing of Groundwater Quality Monitoring

Groundwater quality measurements will be collected semi-annually from the representative monitoring network wells. Although DWR does not provide specific recommendations on the frequency of monitoring for TDS and/or chloride, 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 4-5 identifies the historical frequency of groundwater quality monitoring conducted for local water quality wells by each monitoring agency.

Table 4-5: 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

4.3.4 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 4-2. The spatial density of the groundwater quality monitoring network was calculated for the representative monitoring network, as summarized in Table 4-6. The representative monitoring network consists of a total of 21 monitoring wells, a density of 1.2 wells per 100 square miles.

Table 4-6: Groundwater Quality Monitoring Network Density

Monitoring Network	No. of Wells	Well Density (Wells per 100 sq. miles)
Representative Monitoring Network	21	1.2

4.4 MONITORING NETWORK FOR SEAWATER INTRUSION

Seawater intrusion is not considered an applicable sustainability indicator for the Eastern San Joaquin Subbasin.

4.5 MONITORING NETWORK FOR LAND SUBSIDENCE

Monitoring for inelastic land subsidence is conducted through a representative monitoring network specific for this sustainability indicator. This section provides information on how the monitoring network was developed, criteria for selecting dedicated monitoring locations, monitoring frequency, spatial density, and summary protocols.

The representative monitoring locations for inelastic land subsidence monitoring were selected from existing subsidence datasets and monitoring locations, including CGPS vertical displacement data from the DWR Sustainable Groundwater Management Act (SGMA) Data Viewer, InSAR subsidence rates from the SGMA Data Viewer, and survey benchmarks from U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers (USACE), California Department of Transportation (CalTrans), the San Joaquin County Department of Public Works, and local agencies. There are no DWR or USGS extensometers in the Eastern San Joaquin Subbasin.

4.5.1 Representative Monitoring Network for Subsidence

Four CGPS stations were selected for the Subbasin's representative monitoring network for inelastic land subsidence based on data availability, location, and monitoring status. The first station, P309 (SOPAC), is located in the eastern region of the Subbasin, north of the Calaveras River, and provides a comprehensive data record from March 4, 2006, to January 19, 2024. This station was chosen due to its extensive data period and its spatial coverage in the eastern portion of the Subbasin. The second station, MTWK (UNAVCO), is situated in the southern region of the Subbasin, south of the city of Manteca, with data available from December 12, 2019, to January 19, 2024. It is the closest station to the Corcoran clay, an important area to monitor due to the potential for inelastic subsidence near clay-rich areas.

Additionally, two stations from the University of Nevada Geodetic Laboratory (UNGL) were included in the RMN to provide further spatial coverage and address data gaps. The CMNC station, located along the southern edge of the Camanche Reservoir, has data in 2020 and between February 2022 and January 2024. The CA1S station, north of the city of Stockton, offers a continuous record from October 2021 to September 2023. These stations were selected to enhance the spatial distribution of monitoring locations and continuity of subsidence data in the Subbasin.

Six survey benchmarks from San Joaquin County and National Geodetic Survey (NGS) were selected to supplement the CGPS data. Survey benchmarks were also selected to expand the spatial coverage of the subsidence monitoring network in the Subbasin and verify to InSAR data. From San Joaquin County, survey benchmarks M-20 and O-29 were selected. Benchmark M-20 was chosen for the RMN due to its location in the Subbasin, situated in the area with the highest subsidence rate. Benchmark O-29 was selected for its position near a localized, unverified point location of increased subsidence according to InSAR data.

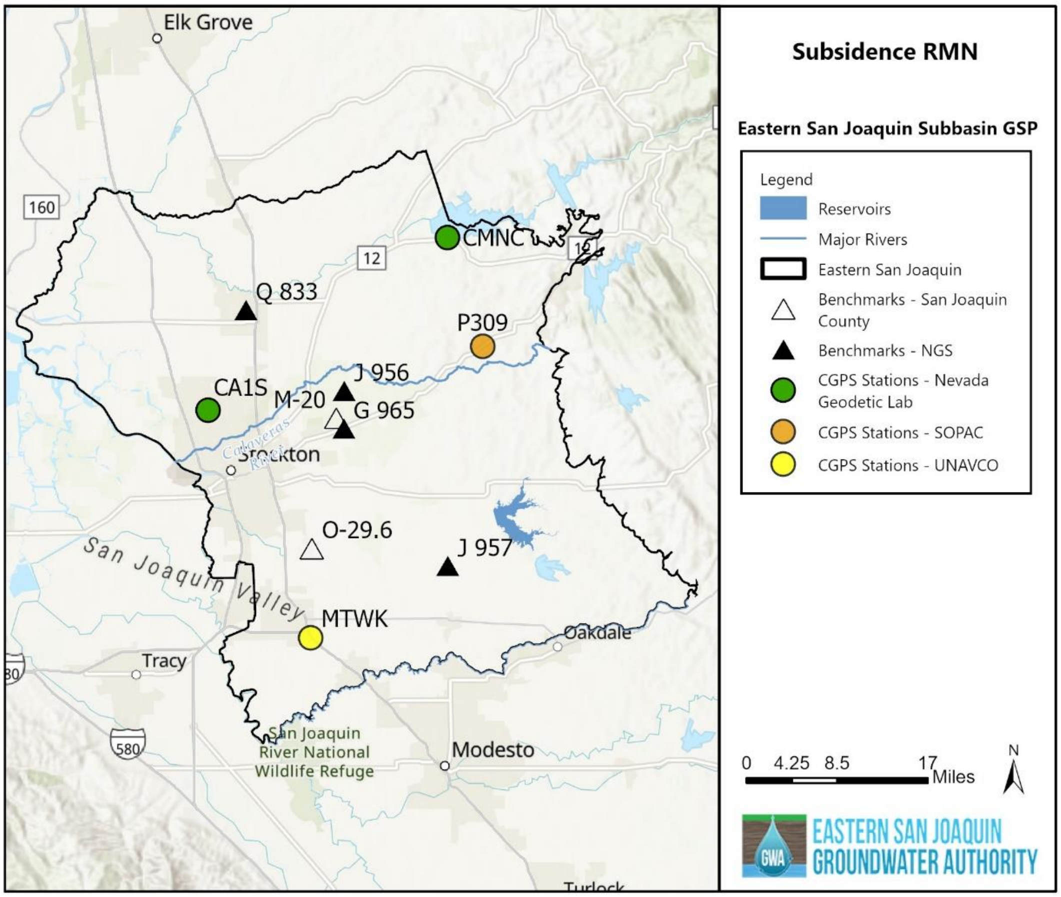
From the NGS, benchmarks Q-833, J-956, G-965, and J-957 were selected. Benchmark Q-833 was chosen due to its proximity to the LODI CGPS Station, its good condition, and elevation observations in 1947 and 1987. Benchmark J-956 is an important survey benchmark because it was recently surveyed in 2024, is in good condition, and is located in the cone of depression area with higher subsidence rates. Benchmark G-965 was selected for the RMN because of its good condition, long period of record dating back to 1962, and its location in the cone of depression area, with the latest survey in 1987. Benchmark J-957 was chosen for its observations in 1962 and 1987, its good condition, and its location in the southeast corner of the Subbasin. InSAR will serve as a supplementary data source for the rest of the Subbasin, and its accuracy will be validated using CGPS and benchmark data.

Table 4-7 describes monitoring site type, location, and data source for the four CGPS Stations and six survey benchmarks that will make up the Subbasin's RMN for the inelastic land subsidence sustainability indicator. Figure 4-3 shows the selected representative monitoring locations across the Subbasin.

Table 4-7: Representative Monitoring Network for Inelastic Land Subsidence

Name	Type	Location (dd)	Source
CA1S	CGPS	Lat: 38.022 N Long: 121.324 W	UNGL
CMNC	CGPS	Lat: 38.206 N Long: 120.999 W	UNGL
MTWK	CGPS	Lat: 37.778 N Long: 121.185 W	UNAVCO
P309	CGPS	Lat: 38.089 N Long: 120.951 W	SOPAC
Q-833	Survey Benchmark	Lat: 38.130 N Long: 121.272 W	NGS
J-956	Survey Benchmark	Lat: 38.043 N Long: 121.139 W	NGS
G-965	Survey Benchmark	Lat: 38.003 N Long: 121.139 W	NGS
M-20	Survey Benchmark	Lat: 38.014 N Long: 121.139 W	San Joaquin County
O-29.6	Survey Benchmark	Lat: 37.875 N Long: 121.183 W	San Joaquin County
J-957	Survey Benchmark	Lat: 37.856 N Long: 120.998 W	NGS

Figure 4-3: Representative Monitoring Network for Inelastic Land Subsidence



4.5.2 Monitoring Protocols for Subsidence Data Collection and Monitoring

Monitoring for inelastic land subsidence will occur semi-annually for survey benchmarks. Standard practices and protocols for land surveying as set forth in the *Caltrans Surveys Manual* (California Department of Transportation, 2021) will be followed to measure land surface elevations at those locations. Measurements will be in the same vertical datum, preferably NAVD88. CGPS data will be downloaded from the online data sources referenced in Section 4.5.1. InSAR data will be sourced annually from DWR's SGMA Data Viewer and compared against the land-based measurements as a quality control check.

4.5.3 Frequency and Timing of Subsidence Monitoring

As noted in Section 4.5.2, land surface elevations will be surveyed semi-annually in the spring and fall at the benchmarks noted in Table 4-7. Data for all other representative monitoring locations will be sourced from online published data in coordination with preparation of the Subbasin's Annual Report.

4.5.4 Spatial Density of Subsidence Monitoring Stations

Per DWR's *Best Management Practices for the Sustainable Management of Groundwater, Monitoring Protocols, Standards, and Sites* (2016a), the representative monitoring locations for inelastic land subsidence in the Subbasin was established to monitor regions where the potential for subsidence exists. As such, the monitoring locations were selected to provide an overall network of sites for data collection that represent the different areas of the Subbasin – areas upland, near the Delta, overlying the Corcoran clay and overlying unconfined alluvial systems. While the representative monitoring network contains discrete data collection locations, the use of InSAR survey data in the annual evaluation for the potential for subsidence provides Subbasin-wide coverage in coordinate with the direct data measurements.

4.6 MONITORING NETWORK FOR DEPLETIONS OF INTERCONNECTED SURFACE WATERS

This section provides information on how the monitoring network was developed for interconnected surface water (ISW), criteria for selecting dedicated monitoring wells, monitoring frequency, spatial density, and summary protocols. Like the wells used to monitor groundwater levels to assess sustainability in the Subbasin, these wells are used to determine compliance with minimum thresholds and measurable objectives for the interconnected surface water sustainability indicator.

4.6.1 Representative Monitoring Network for Interconnected Surface Water

The representative monitoring wells contained in the network for interconnected surface water consists of a subset of the groundwater level (GWL) RMN wells that are within five miles of connected surface waters plus six newly constructed monitoring wells constructed in 2022 and 2024 to address data gaps. Only one well (the shallowest well in a gap area) was selected from the GWL RMN along the Mokelumne River since there are the new ISW wells along other sections of the Mokelumne River. Table 4-8 identifies and summarizes the 12 representative monitoring wells for interconnected surface waters.

Table 4-8: Representative Monitoring Wells for Interconnected Surface Water

Well ID	Latitude, Longitude	Well Perforations (feet below ground surface)	Nearest Adjacent Stream	Well Category
Well A	38.23583, -121.41869	14 – 31.5	Mokelumne River	New ISW Well
Well B	38.245966, -121.217862	25 – 35	Dry Creek	New ISW Well
Well C	38.20457, -121.09278	15 – 30	Mokelumne River	New ISW Well
Well E	38.15838, -121.14675	35 – 50	Mokelumne River	New ISW Well
Well G	37.86248, -120.77601	26 – 41	Little Johns Creek	New ISW Well
Delta Well	38.1229, -121.4932	125 – 150, 275 – 300	Mokelumne River	New ISW Well
04N05E36H003	38.1559, -121.3727	50 – 112	Mokelumne River	GWL RMN
Swenson-3	38.0067, -121.3458	194 – 204	San Joaquin River	GWL RMN
Frankenheimer (01S10E26J001M)	37.8163, -120.8321	323 – 599	Stanislaus River	GWL RMN

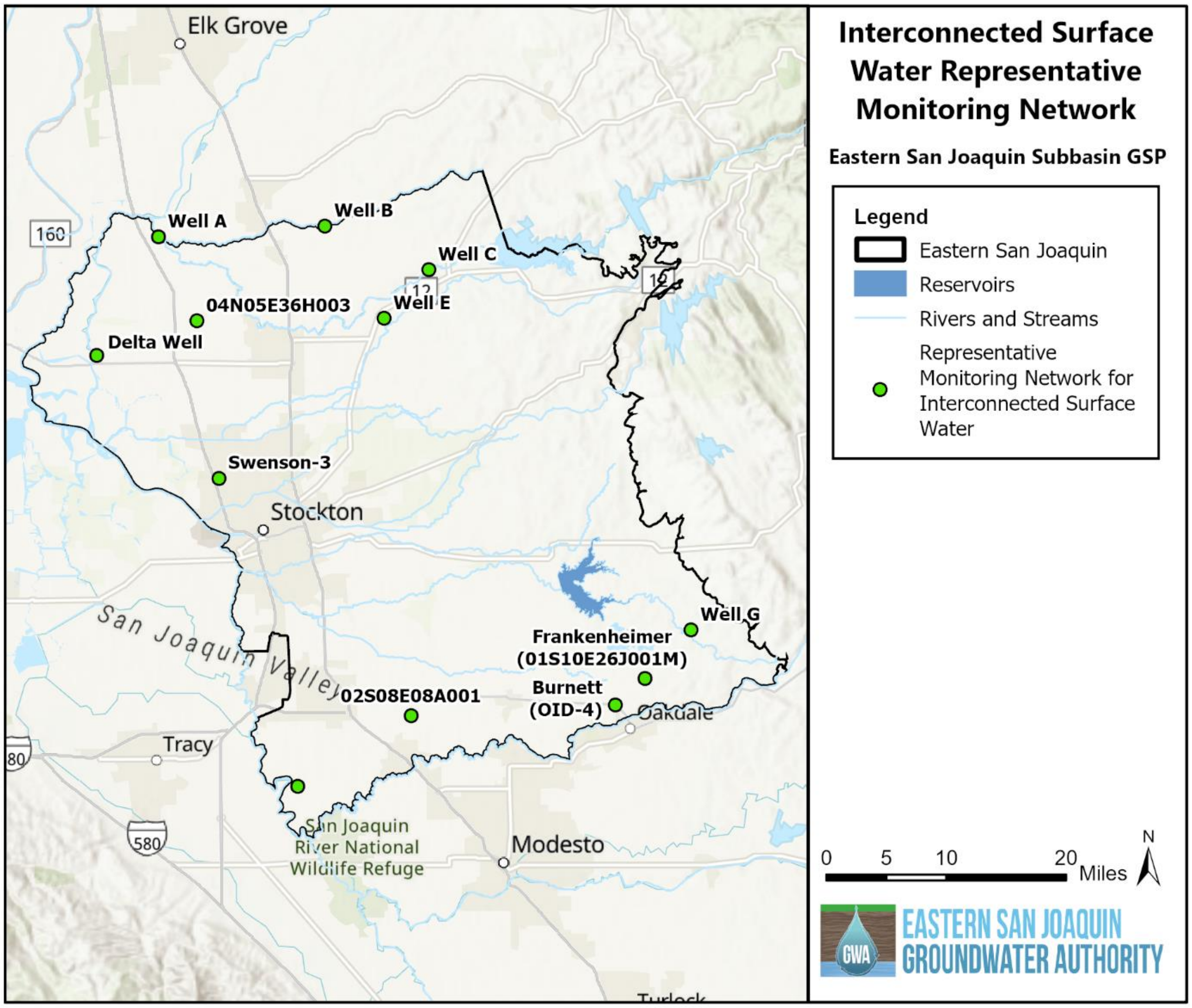
Well ID	Latitude, Longitude	Well Perforations (feet below ground surface)	Nearest Adjacent Stream	Well Category
Burnett (OID-4)	37.7909, -120.86752	168 – 249	Stanislaus River	GWL RMN
02S07E31N001	37.7136, -121.2508	130 – 226	San Joaquin River	GWL RMN
02S08E08A001	37.781, -121.1142	50 – 180	Stanislaus River	GWL RMN

Representative groundwater level monitoring sites were selected from the GWL RMN for their proximity to identified interconnected surface water reaches, thorough and recent groundwater level observations, and known perforations. The six new monitoring wells recently constructed, Well A, Well B, Well C, Well E, Well G and the Delta Well, were sited based on interconnected surface water data gaps described in the 2020 GSP and 2022 Revised GSP identifying a need for additional information on interconnected surface water to inform the SMC and to benefit future model calibration efforts. The specific well locations were further refined based on the additional criteria, including:

- The location of existing monitoring sites, including CASGEM Wells, SJC wells, USGS multi-completion wells, and other multi-completion wells.
- Areas with recharge and service water interaction
- Areas of critical overdraft
- Areas of water quality concern
- Areas in close proximity to subbasin boundaries
- Areas proximate to identified GDEs and interconnected surface water reaches
- Areas to support future model refinement
- Property owned by one of the Subbasin GSAs.

The ISW RMN wells were selected to reflect both shallow, dynamic interactions between streams and the aquifer, as well as deeper regional pumping trends. Figure 4-4 shows the revised representative monitoring network for interconnected surface water.

Figure 4-4: Representative Monitoring Network for Interconnected Surface Water



4.6.2 Monitoring Protocols for Interconnected Surface Water Data Collection and Monitoring

Monitoring protocols for interconnected surface water representative monitoring wells are the same as those used for data collection from groundwater level representative monitoring wells. See Section 4.1.2 for the applicable protocols.

4.6.3 Frequency and Timing of Interconnected Surface Water Monitoring

The frequency and timing of the collection of monitoring data from interconnected surface water representative monitoring wells are the same as those used for the monitoring of groundwater level representative monitoring wells. See Section 4.1.3 for more detail on the frequency and timing of monitoring for the groundwater level RMN. Some wells will have transducers installed using American Rescue Plan Act (ARPA) funding allowing for more frequent groundwater level observation collection.

4.6.4 Spatial Density of Interconnected Surface Water Monitoring Network

As with the representative monitoring network for groundwater level monitoring, the goal of the interconnected surface water monitoring network is to provide adequate spatial coverage within the Subbasin. This includes the ability to monitor and identify changes across the Subbasin boundaries (most of which are comprised of rivers), as well as along interconnected reaches within the Subbasin. The spatial location of monitoring wells in the network was based predominantly on proximity to interconnected reaches of the rivers and streams in 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 4-4). 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, represented by TDS and chloride as constituents of concern. 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 completed some refinements to the representative monitoring network, but a future study and additional refinement of interconnected surface water representative monitoring network will be needed, along with continued coordination efforts with neighboring subbasins to better inform Subbasin conditions and interconnected rivers that serve as boundaries for the Subbasin. As discussed in Section 7.4.1, future model calibration will be improved by more information on interconnected surface water, including the incorporation of additional shallow groundwater levels near interconnected stream reaches.

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 below the ground surface, or were located adjacent to irrigated agriculture. The purpose of this data gap is to identify potential existing GDEs that may have been incorrectly identified or not identified as GDEs through the GDE screening process discussed in Section 2.2.7 and Section 2.3.7. 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. Additional detail on this data gap is discussed in Appendix 3-C.

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 4-5 as orange diamonds). Progress has been made toward drilling new wells at 6 sites since the 2020 GSP (shown as circles with orange outlines). New wells will be measured for groundwater levels and/or groundwater quality, depending on the data gap for which the well is intended to fill. The locations of the proposed monitoring wells are subject to change based on the needs of the Subbasin and well siting feasibility. Additional multi-completion groundwater level information will assist with better understanding of groundwater-surface water interaction and GDEs. Future multi-completion wells and/or well pairs may be constructed to support the efforts to understand groundwater levels and quality at varying depths in the Subbasin.

Additional new shallow groundwater level and quality monitoring wells located near streams, Subbasin boundaries, and the groundwater depression area in the center of the Subbasin will also improve the understanding of aquifer-stream dynamics. The proposed locations of these wells will be 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. 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 analyses of interconnected surface water, including additional refinement of GDEs, and through the use of publicly available data collected by others in the Subbasin. The ESJGWA plans to conduct field verification of the potential GDE sites identified in Appendix 3-C. This field exercise will assess both species presence and source of water for each ecosystem. The results of this study, combined with additional shallow groundwater level data collected at new wells, will determine what additional regional or site-specific biological analyses may be needed to effectively assess locations of GDEs and appropriately manage impacts to them. Future projects and management actions may be developed to address these needs once there is sufficient data to evaluate GDEs effectively.

Additional activities related to filling data gaps are discussed in Chapter 6: Projects and Management Actions and Chapter 7: Plan Implementation.

Figure 4-5: Proposed New Monitoring Well Locations (Shown as Orange Diamonds)

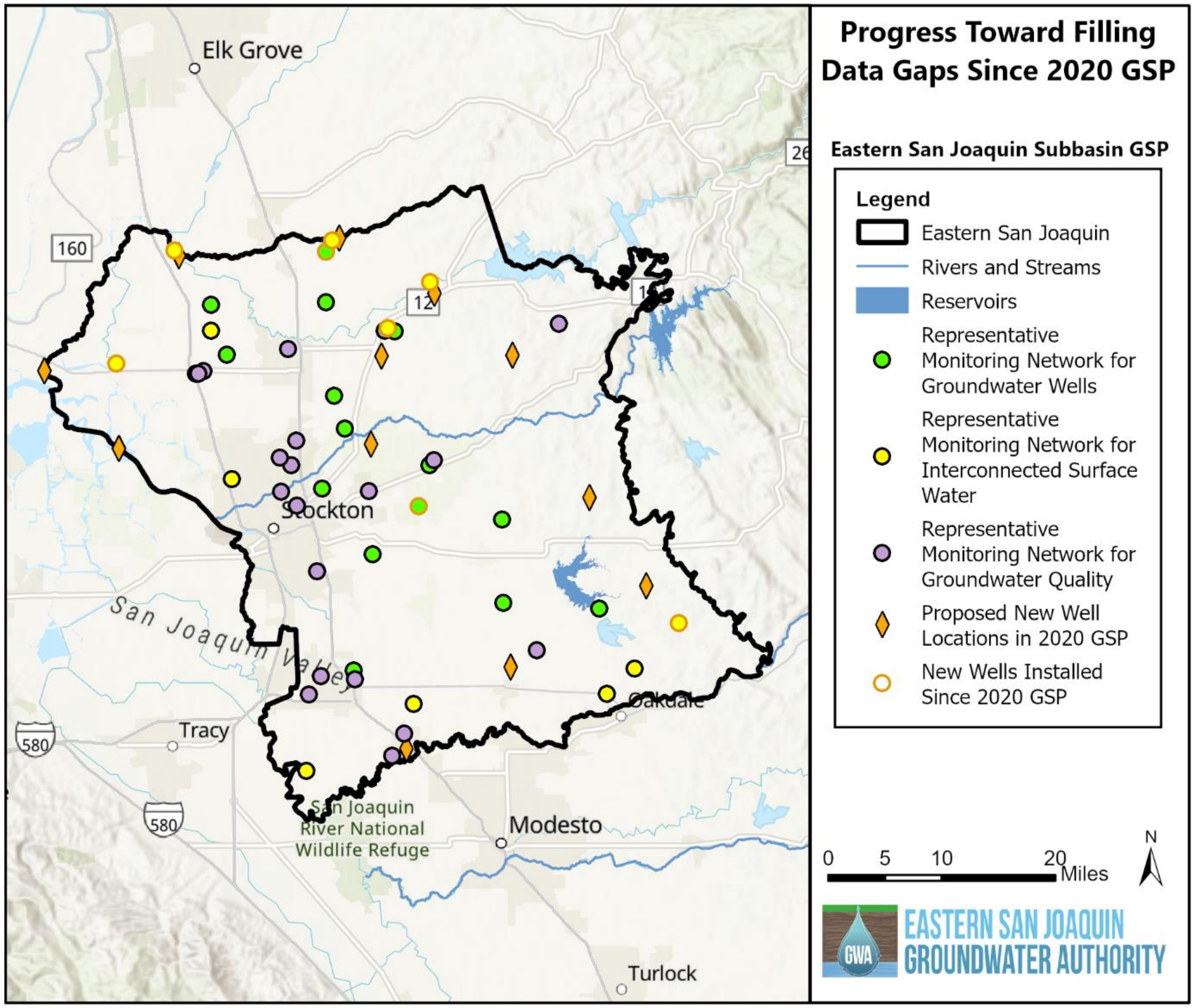


Table 4-9: Considerations for Well Selection and Well Installation

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:

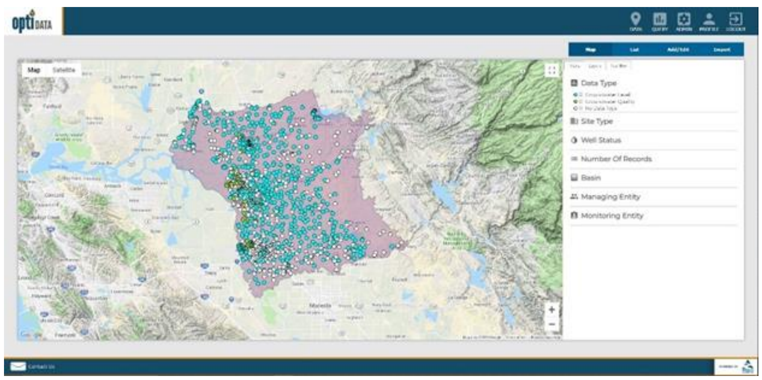
- Overview of the Eastern San Joaquin Subbasin Data Management System
- Functionality of the Data Management System
- Data Included in the Data Management System

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.

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

Figure 5-1: Opti DMS Screenshot



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.

As part of the 2020 GSP and 2022 Revised GSP implementation, a mobile and tablet interface was developed for the DMS to facilitate the real-time upload of data collected in the field. The Eastern San Joaquin (ESJ) Data Management System (DMS) mobile interface is implemented using the Esri ArcGIS Field Maps mobile app (or the Collector app if already installed) and is integrated with the DMS via web services to ArcGIS Online.* The mobile interface is intended to provide all ESJ staff and their consultants with easy-to-use interfaces to collect well and groundwater related data in the field. Data collected using the mobile interfaces are pulled into the DMS on a nightly basis where it is quality controlled prior to insertion into the database.

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

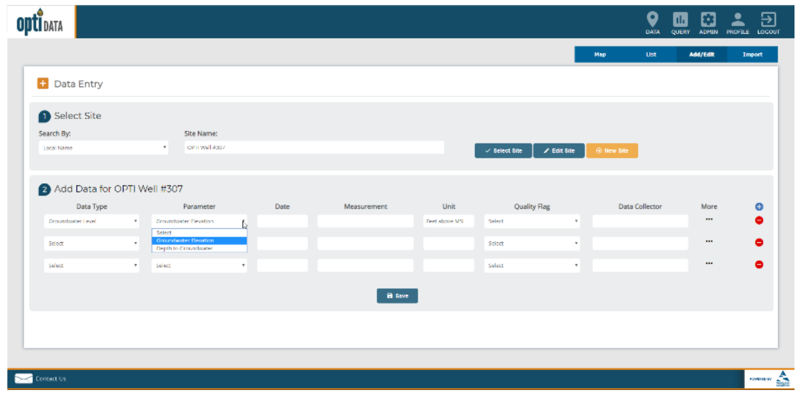
Basic Info	Well Info	Construction Info
Site Type*	State Well ID	Total Well Depth
Local Site Name*	CASGEM ID	Borehole Depth
Local Site ID	Ground Surface Elevation	Casing Perforations
Latitude/Longitude*	Reference Point	Casing Diameter
Description	Reference Point Elevation	Casing Modifications
County	Reference 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

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:

Figure 5-2: DMS Data Entry Tool



- 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.)

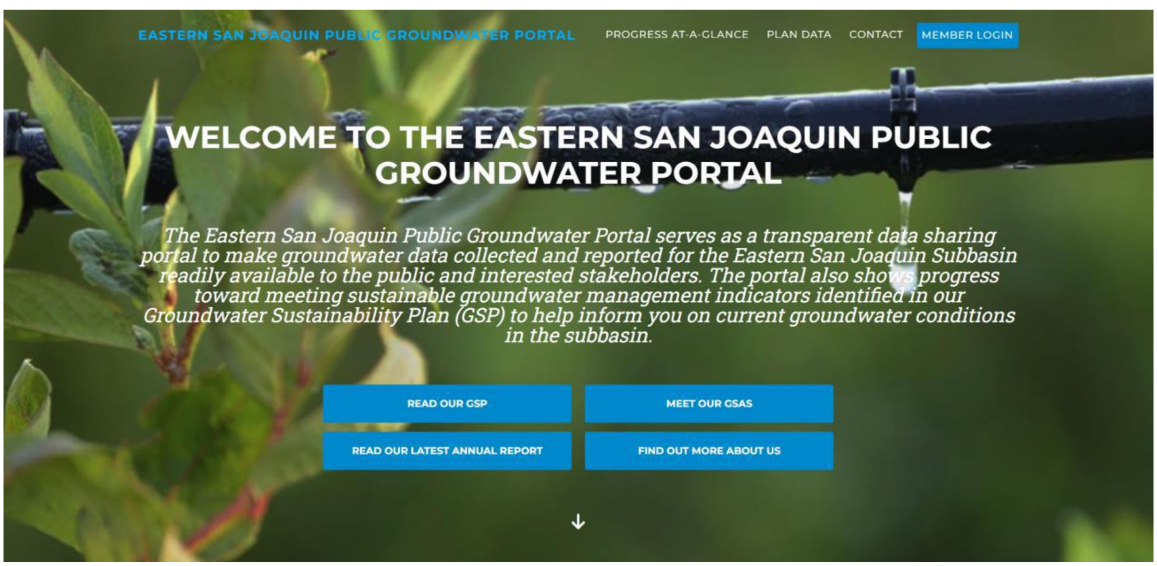
Users are alerted to any validation issues and may either update the data entries or accept the values and continue with the entry/import. Users may access partially completed import validation through the import logs that are saved for each data import. The partially imported data are identified in the Import Log with an incomplete icon under the Status field. This allows a second person to 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.

The Eastern San Joaquin Subbasin DMS underwent refinement in 2023 to improve streamlining of communication of subbasin status to the public and improved access to SGMA-related data. The refined DMS portal is conceived as a simple-to-use public portal that pulls data directly from the ESJ SGMA DMS into an easy-to-understand and interactive website. The new Groundwater Portal also provides access to other subbasin information and websites. Upon entering the Groundwater Portal of the DMS (Figure 5-3), users who wish to login may click on the “Member Login” button to access the existing DMS for data updates, analysis, and reporting. Public users may access the GSP, view a list of member GSAs, read the latest annual report, and visit the ESJ Groundwater Authority webpage.

Figure 5-3: Landing Page of Groundwater Portal

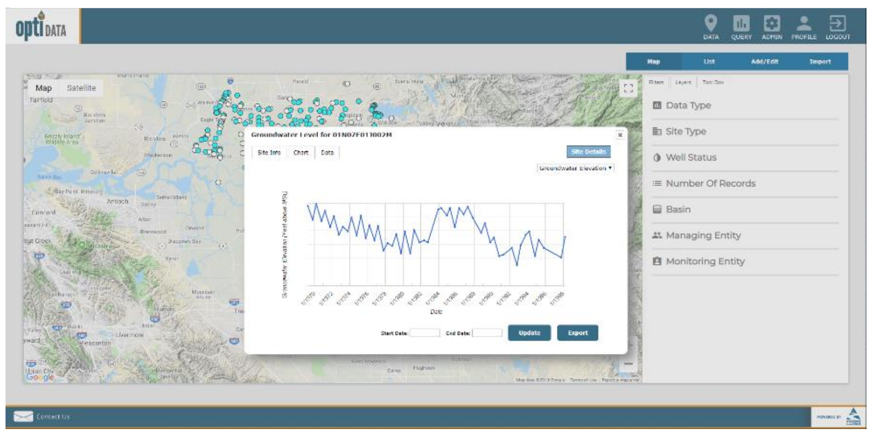


The updated portal also includes a “Progress-At-A-Glance” link or scrolling down displays the ESJ Subbasin dashboard, as shown in Figure 5-4. The dashboard is intended to give a quick and easy-to-understand snapshot of the subbasin conditions. The dashboard framework is ready to be populated when and if the ESJ Groundwater Authority determines what information should be made available to the public.

Figure 5-4: Progress-At-A-Glance Dashboard

5.2.3.1 Map View

Figure 5-5: Typical DMS Data Display



The Map view displays all sites (groundwater wells, stream gages, precipitation meters, etc.) in a map-based interface (see Figure 5-5). 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. The ESJ Plan Data map is an interactive map interface built utilizing the ArcGIS JavaScript API, ArcGIS Online, and a live link to the ESJ SGMA DMS data. The map interface includes geospatial information, search functions based on address or place, map filters, and data view and download functions. 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.). Additionally, data contained in the DMS may be viewed and downloaded. Clicking on the representative monitoring well in the map view will open a modal (pop-out window) to view and download data. The modal displays a hydrograph along with the Measurable Objective and Minimum Threshold for the well. A tabular view of the data is also available. All data can be printed or downloaded to the user's selected location in Excel format.

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 Eastern San Joaquin Subbasin (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 95,000 acre-feet per year (AF/year), identified as part of the sustainable yield estimate presented in Section 2.4.6. 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) are currently working on developing a demand reduction program and 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.

The resultant list of projects and management actions was then updated in coordination with the 5-year Periodic Evaluation and this GSP amendment. Updated project information was solicited from the GSAs, and the list of projects and management actions revised to reflect plans as of 2024.

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 45 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 two categories based on project status as defined below.

- Category A projects - projects that were completed or are anticipated to advance in the next five years and have existing water rights or agreements.
- Category B projects - projects that are not anticipated to advance in the next five years, but may be implemented 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.

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 41 of the 45 projects; full descriptions are included below. Figure 6-1 and Figure 6-2 shows the locations of these projects.

During the September 11, 2024 ESJGWA Board Meeting, the Board approved by resolution the addition of 5 projects to the GSP. These projects include:

- Mariposa Drain Water Delivery Improvement Project – Central San Joaquin Water Conservation District GSA
- South System Pipeline Phase 4 Improvement Project – North San Joaquin Water Conservation District GSA
- Q/Qc Conjunctive Use Project – South San Joaquin GSA
- SSJID Advanced Metering Infrastructure Project – South San Joaquin GSA
- Clements Road Pipeline Project – Stockton East Water District

The South System Pipeline Phase 4 Improvement Project is already included in the 41 projects listed in Table 6-1 and is discussed in Section 6.2.4.5. The other four are new additions that are not included in Table 6-1, nor in the write-ups included in this chapter. More information on these projects is included in Appendix 6-A. With the addition of these four projects, the GSP now includes 45 total 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 Capital Cost	Estimated Annual O&M Cost	Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
Category A Projects - projects that were completed or are anticipated to advance in the next five years and have existing water rights or agreements									
Lake Grupe In-lieu Recharge	In-lieu Recharge	SEWD	Groundwater levels	Completed	2020-2023	$2.3 M	$330,000	Installation for new intake and pipeline requires permits from DFW, CVFPB, RWQCB, and USACE	4,900
SEWD Surface Water Implementation Expansion	In-lieu Recharge	SEWD	Groundwater levels	Implementation	2019-2029	$750,000	$100,000	Permit approvals from DFW, RWQCB, CVFPB, and USACE by private landowners	19,000
White Slough Water Pollution Control Facility Expansion	Recycling/ In-lieu Recharge/Direct Recharge	City of Lodi	Groundwater levels	Construction complete	2019-2020	$6 M	$4,664	None (permitting complete)	1,000
CSJWCD Capital Improvement Program	In-lieu Recharge	CSJWCD	Groundwater levels	Can be implemented immediately	2020-2027, on-going with 7-year completion cycles	N/A	$50,000	Individual applications need CSJWCD Board approval and possible streambed alteration permits	24,000

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Capital Cost	Estimated Annual O&M Cost	Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
NSJWCD South System Modernization	In-lieu Recharge	NSJWCD	Groundwater levels	Environmental review complete, funding secured for Phases 1, 2 and 3. Landowner improvement district formed. Phases 1-2 complete.	2018-2025 for Phases 1, 2, 3; 2025-2028 for Phase 4; 2028-2035 for future phases	Phase 1&2: $7 M Phase 3: $4 M Phase 4: $8 M Future Phases: $10-20 M	Phase 1&2: $200,000 Phase 3: $200,000 Phase 4: $200,000 Future Phases: $200,000	Permits for pump station work have been completed; minor grading and road encroachment permits may be needed	10,000
Long-term Water Transfer to SEWD and CSJWCD	Transfers	SSJ GSA	Groundwater levels	Infrastructure is in place. CEQA completed and agreements in place	2019-2021	N/A	$9 M	Project must comply with CEQA	20,000
South System Groundwater Banking with East Bay Municipal Utilities District (EBMUD)	In-lieu Recharge	NSJWCD	Groundwater levels	Pilot Dream Project will be completed in April 2024. Working on expanded banking project	2020-2024	$5 M	$400,000	SWCRB change petition for Permit 10478 and San Joaquin County groundwater export permit, and regulatory permits as needed	4,000
NSJWCD North System Modernization/ Lakso Recharge	In-Lieu Recharge	NSJWCD	Groundwater levels	Constructed Phase 1A, in progress on Phase 1B. Planning Phase 2	2021-2026	$7 M	$150,000	Regulatory permits as needed	4,000
Tecklenburg Recharge Project	Direct Recharge	NSJWCD	Groundwater levels	Substantially complete	2022-2024	$1 M	$400,000	CEQA review and possible grading permit	2,000
City of Stockton Phase 1: Groundwater Recharge Project	Direct Recharge	City of Stockton	Groundwater levels	Basin design in progress. Construction to begin spring 2025.	2022-2026	$11.5 M	To be Determined	Project must comply with CEQA	20,000

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Capital Cost	Estimated Annual O&M Cost	Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
West Groundwater Recharge Basin	Direct Recharge	SEWD	Groundwater levels	Ongoing	2032	To be Determined	To be Determined	To be Determined	16,000
NSJWCD Private Pump Partnerships	In-Lieu Recharge/Direct Recharge	NSJWCD	Groundwater levels	Ongoing	2024	To be Determined	To be Determined	To be Determined	3,000
Oakdale Irrigation District In-lieu and Direct Recharge Project	Direct Recharge/In-Lieu Recharge	OID	Groundwater levels	Ongoing	2023-2032	To be Determined	To be Determined	To be Determined	25,000
City of Stockton Advanced Metering Infrastructure	Conservation	City of Stockton	Groundwater levels	In progress. Contract awarded in March 2024.	2023-2028	$17 M	To be determined	Not determined	2,000
								Total Category A	***154,900***
Category B Projects - projects that are not anticipated to advance in the next five years, but may be implemented 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									
City of Manteca Advanced Metering Infrastructure	Conservation	City of Manteca	Groundwater levels	Experiencing Delays	Not determined	$650,000	$300,000	None	272
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 Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Capital Cost	Estimated Annual O&M Cost	Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
BNSF Railway Company Intermodal Facility Recharge Pond	Direct Recharge	CSJWCD	Groundwater levels	Planning phase	2020-2025	N/A	$50,000	Streambed alteration permit	1,000
Manaserro Recharge Project	Direct Recharge	NSJWCD	Groundwater levels	Planning phase	2023-2025	$500,000	$50,000	CEQA review, possible grading permit, possible water right change petition	8,000
City of Escalon Wastewater Reuse	Recycling/ In-lieu Recharge/ Transfers	SSJ GSA	Groundwater levels	Planning phase	2020-2028	To be determined	To be determined	CEQA review, RWQCB permits, and road encroachment permits	672
City of Ripon Surface Water Supply	In-lieu Recharge	SSJ GSA	Groundwater levels	Design complete; environmental permitting underway; negotiations for the right to connect are underway.	2028-2030	To be determined	To be determined	NEPA Categorical Exclusion, CEQA Mitigated Negative Declaration, and road encroachment permits	6,000
City of Escalon Connection to Nick DeGroot Water Treatment Plant	In-lieu Recharge	SSJ GSA	Groundwater levels	Conceptual design; environmental review complete; Council approval are pending further design work and rate study	2028-2030	To be determined	To be determined	Road encroachment permits	2,015

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Capital Cost	Estimated Annual O&M Cost	Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
Farmington Dam Repurpose Project	Direct Recharge	SEWD	Groundwater levels	Planning/Initial Study	2030-2050	To be determined	To be determined	Permits and approvals form SWRCB, USBR, DFW, RWQCB, CVFPB, and USACE	60,000
Mobilizing Recharge Opportunities	Direct Recharge	San Joaquin County	Groundwater levels	Project Development	2024-2040	Not determined	Not determined	Not determined	158,000
NSJWCD Winery Recycled Water	Recycling/ In-Lieu Recharge/ Direct Recharge	NSJWCD	Groundwater levels	Conceptual planning and discussion	2025-2027	To be determined	To be determined	WDR permitting through the RWCQB and minor permits for pipeline construction	750
SSJID Storm Water Reuse	Storm Water/ In-lieu Recharge/ Direct Recharge	SSJ GSA	Groundwater levels	Planning phase	2027-2030	To be determined	To be determined	CEQA review and road encroachment permits	1,100
Wallace-Burson Conjunctive Use Program	Conjunctive Use/Direct Recharge	Eastside GSA	Groundwater levels	Conceptual planning and discussion	2030-2040	To be determined	To be determined	Not determined	3,000
Calaveras River Wholesale Water Service Expansion	In-Lieu Recharge	Eastside GSA	Groundwater levels	Conceptual planning	2020-2040	To be determined	To be determined	Not determined	600

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Capital Cost	Estimated Annual O&M Cost	Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
Recycled Water to Manteca Golf Course	Recycling	City of Manteca	Groundwater levels	12-in pipeline installed. Waiting for DWR to determine grant recipients	To Be Determined	To be determined	To be determined	Not determined	406
Threfall Ranch Reservoir, In-Lieu and Direct Recharge Project	In-Lieu Recharge/Direct Recharge	Eastside GSA	Groundwater levels	Design	2025	To be determined	To be determined	Not determined	2,000
Perfecting Mokelumne River Water Right	In-Lieu Recharge	San Joaquin County	Groundwater levels	Planning	2024-2025	$125,000 (spent to date) Total TBD	To be determined	Not determined	158,000
North System Groundwater Recharge Project - Phase 2	Direct Recharge	NSJWCD	Groundwater levels	Design phase with planned construction in 2025-2026	2026-2029	$10 M	$100,000	Not determined	3,000
Stormwater Collection, Treatment, and Infiltration	Direct Recharge/ Stormwater	City of Manteca	Groundwater levels	Planning/Initial Study	To Be Determined	To be determined	To be determined	Not determined	To Be Determined
Off-Stream Regulating Reservoir	Direct Recharge	SEWD	Groundwater levels	Conceptual Phase	2026-2050	To be determined	To be determined	Not determined	To Be Determined
On-Farm Recharge Project	Direct Recharge	SEWD	Groundwater levels	Planning/Initial Study	2024-2030	N/A	$100,000	Not determined	To Be Determined

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Capital Cost	Estimated Annual O&M Cost	Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
Bellota Weir Modifications Project	Direct Recharge/ Stormwater	SEWD	Groundwater levels	SRF Loan Application Submitted. $12.3M Grant awarded. Minor construction started	2023-2030	$ 85 M	$1.5M	USACE, USFWS,CVFPB, NEPA,CEQA,R WQCB	5,200
Water Supply Enhancement Project - Distribution Pipelines	In-Lieu Recharge/Direct Recharge	SEWD	Groundwater levels	Design	2024-2040	$7M	To be determined	RWQCB,CEQA, USACE,CVFPB, CDFW	17,000
Water Treatment Plant Aquifer Storage Recovery Well - 7401	Direct Recharge	SEWD	Groundwater levels	Implementation	2024-2026	$1.5 M	To be determined	RWQCB,CEQA, NEPA	2,420
Beckman Well	Direct Recharge	SEWD	Groundwater levels	Refurbish	2024-2028	$200,000	N/A	RWQCB,CEQA	800
West Linden Project	In-Lieu Recharge/Direct Recharge	SEWD	Groundwater levels	Planning/Design	2024-2035	$60M	To be determined	CEQAmRWCQB	60,000
Water Supply Enhancement Project - Direct Recharge	Direct Recharge	SEWD	Groundwater levels	Design	2024-2030	To be determined	To be determined	Not determined	To Be Determined

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Capital Cost	Estimated Annual O&M Cost	Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
SSJID Water Master Plan - System Improvements	In-Lieu Recharge	SSJ GSA	Groundwater levels	Feasibility study complete	2023-2040	$ 30 – 40 M	To be determined	Not determined	15,000
								Total Category B	***509,985***

[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).

Figure 6-1: Location of Category A Projects

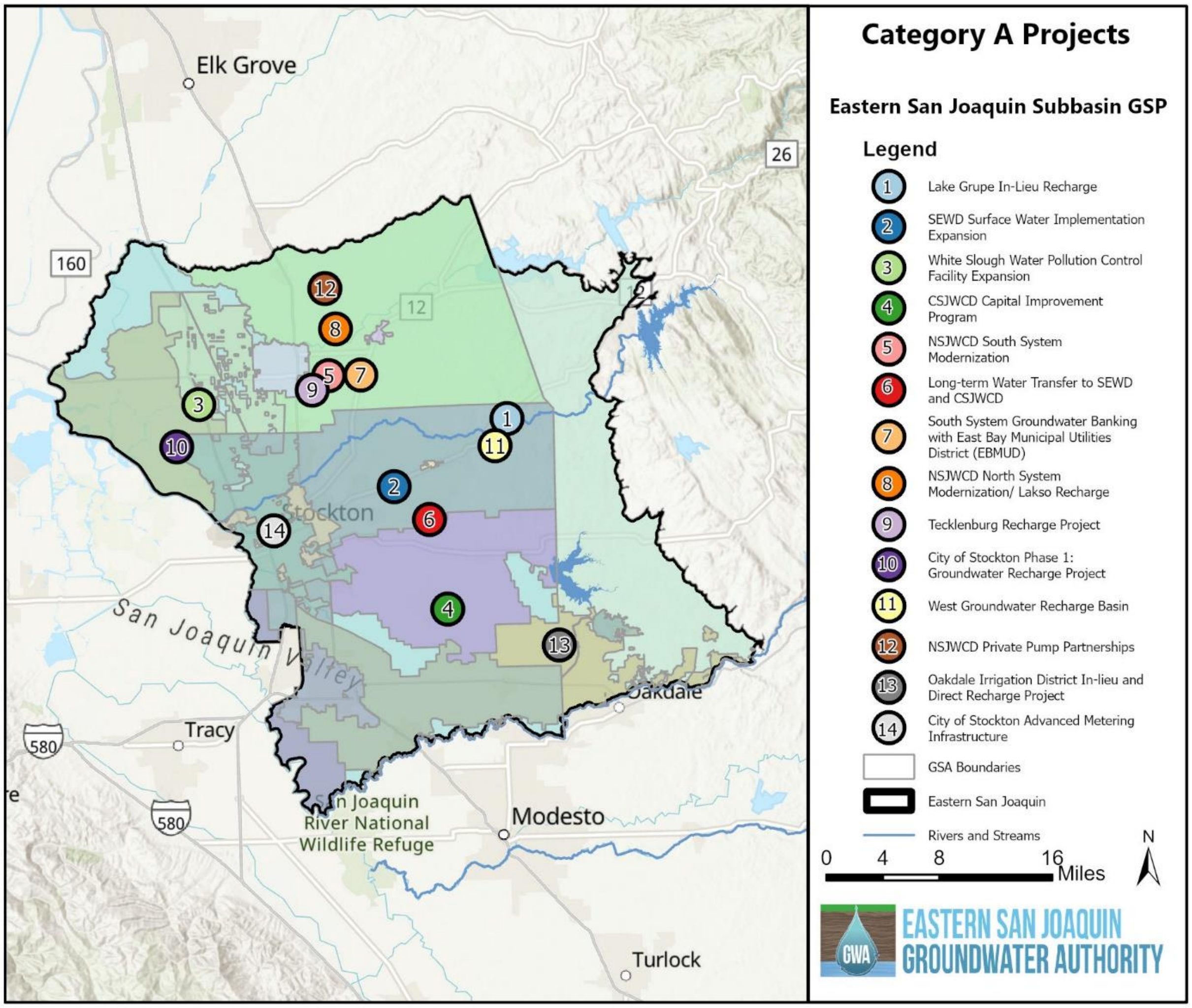
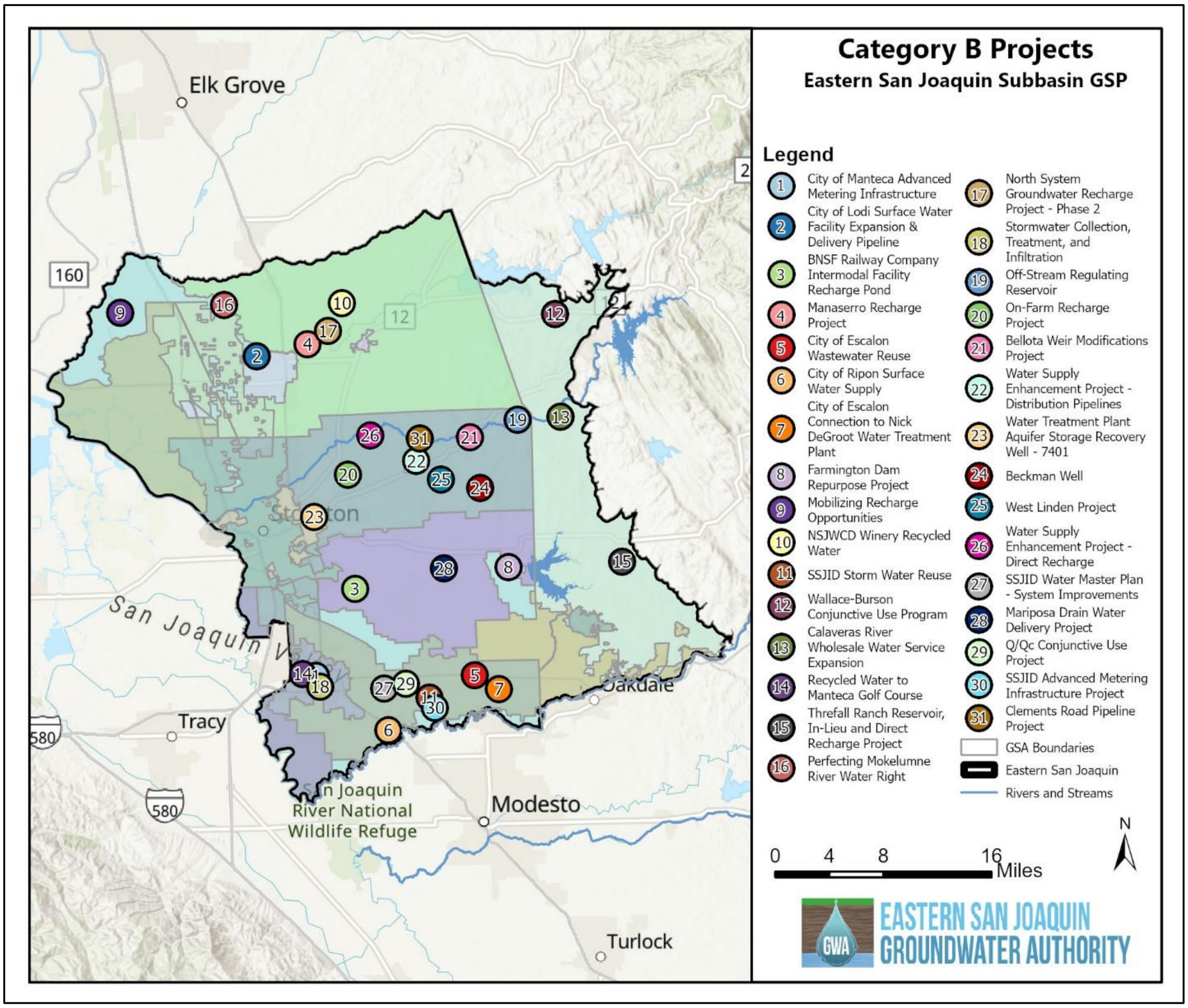


Figure 6-2: Location of Category B Projects



6.2.4 Category A Projects

As previously mentioned, Category A Projects are projects that were completed by 2024 or are anticipated to advance in the next five years and have existing water rights or agreements. The projected supply of projects in this category will be considered as offsetting the projected 2040 supply imbalance. Up to 154,900 AF/year of water is expected to be recharged in Wet years as a result of implementation of the Category A projects.

6.2.4.1 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:	2,000 - 4,900 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 has been completed.

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: Construction on the project was completed in 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 up to 4,900 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: Construction for this project has been completed.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Not applicable; this project has been constructed.

6.2.4.2 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:	4,000 – 19,000 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 currently being implemented in phases. The District converted 2,505 acres to surface water and is in the planning phase to convert an additional 1,135 acres.

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 2029.

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 19,000 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 currently being implemented in phases. As scenarios change, the project can come online to bring additional resources for adaptive management. Implementation of the project 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 currently moving forward.

6.2.4.3 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:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	3,700 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by providing direct groundwater recharge opportunities.

Project Status: Construction of this project has been completed. In WY 2023, 518 AF of direct recharge was provided by this project. Roughly 3,700 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.

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 approximately up to 3,700 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: The construction of this project has been completed. Implementation of the project will be based on long-term management or changing needs of the GSA or Subbasin.

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 Category A project that is currently moving forward.

6.2.4.4 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:	0 - 24,000 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 has been implemented and is on-going each year with available water delivery.

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 up to 24,000 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 up to 24,000 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 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 has been implemented and continues move forward. As scenarios change, the project can be adapted to bring additional resources for adaptive management. Implementation of the project 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 Category A project that is currently in operation.

6.2.4.5 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:	0 - 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 is progressing. Phase 1 was completed in 2019-2021 and included a new pump station, variable frequency drive (VFD), meters, automation equipment, SCADA, and a new main junction box at Tretheway and Brandt Roads. Phase 2 was completed in early 2024 and included new sections of the main pipeline and the addition of meters and SCADA. ID3A, formed in 2021 for construction of the Pixley lateral, was completed in 2022. NSJWCD is working on the formation of ID3B for the Handel lateral for which NSJWCD received $1M federal grant. Additionally, NSJWCD was just awarded a $3M IRWM grant for Phase 3 South System improvements to focus on more mainline replacements and increased groundwater recharge capacity. Phase 3 was awarded in 2024 and will be constructed in 2024-25. NSJWCD applied for a $3M WaterSmart Grant for Phase 4. Future phases will include additional laterals and recharge capacity along the south system to expand capacity to take additional wet year water for recharge, including MICUP water.

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. Phases 1,2,3, and the Pixley and Handel Laterals are expected to be completed by 2025. Phase 4 is expected to begin by 2025 and be completed by 2028, with future phases anticipated from 2028-2035.

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. Phases 1-4 of this project are anticipated to offset up to 10,000 AF/year in groundwater pumping in NSJWCD, with future phases offsetting an additional 15,000 AF/year. 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 $7 million in capital costs and $200,000 in annual operations and maintenance costs for Phases 1 & 2; $4 million in capital costs and $200,000 in annual operations and maintenance costs for Phase 3; $13 million in capital costs and $200,000 in annual operations and maintenance costs for Phase 4, and $10-20 million in capital costs and $200,000 in annual operations and maintenance costs for future phases. Costs for this project will be met through grant funding, landowner assessments, district property taxes, and water charges.

Circumstances for Implementation: This project is currently moving forward. As scenarios change, the full project can come online to bring additional resources for adaptive management.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Not applicable, this is a Category A project that is currently moving forward.

6.2.4.6 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 20,000 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: A 10-year water transfer project was approved by SEWD, OID, and SSJID in April 2023. 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 20,000 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 for agricultural use, and $300 per acre-foot for urban). Costs for this project will be met by recipients of water or groundwater pumping benefit.

Circumstances for Implementation: This project is currently moving forward. As scenarios change, the project can bring additional resources for adaptive management. Implementation of the project 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.

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 Category A project that is currently underway.

6.2.4.7 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 (the “PDA”) in 2014 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 now complete. The DREAM project involved 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 received a banked water credit of 50 percent of the amount of water recharge, not to exceed 500 AF. EBMUD withdrew the banked water between January and April of 2024. NSJWCD controlled the withdrawal of the banked water by pumping groundwater from a well that is centrally located in the area of recharge and then conveyed the pumped groundwater to the EBMUD Mokelumne Aqueduct. The extraction and return of the banked water were subject to a San Joaquin County groundwater export permit. The permit placed 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 and potentially direct recharge within the NSJWCD service area, 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 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:	0 - 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 demonstration portion of the project is complete. Parties need to finalize design, perform environmental review, and obtain necessary permits to operate the permanent project.

Required Permitting and Regulatory Process: The permanent 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: The pilot Dream Project was completed in April 2024. A larger project is currently in the planning stages, with implementation expected by 2030.

Expected Benefits and Evaluation: Subbasin groundwater 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 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 anticipated to move forward. As scenarios change, the project can come online to bring additional resources for adaptive management. Implementation of the project will be based on long-term management or changing needs of the GSA and their partners or Subbasin. Short-term transfers are expected to occur on an as-needed basis.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: The pilot portion of this project has been completed. Implementation of this project will be based on long-term management or changing needs of the GSA and their partners and/or Subbasin.

6.2.4.8 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 and direct recharge. Water would come from NSJWCD Permit 10477 supplies, which are available in about 55 percent of years. Average deliveries would vary around 1,000 AF/year to 4,000 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. The Lakso Project is under negotiations for expansion as the landowner recently removed 160 acres of vineyards with no immediate plans to replant. Capacity could expand to over 6 AF/day year-round if negotiations are successful. 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:	0 - 4,000 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 first phase (Phase 1A) of this project has been completed and is operational. Phase 1B is under construction, and Phase 2 is in the planning stages.

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 began in 2021 and is anticipated to 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 4,000 AF/year in groundwater pumping in NSJWCD. In addition, there are opportunities 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, district property taxes, and water charges.

Circumstances for Implementation: This project is currently moving forward. As scenarios change, the project can bring additional resources for adaptive management. Short-term transfers are expected to occur on an as-needed basis.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation this project is phased and is currently underway.

6.2.4.9 Tecklenburg Recharge Project

This project involved the construction and operation of a 10-acre recharge pond on the south side of the Mokelumne River on property purchased by NSJWCD from the Tecklenburg family. NSJWCD is using Permit 10477 water available during December 1 through June 30, and not needed for irrigation, for recharge. This project could recharge up to 2,000 AF/year 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 include the purchase of 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:	0 - 2,000 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 substantially complete. NSJWCD acquired a 10-acre parcel in 2023 and has constructed and operated the recharge basin since July 2023. NSJWCD is currently working on a new lateral from the South System mainline which would increase the project's capacity.

Required Permitting and Regulatory Process: This project would require CEQA review and a possible grading permit.

Time-table for Initiation and Completion: This project was substantially completed in 2024.

Expected Benefits and Evaluation: This project is anticipated to directly recharge up to 2,000 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 the current project will be met by water charges. Funding for additional phases has not been identified at this time.

Circumstances for Implementation: This project is currently substantially complete. As scenarios change, the project can be adapted to bring additional resources online. Implementation of the project will be based on long-term management or changing needs of the GSA or Subbasin and availability of surface water.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this project is ongoing.

6.2.4.10 City of Stockton Phase 1: Groundwater Recharge Project

This project involves the development of a groundwater recharge and recovery operation adjacent to the Delta Water Treatment Plant. The project would enhance the City of Stockton's water supply reliability by allowing for the direct recharge of surface water into the underlying groundwater basin. This project received a 2022 SGMA Implementation Round 1 grant for $250,000 to conduct a geotechnical investigation of the recharge site to determine the suitability of the site for groundwater recharge and recovery. A feasibility study was completed in December 2023 and determined a recharge potential of approximately 22,000 AFY.

A feasibility memorandum completed in 2009 that estimated that Mokelumne River water purchased from WID, along with stormwater from the City of Lodi available via the Wilkerson Lateral could be utilized for recharge purposes. An estimated amount of up to 6,500 AFY between March 1 and October 15 would be available from WID, with water assumed to be available only during water year types that are “Wet” or “Above Normal.” Additionally, Lodi stormwater is a potential source for groundwater recharge and an estimated 1,545 AFY is available mostly during winter months when precipitation occurs. The estimated recharge rate at the site was 0.8 AF/day.

In order to expand the use of Permit 21176 water, City of Stockton’s water supply from the San Joaquin River could also be utilized. With an assumed infiltration pond size of 70 acres and a wetted period of 228 days, an estimated 12,768 AFY could potentially be stored to the groundwater basin. Though if water was available during only a 90-day application period, the potential recharge volume would be 5,040 AFY. In the City of Stockton’s water rights petition[2], an annual total of 5,102 AFY was estimated to be available for groundwater banking with zero in April through June. As assumed in the feasibility study, if the recharge system can be used four times per year, than the project could provide approximately 20 TAF of recharge annually. Though this project has been called groundwater banking in the past, there are no firm plans to extract water and no more water would be extracted than was recharged. A more detailed technical analysis of the timing and quantity of water supply will be conducted in the future.

Due to the varying sources of water supply that may be available for recharge (WID water, Lodi stormwater, and Stockton water), water is expected to be able to be recharged year-round.

Project Summary	
Submitting GSA:	City of Stockton
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	20,000 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: A feasibility study for this project was completed in December 2023. The design is in progress and construction of the recharge basins will begin in spring 2025.

Required Permitting and Regulatory Process: This project would require CEQA review.

Time-table for Initiation and Completion: This project is anticipated to be completed by 2026.

Expected Benefits and Evaluation: This project is anticipated to provide water for direct recharge in the critically overdrafted subbasin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: Delta Water Treatment Plant

Legal Authority: The City of Stockton has legal authority to administer this project through Water Code §71000-73000.

Estimated Costs and Plans to Meet Costs: The estimated capital costs for this project are $11,500,000.

Circumstances for Implementation: This project is currently moving forward. As scenarios change and the project progresses, the project can come online to bring additional resources for adaptive management. Implementation of the project 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: Implementation of this project is ongoing.

6.2.4.11 West Groundwater Recharge Basin

The West Groundwater Recharge Basin will provide additional opportunities for direct recharge of surface water into the underlying groundwater basin. Between 1,500 and 16,000 acre-feet per year may be available for direct recharge, depending on available water. Due to the varying sources of water for the project (surface water and stormwater runoff), the project is anticipated to be able to recharge project water year-round.

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. Water would be recharged at a recharge basin located near SEWD's water treatment plant.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	1,500 - 16,000 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: Construction on the project started in 2024.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: This project is anticipated to be completed by 2032.

Expected Benefits and Evaluation: This project is anticipated to provide water for direct recharge in the critically overdrafted subbasin. 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 are unknown at this time. USACE is paying SEWD for soil excavation costs. The remainder of the project will be funded by SEWD or additional grant funds.

Circumstances for Implementation: This project is currently moving forward. As scenarios change, the project can come online to bring additional resources for adaptive management. Implementation of project 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: Construction of the project has begun. Implementation of this project will ultimately be based on long-term management or changing needs of the GSA or Subbasin.

6.2.4.12 NSJWCD Private Pump Partnerships

This project involves agreements between NSJWCD and existing riparian pumpers along the Mokelumne River to use their existing pumps to pump NSJWCD's Permit 10477 water for delivery to adjacent non-riparian lands or recharge basins/on-farm recharge. This project leverages existing infrastructure to achieve increased surface water use and reduced groundwater pumping in the district. NSJWCD is implementing this project for one landowner in 2024 to irrigate 200 acres and plans to add an additional 200 acres each year for five years.

Since the project plans to add an additional 200 acres every year, by 2030 there will be an estimated 1,000 acres of land receiving surface water from private pumps. The estimated volume of water for 1,000 acres is 1,500 AFY in normal years and 3,000 AFY in wet years. The project is not expected to run in drought or dry years.

Project Summary	
Submitting GSA:	North San Joaquin Water Conservation District
Project Type:	In-lieu/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	0 - 3,000 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: The first phase of this project was completed in early 2024. NSJWCD is planning to add an additional 200 acres each year for 5 years.

Required Permitting and Regulatory Process: A Minor Change Petition was submitted to the State in 2024 and is awaiting approval.

Time-table for Initiation and Completion: The first phase of this project was completed in 2024 and is anticipated to be completed by 2030.

Expected Benefits and Evaluation: This project is anticipated to provide water for in-lieu and direct recharge in the critically overdrafted subbasin. 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 the Mokelumne River. This is an existing surface water right held by NSJWCD (Permit 10477).

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 are unknown at this time. Costs will be met by District general revenue sources, and individual landowner contributions.

Circumstances for Implementation: This project is currently moving forward. As scenarios change, the project can be expanded to bring additional resources for adaptive management. Implementation of the project 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: Implementation of this project has begun; subsequent phases will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.4.13 Oakdale Irrigation District In-lieu and Direct Recharge Project

The Oakdale Irrigation District In-lieu and Direct Recharge Project is intended to be a cooperative long-term project between OID and landowners to the east of OID's boundaries within the East Side San Joaquin GSA. The purpose of this project is to allow OID to facilitate surface water deliveries for in-lieu use or direct recharge for East Side San Joaquin GSA landowners during times and conditions that will not impact OID's existing agricultural customers.

The project envisions the development of up to approximately 25,000 AF of surface water from the Stanislaus River being made available to landowners east of OID's service area boundaries in both the Eastern San Joaquin and Modesto Subbasins in all, except Critically Dry, water years. Water deliveries would occur through a limited number of existing and newly constructed private irrigation conveyance infrastructure for use between March 1st and September 30th. Some direct recharge is expected to occur from the project as canal or reservoir seepage in the conveyance network. OID surface water will not be delivered as part of the project between October 1st and March 1st. The OID Board of Directors will continue to consider and define the volume of water (if any) available to this Project on an annual basis in non-Critically Dry water years.

The OID 10-Year out-of-District Water Sales Program (10-Year Program) began in 2023 and includes 4,292 irrigated acres in the Eastern San Joaquin Subbasin within the East Side San Joaquin GSA. Under the 10-Year Program, participating landowners are required to purchase a minimum of 1.5 acre-feet per irrigated acre when surplus surface water is available from OID resulting in a minimum of 6,438 acre-feet being purchased each year. The landowners also have the opportunity to purchase and use additional surplus surface water throughout the irrigation season if available.

Project Summary	
Submitting GSA:	Oakdale Irrigation District
Project Type:	In-lieu/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	0 - 25,000 AF/year

<u>Measurable Objective Expected to Benefit</u>: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu and direct recharge opportunities to out-of-district lands in the Subbasin.

<u>Project Status</u>: The project is ongoing.

<u>Required Permitting and Regulatory Process</u>: The required permitting and regulatory process for this project has not been determined.

<u>Time-table for Initiation and Completion</u>: The project began in 2023 and is anticipated to be completed by 2032.

<u>Expected Benefits and Evaluation</u>: This project is anticipated to provide water for in-lieu and direct recharge in the critically overdrafted subbasin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

<u>How Project Will Be Accomplished/Evaluation of Water Source</u>: Surface water from Stanislaus River

<u>Legal Authority</u>: The legal authority for this project is covered under Water Code §20500 et seq.

<u>Estimated Costs and Plans to Meet Costs</u>: The estimated costs for this project are unknown at this time. Landowners participating in the 10-year program are responsible for the costs of new turnouts, private conveyance systems, and surplus surface water purchased for out-of-district irrigation.

<u>Circumstances for Implementation</u>: This project is currently moving forward. As scenarios change, the project can come online to bring additional resources for adaptive management. Implementation of the project will be based on long-term management or changing needs of the GSA, its growers, or Subbasin.

<u>Trigger for Implementation and Termination</u>: Not applicable.

<u>Process for Determining Conditions Requiring the Project have Occurred</u>: Implementation of this project will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.4.14 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 costliest. 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. The contract for this project was awarded in March 2024, and is anticipated to be completed by 2028.

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 will be completed by 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 $17 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 currently moving forward. As scenarios change, the project can be expanded to bring additional resources for adaptive management. Implementation of the project 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: Implementation of this project will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.5 Category B Projects

Category B projects are defined as projects that are not anticipated to advance in the next five years, but may be implemented 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. Together these projects result in a total maximum benefit of 509,985 AF/year in groundwater offset/recharge/conservation that could potentially be made available to the Subbasin if funding and water rights are secured.

6.2.5.1 City of Manteca Advanced Metering Infrastructure

The City of Manteca provides treated drinking water through approximately 20,696 service connections. In order to improve the 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 flows 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 and reducing pumping.

Project Status: This project is currently experiencing delays due to higher priority projects needed.

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 has experienced delays due to higher priority projected needed. The project's implementation will continue once funding is available.

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; however, funding is currently not available due to the need for higher priority projects.

Circumstances for Implementation: 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 project is currently in the planning stage.

6.2.5.2 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 room extension, 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 of savings 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 (surface water) 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 through the expansion of treated surface water. 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 currently a planned project that is anticipated to move forward and be online by 2040.

6.2.5.3 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 is anticipated to proceed in WY 2024, subject to available funding.

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 currently in the planning stages and may move forward if funding becomes available. Category B 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 Category A projects. As scenarios change, this project 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 Category B projects will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.5.4 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 8,000 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. NSJWCD is continuing to work on a strategic plan and funding options for the implementation of this project, and continuing negotiations with the landowner.

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 is anticipated to completed by 2025.

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 Category B project and may move forward as funding becomes available. Category B 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 Category A projects. As scenarios change, the project 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 this will depend on funding availability, securement of the property lease and planning.

6.2.5.5 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 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 2030 and would be completed by 2035.

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 inter-basin 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 Category B project, meaning it is currently in the planning stages and may move forward if funding becomes available. Category B 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 Category A projects.. 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 this project be based on the results of a feasibility analysis. The Escalon City Council would need to make the requisite findings and approve a financing package for this project.

6.2.5.6 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. A 5-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 2028 and would be completed by 2030.

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 6,000 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 Category B project, meaning it is currently in the planning stages and may move forward if funding becomes available. Category B 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 Category A projects.. The City of Ripon is in the process of completing the environmental documentation for this project 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 project construction.

6.2.5.7 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. The project is pending further design work and rate study by the Council.

Required Permitting and Regulatory Process: This project will require road encroachment permits.

Time-table for Initiation and Completion: This project would begin in 2028 (pending funding) and be completed by 2030.

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 Category B project, meaning it is currently in the planning stages and may move forward if funding becomes available. Category B 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 Category A projects. The environmental review for this project has been completed and 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 this project will be based on the Escalon City Council making the requisite findings and approving a financing package and rate increase for this project.

6.2.5.8 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:	15,500 - 60,000 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. SEWD has been working with Congressmen Harder to include this project in the 2024 Water Resources Development Act bill to re-authorize a new feasibility study.

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 60,000 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 Category B project in the early planning stages and will require significant additional work to move forward. This project could be implemented when agreements are reached with all applicable 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 this project will depend on the successfully execution of agreements with applicable federal and state agencies, and after securing funding to complete design, environmental documentation and construction.

6.2.5.9 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:	110,000 – 158,000 AF/year

[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).

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct and/or in-lieu recharge opportunities.

Project Status: This project is still in the early development stages. Under a SGMA Implementation Grant Program Round 1 award, the County has begun advancing the project to put to beneficial use water appropriated through the Mokelumne River Water and Power Authority's water right application using existing and new infrastructure.

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 of this project may begin in 2024, with environmental review and water rights applications beginning in 2025, and expected project completion by 2040.

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: A portion of this project has been funded through a SGMA Round 1 Implementation Grant. The remaining costs for this project and approach for meeting costs are unknown at this time.

Circumstances for Implementation: The plan to be developed under this project has just begun. Once completed, potentially feasible projects would have to undergo design, environmental review, permitting and construction prior to any operation.

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 feasible projects identified in the study being conducted under the grant funding would need to be approved by the identified implementation agency(ies). Design, environmental review, permitting and construction, and the funding stream to support those efforts, would have to occur before the feasible projects can be brought online.

6.2.5.10 NSJWCD 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 conceptual project currently in the early stages and would require significant additional work to move forward. Funding would have to be secured to advance project design, permitting, environmental review and construction, and coordination contracts with the participating winery(ies) executed before the projects can be brought online.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this will be based on long-term management or changing needs of the GSA or Subbasin, the willingness of local winery(ies) to participate, and the availability of funding.

6.2.5.11 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 in the early conceptual planning stages and would require significant additional work to move forward. 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 this project will be based on long-term management or changing needs of the GSAs or Subbasin, and the availability of funding to further the project.

6.2.5.12 Wallace-Burson Conjunctive Use Program

This project would use surface water from New Hogan Reservoir, Mokelumne State-Filed Rights Application, and/or purchased water for direct recharge into the groundwater basin and/or to offset groundwater pumping. Surface water would be recharged in the Wallace Service Area and the communities of Burson and Southworth.

Project Summary	
Submitting GSA:	Eastside GSA
Project Type:	Conjunctive Use/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	500 - 3,000 AF/year

Measurable Objective Expected to Benefit: This project addresses the chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities and/or conjunctive use.

Project Status: This project is still in the conceptual planning and discussion stages. Hydrogeology and water supply studies have been developed, and the design of specific program facilities is ongoing.

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 of this project may begin by 2030 with completion by 2040, if funding is identified and the project is implemented.

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: The legal authority for this project is covered under Water Code § 30000 et seq.

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 this project will be based on long-term management or changing needs of the GSA or Subbasin, the availability of funding, and the willingness of project partners to design, construct and execute the project.

6.2.5.13 Calaveras River Wholesale Water Service Expansion

Calaveras County Water District (CCWD) has available surface water supply to set up agreements that would facilitate in-lieu recharge opportunities in the Calaveras County portion of the Subbasin. This project would identify opportunities for the conjunctive use and recharge of surface water into the groundwater basin. The amount of recharge will be dependent on the opportunities identified, and projects developed and implemented.

Project Summary	
Submitting GSA:	Eastside GSA
Project Type:	In-Lieu Recharge
Estimated Groundwater Offset and/or Recharge:	200 - 600 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 still in the conceptual development 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 currently unknown.

Expected Benefits and Evaluation: This project is anticipated to recharge the groundwater basin in the Calaveras County portions of 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: The legal authority for this project is covered under Water Code § 30000 et seq.

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: This project is in the early stages of planning. Implementation of the project will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.5.14 Recycled Water to Manteca Golf Course

In response to growing demands for recycled water projects, the City of Manteca adopted the Reclaimed Water Facilities Master Plan in January 2023. The City is pursuing recycled water projects to create a replenishable water source for irrigation and water storage. This project would send reclaimed water to irrigate the Manteca Golf Course. Once the recycled water infrastructure is in place, an estimated 5,000 AF/year of groundwater could be offset by the use of recycled water for irrigation.

Project Summary	
Submitting GSA:	City of Manteca
Project Type:	Recycling
Estimated Groundwater Offset and/or Recharge:	406 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by providing recycled water for irrigation, rather than being supplied by groundwater.

Project Status: A 12-inch pipeline that would deliver reclaimed water has been installed. The City is currently pursuing other funding, such as grants, to finance the construction of pump stations and storage tanks needed to deliver the recycled water.

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 completion dates for this project are currently unknown.

Expected Benefits and Evaluation: This project is anticipated to offset groundwater pumping with the use of recycled water. 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: 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 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: Funding is required to complete the design, environmental review, permitting and construction of project facilities. As such, implementation of this project will be based on long-term management or changing needs of the GSA or Subbasin and the fiscal feasibility of the project.

6.2.5.15Threfall Ranch Reservoir, In-Lieu and Direct Recharge Project

This project involves the construction of an unlined reservoir which could provide an estimated 2,000 AF/year of in-lieu recharge in the Subbasin. The reservoir is designed to be unlined, allowing an unspecified volume of water to seep into the groundwater basin through direct recharge.

Project Summary	
Submitting GSA:	Eastside GSA
Project Type:	In-Lieu Recharge/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	2,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu and/or direct recharge opportunities.

Project Status: The final design of this project has been completed. Once funding has been identified, environmental review and permitting for the project will begin.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: This project is anticipated to be completed by 2025.

Expected Benefits and Evaluation: This project is anticipated to provide water for in-lieu and direct recharge in the critically overdrafted 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: The legal authority for this project is covered under Water Code § 30000 et seq.

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 need for funding is the key factor in the implementation of this project. Funding is required to prepare the environmental review documentation, complete permitting, and for project construction and startup.

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 this project will be based on long-term management or changing needs of the GSA or Subbasin and the identification of funding required to complete environmental review documentation, permitting, and for project construction and startup.

6.2.5.16 Perfecting Mokelumne River Water Right (MICUP Project)

This project advances MRWPA's Water Right Application 29835 (A029835) to a Water Right Permit with the State Water Resources Control Board. The application aims to appropriate up 110,000 acre-feet of unappropriated wet year flows from the Mokelumne River annually, with an additional 48,000 acre-feet/year of storage. Appropriated water could be used for addressing groundwater overdraft concerns in the Subbasin by storing wet-year water for use during drier periods.

Project Summary	
Submitting GSA:	San Joaquin County
Project Type:	In-Lieu Recharge
Estimated Groundwater Offset and/or Recharge:	110,000 - 158,000 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: The water rights application for this project is in progress. A Notice of Preparation for CEQA documentation was issued in July 2024.

Required Permitting and Regulatory Process: SWRCB water rights permitting, plus other project-specific permitting as required to put the water to beneficial use.

Time-table for Initiation and Completion: Implementation of this project has begun, with an expected completion by 2025.

Expected Benefits and Evaluation: This project is anticipated to amend the water right application to provide future in-lieu recharge opportunities in the groundwater basin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project is contingent on the SWRCB Division of Water Rights approval of the water right application for the diversion of surface water from the Mokelumne River.

Legal Authority: The legal authority for this project is that accorded under the California Government Code to joint powers of authority for the provision of public services.

Estimated Costs and Plans to Meet Costs: $125,000 has been spent to date. The estimated remaining costs for this project and approach for meeting costs are unknown at this time.

Circumstances for Implementation: SWRCB Division of Water Rights approval of the water rights application and issuance of a water right permit is required for successful implementation of this project.

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 this will be based on securing a water right to the MRWPA's Water Right Application 29835 (A029835) and to identifying, developing and constructing the projects to put that water right to beneficial use to address the long-term management or changing needs of the GSA or Subbasin.

6.2.5.17 North System Groundwater Recharge Project - Phase 2

The North System Master Plan will identify opportunities for direct and/or in-lieu recharge of the underlying critically overdrafted subbasin. Preliminary estimates indicate that additional 1,000-3,000 AF/year of recharge could occur off the North System in wet and normal years through either direct and/or in-lieu recharge.

Project Summary	
Submitting GSA:	North San Joaquin Water Conservation District
Project Type:	In-Lieu/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	1,000 - 3,000 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: The Master Plan for the entire North System is currently in progress. A team has also been retained to design and build a new pump station in 2024-2026.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: Construction on this project is anticipated to begin in 2026 with completion by 2029.

Expected Benefits and Evaluation: This project is anticipated to directly recharge the groundwater basin in the North System extent of NSJWCD. 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: 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 $10 million in capital costs and $100,000 in annual operations and maintenance costs. A $3 million state grant was secured to help with project costs. Additional funds for this project will be met by landowner assessments, water charges, and any further grant funds the District can obtain.

Circumstances for Implementation: Completion of the North System Master Plan will identify potential projects for direct and/or in-lieu recharge. The circumstances for implementation of projects identified in the Master Plan are unknown at this time and will be project dependent.

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: The Master Plan for the North System will identify opportunities for direct and in-lieu recharge in the North System of the District's service area. Design, permitting, and environmental review will need to be completed on the most feasible projects before construction can begin.

6.2.5.18 Stormwater Collection, Treatment, and Infiltration

The City of Manteca will conduct a study to determine what space may be available for use in a stormwater recharge program, identify treatment technologies available and determine volume of rainwater available for groundwater recharge. The City is currently working on identifying a funding source for the study.

Project Summary	
Submitting GSA:	City of Manteca
Project Type:	Direct Recharge/ Stormwater
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 identifying potential direct recharge opportunities using captured stormwater.

Project Status: This project is still in the early planning and initial study stage.

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 currently unknown.

Expected Benefits and Evaluation: This project is anticipated to identify opportunities for direct recharge into the groundwater basin. 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: 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 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 projects will be based on long-term management or changing needs of the GSA or Subbasin and availability of funding.

6.2.5.19 Off-Stream Regulating Reservoir

This project would provide additional opportunities for the direct recharge of surface water into the underlying groundwater basin. This project would use surface water from the New Hogan Reservoir (Calaveras River water) using existing and pending surface water rights.

This project is currently in the early design stages. SEWD has identified a preliminary list of ideal locations based on the operational benefits to the distribution system. These locations will be compared against areas most suitable for recharge. Discussions with landowners are necessary, and land acquisition may also be required. The amount of recharge that this project may provide is still unknown at this time.

Project Summary	
Submitting GSA:	Stockton East Water District
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 providing additional direct recharge opportunities.

Project Status: This project is still in the early conceptual 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 currently unknown.

Expected Benefits and Evaluation: This project is anticipated to directly recharge the groundwater basin. 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 under existing and possible future surface water rights.

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 are unknown at this time. The project would hopefully be funded through grant funds.

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 this longer-term project will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.5.20 On-Farm Recharge Project

The District has developed and approved an On-Farm Recharge Policy to incentivize farmers to participate in Flood-MAR opportunities. The project would use existing farm infrastructure to divert surface water for direct recharge through FloodMAR, or potentially dry wells. SEWD is currently looking for agricultural customers to participate in this program. As such, the amount of water that may be recharged through this program is unknown at this time.

Project Summary	
Submitting GSA:	Stockton East Water District
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 project 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 currently unknown.

Expected Benefits and Evaluation: This project is anticipated to directly recharge water into the groundwater basin. 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: 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 $100,000 in annual operations and maintenance costs. Costs for this project will be met by district staffing, district rates created to establish a new Flood-MAR project, and other district funding for on-farm incentive programs.

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 this longer-term project will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.5.21 Bellota Weir Modifications Project

The purpose of the Bellota Weir Modifications Project is to provide fish passage for the Central Valley Steelhead in addition to providing more efficient water diversion and flow metering of agricultural, municipal and ecological water. The project will conserve approximately 1,100 AF annually of surface water upon completion of Phase 1 with the installation of the concrete sill. The project will increase the Old Calaveras River recharge from 6,300 acre-feet (AF) to 11,500 AF annually per the SEWD's water rights on the Calaveras River.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	Direct Recharge/ Stormwater
Estimated Groundwater Offset and/or Recharge:	2,000 - 5,000 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 still in the design stages. SEWD has promoted the project in Washington DC in order to secure funding through appropriations.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: This District is looking to secure funding for the project. The anticipated completion of this project is by 2030.

Expected Benefits and Evaluation: The project will allow for the controlled flow into the Old Calaveras River to increase infiltration of surface water into the underlying critically overdrafted 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: 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 $85 million in capital costs. Costs for annual operations and maintenance are still unknown. SEWD is looking to obtain grant funding and state and federal loans to cover the costs of this project.

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 this longer-term project will be based on the availability of funding and the long-term management or changing needs of the GSA or Subbasin.

6.2.5.22 Water Supply Enhancement Project - Distribution Pipelines

This project aims to enhance water supply accessibility for on-farm in-lieu recharge by distributing surface water to the Linden area through a network of proposed pipelines, including the Clements Gravity pipeline, Houston Gravity pipeline, Demartini pipeline, and Mosher pipeline. By providing surface water to farmers who currently lack access, the project will significantly reduce groundwater overdraft in these regions. The estimated water offset ranges from 5,000 to 17,000 acre-feet per year, depending on the water year type. SEWD is coordinating with landowners in the project area to secure easements and gauge interest in participation.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	In-Lieu/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	17,000 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 still in the early design 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 dates for this project are currently unknown.

Expected Benefits and Evaluation: This project is anticipated to provide access to surface water to those who currently don't have access, thereby greatly reducing groundwater overdraft. 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: 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 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: The project is currently in the preliminary design phase. The environmental review and permitting of the project remain to be completed ahead of construction.

6.2.5.23 Water Treatment Plant Aquifer Storage Recovery Well – 7401

This project will recharge treated water directly into the groundwater basin and store it until periods of drought, when the water can be extracted and used. A new aquifer storage and recovery (ASR) well will be installed near SEWD's water treatment plant, capable of recharging up to 350 gpm and producing 1,500 gpm. The well will serve as a supplemental water source for the water treatment plant in dry years and will be used to directly recharge groundwater in wet years. The estimated range of water available for recharge is between 1,000 and 2,420 acre-feet per year, depending on the water year type and availability.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	1,000 - 2,420 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 currently being implemented. Design has been completed, and funding has been secured. Construction is scheduled to begin in 2025, with anticipated completion by 2026.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: This project has been initiated and expected to be completed by 2026.

Expected Benefits and Evaluation: This project is anticipated store excess water in wet years for later use in drought periods, thereby reducing the groundwater deficit. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: Supply to this well for aquifer storage will be treated water from the Cal Water distribution system.

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 $1.5 million in capital costs. Funding sources for this project have not yet been identified.

Circumstances for Implementation: Environmental documentation and permitting remain to be completed before the project can be bid and constructed.

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: This project is a Category B project on which design has been completed. Additional work, including environmental documentation and permitting, is required to move the project forward. Additionally, a contract with Cal Water will be required to obtain treated water for injection. .

6.2.5.24 Beckman Well

The Beckman well was a project implemented in the early 2000's as a collaboration between the East Bay Municipal Utilities District and SEWD along the Mokelumne Aqueduct. SEWD is looking assess the current status of the well and determine the requirements to revive it as a functioning aquifer storage and recovery (ASR) well. If implemented, this project would recharge surface water from the East Bay Mud Aqueduct or the New Hogan Reservoir (Calaveras River water) for storage in the aquifer, to be later extracted during drought periods. Estimates of the amount of water available for recharge are currently unknown.

Project Summary	
Submitting GSA:	Stockton East Water District
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 project development stages. SEWD is looking to hire a company to understand the current status of the well and what would be required to revive it as a function ASR well.

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 currently unknown. If implemented, this project may be completed by 2028.

Expected Benefits and Evaluation: This project is anticipated to directly recharge water during wet periods for storage and later extraction. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project would recharge surface water from the East Bay Mud Aqueduct or the New Hogan Reservoir (Calaveras River water).

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 $20,000 million in capital costs. Costs for annual operations and maintenance are unknown. SEWD and MICUP will provide funds for this project.

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: The proposed well needs to be assessed to determined its suitability for use as an injection well. Therefore, the status of the well will determine if the project is feasible for construction.

6.2.5.25 West Linden Project

This project would provide surface water for in-lieu and direct recharge in the area west of Linden, where the groundwater table is at its lowest. Surface water would be provided using Mokelumne Aqueduct Water and New Hogan Reservoir (Calaveras River) water. Estimates of the amount of water that would be available for direct or in-lieu recharge range from 5,000-60,000 AF/year, depending on water year type and availability.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	In-Lieu/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	5,000 - 60,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct and/or in-lieu recharge opportunities.

Project Status: This project is still in the early planning and design stages. SEWD is working on discussion with MICUP and EBMUD to discuss collaboration and funding.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: If implemented, this project may be completed by 2035.

Expected Benefits and Evaluation: This project is anticipated to provide direct and in-lieu recharge opportunities for the groundwater basin in areas where the groundwater table is typically at its lowest. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: Mokelumne Aqueduct Water and New Hogan Reservoir (Calaveras River) water

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 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 this longer term project will be based on long-term management or changing needs of the GSA or Subbasin and coordination with participating partners.

6.2.5.26 Water Supply Enhancement Project - Direct Recharge

This project would use surface water from the New Hogan distribution system to implement direct recharge projects, such as dry wells or recharge basins along SEWD's distribution system. SEWD is currently engaging with landowners of potential sites to assess their interest in participating. At this stage, the estimated volume of water that could be recharged remains undetermined.

Project Summary	
Submitting GSA:	Stockton East Water District
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 project development 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: If implemented, this project may be completed by 2030.

Expected Benefits and Evaluation: This project is anticipated to directly recharge the groundwater basin in areas along SEWD's distribution area. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: New Hogan Reservoir (Calaveras River) water

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 are unknown at this time. Costs would be provided by SEWD and any grants the District is able to secure.

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: This project is in the preliminary stages. Additional analyses need to be conducted to identify appropriate areas for recharge, and coordination agreements with property owners and/or land acquisitions will be required before the project can move forward.

6.2.5.27 SSJID Water Master Plan - System Improvements

Several thousand acres within SSJID are unable to utilize surface water or have limited access due to capacity issues and evolving irrigation practices. To address this, SSJID has identified numerous capital projects aimed at improving capacity and utilizing flow controls to accommodate additional growers returning to SSJID surface water deliveries.

SSJID has embarked on a comprehensive Water Master Plan to address its aging infrastructure and make strategic improvements to its irrigation systems. The plan includes increasing lateral capacity, constructing new reservoirs, and implementing additional SCADA controls. In total, SSJID has identified $191 million in capital improvements. To fund these projects, SSJID completed a substantial Prop 218 rate increase in July 2023. Through 2040, SSJID expects to implement several capital projects outlined in the Water Master Plan. Estimates of the benefit to the groundwater basin range from 10,000 – 15,000 AF/year.

Project Summary	
Submitting GSA:	South San Joaquin GSA
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	10,000 - 15,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by providing surface water to additional customers in the District for use in-lieu of groundwater.

Project Status: A feasibility study for this project has been completed.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: SSJID is anticipating completing several projects outlined in the Water Master Plan through 2040.

Expected Benefits and Evaluation: This project is anticipated to provide surface water to district growers for use in-lieu of groundwater. This will indirectly 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 projects develop but will be utilizing SSJID permitted water supplies.

Legal Authority: SSJID is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SSJID is also a GSA with authority on groundwater pumping.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $30-40 million in capital costs. Costs for annual operations and maintenance are unknown at this time. Funding will be provided through existing revenue sources such as hydropower generation, user fees, and water charges. Enhanced sources such as increased user fees and additional water transfers may also contribute. External funding may also be secured through grants, earmarks, or other water transfers.

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: The feasibility study to identify potential in-lieu recharge projects has been completed. Implementation of projects identified in the study will be based on long-term management or changing needs of the GSA or Subbasin and the availability of funding and willing growers.

6.2.6 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 cost about $100,000 and will take two years to complete once funding has been identified.

6.2.7 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 completed to date for the Subbasin; however, Subbasin GSAs are planning to develop a Demand Management Program that will provide needed structure and flexibility to implement such demand-side management actions in the future if need is determined. As part of the development of the demand reduction program, public outreach and education on the potential structure of the program, as well and feasible monitoring and enforcement mechanisms, will be conducted as necessary to enable a successful program. Outreach could include public notices, meetings, website or social media presence, workshops 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, 2021).
- **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, 2021)
- **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, 2021).
- **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, 2021).
- **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, 2021).
- **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, 2021).
- **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, 2021).
- **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, 2021).

- **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, 2021).

In the 2024 GSP Amendment, two new management actions were added:

- **Dewatered Domestic Well Mitigation Program:** This program will provide a formalized process through which the ESJGWA can track and mitigate the dewatering of domestic wells as a result of subbasin management activities. The program was adopted by the ESJGWA in September 2024 and is expected to be implemented starting in 2025. Additional detail on this program can be found in Appendix 3-J.

- **Demand Management Program:** A framework for a Subbasin-wide Demand Management Program will be developed as part of this management action. This program will serve as a backstop that can be activated if projects fall short of meeting expected supply-side targets. The program will be developed and preliminarily implemented, if needed, by GSAs between 2025 and 2030. The program is expected to rely on an iterative process that incorporates analysis of hydrologic conditions, assessment of PMA progress, development of a demand reduction target using ESJWRM, and distribution of demand reduction goals amongst the GSAs. An initial program outline is included in Appendix 6-B, but the program is expected to evolve significantly by 2030.

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
- Addressing identified data gaps
- 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. It was stated in the 2020 GSP that 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. In the 2024 GSP Amendment, a new management action is being added to the GSP to formalize the development of a Demand Management Program that can be used as a backstop, if necessary, to ensure the recovery of the principal aquifer if the Subbasin falls short on project implementation and groundwater offset targets. It is the still the overall theme and goal of the ESJ GSP to first implement PMAs to manage overdraft and reach basin sustainability. However, this management action is intended to respond to direction provided by DWR and to outline the demand side action that would be taken if supply side actions are not effective in meeting overall basin sustainability goals. 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 herein and in Chapter 2 of this revised GSP), the adaptive management actions identified below could be implemented in coordination with Category B projects if additional measures are required to sustainably manage groundwater in the Subbasin. These alternative 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 2031 following reevaluation of Subbasin sustainability during the 5-Year Periodic Evaluation in 2030. 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.

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Additionally, the ESJGWA 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 of a 2022 Revised GSP, 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 addressed this deficiency). Potential Deficiency 1 also requested 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 had become available in the two years after 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 6-1, along with project assumptions. As part of the 5-year Periodic Evaluation, the ESJGWA again worked with each GSA to update the GSP project and management action descriptions included in the 2022 Revised GSP, to add new projects and management actions to the PMA list, and to remove any project that is no longer feasible. This updated information is also reflected in Table 6-1. Please see Chapter 2, Basin Setting, and Appendix 2-D 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.[1] Category B projects may be elevated to a Category A project should feasibility studies or other assessments 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.

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 projects and management actions and to 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

[1] City of Stockton's Advanced Metering Infrastructure project was added as a Category A project during the Public Comment period of the 2024 GSP Amendment. Therefore, it is not included in the PMA simulation results shown in the 2024 GSP Amendment. It will be simulated in future GSP Amendments.

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 6-2 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 Chapter 7: Plan Implementation.

Table 6-2: 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 (CWSRF)	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 (CWSRF)	Applications accepted on continuous basis.
Drinking Water	Planning and implementation grants	Groundwater Grant Program (SDWSRF)	There are no solicitations currently available under this program.
Public water system improvements	Planning and construction grants and financing	Drinking Water Grants	Applications accepted on continuous basis.
Stormwater recharge projects	Implementation grants	Storm Water Grant Program	There are no solicitations currently available under this program.
IRWM projects (included and implemented in an adopted IRWMP)	Implementation Grant	IRWM Implementation Grant Program	There are no solicitations currently available under this program.
Sustainable Groundwater Management	Planning and implementation grants	SGMA-related grant program	There are no solicitations currently available under this program.
Various	Planning and implementation grants	WaterSMART grant program	There are multiple programs under the USBR WaterSMART grant program with varying requirements. Individual projects should visit grants.gov to look at open funding opportunities.

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 annual reporting
- Data collection and analysis
- Public outreach
- Development of 5-year Periodic Evaluation and GSP amendments as needed
- Grant writing

This chapter provides a description of the above items, including contents of the annual and 5-year Periodic Evaluation 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 an initial 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 GSP implementation continued.

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, updated to reflect current understanding as of the 2024 GSP Amendment. These activities are necessary for ongoing GSP monitoring and updates; Figure 7-1 also includes tentative schedules for projects and management actions. Additional details on the activities included in the timeline are provided in the activities' respective sections of this GSP.

Table 7-1: GSP Schedule for Implementation 2020 to 2040

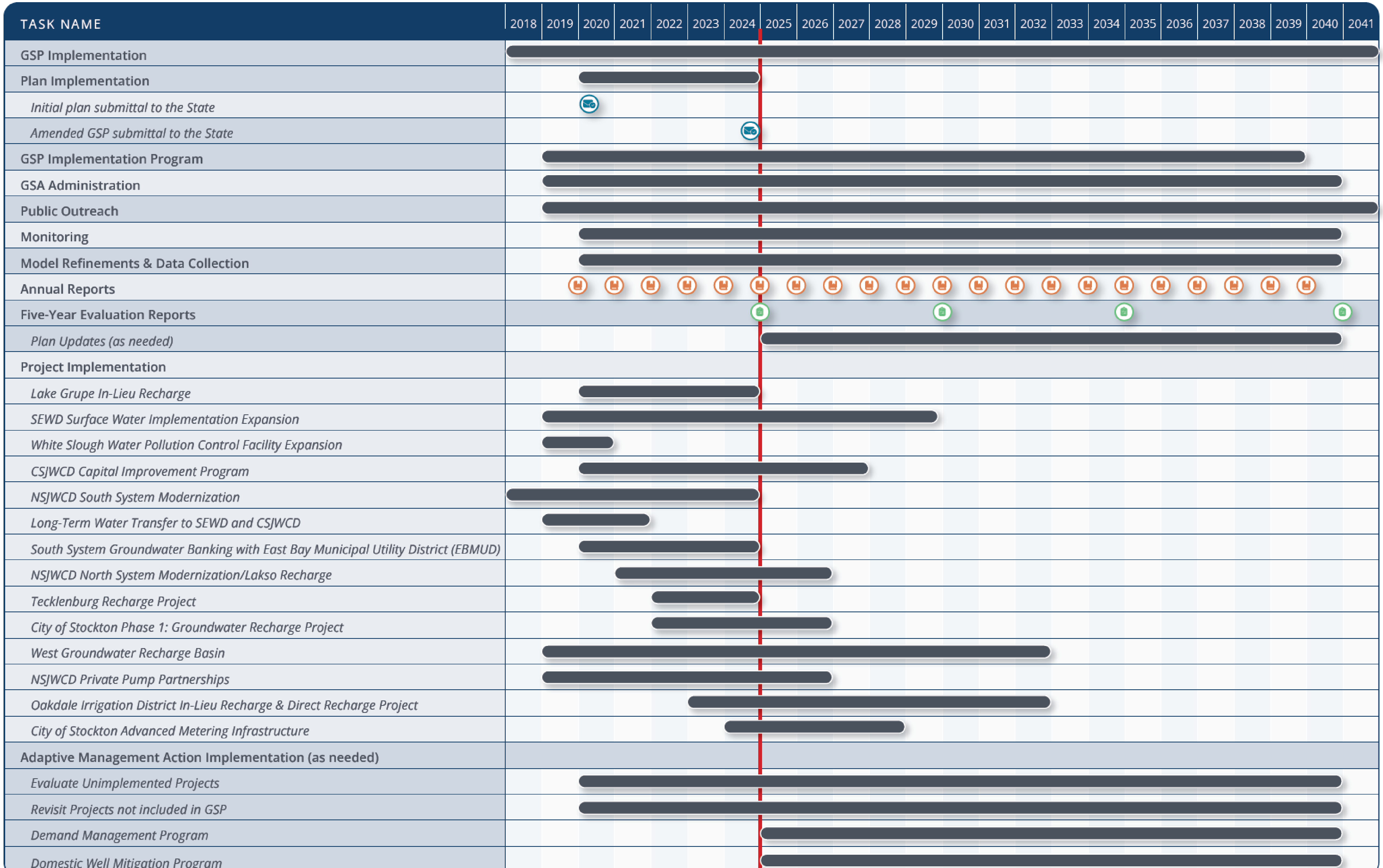
2020 — Monitoring and Reporting	2025 — Project Implementation	2030 — Prepare for Sustainability	2035 — Implement Sustainable Operations (2040)
• Establish monitoring networks • Construct new wells • Model refinement and verification studies • Initial project implementation • Ongoing outreach regarding GSP and projects	• GSAs conduct 5-year periodic evaluation/update • Project implementation continues • Model refinement continues as needed • Demand management policy/plan developed • Demand reduction implemented where possible • Monitoring and reporting continue • Outreach regarding GSP and projects continues	• GSAs conduct 5-year periodic evaluation/update • Longer-term/ conceptual project evaluation • Project implementation continues • Demand management policy/plan implementation begins • Model refinement continues as needed • Monitoring and reporting continue • Outreach continues	• GSAs conduct 5-year periodic evaluation/update • Demand management policy/ plan implemented as needed • Project implementation completed

In the five years since the 2020 GSP was adopted, the ESJGWA has dedicated significant resources to the tasks identified in the first column in Table 7-1. A high-level summary of these efforts is summarized below. For a current understanding of GSP implementation work, please consult the most recent Annual Report and 5-Year Periodic Evaluation.

- Establish and improve monitoring networks
  - Three additional wells were added to the groundwater level Representative Monitoring Network (RMN), for a total of 23 representative monitoring wells.
  - The water quality RMN was expanded into a larger combined network, which now includes 2 new wells in Stockton, 3 new wells from the groundwater level RMN, one nested well from the previous (2020) broad monitoring network for water quality, and five additional wells that fill data gaps on the eastern and southern portions of the Subbasin, for a total of 11 wells. Chloride will also be monitored at these wells in addition to total dissolved solids going forward.
  - The seawater intrusion sustainable indicator was deemed an inapplicable sustainability indicator, and the associated sustainable management criteria and monitoring were removed from the GSP.
  - A new RMN for subsidence was established in the 2024 GSP Amendment. Direct subsidence monitoring will occur at four continuous global positioning system (CGPS) stations and 6 survey benchmark locations going forward. Basin-wide InSAR will also be downloaded and analyzed on an annual basis as part of monitoring for subsidence in the Subbasin.

   - A new RMN for interconnected surface water was established in the 2024 GSP Amendment. This new network includes 6 groundwater levels RMN wells that are within 5 miles of streams, 5 new wells installed specifically for interconnected surface water monitoring, and 1 new well installed in the Delta. Stream gages and other shallow wells adjacent to streams will also be analyzed, but do not have sustainability criteria established.
- Construct new wells
   - Constructed two new multi-completion wells through the Technical Support Services grant with DWR in the NSJWCD and SEWD service areas (2021)
   - Constructed five new wells through the Prop 1 SGM grant through DWR to capture information related to interconnected surface waters (2022)
   - Constructed one new multi-completion well in the Delta (northwestern) area of the Subbasin (2024)
- Model refinement and verification studies
   - Extended hydrology as part of the development of the Annual Reports (2019, 2020, 2021, 2022, 2023)
   - Major model update and calibration (2021-2022)
   - New model scenarios development and calibration (2022)
   - Major model update and calibration (2024)
- Project implementation
   - CCWD Automated Metering Infrastructure (AMI) Replacement and Conversion has been completed (2022).
   - Construction is completed for the White Slough Water Pollution Control Facility Expansion project (2020).
   - Phases 1, 2 and 3 completed for the NSJWCD South System Modernization project (2024).
   - Pilot Dream Project was completed in February 2024 for the South System Groundwater Banking with East Bay Municipal Utilities District project.
   - Phase 1A was constructed and began operation for the NSJWCD North System Modernization/Lakso Recharge project (2024).
   - Tecklenburg Recharge Project began operation in 2023 and is substantially completed.
   - One agreement was executed in 2024 with an existing riparian pumper for the NSJWCD Private Pump Partnerships project.
   - OID in-lieu and Direct Recharge program began deliveries of surface water to be used in-lieu of groundwater in 2023.
   - OID and SSJID long-term transfer to SEWD was approved in 2023 and is set to begin operation in non-wet years.
   - Construction on the Lake Grupe in-lieu recharge project has been completed (2023).
   - SEWD completed conversion of 2,505 acres to surface water through the SEWD Surface Water Implementation Expansion project (2024).
   - Construction began on the West Groundwater Recharge Basin (2024).
   - The City of Stockton Groundwater Recharge Basin design is in progress.
   - The City of Stockton Advanced Metering Infrastructure was contracted in March 2024.
- Ongoing outreach regarding GSP and projects
   - GSA-specific targeted outreach to their constituencies regarding SGMA and ongoing projects to support groundwater sustainability
   - Ongoing webpage updates
   - Public survey to inform future outreach and engagement activities
   - Public meetings and open house during development of the 2024 GSP Amendment

Figure 7-1: GSP Implementation Schedule



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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 Subbasin-wide management and GSP implementation will be borne by the ESJGWA through contributions from the member GSAs under a cost-sharing arrangement developed following adoption of the 2020 GSP. Projects will continue to 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.

The table includes both Category A and Category B projects. Both category types are planned projects. Category A projects however, meet the following criteria:

- Are likely to advance by 2030
- Have necessary water rights or agreements in place

Category B projects 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.

Table 7-2: Costs to GSAs and GSP Implementation Costs

Activity	Estimated Cost[1]
GSP Implementation and Management for GSAs	
Monitoring and Reporting	
Monitoring	$150,000 - $175,000 (annually)
Annual Reporting	$65,000 - $90,000 (annually)
Data Management System Updates	$0 - $125,000 (as-needed, annually)
Data Collection and Analysis	
Model Refinements	$0 - 100,000 (annually)
Additional Wells if needed	$600,000 (as needed)
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 (Category A)	
Lake Grupe In-Lieu Recharge	$2.3 million (one time) $330,000 (annually)
SEWD Surface Water Implementation Expansion	$750,000 (one time) $100,000 (annually)
White Slough Water Pollution Control Facility Expansion	$6 million (one time) – complete $4,664 (annually)
CSJWCD Capital Improvement Program	$50,000 (annually)

NSJWCD South System Modernization	Phase 1&2: $7 million (one time) $200,000 (annually) Phase 3: $4 million (one-time), $200,000 (annually) Phase 4: $8 million (one-time), $200,000 (annually) Future Phases: $10-20 million (one-time), $200,000 (annually)
Long-term Water Transfer to SEWD and CSJWCD	Up to $9 million (annually)
South System Groundwater Banking with East Bay Municipal Utilities District (EBMUD)	Phase 1: $3,000,000 (one-time) Phase 2: Estimated $5-15 million (one-time), annual cost to be determined
NSJWCD North System Modernization/Lakso Recharge	$4,000,000 (one-time) $100,000 (annually)
Tecklenburg Recharge Project	Phase 1: $750,000 (one-time), $100,000 (annually) Phase 2: $1,500,000 (one-time), $100,000 (annually)
City of Stockton Phase 1: Groundwater Recharge Project	$11,500,000 (one-time), annual costs to be determined, as of 2024.
West Groundwater Recharge Basin	To be determined, as of 2024.
NSJWCD Private Pump Partnerships	To be determined, as of 2024.
Oakdale Irrigation District In-lieu and Direct Recharge Project	To be determined, as of 2024.
City of Stockton Advanced Metering Infrastructure	$17,000,000 (one-time), annual costs to be determined, as of 2024.
Implementing GSP: Projects (Category B)	
City of Manteca Advanced Metering Infrastructure	$650,000 (one time) $300,000 (annually)
City of Lodi Surface Water Facility Expansion and Delivery Pipeline	$ 4 million (one time) $2,340,000 (annually)
BNSF Railway Company Intermodal Facility Recharge Pond	$ 50,000 (annually)
Manaserro Recharge Project	Approximately $500,000 (one-time) $50,000 (annually)
City of Escalon Wastewater Reuse	To be determined, as of 2024.
City of Ripon Surface Water Supply	To be determined, as of 2024.
City of Escalon Connection to Nick DeGroot Water Treatment Plant	To be determined, as of 2024.
Farmington Dam Repurpose Project	To be determined, as of 2024.
Mobilizing Recharge Opportunities (MICUP)	$2,700,000 (one-time) To be determined (annually)
NSJWCD Winery Recycled Water	To be determined, as of 2024.
SSJID Storm Water Reuse	To be determined, as of 2024.
Wallace-Burson Conjunctive Use Program	To be determined, as of 2024.
Calaveras River Wholesale Water Service Expansion	To be determined, as of 2024.
Recycled Water to Manteca Golf Course	To be determined, as of 2024.

	Threfall Ranch Reservoir, In-Lieu and Direct Recharge Project	To be determined, as of 2024.
	Perfecting Mokelumne River Water Right	$125,000 spent to date, Total to be determined (one-time) To be determined (annually)
	North System Groundwater Recharge Project - Phase 2	$10,000,000 (one-time) $100,000 (annually)
	Stormwater Collection, Treatment, and Infiltration	To be determined, as of 2024.
	Off-Stream Regulating Reservoir	To be determined, as of 2024.
	On-Farm Recharge Project	$0 (one-time) $100,000 (annual)
	Bellota Weir Modifications Project	$85,000,000 (one-time)
	Water Supply Enhancement Project - Distribution Pipelines	To be determined, as of 2024.
	Water Treatment Plant Aquifer Storage Recovery Well - 7401	$1,500,000 (one-time)
	Beckman Well	$200,000 (one-time)
	West Linden Project	To be determined, as of 2024.
	Water Supply Enhancement Project - Direct Recharge	To be determined, as of 2024.
	SSJID Water Master Plan - System Improvements	Approximately $30,000,000 - $40,000,000 (one-time)
Implementing GSP: Management Actions		
	South Stockton Well Rehabilitation Program	To be determined, as of 2024.
	Mokelumne River Loss Study	To be determined, as of 2024.
	AMI Replacement and Conversion	To be determined, as of 2024.
	Groundwater Monitoring Plan	$500,000 (one-time) $100,000 (annually)
	Demand Management Program	To be determined, as of 2024.
	Well Mitigation Program	$20,000 estimated for initial start-up. Long-term costs to be determined.

[1] Estimates are rounded and based on full implementation years (through FY2040).

7.3 MONITORING AND REPORTING

7.3.1 Monitoring

The GSAs will follow the protocols 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. These 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 Subbasin 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 23 wells
- Upload monitoring data to SGMA Portal Monitoring Network Module

- Semi-annual groundwater quality monitoring at 21 wells for both TDS and chloride
- Annual survey benchmark monitoring for subsidence at 6 locations[1]
- Semi-annual groundwater level monitoring at 12 wells for interconnected surface water
- Documentation of groundwater quality monitoring protocols

Components of the annual monitoring program costs include:

- Field crew ($80,000 - $100,000)
- Equipment rental with truck, level meter, and pumps ($7,000 - $10,000)
- Laboratory costs ($2,000 - $3,000)
- Subsidence surveying costs ($20,000-$30,0000)

7.3.2 Developing Annual Reports

Annual reports must be submitted by April 1st of each year following GSP adoption. Annual reports must include three key sections: 1) General Information, 2) Basin Conditions, and 3) Plan Implementation Progress. A description of what information will be provided in each of these sections is described in the following sections. 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. Please see the DWR guidance document entitled *Groundwater Sustainability Plan Implementation: A Guide to Annual Reports, Periodic Evaluations & Plan Amendments* (2023) for more information on the information required in annual reports per SGMA statutes. Annual reporting is estimated to cost approximately $65,000 to $90,000 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 towards implementation, and an 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 most recent water 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

[1] Data from CGPS stations are recorded by other entities.

- 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 Data Management System Updates

Updates and maintenance to the data management system (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 integrated flow model will continue to be updated based on newly available information or additional information provided by GSAs. For instance, model updates discussed in the original 2020 GSP have been made in the intervening five years; these significant model updates were made to support the Periodic Evaluation and 2024 GSP Amendment and are documented in Appendix 2-C. Model refinement costs will vary in the future and will most likely occur in response to incorporating updated data or adding and running new model scenarios. Annual model refinements are expected to cost roughly $100,000.

7.4.2 Construction of Additional Wells

As previously mentioned, eight new wells have been constructed since the 2020 GSP. While there are currently no plans to construct additional wells, there may be a need in the future to do so. Well construction costs can vary widely based on well depth and soil conditions. An estimated average cost for siting, permitting, and constructing a groundwater level monitoring well is $300,000 per well.

7.4.3 Data Gaps and Uncertainties

The ESJGWA acknowledges that there are many factors that could affect the availability of surface water, including the voluntary agreements in the major rivers feeding Sacramento-San Joaquin Bay-Delta resulting from negotiations surrounding 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 voluntary agreements, as the SWRCB has not yet determined how they will be implemented.

Before the next 5-year Periodic Evaluation in 2030, it is expected that DWR will release the outstanding interconnected surface water (ISW) guidance documents, additional groundwater level data for the new ISW representative monitoring wells will have been collected, and the ESJWRM model will have been enhanced to allow for a reevaluation of the streams and creeks included in the ISW analysis, the definition of the ISW undesirable result, and the subsequent ISW sustainable management criteria. Additional shallow groundwater level data will also inform analysis of potential GDEs. This information will be supplemented by a field verification completed by a biologist prior to the 2030 Periodic Evaluation. More groundwater level data, in conjunction with the GDE assessment in the field, will allow the Subbasin to better evaluate potential GDEs and potential impacts to them.

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 includes: coordination meetings; coordination meetings for any Ad-hoc Committees; 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 the annual reporting, 5-year periodic evaluations, and any associated GSP amendments. Other administrative actions may involve tracking and evaluating GSP implementation and sustainability conditions, coordinating with neighboring subbasins, as well as assessing benefits 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 PERIODIC 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 Periodic Evaluation is provided below and would be prepared in a manner consistent with CCR Title 23 §356.4. Annual costs for 5-Year Periodic Evaluations are estimated to range from $800,000 to $2,000,000 and depend on whether or not the GSP also requires amending.

7.6.1 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.

7.6.2 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.

7.6.3 Status of Projects and Management Actions

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.

7.6.4 Basin Setting Based on New Information or Changes in Water Use

This section of the Periodic Evaluation new information was incorporated into various parts of the Basin Setting Chapter (Chapter 2) of the GSP, including the hydrogeologic conceptual model, current groundwater conditions based on ongoing groundwater elevation monitoring, available new groundwater quality data, updates to the hydrogeological conceptual model (HCM), and data gathered from State datasets and reflecting a new understanding of regional groundwater conditions, water use changes, and model updates.

7.6.5 Monitoring Network Description

A description of the monitoring network will be provided in the 5-year periodic evaluation 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 reassessed 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.

7.6.6 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.

7.6.7 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 periodic evaluation 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.

7.6.8 Other Information

The 5-year periodic evaluation also includes other information such as:

- Any additional information that helps describe progress made towards achieving the sustainability goal for the basin.
- How the Plan considers adjacent basins in its GSP implementation.
- Any technical and/or financial challenges and the most significant challenges and assistance needs.
- How the amended plan may affect relevant city and county general plans related to water resources management, natural resource management and/or land use planning.
- Any technical and/or financial resource limitations and legal matters.

7.7 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 once a month, 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 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. More public workshops may be added as needed.

Additionally, as part of GSP Implementation, and in coordination with preparation of the Annual Reports and 5-Year Periodic Evaluations, the GSAs will collaborate and coordinate with local, state and federal regulatory agencies, as well as other interested parties, for data collection and analyses and to better understand the impacts of Subbasin groundwater pumping and management activities on the beneficial uses and users of groundwater as it relates to groundwater quality, subsidence and induced surface water depletion within the GSAs' jurisdictional areas.

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. Four new additional Category B projects were approved by the ESJGWA Board at the September 11, 2024 meeting and are not included below. More information on these projects is included in Appendix 6-A.

Table 7-3: Funding Mechanisms for Proposed Projects and Management Actions

Project/Management Action Titled	Type	Responsible Agency[1]	Potential Funding Mechanisms
Projects (Category A)			
Lake Grupe In-Lieu Recharge	In-lieu Recharge	SEWD	District staffing and District rates to establish new accounts
SEWD Surface Water Implementation Expansion	In-lieu Recharge	SEWD	District staffing and District rates to establish new accounts
White Slough Water Pollution Control Facility Expansion	Direct Recharge	City of Lodi	DWR Proposition 84 Grant Funding Program
CSJWCD Capital Improvement Program	In-lieu Recharge	CSJWCD	Surface water sales, groundwater extraction fees, and acre assessments
NSJWCD South System Modernization	In-lieu Recharge	NSJWCD	Phase 1 &2: EBMUD funding, CA Prop 1 State Grant funding, Watersmart Federal Grant funding, landowner assessments, district property taxes, groundwater charge revenue Phase 3: IRWM State Grant funding, landowner assessments, district property taxes, groundwater charge revenue Phase 4: USDA Federal Funding ($1 mil); Applied for federal Watersmart grant, district property taxes, groundwater charge revenue, landowner assessments
Long-term Water Transfer to SEWD	Transfers	OID and SSJ GSA	$300 per AF Urban and $200 per AF for Ag
South System Groundwater Banking with East Bay Municipal Utilities District (EBMUD)	In-lieu Recharge	NSJWCD	Phase 1: EBMUD funding, NSJWCD district property taxes and groundwater charge revenue Phase 2: To be determined. Likely to include EBMUD funding, NSJWCD district property taxes and groundwater charge revenue and potential future grant proceeds
NSJWCD North System Modernization/Lakso Recharge	In-Lieu Recharge/Direct Recharge	NSJWCD	SGMA State Grant funding, landowner assessments, and groundwater charge revenue
Tecklenburg Recharge Project	Direct Recharge	NSJWCD	Phase 1: NSJWCD Groundwater charge revenue Phase 2: To be determined, as of 2024.
City of Stockton Phase 1: Groundwater Recharge Project	Direct Recharge	City of Stockton	To be determined, as of 2024.

Project/Management Action Titled	Type	Responsible Agency[1]	Potential Funding Mechanisms
West Groundwater Recharge Basin	Direct Recharge	SEWD	Army Corp. is paying SEWD to excavate the soil. The rest of the project will be funded by SEWD or grant funds.
NSJWCD Private Pump Partnerships	In-Lieu/Direct Recharge	NSJWCD	District general revenue sources and individual landowner contributions
Oakdale Irrigation District In-lieu and Direct Recharge Project	Direct Recharge/In-Lieu Recharge	OID	Landowners participating in the 10-Year Program are responsible for the costs of any new turnouts, private conveyance systems, and surplus surface water purchased for out-of-District irrigation.
City of Stockton Advanced Metering Infrastructure	Conservation	City of Stockton	Met by ratepayers and through grants or other funding sources.
Projects (Category B)			
City of Manteca Advanced Metering Infrastructure	Conservation	City of Manteca	Capital Improvement Project budgeted item with available funding
City of Lodi Surface Water Facility Expansion and Delivery Pipeline	In-lieu Recharge	City of Lodi	Capital Improvement Project budgeted item with available funding
BNSF Railway Company Intermodal Facility Recharge Pond	Direct Recharge	CSJWCD	Groundwater extraction fee revenue, private loans, and/or possible grant funding
Manaserro Recharge Project	Direct Recharge	NSJWCD	Grant funding and groundwater charge revenue
City of Escalon Wastewater Reuse	Recycling/In-Lieu Recharge/Transfers	SSJ GSA	Developer impact fees, connection fees, and sewer rate fees
City of Ripon Surface Water Supply	In-Lieu Recharge	SSJ GSA	Grants, water rates, and development impact fees
City of Escalon Connection to Nick DeGroot Water Treatment Plant	In-Lieu Recharge	SSJ GSA	Grants, water rates, and development impact fees
Farmington Dam Repurpose Project	Direct Recharge	SEWD	Grant and or Federally directed funding
Mobilizing Recharge Opportunities (MICUP)	Direct Recharge	SJ County	One-Time cost funded through a SGMA Round 1 Implementation Grant.
NSJWCD Winery Recycled Water	Recycling/In-Lieu Recharge/Direct Recharge	NSJWCD	Grant funding, landowner assessments, and charges paid by the winery
SSJID Storm Water Reuse	Storm Water/ In-Lieu Recharge/ Direct Recharge	SSJ GSA	Developer impact fees, connection fees, and property related fees.
Wallace-Burson Conjunctive Use Program	Conjunctive Use/Direct Recharge	Eastside GSA	To be determined, as of 2024.

Project/Management Action Titled	Type	Responsible Agency[1]	Potential Funding Mechanisms
Calaveras River Wholesale Water Service Expansion	In-Lieu Recharge	Eastside GSA	To be determined, as of 2024.
Recycled Water to Manteca Golf Course	Recycling	City of Manteca	To be determined, as of 2024.
Threfall Ranch Reservoir, In-Lieu and Direct Recharge Project	In-Lieu Recharge/Direct Recharge	Eastside GSA	To be determined, as of 2024.
Perfecting Mokelumne River Water Right	In-Lieu Recharge	SJ County	San Joaquin County Assessments and member agency contributions.
North System Groundwater Recharge Project - Phase 2	Direct Recharge	NSJWCD	Secured $3 million state grant; additional funds from landowner assessments and groundwater charge revenue and any grant funds the district can obtain
Stormwater Collection, Treatment, and Infiltration	Direct Recharge/ Stormwater	City of Manteca	To be determined, as of 2024.
Off-Stream Regulating Reservoir	Direct Recharge	SEWD	Grant funding.
On-Farm Recharge Project	Direct Recharge	SEWD	District staffing and District rates to establish new Flood-MAR projects, as well as District funding for on-farm incentive programs.
Bellota Weir Modifications Project	Direct Recharge/ Stormwater	SEWD	Grant Funding and State and Federal Loans
Water Supply Enhancement Project - Distribution Pipelines	In-Lieu/Direct Recharge	SEWD	To be determined, as of 2024.
Water Treatment Plant Aquifer Storage Recovery Well - 7401	Direct Recharge	SEWD	To be determined, as of 2024.
Beckman Well	Direct Recharge	SEWD	SEWD and MICUP will fund.
West Linden Project	Direct Recharge/In-Lieu Recharge	SEWD	To be determined, as of 2024.
Water Supply Enhancement Project - Direct Recharge	Direct Recharge	SEWD	SEWD and grants.
SSJID Water Master Plan - System Improvements	In-Lieu Recharge	SSJ GSA	Existing sources (hydropower generation, user fees, water transfers), enhanced sources (additional user fees, additional water transfers), and outside sources (grants, earmarks, water transfers)
Management Actions			
South Stockton Well Rehabilitation Program	Monitoring and Reporting	City of Stockton	To be determined, as of 2024.

Project/Management Action Titled	Type	Responsible Agency[1]	Potential Funding Mechanisms
Mokelumne River Loss Study	Model Refinement and Validation	NSJWCD	To be determined, as of 2024.
Monitoring and recording of groundwater levels and groundwater quality data			ESJ GWA Budget and GSAs.
Maintaining and updating the Subbasin Data Management System (DMS) with newly collected data			ESJ GWA Budget.
Annual monitoring of progress toward sustainability			ESJ GWA Budget.
Annual reporting of Subbasin conditions to DWR as required by SGMA			ESJ GWA Budget.
Addressing Data Gaps			ESJ GWA Budget.
AMI Replacement and Conversion	Monitoring and Reporting/Conservation	Eastside GSA	To be determined, as of 2024.
Groundwater Monitoring Plan	Monitoring and Reporting	NSJWCD	SGMA grant on north system for 3 monitoring wells; use of district groundwater charge revenue for south system wells and on-going cost to gather and analyze data. District will apply for grants to obtain additional funding for more monitoring wells
Demand Management Program			ESJ GWA Budget and Individual GSAs.
Well Mitigation Program			ESJ GWA Budget.

[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 $350,000. Development of the 2020 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 the cost of implementation to participating agencies, residents, and landowners of the Subbasin. However, there will be a need to establish long-term 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. Financing implementation of the 2024 Amendment GSP, including the projects and management actions it contains, is expected to be similar to that of the 2020 GSP and 2022 Revised GSP implementation.

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 a 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)	**Low** – The Westside-San Joaquin IRWM Region and the Eastern San Joaquin IRWM region have pursued and been awarded funding through the Proposition 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; the Eastern San Joaquin IRWM Region falls within the San Joaquin River Funding Area. Proposition 1, passed in 2014, was the last year IRWM funding has been made available; it is unclear at this point if future IRWM funds will be made available through a bond measure.

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